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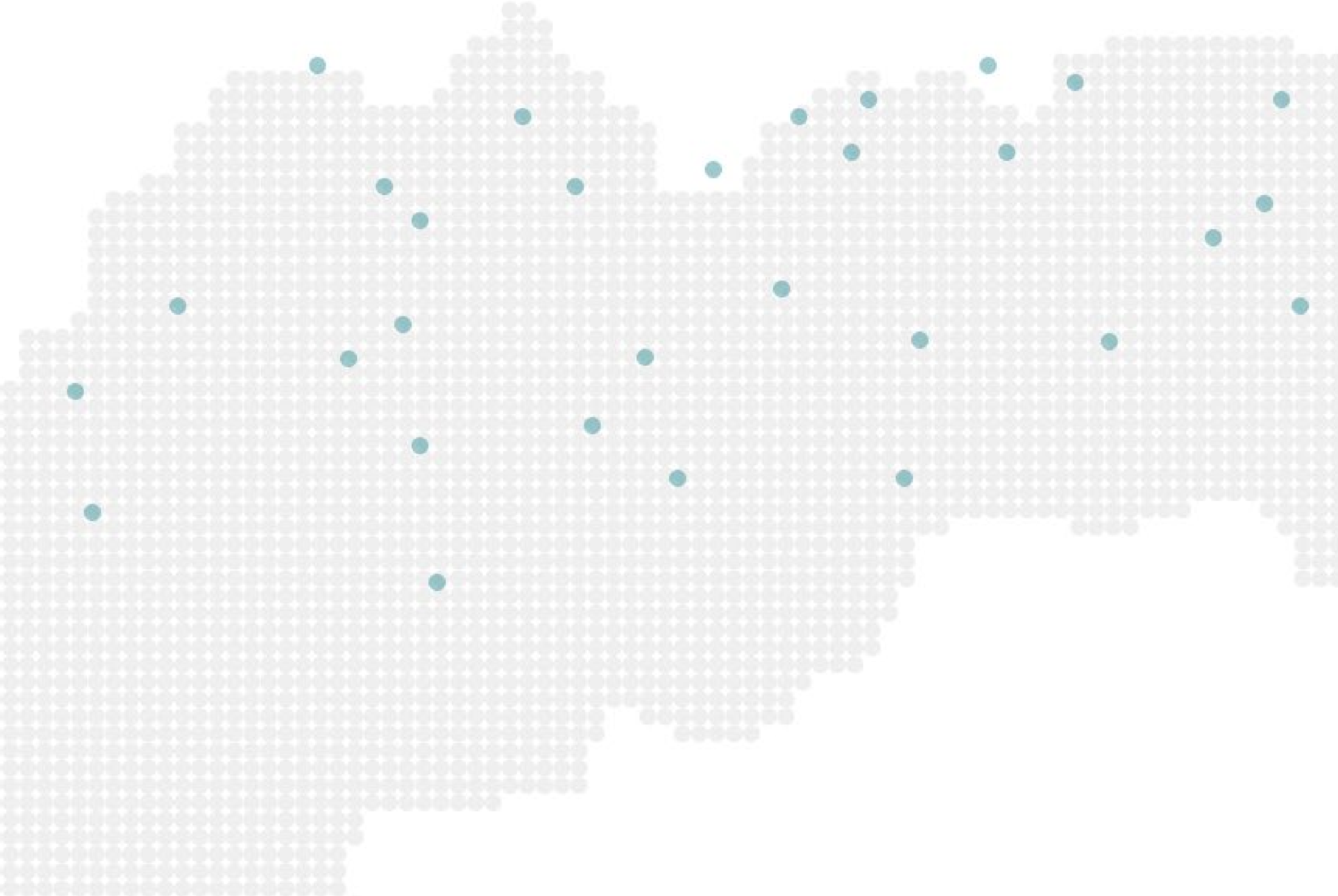

INFORMATIVE INVENTORY REPORT 2025

SLOVAK REPUBLIC

MINISTERSTVO
ŽIVOTNÉHO PROSTREDIA
SLOVENSKEJ REPUBLIKY

SHMÚ

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INFORMATIVE INVENTORY REPORT 2025

SUBMISSION UNDER THE CLRTAP AND NECD
SLOVAK REPUBLIC

MINISTERSTVO
ŽIVOTNÉHO PROSTREDIA
SLOVENSKEJ REPUBLIKY

Bratislava, April 15, 2025

PREFACE

TITLE OF REPORT	Informative Inventory Report 2024 Slovak Republic. Air Pollutant Emissions 1990-2023
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The Slovak Republic Informative Inventory Report (SK IIR) is an official document accompanying the emission inventory submission of the Slovak Republic under the Convention on Long-Range Transboundary Air Pollution (LRTAP Convention). Since the Directive (EU) 2016/2284[1] on the reduction of national emissions of certain atmospheric pollutants (NECD) was adopted, this report represents also the official document as required in the new NEC Directive.

SK IIR is annually prepared by the Slovak Hydrometeorological Institute (SHMÚ) at the Department of Emissions and Biofuels as a responsible body and approved by the Ministry of Environment of the Slovak Republic (MŽP SR), and annually delivered to the United Nations Economic Commission for Europe (UNECE) Environment and Human Settlements Division of the emission inventory and projections and European Commission.

The general purpose of this document is to provide technical and methodological support for the emission information presented in a common template for LRTAP Convention submission and NECD. The report brings sufficiently detailed information that allows a transparent view of the emission preparation process of the Slovak emission inventory.

The structure of the document is in line with general recommendations and presents institutional background information and arrangement, trends of pollutants, the process of the emission inventory preparation, emission factors, sources and references used during the compilations or expert judgements. Then major changes, recalculations and updates, which have been done and reported in the regular template to the European Commission (EC) as well as planned improvements. The national projections and the process of their preparation are also included.

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

GLOSSARY

Acronyms and Definition

CDR	Central Data Repository
CS	Country-specific
CW	Clinical waste
CWI	Clinical waste incineration
EP and Council	European Parliament and the Council
EC	European Commission
EF	Emission factor
EI	Emission Inventory
EIONET	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme
EMEP/EEA GB_{2013}	EMEP/EEA air pollutant emission inventory guidebook 2013
EMEP/EEA GB_{2016}	EMEP/EEA air pollutant emission inventory guidebook 2016
EMEP/EEA GB_{2019}	EMEP/EEA air pollutant emission inventory guidebook 2019
EMEP/EEA GB_{2023}	EMEP/EEA air pollutant emission inventory guidebook 2023
ETS	Emission trading system
GHGs	Greenhouse gases
HMs	Heavy metals
IED	Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)
IPCC	Intergovernmental Panel on Climate Change
IPCC 2006 GL	2006 IPCC Guidelines for National Greenhouse Gas Inventories
IPCC 2019 GL	2019 IPCC Guidelines for National Greenhouse Gas Inventories
ISW	Industrial solid waste
IW	Industrial waste
LCP	Large Combustion Plant
LRTAP Convention	Convention on Long-Range Transboundary Air Pollution
MPaRV	Ministerstvo pôdohospodárstva a rozvoja vidieka The Ministry of Agriculture and Rural Development
MSW	Municipal solid waste
MW	Municipal waste
MŽP SR	Ministerstvo životného prostredia Slovenskej republiky The Ministry of Environment of the Slovak Republic
NECD	National Emission Ceilings Directive
NEC Directive	National Emission Ceiling Directive
NIS SR	National Inventory System of the Slovak Republic
NPPC	Národné poľnohospodárske a potravinárske centrum National Agriculture and Food Centre
NPPC - VÚŽV	Národné poľnohospodárske a potravinárske centrum – Výskumý ústav živočíšnej výroby National Agriculture and Food Centre - Research Institute for Animal Production
NEIS	Národný emisný informačný systém National Emission Information System
OEaB	Odbor Emisie a Biopalivá Department emissions and biofuels
PMs	Particulate matter ($PM_{2.5}$, PM_{10}, TSP, BC)

PTaEÚ MV SR	Požiarnotechnický a expertízny ústav Ministerstva vnútra Slovenskej republiky Fire Engineering and Expertise Institute of the Ministry of the Interior of the Slovak Republic
POPs	Persistent organic pollutants
REZZO	Register emisií a zdrojov znečistenia ovzdušia Emission and Air Pollution Source Inventory
RDF	Refuse-Derived Fuel
RTI	Rated Thermal Input
SHMÚ	Slovenský hydrometeorologický ústav Slovak Hydrometeorological Institute
SK IIR	Slovak Republic Informative Inventory Report
SK NIR	Slovak Republic National Inventory Report
ŠÚ SR	Štatistický úrad Slovenskej Republiky Statistical Office of the Slovak Republic
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	Environmental Protection Agency (United States)
VÚD	Výskumný ústav dopravný Research Institute of Transport
VÚRUP	Výskumný ústav pôdoznalectva a ochrany pôdy Research Institute of Soil Science and Soil Protection
VÚVH	Výskumný ústav vodného hospodárstva Water Research Institute
WI	Waste incineration

EXECUTIVE SUMMARY

Last update: 15.4.2025

ES.1 BACKGROUND INFORMATION ON INVENTORY OF AIR POLLUTANTS

Informative Inventory Report of the Slovak Republic (SK IIR) and the complete set of NFR tables represent official submission under the United Nations Economic Commission for Europe (UNECE) Convention on Long-rage Transboundary Air Pollution (LRTAP Convention) and under Directive 2016/2284/EU (NEC Directive).
The SHMÚ, as a single national entity regarding emission inventories, compiles the annual delivery of the Slovak Republic and submits it officially to the Executive Secretary of UNECE as well as to the European Commission.
As a party to the UNECE/LRTAP Convention and under the NEC Directive, the Slovak Republic is required to annually report data on emissions of air pollutants covered in the Convention and its Protocols:

- main pollutants: nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), sulphur oxides (SOx) and ammonia (NH_3);
- particulate matter (PM): fine particulate matter ($PM_{2.5}$), coarse particulate matter (PM_{10}) and if available, black carbon (BC);
- other pollutants: carbon monoxide (CO);
- heavy metals (HMs): lead (Pb), cadmium (Cd) and mercury (Hg);
- persistent organic pollutants (POPs): polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs).

The SK IIR contains information on the inventory of air pollutants of the Slovak Republic for all years from 1990 to 2023, all requested air pollutants in NFR14 reporting format and detailed descriptions of methods, data sources, information on quality assurance and quality control (QA/QC) activities, and analysis of emission trends.

ES.2 MAJOR GENERAL CHANGES

All changes were made to improve the data quality, data completeness and transparency of the results, in line with the legal requirements and with the SK Review 2024 Recommendations.

In the Energy sector, emissions of BC, HMs and POPs from the categories **1A1a**, **1A4ai**, **14Aci** and **1A5a** were recalculated based on the use of detailed methodologies focused on the combinations of the installation types/fuels used in our country. Emission factors used for calculating emissions of heavy metals and POPs are a combination of default EF from EMEP/EEA GB2019, expert estimation and special source. In categories **1A2a** and **1A2d** emissions of BC, HMs and POPs changed based on the changes in activity data and emission factor. In **1A2f**, **1A2gviii**, **1A4ai** and **1A4ci** categories, emissions of BC changed based on the changes in activity data. Emissions of all rising pollutants changed in category **1A3b** due to COPERT model update. In **1A4bi,** emissions of NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, HMs and POPs changed as the result of 2 types of recalculations. The first, is a change in EF, and the second, is an error correction and clarification in the calculation. In **1A5a,** emissions of all rising pollutants changed based on the reallocation of biogas burning emissions to the energy category in compliance with the GHG inventory. NMVOC emissions changed in **1B2d** category due to changes in activity data.

In the IPPU sector, emissions of Hg, Cu and Zn changed in category **2A3** due to the correction of the activity data of Water glass production. In category **2A5b** the recalculation relates to the update of activity data of constructed highways for the year 2022, the corrected emissions are $PM_{2.5}$, PM_{10} and TSP. In category **2C1**, emissions of Cu, Ni, Zn changed due to recalculation in the BOF Steel Production due to correction of the emission factor to avoid underestimation. In category **2C3** the value of activity data of aluminium production was slightly corrected for the year 2020 for PAHs. Emissions of $PM_{2.5}$, PM_{10} and NMVOC changed in category **2H2** due to activity data correction.

In the Agriculture sector, emissions of NOx and NH_3 changed in categories **3B3**, **3Da2a** and **3Da2c** due to the correction of the nitrogen excretion values by animals and the implementation of revised N content coefficients in other organic fertilizers. In category **3B3,** emissions of NMVOC and TSP were recalculated due to the correction of calculation errors in the distribution of swine population to the categories. In categories **3B1b**, **3B3**, **3B4d**, **3B4e**, **3B4gi**, **3B4gii**, **3B4giii**, **3B4giv** and **3D,c** emissions of $PM_{2.5}$ and PM_{10} changed due to correction of calculation aggregation error. In category **3Da4,** emissions of NH_3 were recalculated due to the revision of the country-specific coefficient for N content. Emission of $PM_{2.5}$, PM_{10} and TSP were recalculated in category **3Dc** due to revision of the activity data. In category **3De,** NMVOC emissions changed due to the implementation of the NECD recommendation **SK-3De-2023-0001.**

In the Waste sector, in category **5A,** NMVOC emissions were recalculated in line with the recalculation of the CH_4 emissions. Also, PMs in **5A** were recalculated due to an update of the activity data of the mineral waste. In category **5B1,** emissions of NH3 changed due to a change in the technology used for composting of waste. NH_3 in **5B2** were recalculated due to changes in activity data. In category **5C1bi**, **5C1bii** and **5C1biii,** emissions of all rising pollutants changed as a result of an improvement to the Tier 2 methodology of the EMEP/EEA GB_{2023} and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB_{2023}. All rising pollutants in category **5C1bv** changed due to error correction in activity data. NMVOC emissions changed in categories **5D1** and **5D2** due to reallocation of the emissions from biogas burning to the energy category in compliance with the GHG inventory. NMVOC, SOx and NH_3 emissions changed in category **11B** due to the improvement of the methodology.

The document structure of the SK IIR reflects the changes mentioned above and previous endeavours to follow the recommended template to ensure the clarity of the reported data. The individual chapters of categories are provided in logical structure:

- general description of the emission trends and key drivers of the changes throughout the years;
- a detailed description of emission trends and key drivers for each category;
- description and more detailed explanation of methodology, level of the method used, activity data and emission factors used in each category;
- the reasoning for notation keys using or an explanation for allocated items if needed;
- description of recalculations that have been done covering the time series.

ES.3 STRUCTURAL CHANGES IN INSTITUTIONAL COOPERATION

The Slovak Hydrometeorological Institute (SHMÚ) maintains long-term cooperation with the Statistical Office of the Slovak Republic (ŠÚ SR) in the field of data exchange through an agreement on the mutual cooperation concluded between the Ministry of Environment of the Slovak Republic (MŽP SR) and the ŠÚ SR. The revision of the existing agreement in 2017 has provided a flexible and secure way of exchanging data. The revision was focused on security-enhancing, especially for data transfer of individual and confidential data and their protection. The content extension of received and provided data was re-assessed and it has allowed the enlargement of activity data received from the ŠÚ SR for inventory usage. Moreover, the shift to regular providing of data via FTP server erases the annual administration and paperwork related to official necessary permissions between institutions. Besides, the determination of qualified and authorized persons with direct access improves the effectiveness of this cooperation.

ES.4 OVERVIEW OF THE EMISSION TRENDS

Following ***Figures ES.1*** – ***ES.4*** show the overall emission trend of Main pollutants (NOx, NMVOC, SOx, NH_3), Particulate matter ($PM_{2.5}$, PM_{10}, BC), Priority heavy metals (Pb, Cd, Hg) and Persistent organic pollutants (PCDD/F, PAHs, HCB, PCBs).

Figure ES.1: *Overall emission trends of main pollutants*

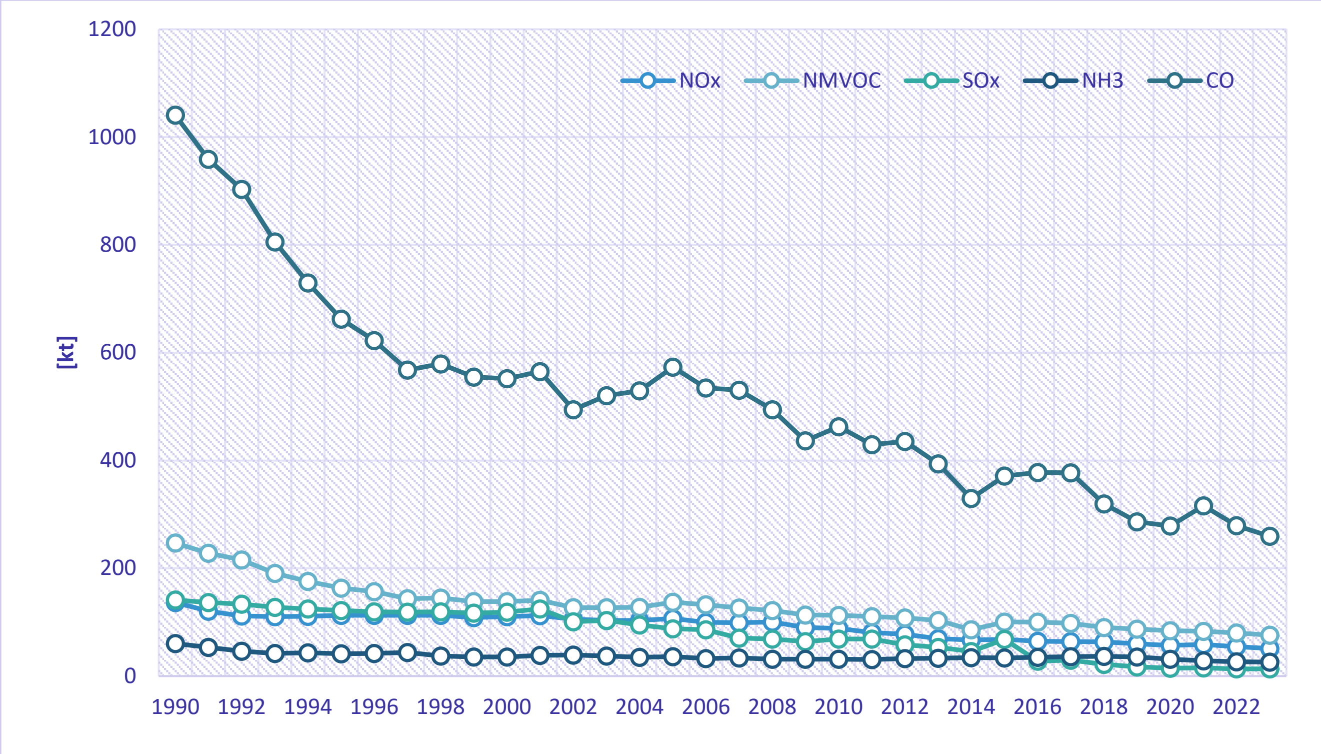


Figure ES.2: *Overall emission trends of the particulate matter*

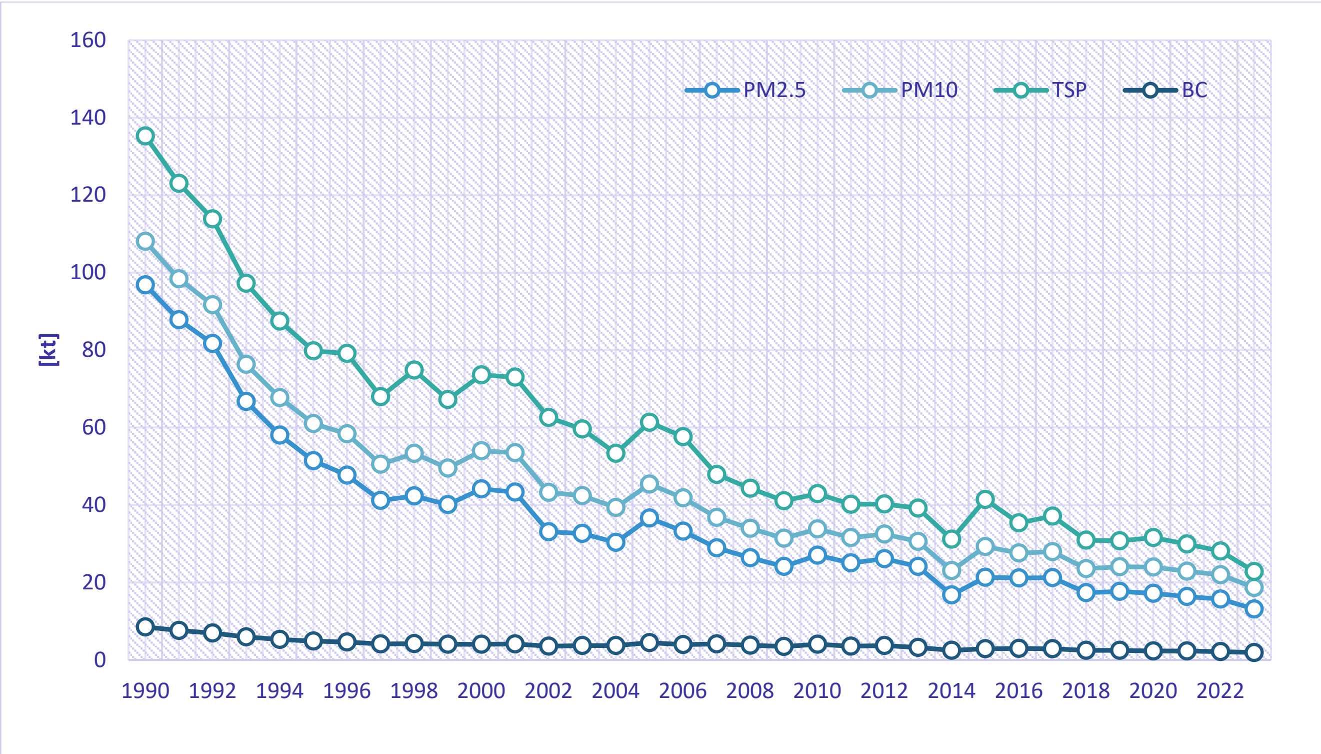


Figure ES.3: *Overall emission trends of the priority heavy metals*

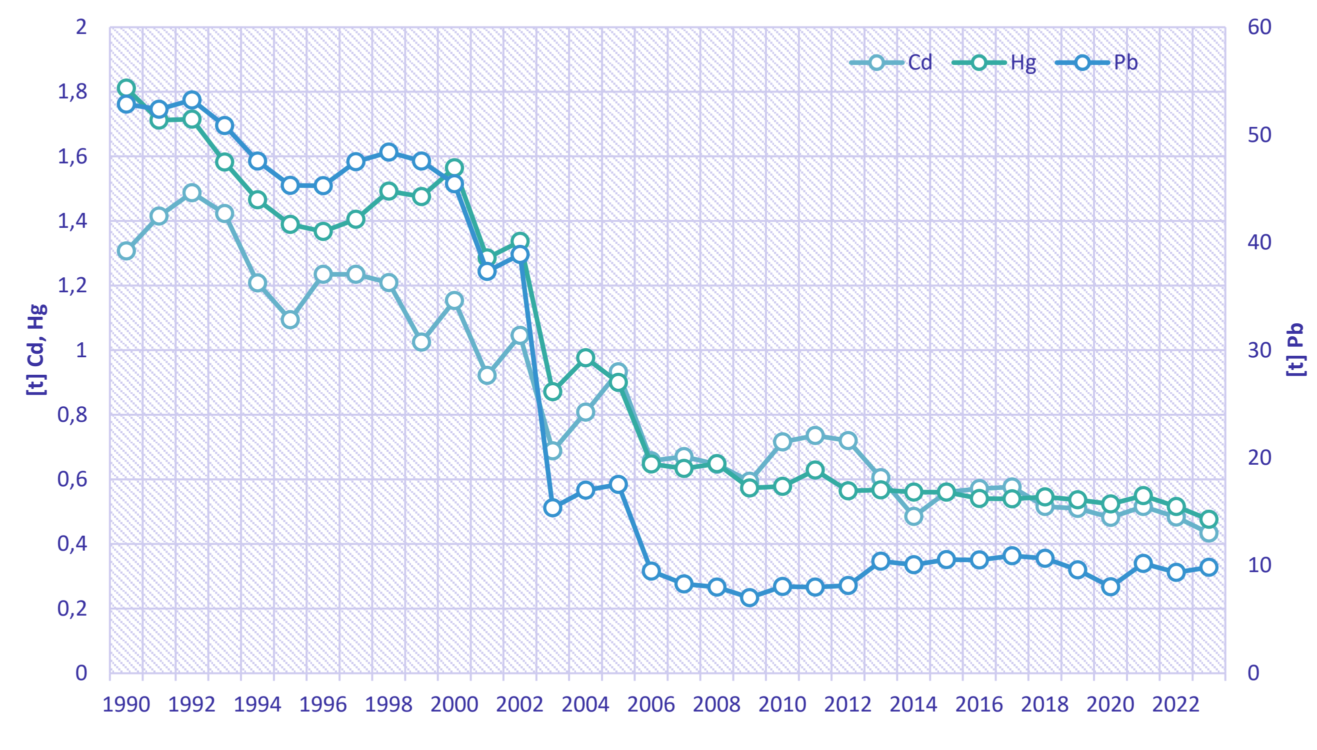
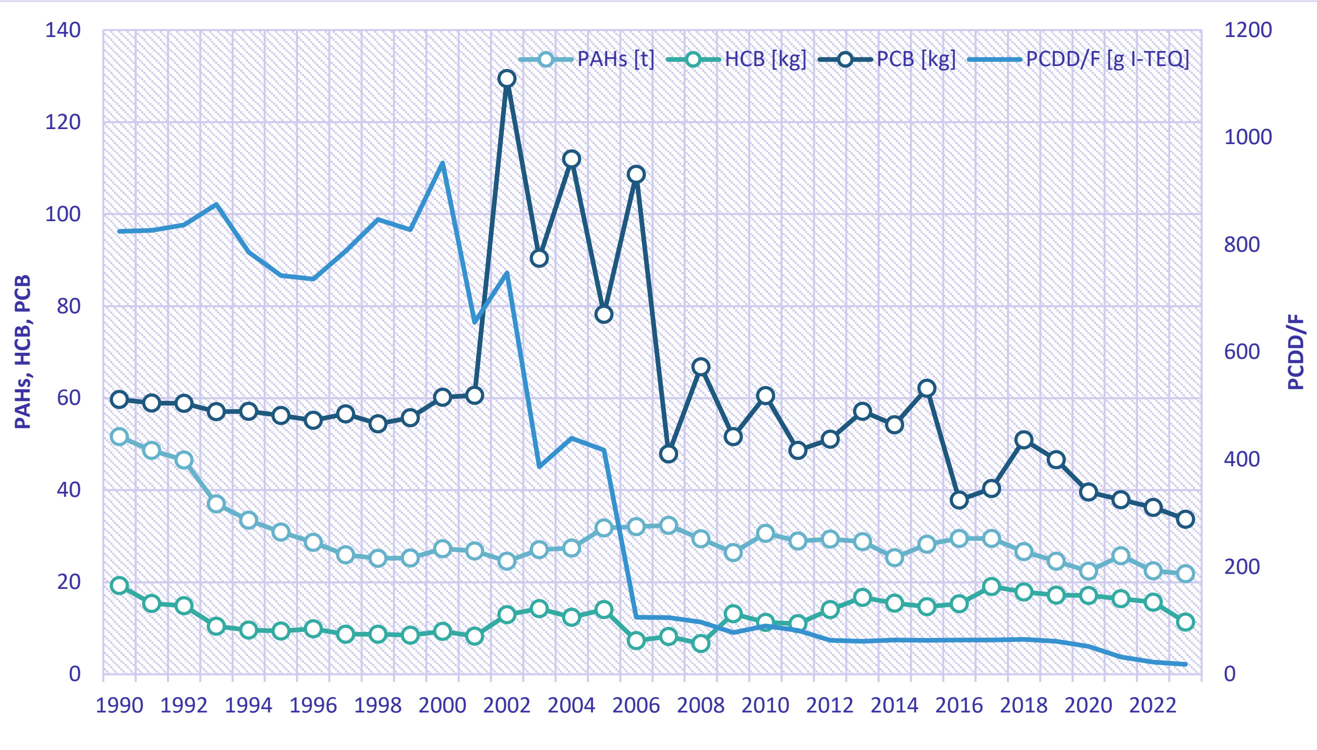


Figure ES.4: *Overall emission trend of the persistent organic pollutants*



ES.5 OVERVIEW OF RECALCULATIONS

Most of the recalculations realized in the 2025 submission were connected with the improvement of activity data and values of emission factors in all sectors, according to the EMEP/EEA$_{2023}$ Guidebook. Also recalculations were connected with improvement of the methodologies focused on the combinations of the installation types/fuels used in our country.in Energy sector especially for emissions of BC, HMs and POPs.

Table ES.1 provides an overview of recalculations in the 2025 submission. More detailed data can be found in the particular chapters of this report.

Table ES.1: *Main recalculations and their explanation, % difference for the years 2019, 2015, 2010, 2005, 2000 and 1990 between the 2024 and 2025 Final Submission*

Pollutant	change for 1990 values	change for 2000 values	change for 2005 values	change for 2010 values	change for 2015 values	change for 2019 values	Units	Comment/Explanation
NOx (as NO_2)	0%	0%	0%	0%	-1%	0%	kt	Emissions decreased slightly due to recalculations in 1A3b category based on the COPERT model update, due to recalculation in categories 3B3, 3Da2a, 3Da2c. In category 5C1bi, 5C1bii and 5C1biii emissions changed as a result of an improvement of the methodology. In category 5C1bv emissions changed due to in activity data correction.
NMVOC	0%	1%	1%	2%	2%	2%	kt	A slight increase in emissions in the period 2013 - 2022 was caused by COPERT model upadate in 1A3b category. In the whole time series emissions slightly increased by activity data correction in category 1A5a, 2H2, 3B3, 5C1bv and 5D. In category 3De category was implemented NECD recommendation SK-3De-2023-0001. In category 5A, emissions changed in line with the recalculation of the CH4 emissions. In category 5C and 11B emissions changeddue to the improvement of the methodology.
SOx (as SO_2)	0%	0%	0%	0%	0%	0%	kt	Minor changes were caused due to activity data correction in 1A3b, 1A3c, 1A5a. In category 5C1bi, 5C1bii, 5C1biii and 11B emissions changed due to methodology improvement and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023.
NH_3	-9%	-14%	-17%	-26%	-22%	-16%	kt	Emissions decreased due to recalculaton in Agriculture sector, in categories 3B, 3Da2a, 3Da2c and 3Da4. In categories 1A4bi, 1A5a, 1A3b, 5B1, 5B2 and 5D emissions changed due to changes in activity data. In category 11B emissions changed due to the improvement of the methodology.
$PM_{2.5}$	0%	-1%	-2%	-3%	-2%	-2%	kt	A slight decrease in emissions was caused by activity data correction in 1A3b, 1A3c, 1A4bi, 1A5a, 2H2, 3Dc, 5A and 5C1bv . Due to the correction of calculation aggregation error in categories 3B. In category 5C emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources accordingof the EMEP/EEA GB2023.
PM_{10}	0%	0%	-1%	-1%	0%	0%	kt	A slight decrease in emissions was caused by activity data correction in 1A3b, 1A3c, 1A4bi, 1A5a, 2H2, 3Dc, 5A and 5C1bv . Due to the correction of calculation aggregation error in categories 3B. In category 5C emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources accordingof the EMEP/EEA GB2023.
TSP	1%	1%	0%	0%	1%	1%	kt	A slight decrease in emissions was caused by activity data correction in 1A3b, 1A3c, 1A4bi, 1A5a, 2H2, 3Dc, 5A and 5C1bv . Due to the correction of calculation aggregation error in categories 3B. In category 5C emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources accordingof the EMEP/EEA GB2023.
BC	0%	0%	0%	0%	-2%	1%	kt	Emission slightly changed due to recalculations in 1A3b, 1A3c, 1A5a and in category 5C1bi, 5C1bii, 5C1biii emissions changed as a result of an improvement to Tier 2 methodology of the EMEP/EEA GB2023 and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023.
CO	0%	0%	0%	0%	-1%	0%	kt	Emission changed due activity data correction in 1A3b, 1A3c, 1A5a and in category 5C1bi, 5C1bii emissions changed as a result of an improvement to Tier 2 methodology of the EMEP/EEA GB2023 and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023. In category 5C1bv emissions changed due to error correction in activity data.

Table ES.1: *Main recalculations and their explanation, % difference for the years 2019, 2015, 2010, 2005, 2000 and 1990 between the 2024 and 2025 Final Submission*

Pollutant	change for 1990 values	change for 2000 values	change for 2005 values	change for 2010 values	change for 2015 values	change for 2019 values	Units	Comment/Explanation
Pb	-3%	0%	2%	-2%	24%	38%	t	Emissions changed significantly after 2013 due to recalculatioons in 1A3b categroies due to the COPERT model upade. Int he whole time series emission changed due to recalculations in categories 1A1a, 1A2d, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i, 5C1bi, 5C1bii 5C1bv.
Cd	-11%	-4%	-2%	-9%	-14%	-9%	t	Emissions changed due to improvement inmethodology in categories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i, 5C1bi, 5C1bii. In 1A2d and 5C1bv emissions changed due to activity data corrections.
Hg	-9%	-4%	-5%	-7%	3%	7%	t	Emissions changed due to improvement in methodology in categories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i, 5C1bi, 5C1bii. In 1A2d and 5C1bv emissions changed due to activity data corrections.
As	-34%	-29%	-35%	-37%	-19%	0%	t	Emissions changed due to improvement in methodology in categories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i, 5C1bi, 5C1bii. In 1A2d and 5C1bv emissions changed due to activity data corrections.
Cr	0%	0%	1%	-2%	19%	24%	t	Emissions changed due to improvement in methodology in categories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i. In 1A2d and 5C1bv emissions changed due to activity data corrections.
Cu	0%	0%	1%	0%	163%	226%	t	Emissions changed singnificantly after 2013 due to recalculations in 1A3b category due to the COPERT model update. In the whole time serie emissions changed due to improvement in the methodology in categories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i. In 1A2d and 5C1bv emissions changed due to activity data corrections.
Ni	25%	-4%	-8%	-12%	5%	18%	t	Emissions changed due to recalculations in 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i, 5C1bi, 5C1bii, 5C1biii due to improvement of the methodology. In category 2C1, emissions changed due to due to correction of the emission factor. In category 1A2d and 5C1bv emissions changed due to error correction in activity data.
Se	2%	0%	4%	1%	35%	75%	t	Emisions changed significantly after 2011 due to recalcultions in 1A1a category. Than minor changes were done due to recalculatios in 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a due to improvement in methodology. In categoriery 1A2d and 5C1bv emissions changed due to correction in activity data.
Zn	-7%	-2%	-2%	-6%	2%	6%	t	Emissions changed due to recalculations in 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 2D3i due to improvement in methodology. In category 2C1, emissions changed due to emission factor correction. In category 1A2d, 2A3, 5C1bv emissions changed due to correction in activity data.
PCDD/PCDF	2%	1%	13%	53%	-2%	-2%	g I TEQ	Emission inreased mainly during the 2002 - 2011 period due to recalculation in 5C1biii category due to improvement of the methodology and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023. In catgeories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a, 5C1bi, 5Cibii due to improvement in methodology. In 1A2d and 5C1bv due to activity data correction.
PAHs	-3%	-1%	0%	-1%	-2%	-2%	t	Emission slighly decreased due to recalculations in 1A1a,, 1A3c, 1A4ai, 1A4ci, 1A5a, 5C1bi, 5C1bii based on the improvement of the methodology. In 1A2d and 5C1bv due to activity data corection.
HCB	23%	73%	285%	230%	339%	444%	kg	Emissions incrreased due to recalculations in the categories 1A1a, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a and especially in categories 5C1bii and 5C1bv due to improvement methodology to Tier 2 methodology of the EMEP/EEA GB2023 and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023. In category 5C1bv emissions changed due to error correction in activity data.
PCBs	142%	179%	233%	156%	161%	117%	kg	Emissions significantly increased mainly due to methodology improvement to Tier 2 methodology due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023. In 1A1a, 1A2d, 1A3b, 1A3c, 1A4ai, 1A4ci, 1A5a and 5C1bv due to activity data correction

ES.6 IMPROVEMENT AND PRIORITIES

General and sectoral uncertainty analysis is one of our main future goals. Due to the necessity of total approach change in most of the categories in sectors of energy and industry, this cannot be done in the short term.
In 2023, the uncertainty analysis was created for the first time, using the uncertainty tool provided to the MS by CEIP. Also, it was included in the key category analysis for the first time. Last year, additional heavy metals were included in both analyses.
An analysis is planned to be improved for the sectors of agriculture and transport as only default uncertainty for emission factors was used.
Also, sectoral uncertainty analysis is planned for future submissions.
The next important improvement planned for the next period is to develop a new methodology for heavy metals and POPs, with priority to key categories as the uncertainty analysis changed the key categories.
A categorisation of operators is not fully in compliance with GHG inventory at this moment, although major improvements were achieved. Cooperation with the GHG inventory experts was initiated, but due to a lack of capacity, a complex solution was not yet achieved.
Another of the key priorities is to widen the participation of the independent experts assigned by the MŽP SR to improve the quality assessment of the inventory and the IIR.

ES.7 OVERVIEW OF SECTORS INCLUDING CONDENSABLE COMPONENT OF $PM_{2.5}$ AND PM_{10}

In the sector Industry and subsector Energy production, emissions are mostly measured on stacks, therefore, the condensable component is not included. There are three categories in the sector Transport, which include the condensable component in PMs emission factors: Aviation (**1A3a**), Off-road vehicles and other machinery (**1A4cii**) and Other mobile sources (**1A5b**), other categories are estimated using the model COPERT and the inclusion of condensable compound in EF is unknown. In the sector of Agriculture and Waste, estimations were provided using EMEP/EEA GB_{2023} emission factors, which do not include the condensable component. Detailed information about the methodology used to estimate emissions and inclusion/exclusion of condensable components in PM emission factors of individual categories is described in **ANNEX II** of this report.

CHAPTER 1: INTRODUCTION

Last update: 15.4.2025

1.1 NATIONAL INVENTORY BACKGROUND

The Slovak Republic, as a signatory of several international conventions, is obliged to report air emissions data annually to meet the mandatory requirements arising from the adopted and implemented acts and agreements:

Geneva Protocol[2] on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)

- acceded as Czechoslovakia on 26 November 1986
- succession: the Slovak Republic on 28 May 1993

LRTAP Convention[3] – The Convention on Long-range Transboundary Air Pollution and related protocols

- *Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (1985)*
    - Signed and approved as Czechoslovakia on 9 July 1985 and 26 November 1986, respectively
    - The Slovak Republic succession on 28 May 1993
- *Sofia Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes (1988)*
    - Signed and approved as Czechoslovakia on 1 November 1988 and 17 August 1990, respectively
    - The Slovak Republic succession on 28 May 1993
- *Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (1991)*
    - The Slovak Republic's accession on 15 December 1999
- *Oslo Protocol on Further Reduction of Sulphur Emissions (1994)*
    - The Slovak Republic ratification on 1 April 1998
- *Aarhus Protocol on Heavy Metals (1998)*
    - The Slovak Republic accepted on 30 December 2002
- *Aarhus Protocol on Persistent Organic Pollutants (POPs)* (1998)
    - The Slovak Republic accepted on 30 December 2002
- *Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999)*
    - The Slovak Republic ratification on 28 April 2005

NEC Directive[4] – Directive (EU) 2016/2284 of the European Parliament and the Council on the reduction of national emissions of certain atmospheric pollutants Ceilings for certain pollutants[5]

This Directive sets national reduction commitments for each country for the five pollutants that cause acidification, eutrophication and ground-level ozone pollution. The new Directive repeals and replaces NEC Directive 2001/81/EC, the National Emission Ceilings Directive (***Table 1.1***). In line with the objective of the Union's air policy to achieve levels of air quality that do not give rise to significant negative impacts on, and risks to, human health and the environment, the new Directive 2016/2284 sets emission reduction commitments for:

- Sulphur dioxides (SOx)
- Non-methane volatile organic compounds (NMVOC)
- Nitrogen oxides (NOx)
- Ammonia (NH_3)
- Fine particulate matter ($PM_{2.5}$)

[2] https://www.unece.org/env/lrtap/emep_h1.html
[3] http://www.unece.org/env/lrtap/status/lrtap_s.html
[4] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1491821672988&uri=CELEX:32016L2284
[5] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0081&from=EN

The objective is to be achieved by setting a percentage reduction in national emissions between 2020 and 2029 and, after 2030, with the base year 2005 (***Table 1.2***).
To ensure continuity in improving air quality, the 2001/81/EC emission ceiling to be reached by the Slovak Republic in 2010 is valid until new national emission reduction commitments will be into force in 2020.

Table 1.1: *Emission Ceiling of the Slovak Republic for the year 2010*

	NOx	SOx	VOC	NH_3
Slovak Republic	130	110	140	39
EU-28	8 297	9 003	8 848	4 294

Table 1.2: *Emission Reduction Commitments for the Slovak Republic set in New NECD*

	NOx	SOx	NMVOC	NH_3	$PM_{2.5}$
2020-2029	36%	57%	18%	15%	36%
2030 and onwards	50%	82%	32%	30%	49%

UN context – UN Framework Convention on Climate Change was adopted in 1992 as an instrument to tackle climate change. The objective of the Convention was to stabilize atmospheric concentrations of greenhouse gases at a safe level that enables the adaptation of ecosystems. The UNFCCC covered 195 countries or international communities, including the Slovak Republic, and the EU, which was also a Party to the Convention. The Convention required the adoption of mitigation measures to reduce GHG emissions in developed countries by 25-40% by 2020 compared to 1990. In the Slovak Republic, the Convention came into force on 23rd November 1994. The Slovak Republic accepted all the commitments of the Convention, including the reduction of GHG emissions by 2000 to the 1990 level. In response to the significant increase in GHG emissions since 1992, an urgent need to adopt an additional and efficient instrument that would stimulate mitigation efforts has occurred. In 1997, the Parties of the Convention agreed to adopt the Kyoto Protocol (KP). This protocol defines reduction objectives and means to achieve mitigation goals by the countries included in Annex I to the Convention. The Slovak Republic and the EU Member States ratified the Kyoto Protocol on the 31st of May 2002. One of the commitments, resulting from the Convention, was the preparation and submission of greenhouse gas emission inventories to the UNFCCC secretariat on an annual basis by the 15th of April each year.
The Paris Agreement (PA) was adopted on December 12, 2015, as a result of the international effort of the 196 parties of the UNFCCC and entered into force on November 4, 2016, as the world's first-ever climate change agreement.
The EU, together with the Heads of State, including the Slovak Republic, signed the Paris Agreement together at the ceremony held on April 22, 2016, in New York. The proposal for the adoption of the Paris Agreement was negotiated by the Government of the Slovak Republic on September 14, 2016, and approved by Resolution No 387/2016. Subsequently, the proposal was submitted by the National Council of the Slovak Republic, which approved the Paris Agreement by Resolution No 215/2016 on September 21, 2016. The SR completed its ratification process on September 28, 2016, signed by the President of the Slovak Republic. The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Monitoring, reporting and reducing emissions, including adaptation to climate change, is mandatory for all countries, not just those listed in Annex 1 to the Convention. Emissions reduction action plans, defined as nationally determined contributions (NDCs), set targets for reducing greenhouse gas emissions by 2025 or 2030, along with adaptation to climate change. Countries should review and tighten their NDCs every 5 years to achieve carbon neutrality by 2050.
EU context – The European Union (EU) considers climate change as one of the four environmental priorities. On November 28, 2018, the European Commission presented its Long-Term Strategy for a prosperous, modern, competitive and climate-neutral economy by 2050. The Low-Carbon Development Strategy of the Slovak Republic until 2030 with a View to 2050 was adopted by the Government of the Slovak Republic by Resolution

No 104/2020. The European Commission launched the European Climate Pact in December 2020, an EU-wide initiative inviting people, communities and organisations to participate in climate action and build a greener Europe. As part of the European Green Deal, the Climate Pact offers a space for everyone to share information, debate and act on the climate crisis, and be part of an ever-growing European climate movement. The Commission's proposal to cut greenhouse gas emissions by at least 55% by 2030 sets Europe on a responsible path to becoming climate neutral by 2050.

Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action

The regulation (EU) 2018/1999 together with Commission implementing regulation EU) 2020/1208 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 integrated rules to ensure planning, monitoring and reporting of progress towards its 2030 climate and energy targets and its international commitments under the Paris Agreement have adopted. The regulation established a governance mechanism for the implementation of strategies and measures designed to meet the objectives and targets of the Energy Union and the EU's long-term greenhouse gas emission commitments under the Paris Agreement, in particular the EU's ambition to achieve climate neutrality by 2030. Slovakia submitted the 2021 – 2030 draft plans under the Regulation on Governance by the end of 2018 and final plans by the end of 2019. The Commission has assessed both at the EU and Member State levels. The update of the national energy and climate plans is expected by the end of June 2023 in a draft form and by 30 June 2024 in a final form to reflect an increased ambition.

1.1.1 Historical Background and Circumstances

Political changes in the 1990s, as well as the efforts of the Slovak Republic to join the European Union, enabled significant changes in environmental policy. The Slovak Republic expressed interest in being a member of the European Union in 1991. However, the fulfilment of this vision disrupted the division of former Czechoslovakia into Czech and Slovak independent states in 1993. On 4 October 1993, the Slovak Republic signed the agreement in Luxembourg, which was ratified in the year 1995. The integration process, when the necessary political, economic and legislative changes had to be made, culminated in the accession of SR to the EU on 1st May 2004.

In the field of the environment, this effort led to the introduction of strict air protection, which was already in place in 1992 (in legislation - Act No 17/1992 Coll. on Environment). This strict basis was introduced into Slovak law, according to the German model. Therefore, there was no room for the uncontrolled expansion of the industry. The air quality issue (Council Directive 96/62/EC on air protection) has been governed in the legal system of the Slovak Republic in particular by the following legislation:

- Act No 309/1991 Coll. on the Protection of Air from Pollutants (Air Act) as amended[6]
- Act No 134/1992 Coll. on State Administration of Air Protection as amended[7]
- Governmental Ordinance No 92/1996 Coll. through which Act No 309/1991 Coll. on the Protection of Air from Pollutants (Air Act) as amended is implemented[8]
- Decree of Ministry of the Environment of the Slovak Republic No 103/1995 Coll. as amended[9]

Nowadays these acts/decrees were repealed and covered by new acts/decrees.

In 2004, the Slovak Republic became a member of the European Union during the largest enlargement. The integration process has brought the transposition of the earlier EU acquis, which has been fully implemented:

- Air Quality Framework Directive 96/62/EC and its daughter directives (1999/30/EC, 92/72/EEC, 2000/69/EC, 2002/3/EC, 2004/107/EC)

[6] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1991/309/vyhlasene_znenie.html
[7] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1992/134/vyhlasene_znenie.html
[8] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1996/92/vyhlasene_znenie.html
[9] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1995/103/

- Directive 84/360/EEC of the European Parliament and of the Council on combating of air pollution from industrial plants
- Directive 2001/81/EC of the European Parliament and of the Council on national emission ceilings for certain atmospheric pollutants
- Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants
- Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
- Council Directive 94/63/EC of the European Parliament and of the Council on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations
- Council Directive 1999/13/EC of the European Parliament and of the Council on the limitation of emission of volatile organic compounds due to the use of organic solvents in certain activities and installations
- Council Directive 1999/32/EC of the European Parliament and of the Council relating to a reduction in the sulphur content of certain liquid fuels
- Council Directive 96/61/EC of the European Parliament and of the Council concerning integrated pollution prevention and control

In May 2000, twinning project SR 98/IB/EN/3: "*Strengthening of the institutions in the air pollution sector*" was launched. As a result of this project, proposals were made to amend the legislation on air protection and transposition into Slovak legislation. The new Clean Air Act and related ministerial decrees were adopted by the end of 2002 and full harmonization was achieved:

- Act No 478/2002 Coll. on air protection[10]
- Decree of the Ministry of Environment of the Slovak Republic No 408/2003 Coll. on monitoring of emissions and air quality monitoring[11]
- Decree No 409/2003 Coll. on emission limits, technical requirements and general operating conditions of certain activities and installations, which use organic solvents[12]
- Decree No 706/2002 Coll. on air pollution sources, on emission limits, on technical requirements and general operational conditions, on the list of pollutants, on the categorization of air pollution sources and on requirements of emission's dispersion as amended[13]
- Decree No 705/2002 Coll. on air quality[14]
- Decree No 704/2002 Coll. on the control of volatile organic compounds emissions resulting from the storage of petrol and its distribution from terminals to service stations[15]
- Decree No60/2003 Coll. on the Specification of a maximum volume of discharged pollutants (emission quotas)[16]
- Decree No 144/2000 Coll. on the Requirements for the quality of fuels[17]

Nowadays are these acts/decrees repealed or it is covered by Act on air protection No 137/2010 Coll.[18] as amended and related regulations.

[10] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/478/vyhlasene_znenie.html
[11] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2003/408/vyhlasene_znenie.html
[12] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2003/409/vyhlasene_znenie.html
[13] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/706/vyhlasene_znenie.html
[14] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/705/vyhlasene_znenie.html
[15] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/704/vyhlasene_znenie.html
[16] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2003/60/vyhlasene_znenie.html
[17] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2000/144/20000601.html
[18] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2010/137/20160101

1.2 INSTITUTIONAL ARRANGEMENTS AND COMPETENCES

The MŽP SR is responsible for the development and implementation of the national environmental policy, including climate change and air protection objectives. The Ministry is responsible for developing strategies and other implementation tools such as acts, regulatory measures, and economic and market instruments to meet the targets cost-effectively. Both conceptual documents and legislative proposals always comment on all ministries and other competent authorities.

After the comments, the proposed acts are discussed at the Governmental Legislative Council approved by the Government, and finally, in the Slovak Parliament. The MŽP SR is the main body to ensure conditions and monitor the progress of the Slovak Republic to meet all commitments and obligations of air protection, climate change and adaptation policy.

Articles 4 and 12 of the UNFCCC require the Parties to UNFCCC to develop, periodically update, publish, and make available to the Conference of the Parties their national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled under the Montreal Protocol. Moreover, the commitments require estimation of emissions and removals as a part of ensuring that Parties comply with emission limits, that they have a national system for estimation of sources and sinks of greenhouse gases, that they submit an inventory annually, and that they formulate national programs to improve the quality of emission factors, activity data, or methods. The obligation of the Slovak Republic to create and maintain the national inventory system (NIS) which enables continual monitoring of greenhouse gases emissions is given by Article 5, paragraph 1 of the Kyoto Protocol.

The National Inventory System of the Slovak Republic (www.oeab.shmu.sk) has been established and officially announced by the Decision of the Ministry of Environment of the Slovak Republic on 1st January 2007 in the official bulletin: Vestník, Ministry of Environment, XV, 3, 2007.[19] In agreement with paragraph 30(f) of Annex to Decision 19/CMP.1, which gives the definitions of all qualitative parameters for the national inventory systems, the description of quality assurance and quality control plan according to Article 5, paragraph 1 is also required. The revised report of the National Inventory System dated November 2008 was focused on the changes in the institutional arrangement, quality assurance/quality control plan and planned improvements. The regular update of the National Inventory System with all qualitative and quantitative indicators is provided in the National Inventory Reports and in the Seventh National Communication of the SR on Climate Change, published in December 2017.

SHMÚ is delegated by the MŽP for the technical preparation of the national emission inventories and projections. The SHMÚ, as the allowance resort organisation, arranges necessary cooperation with external experts, who are contributors to the preparation process and participate in compilations. The list of internal experts of the Slovak Hydrometeorological Institute and designated external experts involved in the inventory of emissions are in the following ***Table 1.3***.

Table 1.3: *List of internal and external contributors to the Emission Inventory under CLRTAP*

SECTOR/SUBSECTOR	CONTRIBUTOR	INSTITUTION	E-MAIL
CLRTAP coordinator	Petra Kršáková	SHMÚ	petra.krsakova@shmu.sk
Energy	Monika Jalšovská	SHMÚ	monika.jalsovska@shmu.sk
	Michaela Câmpian Ján Horváth Marcel Zemko	SHMÚ SHMÚ SHMÚ	michaela.campian@shmu.sk jan.horvath@shmu.sk marcel.zemko@shmu.sk
Transport	Ján Horváth	SHMÚ	jan.horvath@shmu.sk
IPPU	Ivana Bellušová	SHMÚ	ivana.bellusova@shmu.sk
	Vladimír Danielik	STU BA	

[19] Vestník (Official Journal of the Ministry of Environment), XV, 3, 2007, page 19: National inventory system of the Slovak Republic for the GHG emissions and sinks under the Article 5, of the Kyoto Protocol

SECTOR/SUBSECTOR	CONTRIBUTOR	INSTITUTION	E-MAIL
Agriculture	Kristína Tonhauzer	SHMÚ	kristina.tonhauzer@shmu.sk
	Zuzana Palkovičová	NPPC	
	Vojtech Brestenský	NPPC	
Waste	Zuzana Jonáček	SHMÚ	zuzana.jonacek@shmu.sk
Projections	Marcel Zemko Kristína Tonhauzer	SHMÚ SHMÚ	marcel.zemko@shmu.sk kristina.tonhauzer@shmu.sk
	Ján Horváth Jiří Balajka	SHMÚ Senior consultant	jan.horvath@shmu.sk
Gridded emissions	Marcel Zemko	SHMÚ	marcel.zemko@shmu.sk
LPS	Monika Jalšovská	SHMÚ	monika.jalsovska@shmu.sk
QA/QC	Alexandra Nadžadyová Petra Kršáková	SHMÚ SHMÚ	alexandra.nadzadyova@shmu.sk petra.krsakova@shmu.sk

Based on the official Agreement between the MŽP SR[20] and the ŠÚ SR, the data are annually exchanged via the FTP server. Data transfer of individual and confidential data and their protection is ensured by the determination of qualified and authorized persons with direct access to the server.

In the emissions inventory of the transport, the model COPERT V was used. Activity data for the model were obtained from Transport Research Institute (VÚD) in cooperation with the Ministry of Transport, Construction and Regional Development of the Slovak Republic (MDVRR), and from the ŠÚ SR.

The agricultural sector of the emission inventory was performed in cooperation with the Ministry of Agriculture and Rural Development[21] (MPaRV). The responsibility for data and compilations of 3B Manure management was consequently shifted to the allowance organization - the National Agriculture and Food Centre[22] (NPPC).

1.3 INVENTORY PREPARATION PROCESS

The emission inventory is prepared to meet set quality requirements: transparency, consistency, comparability, completeness and accuracy.

The SHMÚ is responsible for the overall LRTAP Convention emission inventory preparation, namely:

- ensure the cooperation with institutions, experts and necessary background studies or papers
- ensure the processing and verification of data in the NEIS database
- ensure the technical preparation and compilation of data
- ensure the processing of data from the Statistical Office
- preparation of the LRTAP Convention reporting template
- annual update of the SK IIR
- submission of the LRTAP Convention reporting template and SK IIR
- cooperation during the review procedure for national emission inventories
- providing data to the Slovak Environmental Agency (Slovenská agentúra životného prostredia – SAŽP)
- providing processed emission data to the ŠÚ SR

The SHMÚ also provides the technical preparation and compilation of data for Air Environmental Accounts - AEA[23] that are processed by the inventory first approach for air pollutants and the energy first approach for the GHGs.

The NEIS database and emission outputs are used for several international reports:

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[20] Note: Slovak Hydrometeorological Institute is the allowance institution to the Ministry of Environment and thus the Contract is formally between Statistical Office of the Slovak Republic and the Ministry of Environment

[21] http://www.mpsr.sk/

[22] http://www.nppc.sk/index.php/sk/

[23] under the Regulation (EU) No 691/2011 of the EP and of the Council on European environmental economic accounts

a) LRTAP Convention and Directive 2016/2284 of the European Parliament and the Council on the reduction of national emissions of certain atmospheric pollutants
b) for verification of E-PRTR

The emission inventory under the LRTAP Convention and NEC Directive is prepared consistently with the greenhouse gases (GHG) emission inventory under UNFCCC and the projection requirements of Decision 280/2004/EC. UNFCCC and the projection requirements of Regulation 2018/1999/EU and Implementing Regulation 2020/1208/EU.
The National Emissions Inventory is being prepared following EMEP/EEA GB_{2019} and the updated EMEP/EEA $GB_{2023,}$ and implements the NFR (reporting nomenclature) and the category. Data are provided between 1990 and 2023[24, 25]. Where necessary, the methodology is adapted to the specific circumstances of the country.

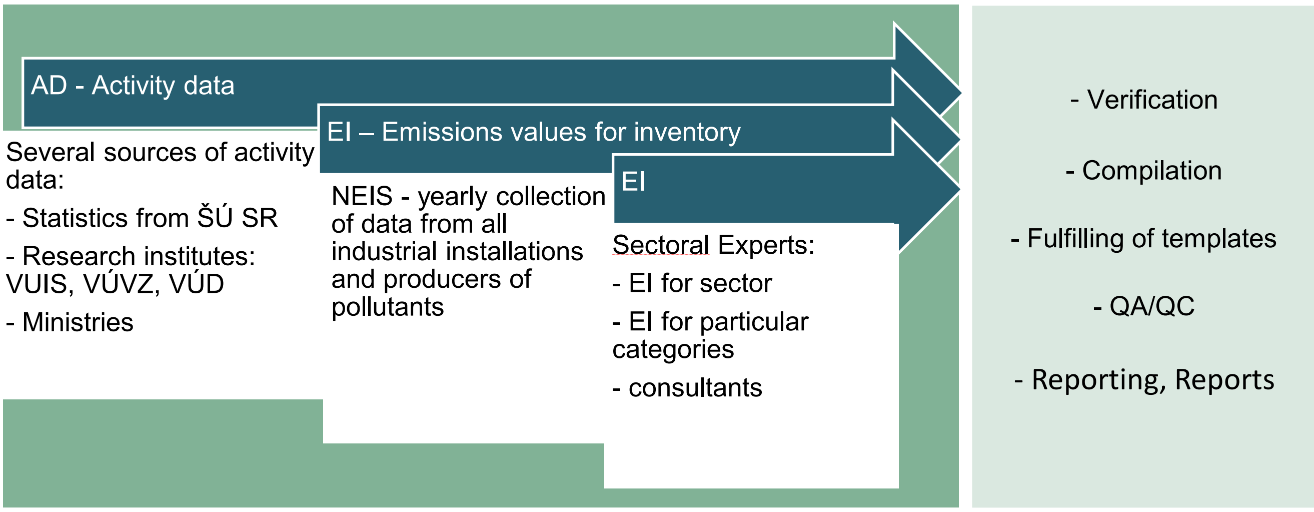
1.4 METHODS AND DATA SOURCES

There are several sources of input data among which the most important are the National Emission Information System (NEIS) and activity data from the ŠÚ SR. The basic principles of the NEIS are shown in ***Figure 1.1***.
Activity data from the ŠÚ SR are provided to the SHMÚ based on the long-term cooperation in the field of data exchange through an agreement on the mutual cooperation concluded between the Ministry of Environment of the Slovak Republic (MŽP SR) and the ŠÚ SR. Data are provided via the FTP server to qualified and authorized persons with direct access.
Information System NEIS was established in 1998. The database was developed to fulfil the national legislation in air quality and the requirements for pollutants fees decisions (Act No. 401/1998 on air pollution charges as amended). Since 2000, when the NEIS was set into operation, emissions have been directly collected consistently and verified on more levels. This database replaced the old system REZZO (Inventory of Emissions and Air Pollution Sources).
Annual data is collected from large and medium sources from sector energy and industry. The collection of annual activity data is performed through questionnaires, where specific data is required.
All annual sets of input data involving fuel amounts (according to the types and quality marks) necessary for the emission balance are obtained from the district offices by means of the NEIS BU module. Activity data collected in the NEIS central database are allocated according to the NFR categorization for solid, liquid, gaseous fuels, biomass and other fuels. The emissions balances of air pollutants in the range from 2000–2023 were processed in the NEIS CU module in the same way of calculation.
Detailed methodology of the NEIS database is available in **ANNEX IV**.
The NEIS remains a major source of data for inventory in the key categories and sectors (Energy, Industry) for the main pollutants. Sectoral experts from research institutes or cooperative external experts provide emission inventory studies or material balance studies that are consequently involved in the compilation process.
The MŽP SR has mandated the SHMÚ to ensure communication with the producers to collect the necessary data, which they are not obliged to provide to the NEIS.
The MŽP SR, the MPaRV SR and some other governmental institutions provided input data into projections.
Data on the quantity of emitted total suspended particulate matter (TSP) were provided directly by operators of individual large and medium sources based on measurements or calculations (under the Slovak Air Protection Act). The PM_{10} and $PM_{2.5}$ emission inventory for the Slovak Republic was compiled according to the EMEP/EEA GB_{2023}, following the requirements of the relevant UNECE Working Group on Inventory of Emissions and the methodology based on the IIASA report.[25]

[24] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019
[25] https://www.eea.europa.eu/publications/emep-eea-guidebook-2023
[26] hhttp://www.iiasa.ac.at/web/home/research/researchPrograms/air/ir-02-076.pdf

The NEIS database contains a special program that automatically calculates emissions of PM_{10} and $PM_{2.5}$. The outputs from the NEIS database are verified and performed in Excel sheets. ***Figure 1.1*** shows the general principle of how inventory compiling works.

Figure 1.1: *Scheme of different sources for Emission Inventory of air pollutants and processes performed in SHMÚ*



1.5 KEY CATEGORIES

The identification of key categories is described in the EMEP/EEA GB_{2023}. It stipulates that a key category is one that is prioritised within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants in terms of the absolute level, the trend, or the uncertainty in emissions.

It is good practice for each country to use key category analysis systematically and objectively as a basis for choosing methods of emission calculation. Such a process will lead to improved inventory quality as well as greater confidence in the resulting estimates. This can be achieved by performing a quantitative analysis of the relationship between the magnitude of emissions in any one year (i.e. level) and the change in emissions year to year (i.e. trend) for each category's emissions compared to the total national emissions. The identification includes all NFR categories and all mandatory gases.

Purpose of key category analysis:

- **Regular update**: Making sure the methods, data flows and country-specific emission factors are kept up to date and available for important regular estimate updates.
- **More focussed checking and review**: Making sure that specific QA/QC activities are implemented for *key categories*. It is *good practice* to give additional attention to *key categories* with respect to quality assurance and quality control (QA/QC)
- **Improving the accuracy of estimates and reducing overall uncertainty** using higher-tiered methods. For most sources/sinks, higher Tier methods are suggested for key categories. In some cases, inventory compilers may be unable to adopt a higher tier method due to a lack of resources. This may mean that they are unable to collect the required data for a higher Tier or are unable to determine country-specific emission factors and other data needed for Tier 2 and 3 methods. In these cases, although this is not accommodated in the category-specific decision trees, a Tier 1 approach can be used. It should be clearly documented why the methodological choice was not in line with the sectoral decision tree. Any key categories where the good practice method cannot be used should have priority for future improvements.

A category can be identified as *key* for different reasons. These include:

- **Level**: the absolute level the source category contributes to the total pollutant emissions for a particular year of interest.
- **Trend**: the change of emissions for the source category across a time series. This is particularly important for categories with increasing or decreasing emissions trends over time.
- **Uncertainty**: if the contribution of a source category's uncertainty to total inventory uncertainty in a particular year, or the trend uncertainty is high, then the category should be identified as key.
- In addition to making a quantitative determination of *key categories*, it is *good practice* to consider qualitative criteria for identifying categories that are likely to need prioritised attention (e.g. where significant changes in trends are expected, categories not presently estimated or having a suspected high uncertainty)

The identification includes all NFR categories and all mandatory gases

- Main pollutants and CO: SOx, NOx, NMVOC, NH_3, CO
- PMs: TSP, PM_{10}, $PM_{2.5}$
- HMs: Cd, Hg, Pb, As, Cr, Cu, Ni, Se, Zn
- POP: PAH, PCDD/F, HCB, PCBs

The methodology used for identification of key categories: Approach 1

Approach 1 to identifying key categories assesses the influence of various categories of sources on the level, and, possibly, the trend of the national inventory. When the inventory estimates are available for several years, it is good practice to assess the contribution of each category to both the level and trend of the national inventory.

Key categories are those which, when summed together in descending order of magnitude, cumulatively add up to 80% of the total level.

Level assessment: The contribution of each source category to the total national inventory level is calculated according to ***Equation 1.1***.

Equation 1.1: *Level assessment*

$$L_{x,t} = E_{x,t} / \sum E_t$$

Where:

$\boldsymbol{L_{x,t}}$ = level assessment for source x in the latest inventory year (year *t*)

$\boldsymbol{E_{x,t}}$ = value of emission estimate of source category *x* in year *t*

$\Sigma \boldsymbol{E_t}$ = total contribution, which is the sum of the emissions in year *t*, calculated using the aggregation level chosen by the country for key category analysis.

Trend assessment: The purpose of the trend assessment is to identify categories that may not be large enough to be identified by the level assessment, but whose trend contributes significantly to the trend of the overall inventory, and should, therefore, receive particular attention. The trend of a category refers to the change in the source category emissions over time. The trend assessment can be calculated according to ***Equation 1.2*** if more than one year of inventory data is available.

Equation 1.2: *Trend assessment*

$$T_{x,t} = \left| \frac{E_{x,t} - E_{x,0}}{\sum_i E_{x,t} - \sum_i E_{i,0}} \right|$$

Where:

$T_{x,}$ = trend assessment of source category *x* in year *t* as compared to the base year (year 0) or starting year of the inventory

$E_{x,}$ and $E_{x,0}$ = values of estimates of source category *x* in year *t* and 0 respectively

ΣE_i, and $\Sigma E_{i,0i}$ = sum of emissions across all *n* source categories (*i* = 1, …*x, n*) (total inventory estimates) in years *t* and 0, respectively

The presented key category analysis was performed with data for air emissions of the submission 2024 to the UNECE/LRTAP. For all gases a level assessment for all years 1990 (base year) and 2023 (last year), was prepared.

Final ranking and results of the Level and Trend Assessment (Approach 1)

As the analysis was made for all mandatory pollutants reported to the UNECE and as these pollutants differ in their way of formation, most of the identified categories are key for more than one pollutant (***Table 1.4***). For the first time, uncertainty was taken into account for the identification of key categories. The table below represents the key categories, but the detailed analysis is provided in **Chapter ANNEXES** as this table does not show the technology and fuels.

Table 1.4: *Summary of Key Categories of key pollutants with uncertainty – Contributions per pollutant for Level Assessment (LA) and Trend Assessment (TA) in %*

NFR	NOx		SOx		NH_3		NMVOC		$PM_{2.5}$		PM_{10}		TSP		CO		BC		Pb		Cd		Hg		As		Cr		Cu		Ni		Se		Zn		PCDD/F		PAHs		HCB		PCB		Sum of KC
	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	
1A1a		6	10	14						1										10	5	27	6	15	42	34					28	20	34	26		2		20							302
1A1b			10	5																																	0								14
1A1c																																					4	3							6
1A2a			3																		6	4	8	11								2	8	12											56
1A2c																																						5							5
1A2d				4																		4	7	6	3	0																			24
1A2f	3	2																			3		22	15	0							3		3			10	8							69
1A2gvii	3	3															2	2																											10
1A2gviii								1													0																								1
1A3bi	11	10						6	3	2					4	8	15	9		21			5	4						7						3	6	4		0					119
1A3bii	4	3															5	2																											14
1A3biii	4	15															2	7					2							9						4									44
1A3bv							4	4																																					8
1A3bvi									5	4	5	5	4	4			7	7	75	47	13	8			13	8	81	78	97	59	22	27	12	13	44	51									687
1A3bvii									3	2	2	2	3	3																															15
1A3c	3	3																																			3								9
1A3di(ii)	2	1																							0						21	14													39
1A3dii																															6	8													14
1A4ai																					2	1		2	0																				5
1A4bi	2	2		11			8	18	44	57	19	33	9	25	40	48	31	45			28	15				4											18	12	0	15					481
1A4bii		1													7	5																													13
1A4cii	10	17							2							5	6																												40
1A5a																										25																			25
1B1a							2	1																																					3
1B1b									2		2	2	4	3	3	2					4	1			3							3	9	6			11	8	22	11					99

NFR	NOx		SOx		NH_3		NMVOC		$PM_{2.5}$		PM_{10}		TSP	
	L	T	L	T	L	T	L	T	L	T	L	T	L	T
1B2ai							8	5						
1B2aiv			40	33										
1B2av							7	6						
1B2b							10	11						
1B2d							7	6						
2A3														
2A5b							7				3	2	6	6
2B10a			6	5										
2C1	3	3	13	9										
2C3														
2C7a														
2D3d							3	2						
2D3i														
2G														
2H2							18	18						
2K														
3B1a							4		3	2	2		3	
3B1b						8	5		4	2	3		4	
3B3						10							9	0
3B4gi											4	2	12	7
3B4gii					5		1	1			5	4	6	5
3Da1	27	10			36	29								
3Da2a	5				29	31								
3Da3	4	2			4									
3Da4					7	5								

NFR	CO		BC		Pb		Cd		Hg		As		Cr		Cu		Ni		Se		Zn		PCDD/F		PAHs		HCB		PCB		Sum of KC
	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	
1B2ai																															12
1B2aiv																															73
1B2av																															14
1B2b																															21
1B2d																															13
2A3																				2											2
2A5b																															24
2B10a																															11
2C1	9	5			10	4	4	2		2	11	4				10	5	2	19	18	19	9	3		55	49			22		291
2C3																										0					0
2C7a								6				3		3									22	16							50
2D3d																															5
2D3i																					24	10									34
2G			4	4	0	0	9	6																							23
2H2																															36
2K									19	13																					31
3B1a																															15
3B1b																															24
3B3																															19
3B4gi																															25
3B4gii																															27
3Da1																															103
3Da2a																															66
3Da3																															10
3Da4																															11

NFR	NOx		SOx		NH_3		NMVOC		$PM_{2.5}$		PM_{10}		TSP		CO		BC		Pb		Cd		Hg		As		Cr		Cu		Ni		Se		Zn		PCDD/F		PAHs		HCB		PCB		Sum of KC
	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	
3Dc									4	3	32	27	17	16																															99
5C1bi													2	5																														33	39
5C1bii														3							6	3			0																91	83	63	48	297
5C1biii																								2													0	3							4
5C1bv																							11	10																					21
5C2		2							10	8	5	5	3	3	17	10	8	7			4	2			10	5										2	4	3	7	8					121
5E									1																																				1

1.6 QA/QC AND VERIFICATION METHODS

The Slovak Hydrometeorological Institute has built and introduced the quality management system (QMS) according to the requirements of EN ISO 9001:2008 standard of conformity. In the frame of introduction of the QMS for the SHMÚ as a global standard, the certification itself proceeds according to the partial processes within the SHMÚ structure.

Compiling an inventory is an annual process – the steps of this process are Plan, Do, Check and Act.

Sectoral experts apply the QA/QC methodology according to EMEP/EEA GB_{2023}, collect data from providers and process emission inventory for a given sector – they provide partial reports with information on the quality and reliability of data on activities and emissions and fulfil the QA/QC documents.

The set of templates and checklists consists of these documents:

- QA/QC Plan
- Matrix of Responsibility
- General QC
- Improvement plan
- Recommendation list

Part of the QA procedures is bilateral cooperation with the Czech Republic. The first meeting took place in July 2013 and since then has been repeated every year. A team of GHG inventory experts from the SHMÚ and the Czech Hydrometeorological Institute (CHMI) met to exchange information and experience relating to the preparation of GHG inventory. In the last meeting, the experts from Slovakia, the Czech Republic, Poland, Hungary and Austria attended.

1.6.1 QA/QC Plan

A QA/QC plan is an internal document to organise and implement all activities across all of the emission inventory activities. In these documents, deadlines and responsibilities are described.

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plans for the coming inventory preparation, compilation and reporting work. The setting of quality objectives is based on inventory principles.

The quality objectives regarding all calculation sectors for inventory submissions are the following:

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

The general QC procedures are performed by the experts during inventory calculation and compilation.

General quality control includes routine checks, correctness, completeness of data, identification of errors, deficiencies and documentation and archiving of the inventory material. The sectoral experts must adopt adequate procedures for the development and modification of spreadsheets to minimise emission calculation errors. Checks ensure compliance with the established procedures as well as allow the detection of the remaining errors. Parameters, emission units and conversion factors used for the calculations must be clearly singled out and specified.

Experts fill QC forms during the compilation of inventory; results from QC activities are documented and archived.

1.6.2 Quality Assurance (CHECK)

Quality assurance is performed after application QC checks concerning the finalised inventory. QA procedures include reviews and audits to assess the quality of inventory and the inventory preparation and reporting process, determine the conformity of the procedures taken and identify areas where improvements could be made. These procedures are at different levels; include basic reviews of the draft report, external peer review, internal audit and EU/UNECE reviews.

Sectoral experts and the members of the inventory team during the year participate in various seminars, meetings, conferences and sector-specific workshops, where are reported the activities of inventory members and results. The comments received during these processes are reviewed and, as appropriate, incorporated into the IIR or reflected in the inventory estimates.

When checking the quality of data in each sector, the coordinator, quality manager and other stakeholders must conduct the following general activities:

Checking: Check whether the data in the sectoral reports (calculations and documents) for each sector conform both to the general and specific procedures.

Documentation: Write down all verification results by filling out a checklist, including conclusions and irregularities that have to be corrected. Such documentation helps to identify potential ways to improve the inventory as well as store evidence of the material that was checked and of the time when the check was performed.

Follow-up of corrective actions: All corrective actions necessary for documenting the activities carried out and the results achieved must be taken. If such a check does not provide a clear clue concerning the steps to be taken, the quality control, a bilateral discussion between the expert and coordinator will take place.

Data transference: All checked documents (including the final questionnaire and all annexes) shall be put into the project file and copies and shall be forwarded to all sectoral experts. Certain activities, such as verification of the electronic data quality or project documentation for checking whether all documents have been provided, must be carried out every year or at least at set intervals. Some checks may be conducted only once (however, comprehensively) and then only from time to time.

1.6.3 Verification Activities

Verification refers to the collection of activities and procedures that can be followed during the planning and development, or after the completion of an inventory, that can help to establish its reliability for the intended applications of that inventory. The used parameters and factors and the consistency of data are checked regularly. Completeness checks are undertaken and new and previous estimates are compared every time. Data entry into the database is checked many times by the sector expert for uncertainty. If possible, activity data from different data sources are compared and thus verified. Comprehensive consistency checks between national energy statistics and IEA time series. Checking the results of the EU's internal review for the EU27, and analysing its relevance for the Slovak Republic.

1.6.4 Inventory Improvement (ACT)

The main aim of the QA/QC process is the continuous improvement of the quality of inventory. The outcomes and experiences from the annual reviews are the main sources for the preparation of recommendation lists and improvement plans based on these recommendation lists.

The recommendation and improvement plans are updated annually after the regular UNECE and EU compliance reviews take place.

The prioritisation process is based on problems and recommendations raised during reviews and expert consultations. The results of prioritisation are included in the improvement plans. Detailed recommendation lists and improvement plans are prepared by sectors and delivered to the sectoral experts for consideration and prioritisation of planned activities for the next inventory cycle.

During the last years, the prioritisation of the improvement plan was focused on the Energy and Industry sectors. In this submission, several emissions sources were reallocated and the methodology for the calculation of heavy metals and POPs in these sectors was changed to comply with EMEP/EEA GB_{2023}, however, a methodology for these pollutants needs further development as it is on a sufficient level.

1.7 UNCERTAINTY ASSESSMENT

Uncertainty analysis was provided for the main pollutants (SO_2, NOx, NMVOC, NH_3 and $PM_{2.5}$, CO), priority heavy metals and POPS. Information on the methodology and data sources used is provided in the following sections.

1.7.1 Methodological Issues

Uncertainty analysis of the Slovak Republic used Approach 1 for all the mandatory pollutants: SOx, NOx, NMVOC, NH_3, CO, TSP, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PAHs, PCDD/F, HCB, PCB and BC. By using the error propagation method, the uncertainties for a specific source category can be estimated and by combining these uncertainties an overall uncertainty can be calculated.

For the purpose of uncertainty calculation, the Uncertainty Analysis Inventory Tool was used.

1.7.2 Source of Data

For the estimation of the overall uncertainty, the uncertainty of activity data and emission factor must be calculated. The uncertainties of activity data on the sectoral level were based on the GHG uncertainty analysis. Uncertainties of emission factors were based on the ratings from the EMEP/EEA GB_{2023}.

1.7.3 Qualitative Uncertainty Analysis Results

A qualitative assessment was performed on a sectoral level for all pollutants. The relevant sectors of each pollutant were classified into different quality groups from A to E (***Table 1.5***) following the EMEP/EEA GB_{2023}.

Table 1.5: *Qualitative uncertainty analysis*

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD/F	PAHs	HCB	PCB
1A1a	A	A	A	A	A	A	A	A	A	C	C	D	C	C	C	D
1A1b	A	A	A	A	A	A	A	A	A	C	C	C	E	C	E	
1A1c	A	A	A	A	A	A	A	A	A	D	D	D	D	D		
1A2a	A	A	A	A	A	A	A	A	A	E	E	E	E	E	E	E
1A2b	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	
1A2c	A	A	A	A	A	A	A	A	A	C	C	C	E	C	E	C
1A2d	A	A	A	A	A	A	A	A	A	E	E	E	E	E	E	E
1A2e	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1A2f	A	A	A	A	A	A	A	A	A	C	C	C	E	E	D	C
1A2gvii	D	D	B	E	E	E	E	C	C		E			E		
1A2gviii	A	A	A	A	A	A	A	A	A	E	E	E	E	E	E	E
1A3a	B	B	A	C	C	C	C	C	**B**	B	B	B				
1A3b	B	B	A	C	C	C	C	C	B	E	E	E	E	E	E	E
1A3c	C	C	B	C	C	C	C		C		C		E	E	E	E
1A3d	D	D	B	E	C	C	C	C	C	E	E	E	E	E	E	E
1A3ei	A	A	A	A	A	A	A	A	A							
1A4ai	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	D
1A4aii, bii, cii, 1A5b	D	D	B	E	E	E	E	C	C		E			E		
1A4bi	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
1A4ci	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	D
1A5a	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	D
1B1a		E			E	E	E									
1B1b	D	E	D	C	D	D	D	C	D	C	E	C	C	E		
1B2ai		E														
1B2aiv										C	C	C	C			
1B2av		E														
1B2b		E														
1B2d		B		D								D				
2A1					A	A	A	A								
2A2					A	A	A	A								
2A3					A	A	A	A		C	C	E				
2A5a	A	A	A	A	A	A	A	A								

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD/F	PAHs	HCB	PCB
2A5b					C	C	C									
2A6	A	A	A	A	A	A	A		A							
2B1	A	A	A	A	A	A	A		A							
2B2	A															
2B5	A	A	A	A	A	A	A		A							
2B10a	A	A	A	A	A	A	A	A	A							
2B10b	A	A	A	A	A	A	A		A							
2C1	A	A	A	A	A	A	A	A	A	C	C	C	C	C	E	C
2C2	A	A	A	A	A	A	A	A	A							
2C3	A	A	A	A	A	A	A	A	A					E		
2C5	A	A	A	A	A	A	A		A	C	C	D	C			C
2C7a	A	A	A	A	A	A	A	A	A	C	C	C	E			C
2C7c	A	A	A	A	A	A	A	A	A							
2D3a		B										C				
2D3b		A			A	A	A	A					E			
2D3c		A			A	A	A	A								
2D3d		A														
2D3e		A														
2D3f		A														
2D3g		A									C			C		
2D3h		A														
2D3i		A	A							E	E	E				
2G	B	C	C	B	C	C	C	C	A	C	E	E	C	C		
2H1					A	A	A	A								
2H2		E														
2H3	A	A	A	A	A	A	A		A							
2I	A	A	A	A	A	A	A		A							
2K												E				D
3B	C	C		C	E	E	E									
3D	C	C		C	E	E	E									
5A		A			D	D	D									
5B1				C												
5B2				A												

NFR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD/F	PAHs	HCB	PCB
5C1bi	E	E	E		B	B	B	C	E	C	C	C	B	C	B	
5C1bii	E	E	E		B	B	B	C	E	C	C	C	B	C	B	
5C1biii	B	B	C				C	C	B	C	C	C	C	C	E	E
5C1biv	E	E	B						E	E	E	E	E	E	B	
5C1bv	E	E	E		E	E	E		E	E	E	E	E	E	E	E
5C2	D	D	D		D	D	D	C	D	D	D		D	D		
5D1	A	C	A	C	A	A	A		A							
5D2	A	C	A	A	A	A	A		A							
5E					C	C	C			C	C	C	C			

1.7.4 Quantitative Uncertainty Analysis Results

The quantitative uncertainty assessment was performed with Approach 1 according to EMEP/EEA GB_{2023} for the air pollutants NOx, NMVOC, SOx, NH_3, PMs, CO, Pb, Cd, Hg, As, Cr. Cu, Ni, Se, Zn, PAH, PCDD/F, HCB, PCBs and BC in the year 2023 and the respective level and trend uncertainties. The basis for this assessment is the qualitative rating as presented in ***Table 1.5***. The results of the uncertainty analysis are indicated in the following ***Table 1.6***.

Table 1.6: *Results of quantitative uncertainty analysis of mandatory main pollutants, heavy metals and persistent organic pollutants*

POLLUTANT	LEVEL ANALYSIS IN 2023 [%]	TREND ANALYSIS IN 2023 [%]
NOx	20,73	4,22
NMVOC	31,42	8,59
SOx	16,03	1,46
NH_3	89,63	28,96
$PM_{2.5}$	22,54	3,51
PM^{10}	42,67	6,58
TSP	40,51	5,53
BC	30,08	6,46
CO	12,98	4,43
Pb	248,29	50,25
Cd	63,97	29,97
Hg	104,28	24,26
As	179,79	70,26
Cr	266,10	136,93
Cu	707,80	1115,24
Ni	218,09	18,82
Se	46,14	6,22
Zn	280,41	175,66
PCDD/F	86,53	3,17
PAHs	224,60	53,43
HCB	424,54	193,58
PCBs	141,72	74,04

1.8 ARCHIVING, DOCUMENTATION AND REPORTING

The compilation of the emission inventory starts with the collection of activity data. A comprehensive description of the inventory preparation is described in methodologies for individual sectors. The methodologies are updated annually within the improvement plan and recommendation list and they are archived after formal approval.

Collected input data are compared and checked with international statistics (Eurostat, IAE, FAO and others). In some cases, the collected input data are compared with the results from models (e.g. in road transport it is the COPERT model).

Official submissions of the emission inventory and projections are archived electronically at SHMÚ as well as at the MŽP SR.

Data related to the NEIS are all archived and backup is done on a daily basis on the backup serves of SHMÚ. This activity is performed for all data processed in SHMÚ (that covers many different sources – meteorological, hydrological, air quality data and others). In addition, the backup, especially for the NEIS database, is also performed automatically once a week on the remote server of the developer company Spirit-informačné systémy a. s.

The data from the ŠÚ SR are, except the arranged FTP server, archived electronically at SHMÚ as well as the Statistical yearbook published annually by the ŠÚ SR are stored in paper form.
All documents and background materials of the internal expert of SHMÚ and external are archived, too. Printed documents are archived in the central archive of the SHMÚ and at the OEaB. The electronic archive has been created for all electronic documents related to emission inventories.

1.9 GENERAL ASSESSMENT OF COMPLETENESS

Assessment of completeness is one of the elements of quality control procedure in inventory preparation on the general and sectoral levels. The completeness of the emission inventory is improving from year to year and the updates are regularly reported in the national inventory reports. The completeness checks for ensuring time-series consistency are performed and the estimation is completed in recent inventory submission (2024). The list of categories reported by the notation keys NE and IE is provided in ***Table 1.7.***
Several NE key categories have been reported in the 2025 submission for 1990-2023.
Three reasons for not estimated (NE) categories are:

- No methodology is available;
- Insufficient activity data
- Information on the contribution of a particular type of fuel to overall emissions is unavailable.

The geographic coverage is complete; the whole territory of the Slovak Republic is covered by the inventory.

Table 1.7: *List of NFR categories reported with notation key NE or IE*

NFR	NOT ESTIMATED	YEARS	INCLUDED ELSEWHERE	YEARS
1A1b	B(a)P, B(b)F, B(k)F, I()P	1990-2023	Cr, Cu, Se, Zn	1990-2023
1A2b	HCB, PCBs	1990-2002, 2008-2023		
1A2gvii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2023		
A3ai(i)	NH_3, Pb, Hg, Cd, AHMs, PCDD/F, PAHs	1990-2023		
1A3aii(i)	NH_3, Pb, Hg, Cd, AHMs, PCDD/F, PAHs	1990-2023		
1A3bvi	Hg, PCDD/F, PAHs	1990-2023		
1A3bvii	HMs, POPs	1990-2023		
1A3c	Pb, Hg, As	1990-2023		
1A4aii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2023		
1A4bii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2023		
1A4cii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2023		
1A5b	Cd, Hg, AHMs, POPs	1990-2023	All pollutants	1990-2014
1B1a	BC, HMs	1990-2023		
1B1b	HCB, PCBs	1990-2023		
1B2aiv	BC, PAHs	1990-2023	NH_3	1990-2023
1B2c	NH_3, POPs	1990-2023	NOx, NMVOC, SOx,, PMs, CO, HMs	1990-2023
2A1			MPs, HMs, POPs	1990-2023
2A2	PHMs	1990-2023	MPs	1990-2023
2A3	PCDD/F, PAHs, HCB	1990-2021	MPs	1990-2021
2A5c			All pollutants	1990-2023
2A6	BC	1990-2023		
2B5	BC, HMs, PCDD/F, PAHs, HCB	1990-2023		
2B10a	HMs, POPs	1990-2023		
2B10b	BC	1990-2023		
2C1	B(a)P, B(b)F, B(k)F, I()P	1990-2023		
2C2	HMs, POPs	1990-2023		
2C3	NH_3, HMs, PCDD/F, HCB	1990-2023		

NFR	NOT ESTIMATED	YEARS	INCLUDED ELSEWHERE	YEARS
2C5	NH_3, BC, Cr, Cu, Ni, Se, B(a)P, B(b)F, B(k)F, I()P, HCB	2011-2023		
2C6	NOx, NMVOC, NH_3, BC, CO, Cr, Cu, Ni, Se, PAHs, HCB	2012-2014		
2C7a	NH_3, Se, Zn, PAHs, HCB	1990-2023		
2C7c	BC, HMs, POPs	1990-2023		
2C7d			All pollutants	1990-2023
2D3a	$PM_{2.5}$	1990-2023		
2D3b	NOx, SOx, CO, PAHs, HCB	1990-2023		
2D3c	NOx, CO, PHMs, PCDD/F, PAHs, HCB	1990-2023		
2D3e	$PM_{2.5}$	1990-2023		
2D3f	$PM_{2.5}$	1990-2023		
2D3g	NOx, SOx, NH_3, PMs, CO, Pb, Hg, Cu, Zn, PCDD/F, B(a)P, B(b)F, B(k)F, I()P, HCB, PCB	1990-2023		
2D3h	$PM_{2.5}$, BC	1990-2023		
2D3i	NOx, NH_3, PMs, CO, POPs	1990-2023		
2G	Se, HCB, PCBs	1990-2023		
2H1	NH_3, PAHs, HCB	1990-2023	NOx, NMVOC, SOx, CO	1990-2023
2H2	BC	1990-2023		
2H3	BC	1990-2023		
2I	BC, As, Cu	1990-2023		
2K	Pb, Cd, AHMs, HCB	1990-2023		
3Da2a			NMVOC	1990-2023
3Da3			NMVOC	1990-2023
5A	NH_3, CO, Hg	1990-2023		
5B1	NOx, NMVOC, SOx, PMs	1990-2023		
5B2	NOx, NMVOC, SOx, PMs, CO, PHMs, Cr, Zn, POPs	2001-2023		
5C1bi	NH_3[1], Se[2], I()P[1]	1990-2006, 2018-2020, 2022-2023[1]; 1990-2016, 2017-2023[2]		
5C1bii	NH_3	1990-2023		
5C1biii	NH_3, Se, Zn, PAHs	1990-2023		
5C1bv	BC	1990-2023		
5C2	NH_3, Hg, Cr, Ni, I()P, HCB	1990-2023		
5D1	PMs, HMs	1990-2023		
5D2	NH_3, PMs HMs	1990-2023		
5E	NOx, NMVOC, SOx, BC, CO, Ni, Se, Zn, PAHs, HCB, PCBs	1990-2023		

MPs – Main Pollutants: NOx, NMVOC, SOx, NH_3, CO; **PMs – Particulate Matter:** $PM_{2.5}$, PM_{10}, TSP, BC; **HMs – Heavy metals: PHMs – Priority Heavy Metals**: Pb, Cd, Hg; **AHMs – Additional Heavy metals:** As, Cr, Cu, Ni, Se, Zn; **POPs – Persistent Organic Pollutants:** PCDD/F; **PAHs – Polycyclic Aromatic Hydrocarbons**: B(a)P, B(b)F, B(k)F, I()P; HCB, PCBs

Several categories are reported as not occurring (NO) due to the not existence of the emission source or the source being out of threshold and measurement range. If the methodology does not exist in the EMEP/EEA GB_{2023}, the notation key not applicable (NA) was used. The lists of notation keys NA and NO are available in ***Table 1.8***.

Table 1.8: *List of NFR categories with notation key NA and NO*

NFR	NOT APPLICABLE	YEARS	NOT OCCURRING	YEARS
1A1a			NH_3	1990-2014, 2018, 2020-2023

NFR	NOT APPLICABLE	YEARS	NOT OCCURRING	YEARS
1A1b	PCBs	1990-2023		
1A1c	Hg, HCB, PCBs	1990-2023		
1A2a			NH_3	1990-2015, 2017-2023
1A2b			NH_3	1990-2023
1A2c			NH_3	1990-2023
1A2d			NH_3	1990-2006
1A2f			NH_3	1990-1999,2006-2011
1A3ai(i)	HCB, PCBs	1990-2023		
1A3ai(ii)	HCB, PCBs	1990-2023		
1A3aii(i)	HCB, PCBs	1990-2023		
1A3aii(ii)	HCB, PCBs	1990-2023		
1A3bv	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2023		
1A3bvi	MPs	1990-2023		
1A3bvii	MPs	1990-2023		
1A3ei	NH_3, HMs, POPs	1990-2023		
1A3eii			All pollutants	1990-2023
1A4ai			NH_3	1990-2013
1A4aii			All pollutants	2013
1A4ciii		1990-2023	All pollutants	1990-2023
1A5b			NH_3, Pb	1990-2021
1A5c			All pollutants	1990-2023
1B1a	NOx, SOx, NH_3, CO, POPs	1990-2023		
1B1c			All pollutants	1990-2023
1B2ai	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2023		
1B2av	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2023		
1B2b	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2023		
1B2d			NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2023
2A2	AHMs, POPs	1990-2023		
2A3	PCBs	1990-2023		
2A5a	NH_3, BC, HMs, POPs	1990-2023		
2A5b	MPs, BC, HMs, POPs	1990-2023		
2A6	HMs, POPs	1990-2023		
2B1	BC, HMs, POPs	1990-2023		
2B2	NMVOC, SOx, PMs, CO, HMs, POPs	1990-2023		
2B3			All pollutants	1990-2023
2B5	NH_3, PCB	1992-2023	All pollutants	1990-1991
2B6			All pollutants	1990-2023
2B7			All pollutants	1990-2023
2B10b	HMs, POPs	1990-2023	NH_3	2006-2023
2C2			NH_3	2004-2009
2C3	PCBs	1990-2023		
2C4			All pollutants	1990-2023
2C5			All Pollutants	1990-2010
2C6			All pollutants	1990-2011, 2015-2023
2C7b			All Pollutants	1990-2023
2D3a	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, Pb, Cd, AHMs, POPs	1990-2023		
2D3b	NH_3, HMs, PCBs	1990-2023		

NFR	NOT APPLICABLE	YEARS	NOT OCCURRING	YEARS
2D3c	SOx, NH_3, AHMs, PCBs	1990-2023		
2D3d	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2023		
2D3e	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, HMs, POPs	1990-2023		
2D3f	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, HMs, POPs	1990-2023		
2D3h	NOx, SOx, NH_3, PM_{10}, TSP, CO, HMs, POPs	1990-2023		
2H1	HMs, PCDD/F, PCBs	1990-2023		
2H2	NOx, SOx, NH_3, CO, HMs, POPs	1990-2023		
2H3	HMs, POPs	1990-2023	CO	2017-2023
2I	PHMs, Cr, Ni, Se, Zn, POPs	1990-2023	NH_3	2011-2013
2J			All Pollutants	1990-2023
2K	MPs, PMs, PCDD/F, PAHs	1990-2023		
2L			All Pollutants	1990-2023
3B1a	SOx, BC, CO, HMs, POPs	1990-2023		
3B1b	SOx, BC, CO, HMs, POPs	1990-2023		
3B2	SOx, BC, CO, HMs, POPs	1990-2023		
3B3	SOx, BC, CO, HMs, POPs	1990-2023		
3B4a			All Pollutants	1990-2023
3B4d	SOx, BC, CO, HMs, POPs	1990-2023		
3B4e	SOx, BC, CO, HMs, POPs	1990-2023		
3B4f			All Pollutants	1990-2023
3B4gi	SOx, BC, CO, HMs, POPs	1990-2023		
3B4gii	SOx, BC, CO, HMs, POPs	1990-2023		
3B4giii	SOx, BC, CO, HMs, POPs	1990-2023		
3B4giv	SOx, BC, CO, HMs, POPs	1990-2023		
3B4h	SOx, BC, CO, HMs, POPs	1990-2023		
3Da1	NMVOC, SOx, TSP, BC, CO, HMs, POPs	1990-2023	$PM_{2.5}$, PM_{10}	1990-2023
3Da2a	SOx, PMs, HMs, POPs	1990-2023		
3Da2b	NMVOC, SOx, PMs, CO, HMs, POPs	1990-2023		
3Da2c	NMVOC, SOx, TSP, BC, CO, HMs, POPs	1990-2023		
3Da3	SOx, PMs, CO, HMs, POPs	1990-2023		
3Da4	NOx, NMVOC, SOx, PMs, HMs, POPs	1990-2023		
3Db	NOx, NMVOC, SOx, PMs, HMs, POPs	1990-2023	NH_3	1990-2023
3Dc	MPs, BC, HMs, POPs	1990-2023		
3Dd	All Pollutants	1990-2023		
3De	NOx, SOx, PMs, HMs, POPs	1990-2023	NH_3	1990-2023
3Df	MPs, PMs, HMs, PCDD/F, PAHs, PCBs	1990-2023		
3F			All Pollutants	1990-2023
3I	All Pollutants	1990-2023		
5A	NOx, SOx, BC, Pb, Cd, AHMs, POPs	1990-2023		
5B1	HMs, POPs	1990-2023		
5B2	As, Cu, Ni, Se	2001-2023	All Pollutants	1990-2000
5C1a			All Pollutants	1990-2023
5C1bi		1990-2023	All Pollutants	2017
5C1biv			All Pollutants	1990-2023
5C1bv	NH_3	1990-2023		
5C1bvi			All Pollutants	1990-2023
5C2	PCBs	1990-2023		
5D1	NOx, SOx, POPs	1990-2023		
5D2	NOx, SOx, POPs	1990-2023		
5D3			All Pollutants	1990-2023

NFR	NOT APPLICABLE	YEARS	NOT OCCURRING	YEARS
5E	NH_3	1990-2023		
6A			All Pollutants	1990-2023

MPs – **Main Pollutants:** NOx, NMVOC, SOx, NH_3, CO; **PMs** – **Particulate Matter:** $PM_{2.5}$, PM_{10}, TSP, BC; **HMs** – **Heavy metals: PHMs** – **Priority Heavy Metals**: Pb, Cd, Hg; **AHMs** – **Additional Heavy metals:** As, Cr, Cu, Ni, Se, Zn; **POPs** – **Persistent Organic Pollutants:** PCDD/F; **PAHs** – **Polycyclic Aromatic Hydrocarbons**: B(a)P, B(b)F, B(k)F, I()P; HCB, PCBs

CHAPTER 2:KEY TRENDS

Last update: 15.4.2025

This chapter is concerned with the latest emission estimates for selected pollutants and analyses the trends in time series across the main source sectors. The pollutants considered are the NECD pollutants (SOx as SO_2, NOx as NO_2, NMVOC, NH_3 and $PM_{2.5}$), PM_{10}, black carbon (BC), Carbon monoxide (CO), the priority metals (lead, cadmium and mercury), Dioxins & Furans (PCDD/PCDF) and Polyaromatic Hydrocarbons (PAHs), Hexachlorobenzene (HCB) and Polychlorinated biphenyls (PCBs). This chapter discusses each of the air pollutants separately and provides explanations of the main changes in the time series.

2.1 TRENDS IN EMISSIONS OF NECD POLLUTANTS

In Europe, regional air pollution is regulated by a number of protocols under the CLRTAP (Convention on Long Range Transboundary Air Pollution) under the UNECE (United Nations Economic Commission for Europe). Additionally, there is EU legislation that mostly mirrors the obligations under the CLRTAP.

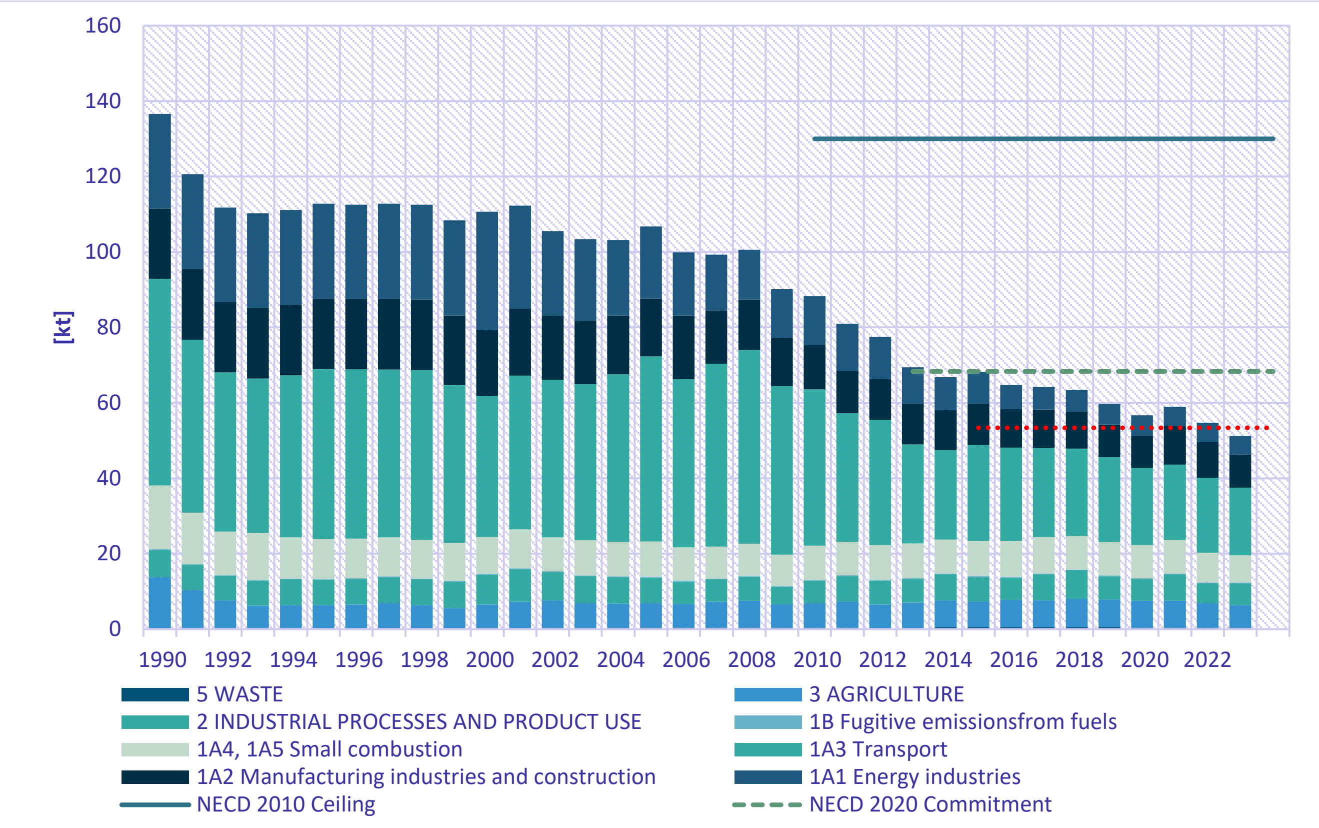
The Directive 2001/81/EC on National emissions ceilings (NEC Directive) sets limit values of emissions of **sulphur dioxide** (SO_2), **nitrogen oxides** (NOx), **volatile organic compounds** (VOCs) and **ammonia** (NH_3).

This Directive was replaced by The **New NEC Directive** 2284/2016, which sets national emission reduction commitments for the Member States and the EU for five important air pollutants: NOx, NMVOCs, SO_2, NH_3 and for the first time for fine **particulate matter** ($PM_{2.5}$).

2.1.1 Trends in Emissions of NOx

In ***Figure 2.1*** can be seen that emissions of NOx have a constantly decreasing trend and do not exceed the emission ceilings set up in **NEC Directive 2001/81/EC** for 2010. Since the year 2005, emissions decreased by 42 which means the Slovak Republic reached its National Commitment for this pollutant, set by **NEC Directive 2016/2284/EU** for the period 2020-2029. Road transport remains the main contributor to this pollutant throughout the whole time-series and emissions in this subsector are decreasing only slowly. **Sofia protocol** of CLRTAP concerning the control of emissions of nitrogen oxides or their transboundary fluxes was fulfilled.

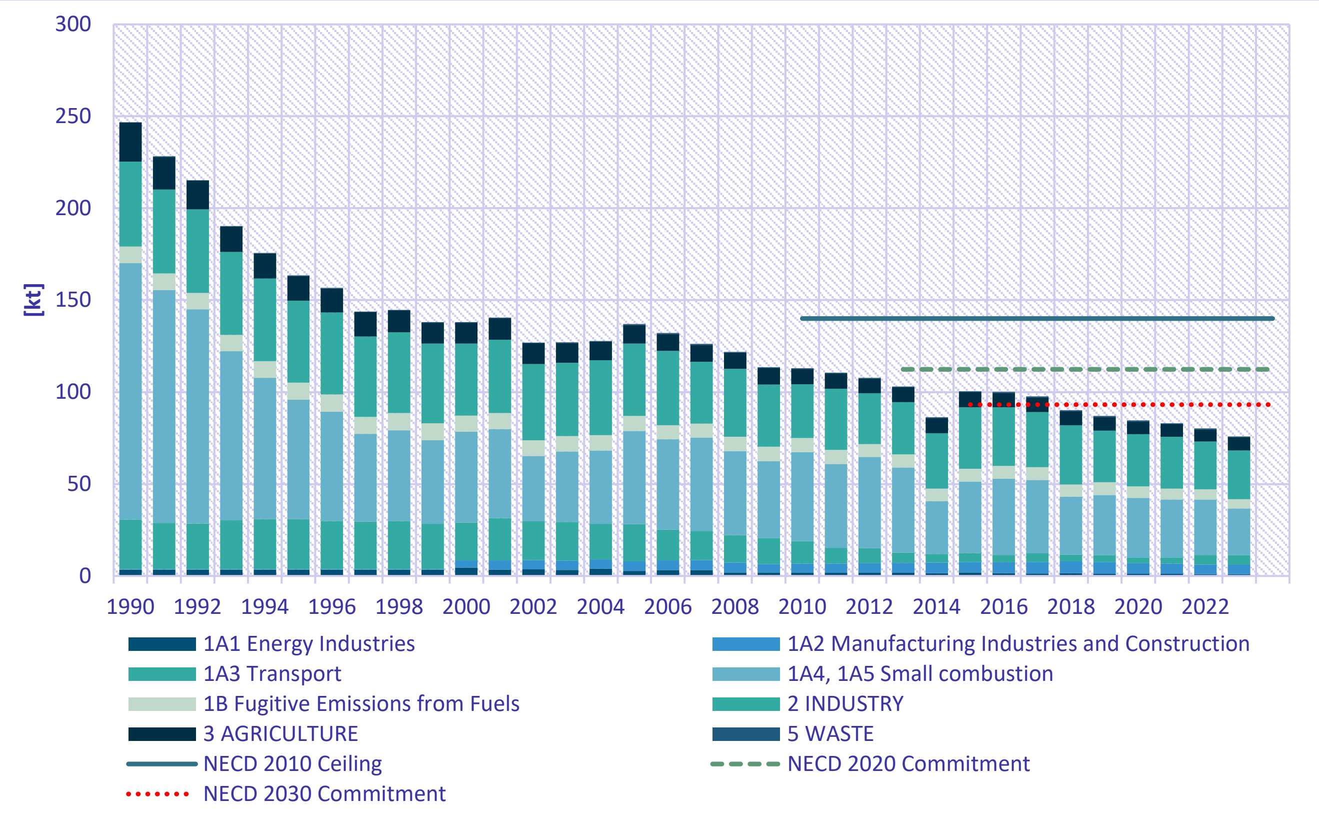
Figure 2.1: *Total NOx emissions by sectors*



2.1.2 Trends in Emissions of NMVOC

Emissions of NMVOC have a decreasing trend in the whole time-series although the most significant decrease occurred in the period 1990-2000. The main source of NMVOCs in the Slovak Republic is residential heating sources, which produced 38% of total NMVOCs emissions in 2023. The decrease in the period 1990-2000 was caused primarily by a decrease in energy demand in the households, which reconstructed their houses and also an increase in the energy effectiveness of boilers. National Emission 2010 Ceiling set by **NEC Directive 2001/81/EC**, as well as Commitment set by new **NEC Directive 2016/2284/EU** for the period 2020-2029, were not exceeded (***Figure 2.2***). **Geneva Protocol** of CLRTAP concerning the control of emissions of volatile organic compounds or their transboundary fluxes, which requires a decrease of VOCs by at least 30 % by the year 1999, using 1990 levels as a basis was also fulfilled.

Figure 2.2: *Total NMVOC emissions by sectors*



2.1.3 Trends in Emissions of SOx

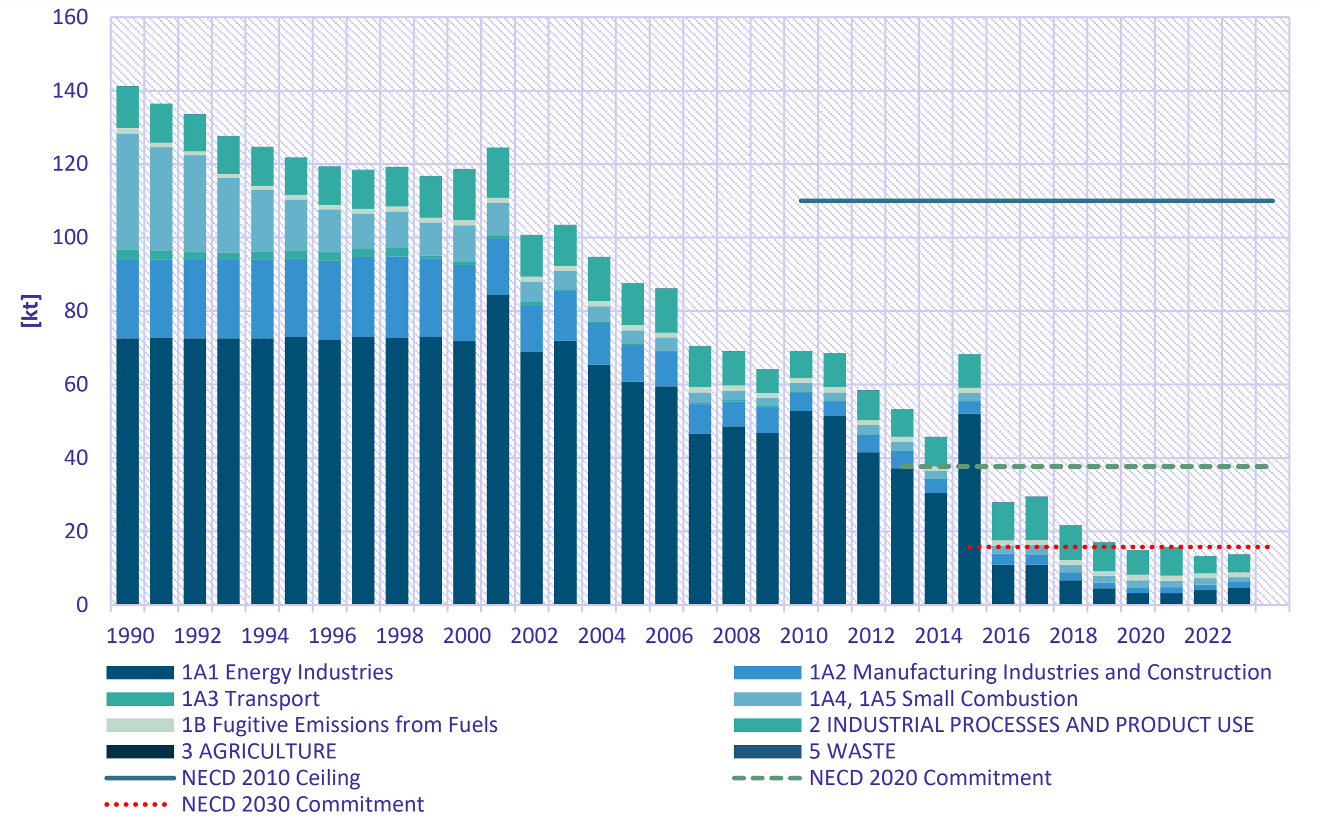
The trends of SOx emissions decreased until 2014 continually. Since 1990, SOx emissions have noticed a significant decrease due to strict air protective legislation. The downward trend relates also to the composition of the fuel used in all sectors and related legislative limitations.

In 2015, a substantial increase was recorded. These emissions originated from the source Slovenské elektrárne (SE). According to records of the NEIS, power plant - ENO 0023 B-block 3 and 4 burned twice the amount of brown coal than in the previous year 2014. Due to the extensive reconstruction of blocks B1 B2 ENO (from a report SE), the ENO and K1, K2 were used, which are not abated granules boilers. Apparently, SE used the last year of special exception (max. 20 000 hours of operation from 1.1.2008 to 31.12.2015), for not applying any emission limits and abatement technology. Subsequently, in 2016, emissions dropped significantly.

Although Energy production was the main contributor in the period 1990-2017, in the year 2018 this sector was replaced by Metal production.

Emissions of SOx are in compliance with **NEC Directive** (ceiling for the year 2010, national commitment for the period 2020-2029 and 2030 onwards) so as with **Oslo Protocol** on further reduction of sulphur emissions and **Helsinki Protocol** of CLRTAP on the reduction of sulphur emissions or their transboundary fluxes at least 30 per cent (***Figure 2.3***).

Figure 2.3: *Total SOx emissions by sectors*



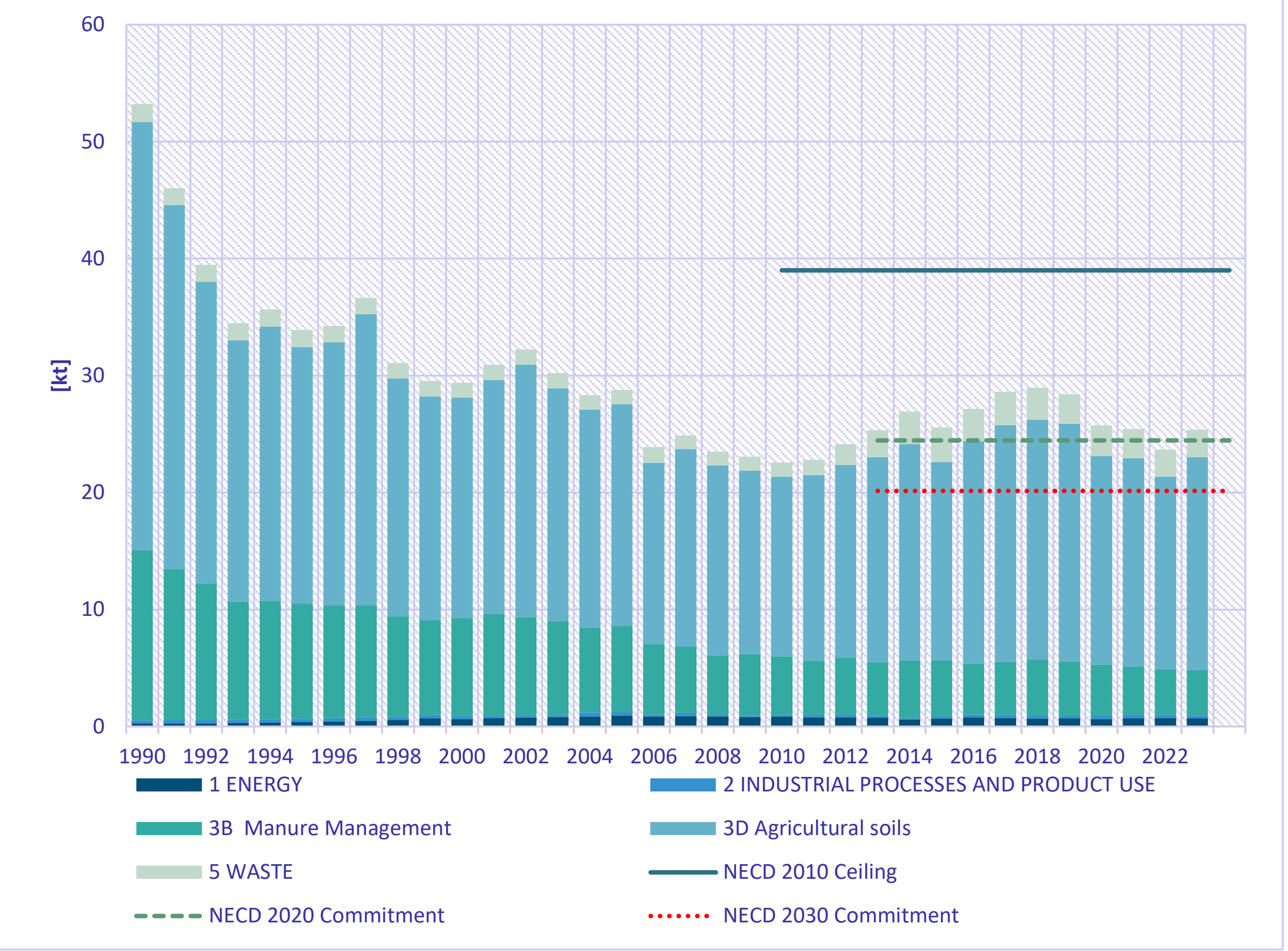
2.1.4 Trends in Emissions of NH_3

The overall trend of emission inventory for ammonia (NH_3) from 1990 has a stable decreasing tendency until 2011. The following years until 2015 show a slight increase and the major driver for this change was an increase in the number of animals and application of the inorganic N-fertilized into soils (***Figure 2.4***).

This category is the main polluter of NH_3 in the whole time series.

As shown in ***Figure 2.4***, the Slovak Republic fulfils both the 2010 emission ceiling set by the **2001/81/EC Directive.**

Figure 2.4: *Total NH_3 emissions by sectors*



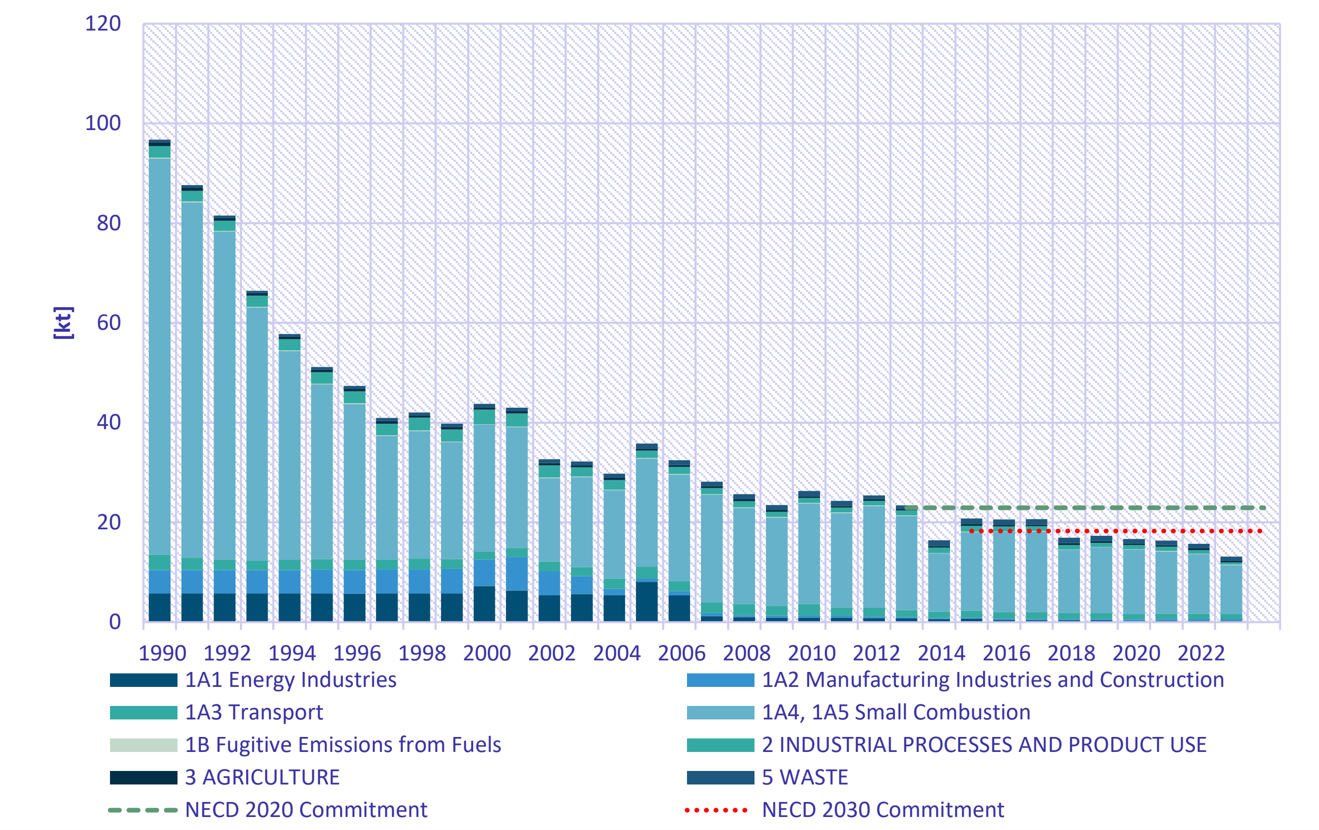
2.1.5 Trends in Emissions of $PM_{2.5}$

The emission trend of $PM_{2.5}$ is significantly affected by the emission trend of the category of Residential heating. This category produced 73% of total $PM_{2.5}$ emissions in the Slovak Republic in the year 2023. Emissions in this category are connected to the energy demand of households, which is influenced by several conditions, such as climate factors, reconstruction status of buildings etc.

The highest decrease in emissions occurred in the period 1990-2000, since then, emissions are moderately fluctuating according to conditions connected with the heating season and energy demand of households (***Figure 2.5***).

National emission commitments set by the **2016/2284/EU Directive** for the period 2020-2029 and after 2030 have been fulfilled.

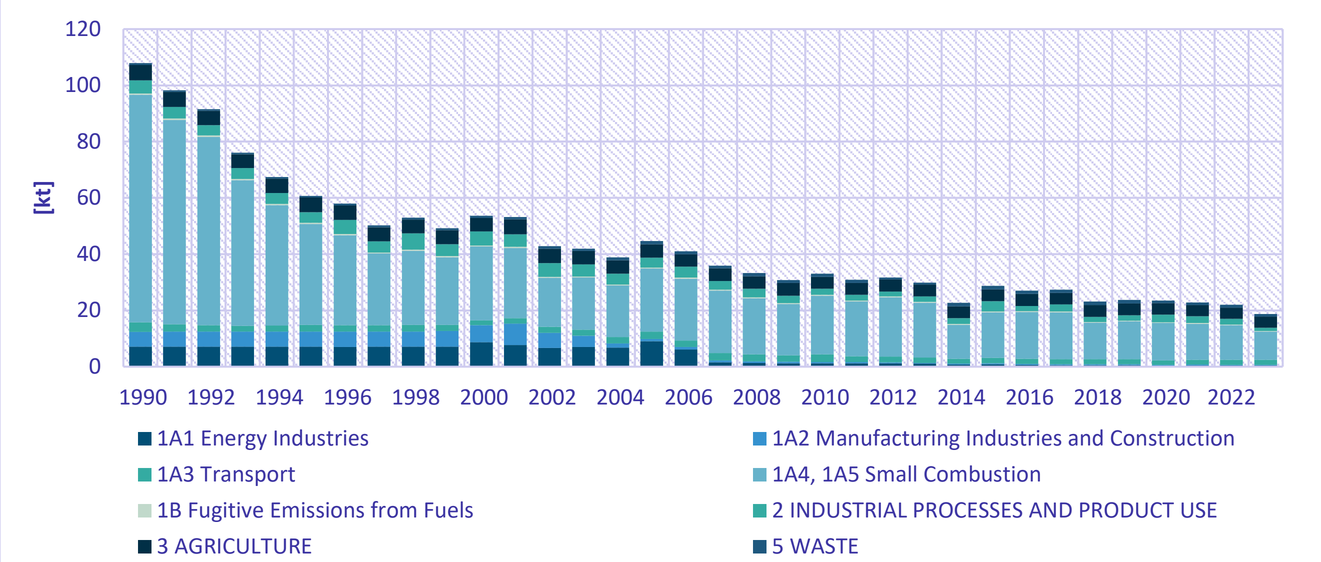
Figure 2.5: *Total $PM_{2.5}$ emissions by sectors*



2.2 TRENDS IN EMISSIONS OF PM_{10}, BC AND CO

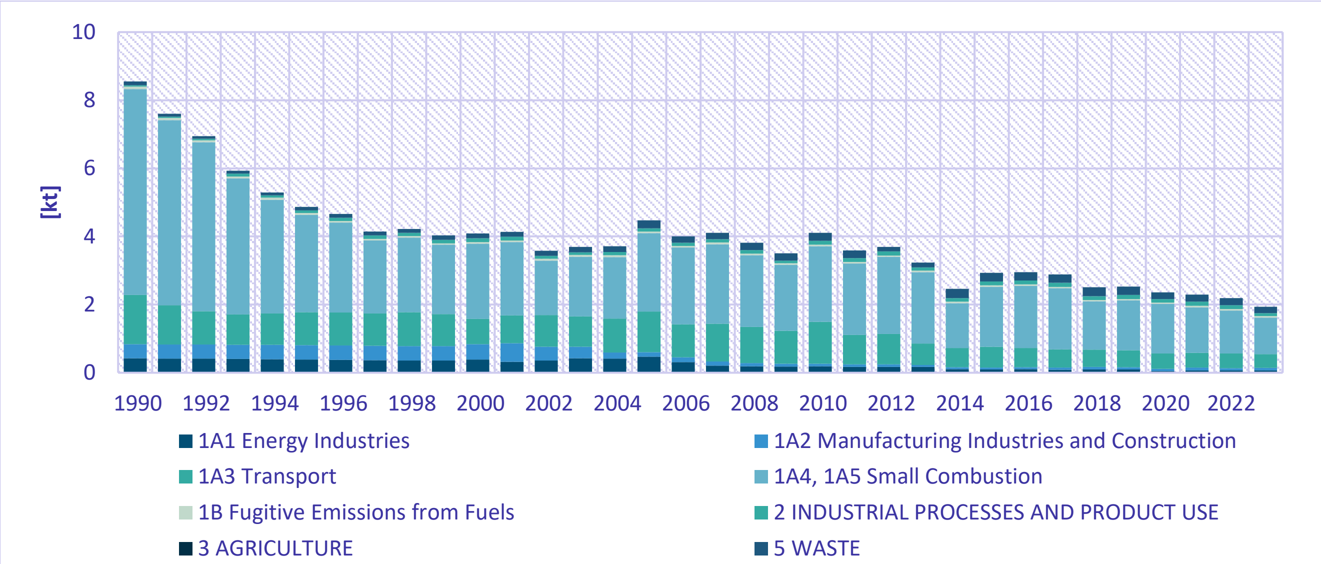
Similarly to $PM_{2.5}$, emissions of PM_{10} are strongly connected to the category of Residential heating, which is the main contributor in the whole time series (***Figure 2.6***).

Figure 2.6: *Total PM_{10} emissions by sectors*



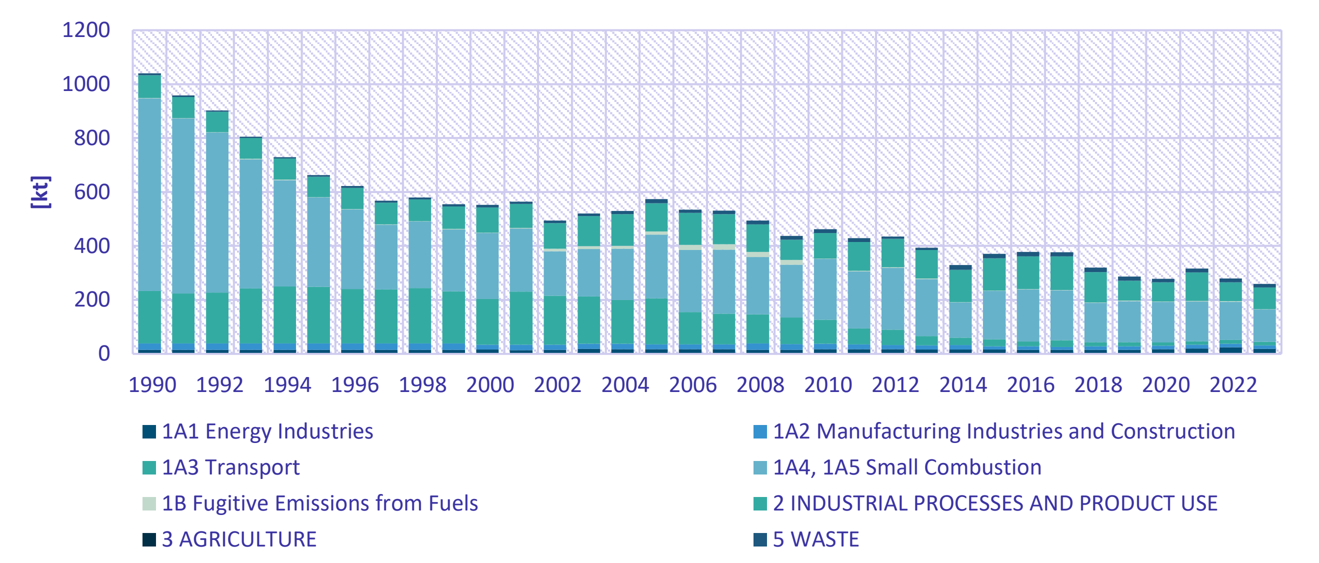
Emissions of BC decreased significantly in the period 1990-2000, and since then they have fluctuated slightly ***(Figure 2.7)***. These emissions originate mostly from Residential heating, but are emitted in Road transport considerably, too.

Figure 2.7: *Total BC emissions by sectors*



CO emissions have had a stable decreasing trend with slight fluctuation in the last two decades ***(Figure 2.8)***. These emissions come especially from residential heating.

Figure 2.8: *Total CO emissions by sectors*



2.3 TRENDS IN EMISSIONS OF HEAVY METALS

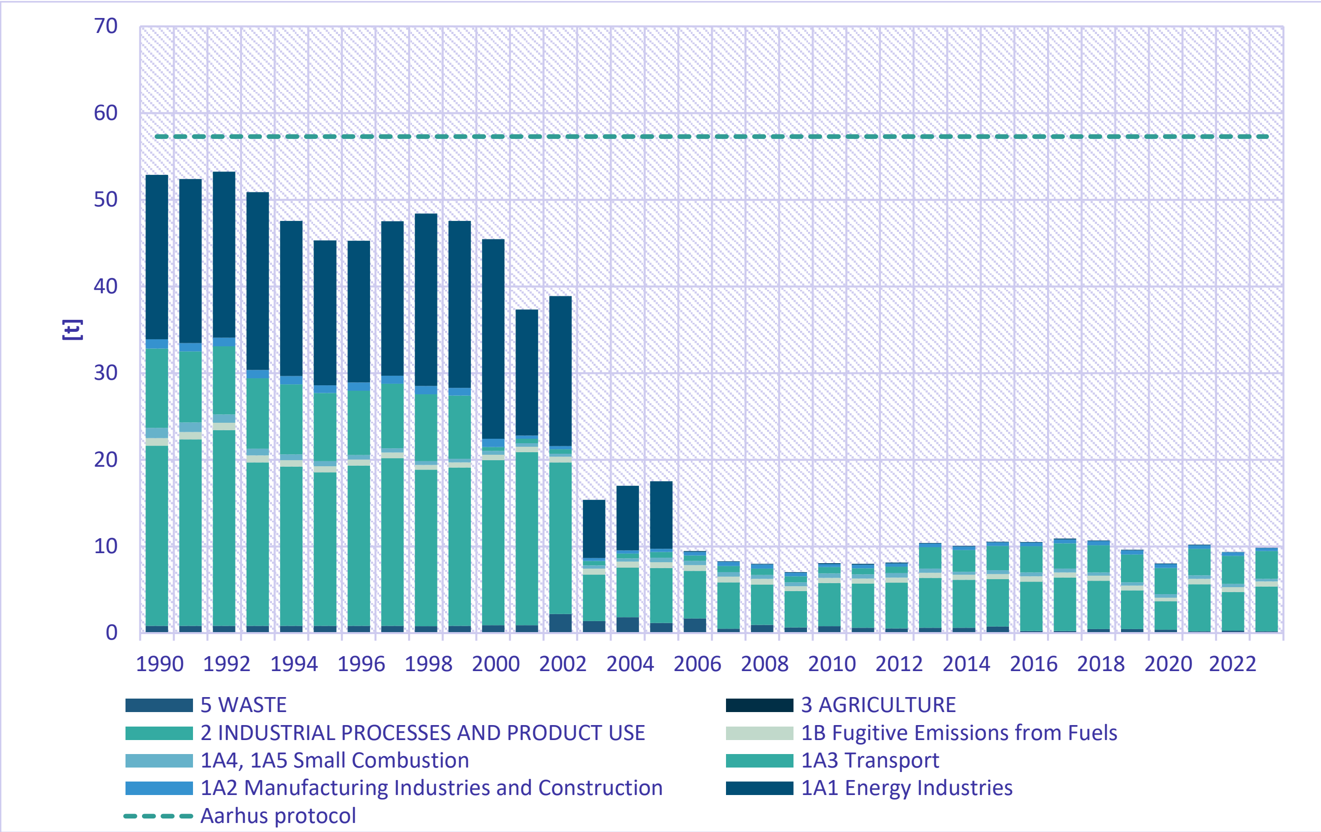
2.3.1 Trends in Emissions of Pb

In general, the pollutant has a moderately fluctuating trend. In the year 2001, emissions dropped due to the end of the use of leaded petrol in transport activities. The next significant decrease occurred in 2007 due to stricter legislation and emission limits for large sources. The next decrease was recorded in 2009, which is connected to the economic crisis.

The main contributor to Pb emissions since 2001 is Iron and Steel production, previously it was Energy production.

Aarhus Protocol of CLRTAP on heavy metals requires that parties do not exceed their base year (1990) level of emitted heavy metals. The Slovak Republic's emissions did not exceed this level.

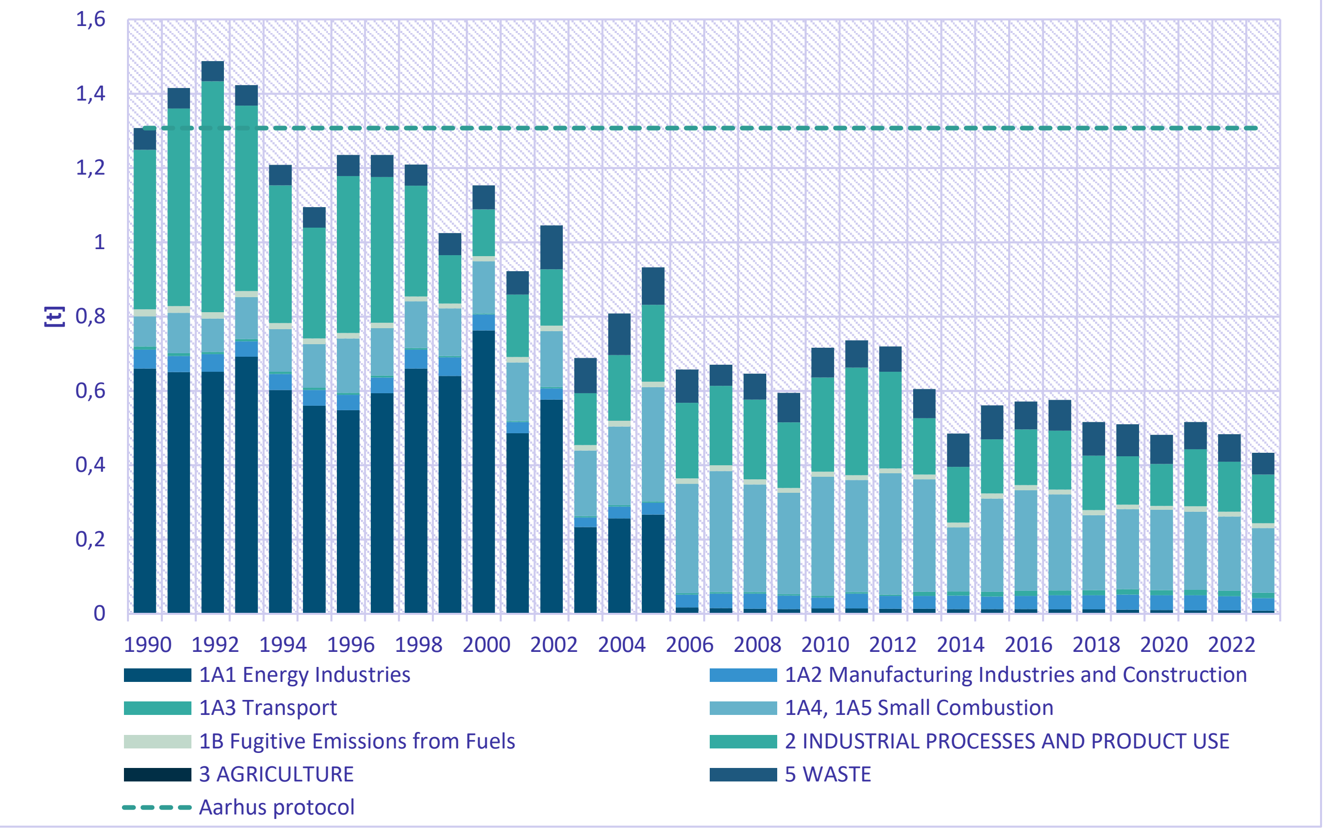
Figure 2.9: *Total Pb emissions by sectors*



2.3.2 Trends in Emissions of Cd

As shown in ***Figure 2.10*** emissions of Cd have had a decreasing trend since 1992. The largest decline occurred in 2003 when municipal waste incineration facilities installed abatement technologies. Since 2004 the main contributing categories are households heating and the production of paper and pulp, which both are characteristic of the wide use of biomass as fuel.

Figure 2.10: *Total Cd emissions by sectors*



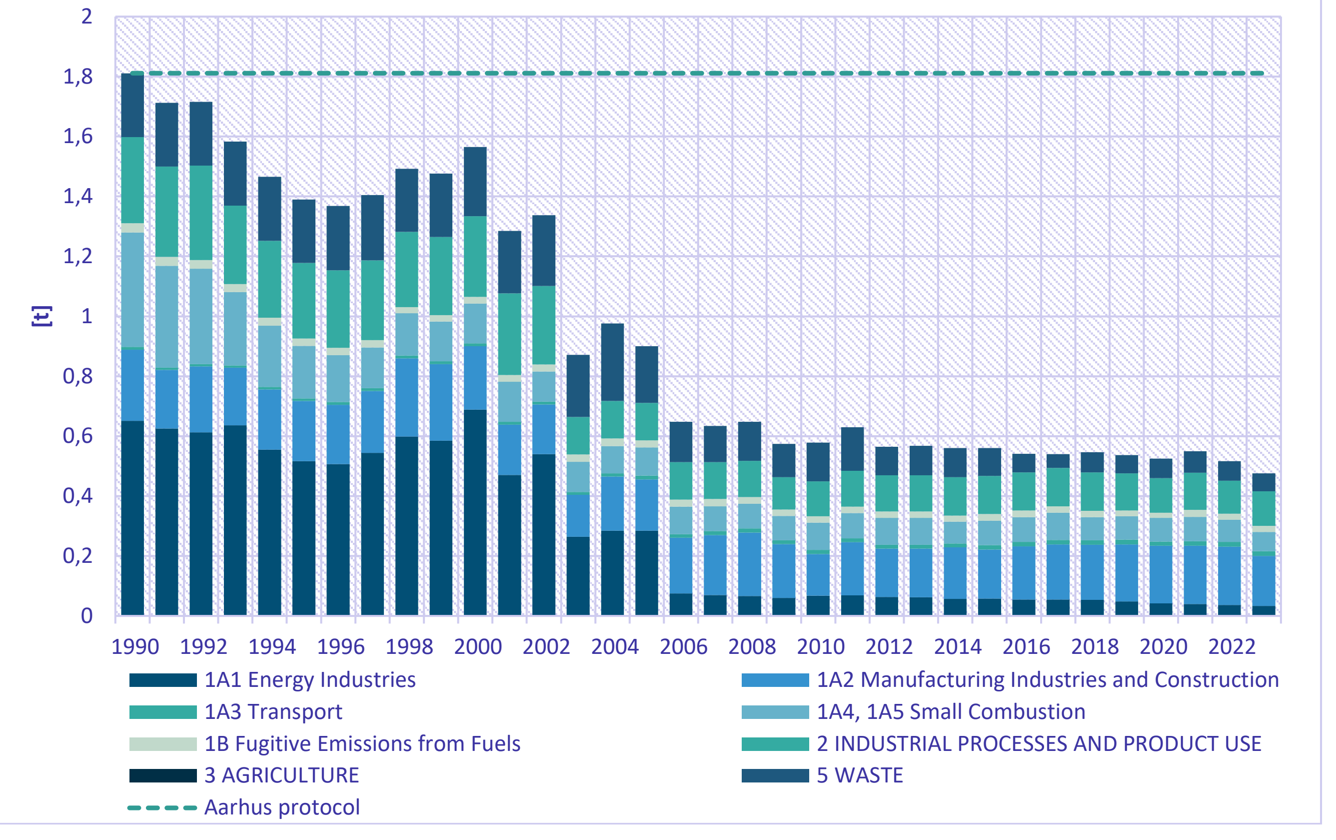
2.3.3 Trends in Emissions of Hg

The emissions trend of Hg is decreasing in general (***Figure 2.11***). Since 2009, the emission trend has remained stable.

The main contributor to emissions of Hg was Energy production, mainly municipal waste incineration with energy recovery until 2006. After this year both Slovak MSW incineration plants installed abatement technologies to reduce emissions of this pollutant.

No exceedances of the Aarhus protocol were recorded.

Figure 2.11: *Total Hg emissions by sectors*



2.4 TREND IN EMISSION OF POPS

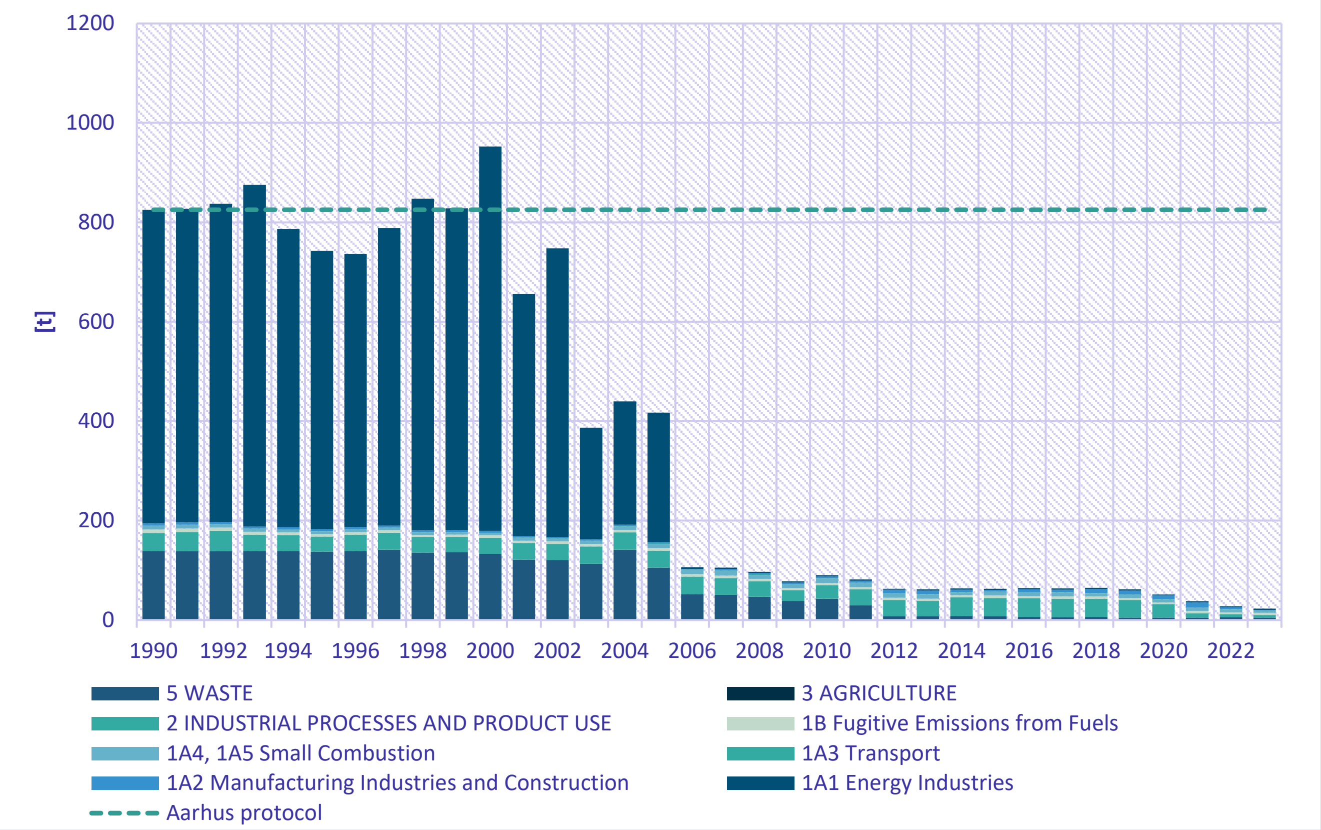
The emission inventory of POPs (PCB, DIOX, PAHs - benzo(a)pyrene, benzo(k)fluoranthene, benzo(b)fluoranthene and ideno(1,2,3-cd)pyrene) for the Slovak Republic is elaborated according to EMEP/EEA Air Pollution Emission Inventory Guidebook 2019 and in compliance with requirements of the respect of the working group for emission inventory (UNECE Task Force on Emission Inventory).

2.4.1 Trends in Emissions of PCDD/PCDF

Emissions of PCDD/F dropped in 2003 and 2006 due to technological improvements in facilities that combust municipal waste as a fuel to produce energy (***Figure 2.12***). Since 2006, emissions have shown a slightly increasing trend as a result of waste management policies in the Slovak Republic, which prefers combustion to the landfill of waste.

In 2023, the main contributors are metal production (24%), households with their share of 21% and waste incineration without energy recovery, which includes incineration of industrial and clinical waste, also 21% then continue with energy production (including incineration of municipal waste with energy recovery), 11%.

Figure 2.12: *Total PCDD/PCDF emissions by sectors*



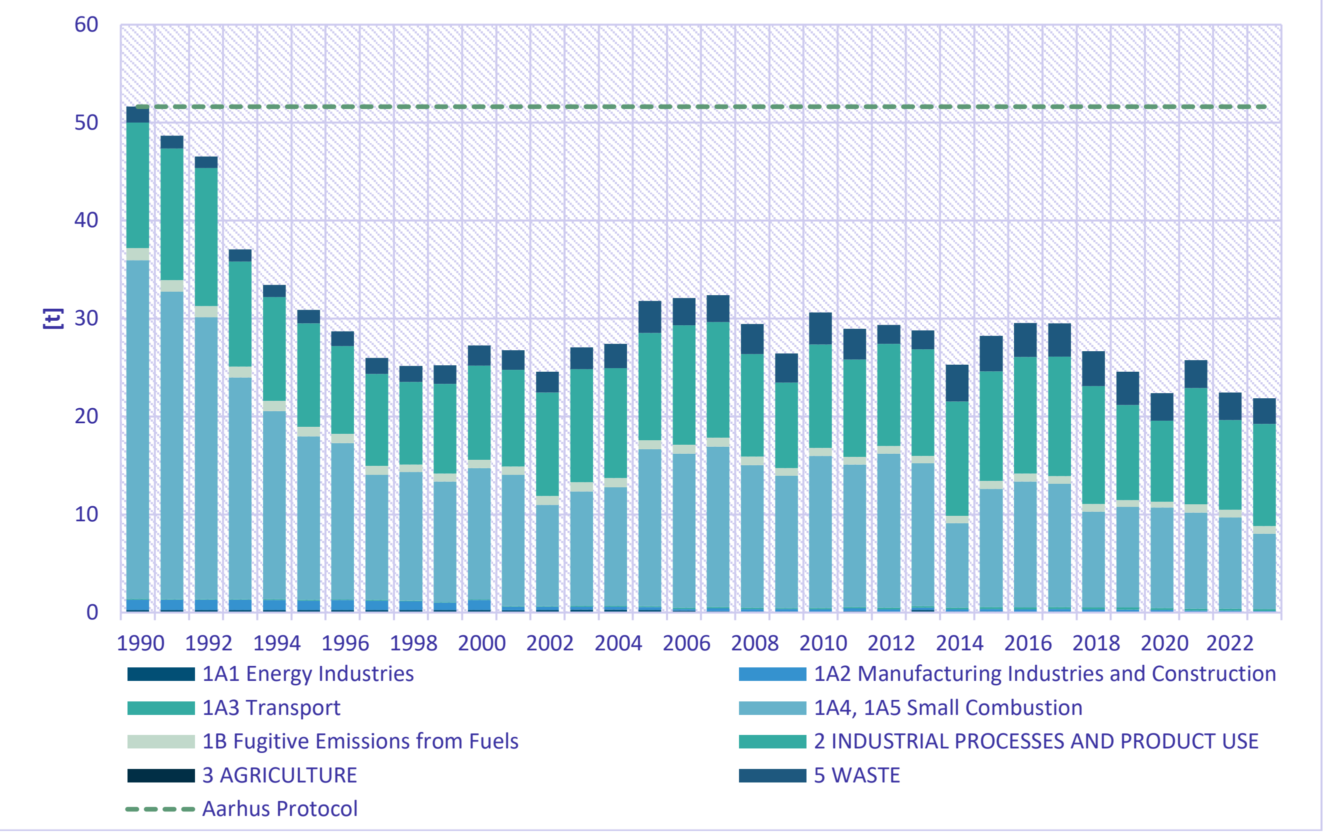
2.4.2 Trends in Emissions of PAHs

The decreasing trend of PAHs emissions is the most intensive in the period 1990-2000. Since then these emissions fluctuating slightly. (***Figure 2.13***).

The emission of PAHs originated in the sector of metal production (47%) and households (35%) in 2023.

Aarhus Protocol of CLRTAP on persistent organic pollutants requires that parties do not exceed their base year (1990) level of emitted heavy metals. The Slovak Republic's emissions did not exceed this level.

Figure 2.13: *Total PAHs emissions by sectors*

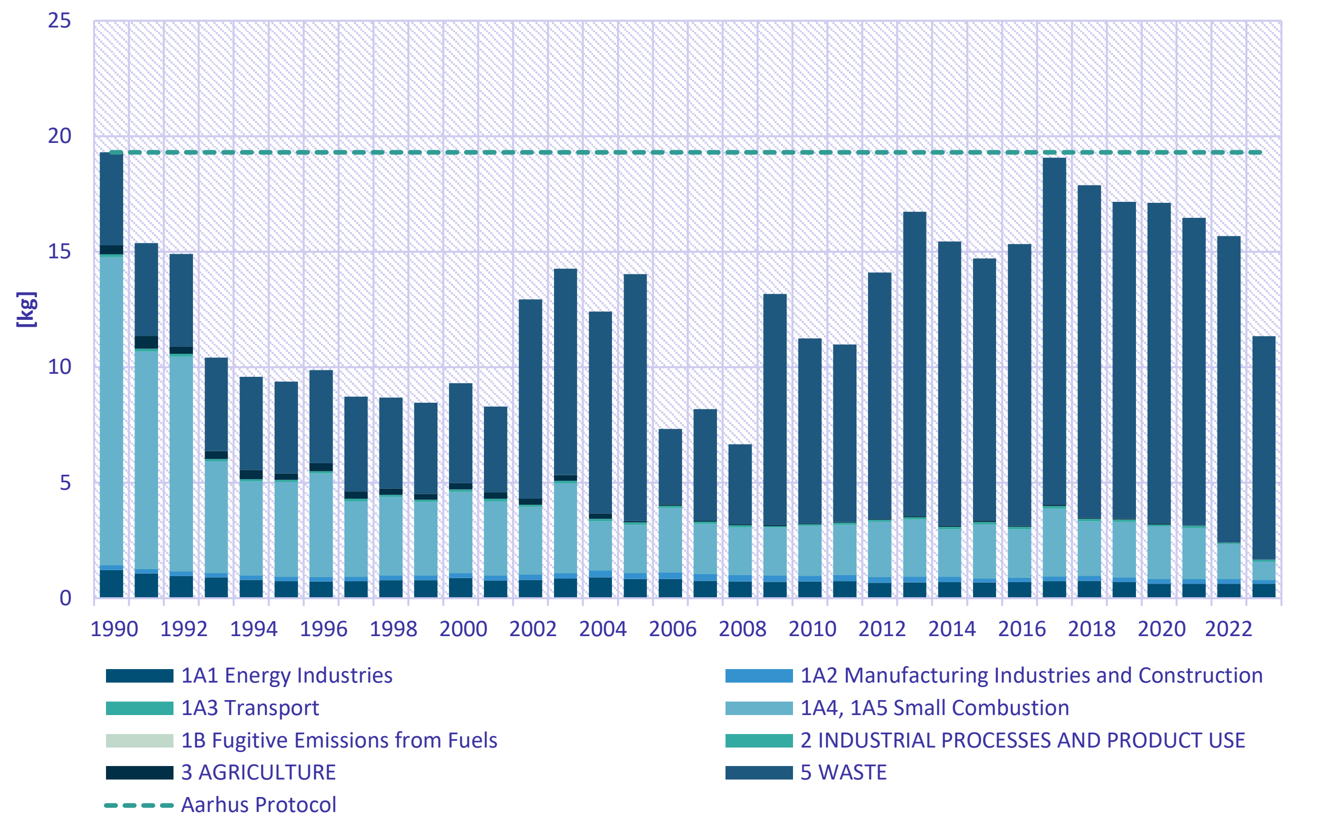


2.4.3 Trends in Emissions of HCB

Emissions of HCB are connected to households heating. ***Figure 2.14*** shows a general declining trend since 1990, although since 1995, the trend has been rather fluctuating. It is a result of the number of fuels and their quality in the sector of households. The main contributing category to the emissions of this pollutant is MSW incineration with energy recovery in the whole time series.

No exceedances of the Aarhus protocol were recorded.

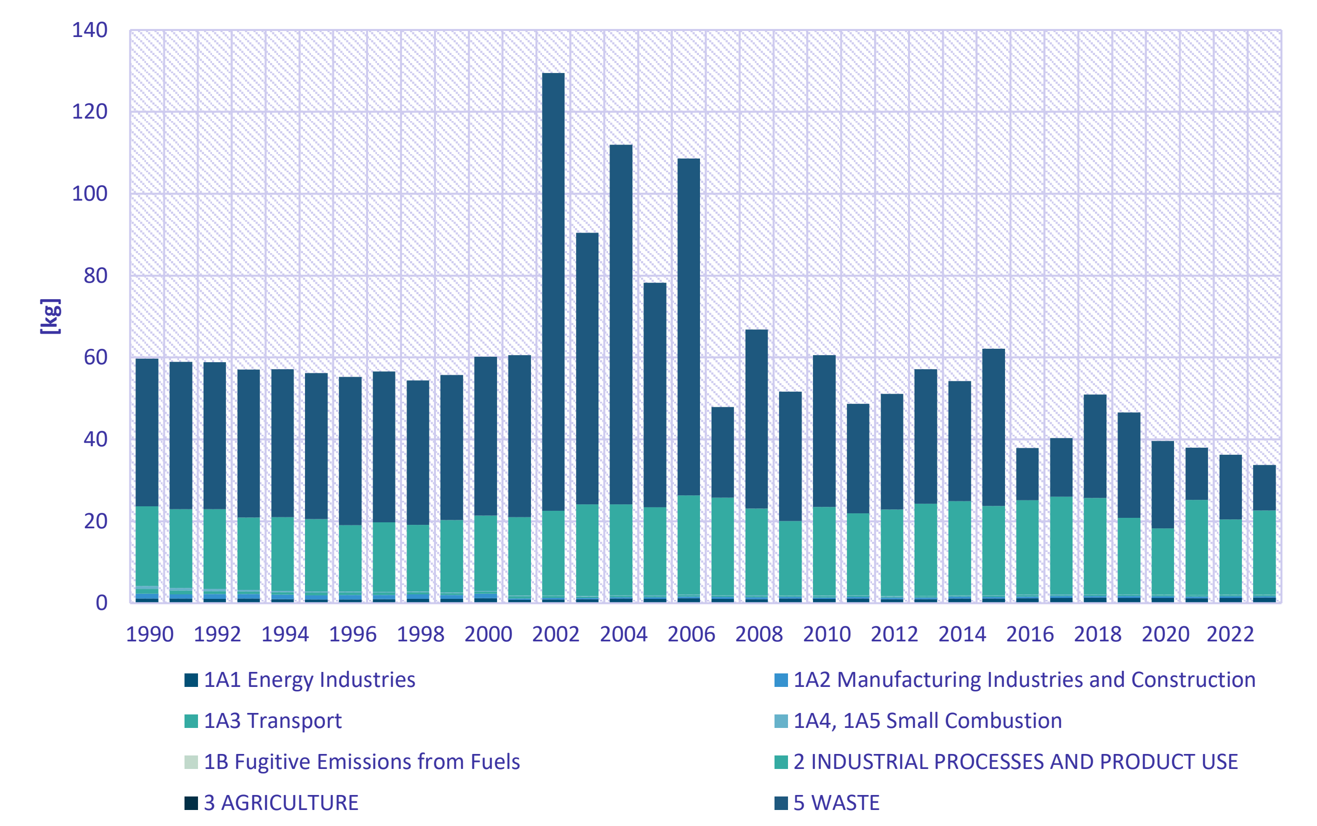
Figure 2.14: *Total HCB emissions by sectors*



2.4.4 Trends in Emissions of PCBs

Emissions of PCB show fluctuating trend due to changes in the Iron and Steel production industry. This activity is the main contributor to the emission of PCBs and its share of total emissions in 2023 was 87%. (***Figure 2.15***).

Figure 2.15: *Total PCBs emissions by sectors*



CHAPTER 3: ENERGY (NFR 1)

Last update: 15.4.2025

3.1 OVERVIEW OF THE SECTOR ENERGY

The energy sector covers the following subsectors: energy industries (NFR **1A1**), stationary combustion in manufacturing and construction (NFR **1A2**), transport (NFR **1A3**), small combustion (NFR **1A4**), non-road mobile machinery (NFR **1A5**) and fugitive emissions (NFR **1B**). The emissions covered by the energy sector originate from fuel combustion (NFR **1A1**, **1A2**, **1A3**, **1A4** and **1A5**) and fugitive emissions (NFR **1B**). These subsectors are further described in the following chapters.

The data sources

a/ NEIS database of stationary large and medium sources providing facility data for nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) sulphur oxides (SOx), ammonia (NH_3), total suspended particles (TSP, PM_{10} and $PM_{2.5}$ are consequently compiled) and carbon monoxide (CO). All data that comes from the database is considered as T3 methodology. In the year 2023, the system contained 13 584 large and medium sources.

b/ COPERT 5 model – this methodology is balancing fifteen different emissions including greenhouse gases from road transport. All data that comes from the model is considered as T3 methodology. A detailed description is provided in ***Chapter 3.6.3 Road Transport***.

c/ Estimations are based on statistical data and emission factors for air pollutants, heavy metals (HM) and persistent organic pollutants (POPs). Reported emissions that use this type of activity data are considered T2 or T1. The overview of categories according to NFR structure and tier level of inventory is presented in the following ***Table 3.1***.

The inventory of air pollutants except for heavy metals and persistent organic pollutants is performed by the National Emission Information System – NEIS. It is a national system of data collection from air pollution sources and released emissions. The reporting duties are bonded to the national legislative obligations for air pollution sources to report their annual balances of fuels, emissions and all auxiliary data necessary for the compilation of final emissions.

The energy subsectors **1A1a**, **1A1b**, **1A1c**, **1A2a**, **1A2b**, **1A2c**, **1A2d**, **1A2e**, **1A2f**, **1A2gviii**, **1A3e**, **1A4ai**, **1A4bi**, **1A4ci**, **1A4cii** covers large and medium energy stationary sources of air pollution in the Slovak Republic.

Table 3.1: *Overview of reported categories, tier or notation key used in the energy sector*

NFR	LONGNAME OF CATEGORY	METHODOLOGY/TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TSP	BC	HM	POPs
ENERGY INDUSTRIES							
1A1a	Public electricity and heat production	T3	T3, NK	T3	T3	T2	T2
1A1b	Petroleum refining	T3	T3	T3	T1	T1, NK	T1, NK
1A1c	Manufacture of solid fuels and other energy industries	T3	T3	T3	T1	T2, NK	T2, NK
STATIONARY COMBUSTION IN MANUFACTURING AND CONSTRUCTION							
1A2a	Iron and steel	T3	T3, NK	T3	T3	T2	T2
1A2b	Non-ferrous metals	T3	NK	T3	T3	T2	T2, NK
1A2c	Chemicals	T3	NK	T3	T3	T2	T2
1A2d	Pulp, Paper and Print	T3	T3, NK	T3	T3	T2	T2
1A2e	Food processing, beverages and tobacco	T3	T3	T3	T3	T2	T2
1A2f	Non-metallic minerals	T3	T3, NK	T3	T3	T1	T1

NFR	LONGNAME OF CATEGORY	METHODOLOGY/TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TSP	BC	HM	POPs
1A2gvii	Mobile combustion in manufacturing industries and construction (please specify in the IIR)	T1	T1	T1	T1	T1, NK	T1, NK
1A2gviii	Other (please specify in the IIR)	T3	T3	T3	T3	T2	T2
TRANSPORT							
1A3ai(i)	International aviation LTO (civil)	T3	T3	T3	T3	NK	NK
1A3aii(i)	Domestic aviation LTO (civil)	T3	T3	T3	T3	NK	NK
1A3bi	Road transport: Passenger cars	T3	T3	T3	T3	T3	T3
1A3bii	Road transport: Light-duty vehicles	T3	T3	T3	T3	T3, NK	T3
1A3biii	Road transport: Heavy-duty vehicles and buses	T3	T3	T3	T3	T3, NK	T3
1A3biv	Road transport: Mopeds & motorcycles	T3	T3	T3	T3	T3, NK	T3
1A3bv	Road transport: Gasoline evaporation	T3, NK	NK	NK	NK	NK	NK
1A3bvi	Road transport: Automobile tyre and brake	NK	NK	T3	T3	T3	NK
1A3bvii	Road transport: Automobile road abrasion	NK	NK	T3	NK	T3	NK
1A3c	Railways	T1	T1	T1	T1	T1	T1
1A3di(ii)	International inland waterways	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK
1A3dii	National navigation (shipping)	T2	T2	T2	T2	T2	T2
1A3ei	Pipeline transport	T3	NK	T3	T3	NK	NK
1A3eii	Other (please specify in the IIR)	NK	NK	NK	NK	NK	NK
SMALL COMBUSTION							
1A4ai	Commercial/institutional: Stationary	T3	T3, NK	T3	T3	T2	T2
1A4aii	Commercial/institutional: Mobile	T1	T1	T1	T1	T1, NK	T1, NK
1A4bi	Residential: Stationary	T2	T2	T2	T2	T2	T2
1A4bii	Residential: Household and gardening (mobile)	T1	T1	T1	T1	T1, NK	T1, NK
1A4ci	Agriculture/Forestry/Fishing: Stationary	T3	T1	T3	T3	T2	T2
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	T1	T1	T1	T1	T1, NK	T1, NK
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NK	NK	NK	NK	NK	NK
NON-ROAD MOBILE MACHINERY							
1A5a	Other stationary (including military)	T3	T3	T3	T3	T2	T2
1A5b	Other, Mobile (including military, land based and recreational boats)	T2, NK	T2, NK	T2, NK	T2, NK	T2, NK	NK
FUGITIVE EMISSIONS							
1B1a	Fugitive emission from solid fuels: Coal mining and handling	T1, NK	NK	T1	NK	NK	NK
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	T1	T1	T1	T1	T1	T1, NK
1B1c	Other fugitive emissions from solid fuels	NK	NK	NK	NK	NK	NK
1B2ai	Fugitive emissions oil: Exploration, production, transport	T1, NK	NK	NK	NK	NK	NK
1B2aiv	Fugitive emissions oil: Refining and storage	T1	NK	T1	NK	T1	T1, NK
1B2av	Distribution of oil products	T1, NK	NK	NK	NK	NK	NK
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	T1, NK	NK	NK	NK	NK	NK
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NK	NK	NK	NK	NK	NK
1B2d	Other fugitive emissions from energy production	T1, NK	NK	NK	NK	NK	NK

3.2 TRENDS IN THE SECTOR ENERGY

Table 3.2 below shows an overall decreasing trend of emissions of the main pollutants since 1990 due to the strict air protection legislation. This, together with the advancements and progress of abatement systems led to the reduction of air pollutants as a result of the transposition of European legislation, continual improvement in the national legislation and the endeavour of the industry to implement BAT technologies (if the investments are available).

Categories of the energy sector are the key categories for most of the main pollutants, heavy metals and POPs. The most significant categories are **1A1a**, which is the key category for NOx, SOx, $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Ni, Se, PCDD/F, HCB and **1A4bi** is the key category for NOx, SOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Cd, Hg, As, Cr, Ni, Zn, PCDD/F, PAHs, HCB and PCBs.

Table 3.2: *Overview of emissions in the energy sector*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	115.9995	179.1462	129.8438	0.2648	93.1573	97.1536	110.0795	8.3984	948.5171
1995	99.9972	105.2202	111.6195	0.3710	47.8288	51.1214	59.3662	4.6872	580.9085
2000	96.3175	87.1851	104.7169	0.6150	39.6983	43.0982	50.8061	3.8368	449.5526
2005	93.1888	87.0226	76.1362	0.9347	32.9173	35.2474	42.7842	4.1491	454.2587
2010	75.6564	75.0706	61.7126	0.8457	23.9287	25.5266	28.5005	3.7562	353.4863
2011	66.9527	68.5090	59.2765	0.7742	22.0000	23.5271	26.3414	3.2518	308.0055
2012	64.7098	71.7075	50.2692	0.7802	23.4019	24.9999	27.8876	3.4444	320.7742
2013	56.2694	66.2130	45.7950	0.7661	21.4062	22.9960	25.8027	2.9948	279.5444
2014	52.3516	47.5106	37.6786	0.5969	13.8837	15.1962	17.4308	2.0854	192.2712
2015	54.3450	58.3428	59.1509	0.6747	18.1392	19.6135	22.1307	2.5681	234.6193
2016	51.0932	59.9592	17.5267	0.7915	18.2507	19.7132	22.1493	2.5983	239.9353
2017	49.6954	59.2264	17.6599	0.7359	18.2798	19.6716	22.0902	2.5236	237.3207
2018	47.8901	49.7619	12.2353	0.6845	14.5881	15.9111	18.1118	2.1380	191.0231
2019	45.6707	50.9092	9.2064	0.6901	15.0811	16.3959	18.5831	2.1645	197.2111
2020	43.4107	48.7543	8.1983	0.6334	14.6333	15.8168	17.7495	2.0589	194.3576
2021	44.4345	47.4209	7.9184	0.6930	14.2877	15.5498	17.6335	1.9665	196.5045
2022	42.5970	47.0930	8.5424	0.7202	13.7534	14.9861	16.9765	1.8726	195.1749
2023	39.1130	41.7749	8.8003	0.7094	11.5132	12.6950	14.5092	1.6622	165.6474
1990/2023	**-66%**	**-77%**	**-93%**	**168%**	**-88%**	**-87%**	**-87%**	**-80%**	**-83%**
2022/2023	**-8%**	**-11%**	**3%**	**-2%**	**-16%**	**-15%**	**-15%**	**-11%**	**-15%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	31.2608	0.8201	1.3110	1.4844	4.4949	8.7853	7.8584	5.4911	18.1721
1995	26.7564	0.7416	0.9262	0.8740	2.4880	5.8924	3.0915	2.8387	11.1870
2000	25.4847	0.9630	1.0651	0.8439	2.1181	4.7177	1.3440	2.8716	10.2268
2005	10.0079	0.6250	0.5863	0.4183	2.2866	6.6071	1.1847	3.0048	12.8364
2010	2.2786	0.3824	0.3329	0.2400	2.0916	6.8930	1.2951	2.2666	12.2625
2011	2.2920	0.3735	0.3650	0.2546	2.0382	6.5481	1.2399	2.2318	12.1525
2012	2.3105	0.3914	0.3482	0.2427	2.0714	6.8815	1.0487	2.0898	12.4992
2013	4.0182	0.3751	0.3482	0.2678	2.6281	21.1598	1.1262	2.0085	16.0215
2014	3.9041	0.2454	0.3353	0.2483	2.2356	21.4474	1.0570	1.8114	13.6574
2015	4.3475	0.3240	0.3400	0.2600	2.6010	23.9031	1.2290	1.8439	15.8415
2016	4.5803	0.3464	0.3516	0.2658	2.7067	25.5494	1.2099	1.7140	16.7107
2017	4.4886	0.3348	0.3655	0.2748	2.6569	24.7621	1.1520	1.7312	16.6825
2018	4.6269	0.2788	0.3511	0.2606	2.5584	26.6331	1.0425	1.6967	16.1892
2019	4.6532	0.2940	0.3516	0.2602	2.5593	27.1960	1.0698	1.4795	16.2754
2020	4.3581	0.2907	0.3445	0.2513	2.3975	25.4888	0.9938	1.2297	15.1198

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2021	4.5664	0.2894	0.3538	0.2625	2.4721	25.9889	1.0732	1.1385	15.7003
2022	4.6337	0.2745	0.3416	0.2567	2.4837	27.5171	1.0500	1.0695	15.6556
2023	4.4832	0.2445	0.3026	0.2267	2.3216	27.1232	1.0003	0.8938	14.6617
1990/2023	**-86%**	**-70%**	**-77%**	**-85%**	**-48%**	**209%**	**-87%**	**-84%**	**-19%**
2022/2023	**-3%**	**-11%**	**-11%**	**-12%**	**-7%**	**-1%**	**-5%**	**-16%**	**-6%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	650.0958	13.6818	10.0304	5.8588	7.1814	37.1881	14.7650	4.2008
1995	574.8074	6.8658	5.1294	2.9701	3.5802	18.9674	5.0333	2.8714
2000	786.8567	5.5923	4.3048	2.3866	2.9048	15.5875	4.6041	3.0191
2005	278.1734	6.4041	4.8144	2.6398	3.3379	17.5839	3.1750	1.9084
2010	19.6463	6.1796	4.6772	2.5406	3.2339	16.7953	3.1274	1.8281
2011	19.9611	5.8013	4.4291	2.3877	3.0428	15.9037	3.1783	1.9381
2012	22.7386	6.2361	4.7518	2.5606	3.2812	17.0061	3.3077	1.7331
2013	22.8973	5.7766	4.4530	2.3774	3.0503	16.0048	3.4152	1.7988
2014	17.9850	3.5316	2.8447	1.4898	1.8705	9.8886	2.9838	1.9432
2015	18.3345	4.8520	3.8251	2.0239	2.5844	13.4473	3.1917	1.9501
2016	20.4094	5.1207	4.0258	2.1540	2.7409	14.2001	2.9801	2.0469
2017	20.4403	4.9642	4.0005	2.0792	2.7044	13.9322	3.8762	2.1499
2018	21.5257	3.9065	3.2174	1.6656	2.1480	11.0833	3.3226	2.1782
2019	21.3373	4.0570	3.3250	1.7229	2.2472	11.4817	3.3002	2.1595
2020	19.7766	4.0066	3.2625	1.6875	2.2353	11.3072	3.1194	2.0806
2021	24.0997	3.8944	3.2317	1.6729	2.1740	11.0610	3.0386	2.0302
2022	16.5359	3.6839	3.0394	1.5941	2.0769	10.4956	2.3492	2.0511
2023	12.7230	3.0999	2.5541	1.3566	1.7352	8.8324	1.5961	2.0576
1990/2023	**-98%**	**-77%**	**-75%**	**-77%**	**-76%**	**-76%**	**-89%**	**-51%**
2022/2023	**-23%**	**-16%**	**-16%**	**-15%**	**-16%**	**-16%**	**-32%**	**0.3%**

Shares of categories in emissions of individual pollutants in the energy sector are shown in ***Figure 3.1*** below. Transport categories are the main contributor to NOx emissions, especially category **1A3bi** (Passenger cars) with a share of 23% of emissions in the energy sector in 2023 (***Figure 3.1***). Emissions in these categories decrease slowly.

Emissions of NMVOC are emitted mostly by the category **1A4bi** (Residential: Stationary). In 2023, it was almost 54% of all NMVOC emissions in the energy sector (***Figure 3.1***) and almost 30% of the total emissions of this pollutant. Emission is relatively stable, with only slight fluctuation since 2005.

SOx emissions are mainly emitted by category **1A1a** (26% in 2023) in the energy sector (***Figure 3.1***). This category shows an overall decreasing trend except for the year 2015. The increase in 2015 and the drop in 2016 were caused by one source of Slovak power plants (***Table 3.2***). This increase was in ENO A K1, K2 – granulated boiler: higher deployment of not abated ENO B3.4 blocks during the extensive reconstruction of ENO B1.2 blocks (from the SE annual report). The source according to the NEIS database burned double the amount of brown coal as in the previous year 2014.

Residential heating is the main contributor to emissions of $PM_{2.5}$, PM_{10} and TSP. From ***Table 3.2*** is clear that emissions of $PM_{2.5}$ (the trend for PM_{10} and TSP is very similar) show a decreasing trend since 1990 although since 2005 emissions in this category are relatively stable. In 2023 this category contributed almost 81% of total emissions of $PM_{2.5}$ in the energy sector (***Figure 3.1***).

CO emissions are emitted mostly by residential heating and road transport (***Figure 3.1***).

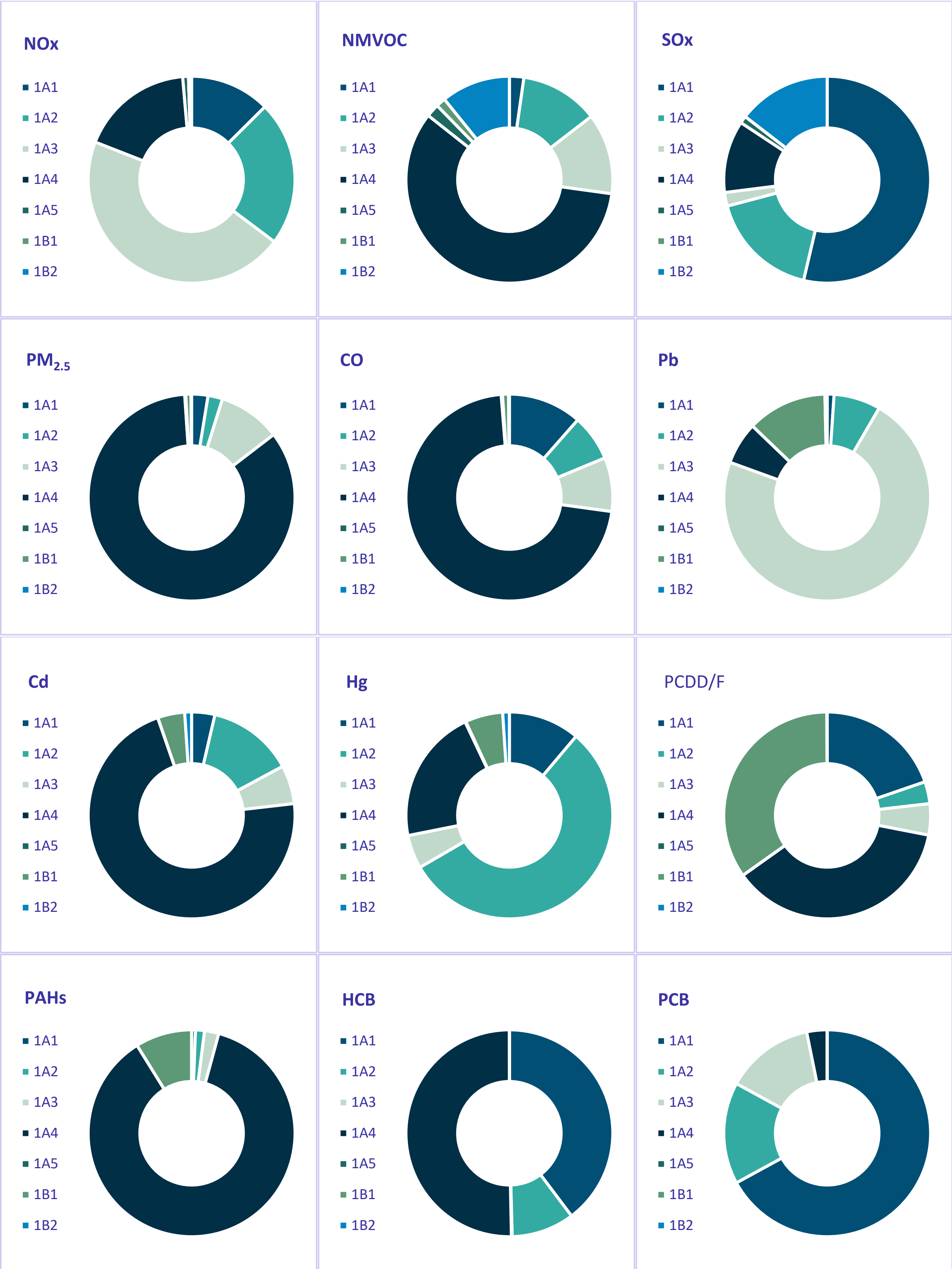
Until 2005, the main contributor to emissions of Pb was the incineration of municipal waste with energy recovery allocated in category **1A1a**. Reconstruction of both MSW incineration plants led to a significant decrease in emissions. The decrease in Pb emission from road transport in 2000 was caused by the ban on lead addition to fuels. Since 2006 the main contributor to these emissions is category **1A2a**.

Emissions of Cd decreased only slightly in this sector since 1990. Similar to Pb emissions, MSW incineration plants contributed significantly to its emissions until 2005 (***Table 3.2***). Since then, combustion activities in iron and steel production and households heating have become important.

The amount of emissions of PCDD/F emitted into the air in the Slovak Republic is affected mostly by MSW incineration plants. Since reconstruction, both plants reduced emissions of this pollutant significantly. Category **1A1a** is the main contributor to emissions of PCBs in the whole time series (***Figure 3.1***). In 2023, 67% of emissions of PCB were emitted by this category in the energy sector.

PAHs and HCB emissions are emitted mostly by residential heating. The emission trend of these pollutants is slightly decreasing in the energy sector since 2005 (***Figure 3.1***).

Figure 3.1: *Shares of categories in emissions of individual pollutants in 2023 – energy sector*



3.3 RECALCULATIONS, IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

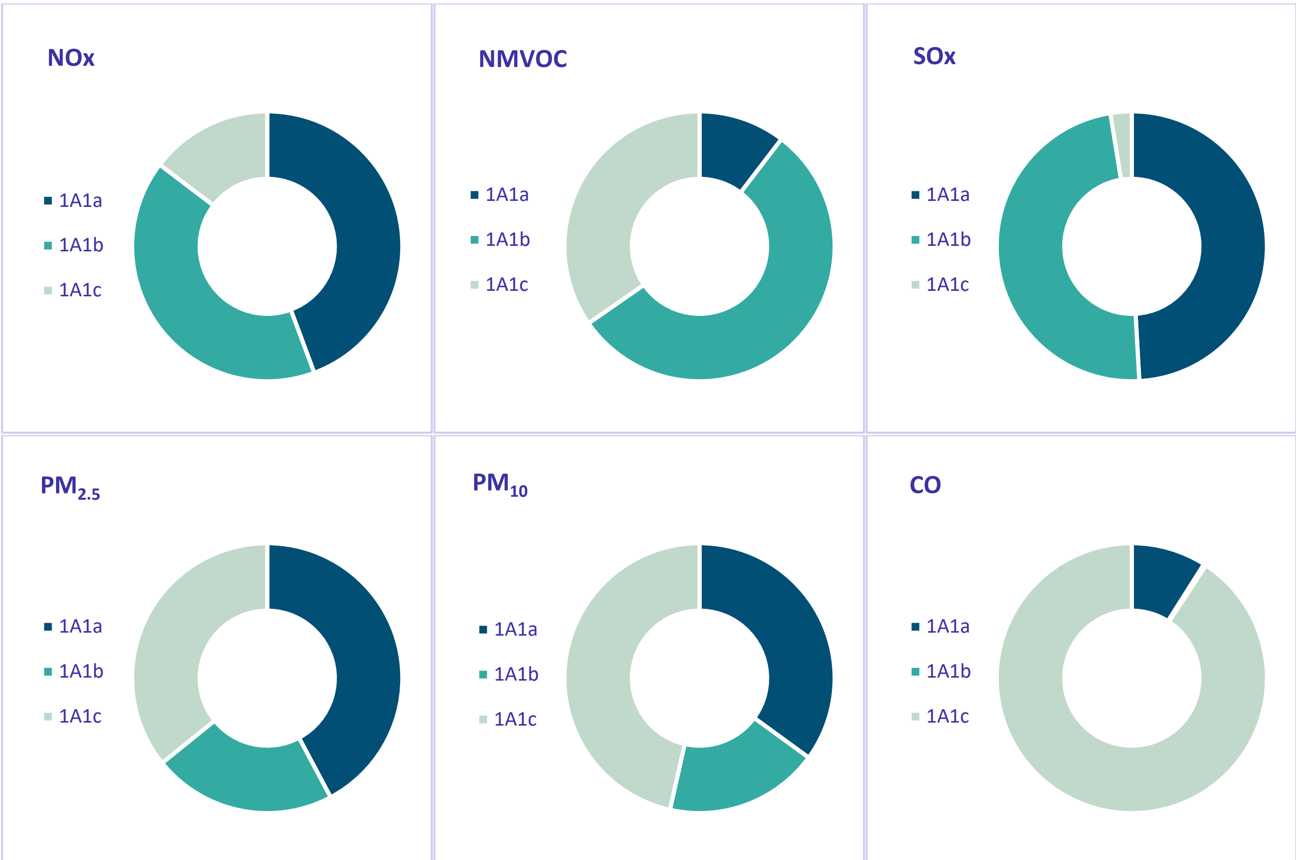
The energy sector undertakes continuing improvements. In submission 2025, an updated COPERT model was introduced according to ***Recommendation No SK-1A3b-2024-0001***. Also new time-series was introduced in the category **1A5b** and new activity data and emission factors were used in category **1.B** Fugitive emissions (more details see ***Chapter 3.8***). Also ***Recommendations No SK-1A1ci-2022-0001***, ***No SK-1A2a-2023-0002***, ***No SK-1A1a-2024-0001***, ***No SK-1A2gviii-2024-0001***, and ***SK-1A4bi-2024-0001*** were implemented in this submision. The detailed analysis of the allocation of sources to the NFR categories across the whole NEIS database is planned for the next period, as it was identified that some sources might be allocated incorrectly within the database.

3.4 ENERGY INDUSTRIES (NFR 1A1)

3.4.1 Overview

Category energy industries **1A1** covers the following subcategories: Public Electricity and Heat Production (**1A1a**), Petroleum Refining (**1A1b**) and Manufacture of Solid Fuels and Other Energy Industries (**1A1c**). These subcategories are further described in the following chapters.
Energy industries are a substantial contributor to most air pollutants. Category **1A1a**, which also includes municipal waste incineration with energy utilization contributes to most main pollutants, heavy metals and POPs. Shares of emissions of main pollutants in individual subcategories are shown in ***Figure 3.2***.

Figure 3.2: *Shares of main pollutants emissions in category 1A1 in 2023*



3.4.2 Public Electricity and Heat Production (NFR 1A1a)

3.4.2.1 Overview

This activity covers emissions from combustion plants as point sources. The emissions considered in this activity are released by a controlled combustion process (boiler emissions, furnace emissions, emissions from gas turbines or stationary engines) and are mainly characterised by the types of fuels used. Activities listed within this category are shown in ***Table 3.3***.

This category includes the power installations for the production of electricity and heat and the combined heat-power installations (CHP). The emissions from the combustion of municipal waste are included because of the energy recovery from the combustion process.

Table 3.3: *Activities according to national categorization included in category 1A1a*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE S., NACE: 35.1; 35.2; 35.3
5.1. Waste incineration plants (with the specification for MWI) *a) combustion of hazardous waste with a projected capacity in tonnes /day* *b) combustion of non-hazardous waste with a capacity in tonnes /hour*	combustion

This category is key for emissions of NOx, SOx, $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Ni, Se, PCDD/F and HCB. From emission data is a visible increase in 2015 and a drop in 2016, the most significant in SOx. This annual fluctuation is caused by one source of Slovak power plants. This increase was in ENO A K1, K2 – granulated boiler: higher deployment of not abated ENO B3.4 blocks during the extensive reconstruction of ENO B1.2 blocks (from the SE annual report). The source according to the NEIS database burned double the amount of brown coal as in the previous year 2014.

The source took advantage of the last year of the special survival regime (maximum 20,000 hours of operation from 1.1.2008 to 31.12.2015) during which they did not apply any Emission Limits. From 1.1.2016, such devices can only be operated if they are applied to new equipment to comply with national legislation, so the expected significant reduction in SOx emissions was visible in 2016 emissions.

Emission of heavy metals and POPs decreased most significantly after the year 2005. This decrease is connected mainly to the reconstruction of MSW incineration plants which use waste to produce electricity and heat for households and other companies using the CHP system.

The increase in $PM_{2.5}$ emissions in 2005 was caused by a single source (Elektráreň Vojany). As mentioned in their Annual report, in 2005, the trend of gradual reduction of emissions of basic pollutants into the air, which was the result of increased use of reconstructed fluid combustion boilers and reliable operation of flue gas cleaning technologies, stopped. In this period, it prevailed in SE, a. s., by trying to use the remaining life of equipment which, in accordance with the air protection legislation of the Slovak Republic, could continue to be operated in the mode of exceeding the established emission limits during that period. The increased deployment of units 3 and 4 at Elektrárne Vojany in 2005 led to an increase in the absolute amount of $PM_{2.5}$ released into the air. Mitigation of these negative phenomena in SE conditions occurred only after 2006 and subsequently after 2010 when the Slovak air protection legislation no longer permitted the operation of the mentioned facilities due to non-compliance with the prescribed emission limits for the release of harmful substances into the air (***Recommendations No SK-1A1a-2024-0001***).

The emission data of air pollutants is presented in ***Table 3.4***. The emissions originating from MSW incineration with energy utilisation are described in ***Chapter 6.6.2***.

Table 3.4: *Overview of emissions in category 1A1a*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	20.8652	0.1699	60.6572	NO	5.0981	6.1196	8.1175	0.1747	2.6616
1995	20.9769	0.1708	60.9819	NO	5.1254	6.1524	8.1609	0.1449	2.6759

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2000	26.3778	0.1559	58.8624	NO	6.3197	7.5860	10.0625	0.1322	2.6729
2005	15.2963	0.1529	51.9931	NO	7.2630	7.8104	11.7351	0.1485	2.3064
2010	9.5278	0.1612	43.1548	NO	0.4317	0.5171	0.6571	0.0117	1.6932
2011	9.7997	0.1676	45.1935	NO	0.5053	0.5963	0.7224	0.0140	1.6207
2012	8.9735	0.1799	39.3491	NO	0.4601	0.5735	0.7016	0.0134	1.7577
2013	7.8687	0.1766	36.1728	NO	0.3722	0.4683	0.6452	0.0110	1.8626
2014	7.0565	0.1678	29.2536	NO	0.3507	0.4282	0.5545	0.0105	1.6862
2015	6.5387	0.1702	50.8989	0.0148	0.4611	0.5645	0.7051	0.0139	1.6742
2016	4.2010	0.1530	9.2366	0.0202	0.2072	0.2494	0.3018	0.0062	2.1715
2017	3.8701	0.1504	8.6485	0.0194	0.1494	0.1796	0.2277	0.0044	1.7777
2018	3.6499	0.1438	4.4968	NO	0.1168	0.1363	0.1675	0.0035	1.5783
2019	3.3581	0.1324	2.3546	0.0000	0.1388	0.1499	0.1774	0.0042	1.4240
2020	2.8764	0.1157	1.8447	NO	0.1375	0.1541	0.1861	0.0042	1.4527
2021	2.6306	0.1145	1.8073	NO	0.1312	0.1412	0.1586	0.0041	1.8778
2022	2.4764	0.1167	1.8718	NO	0.1051	0.1194	0.1476	0.0033	1.8739
2023	2.1764	0.0978	2.3200	NO	0.1244	0.1340	0.1496	0.0039	1.7094
1990/2023	**-90%**	**-42%**	**-96%**	**-**	**-98%**	**-98%**	**-98%**	**-98%**	**-36%**
2022/2023	**-12%**	**-16%**	**24%**	**-**	**18%**	**12%**	**1%**	**19%**	**-9%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	18.9513	0.6584	0.6509	0.5422	1.0013	0.6171	5.5355	4.6181	6.7499
1995	16.6790	0.5588	0.5157	0.3991	0.4713	0.2721	1.4589	2.1537	2.8348
2000	22.9953	0.7615	0.6881	0.5160	0.4903	0.2667	0.4823	2.2348	2.6416
2005	7.7642	0.2657	0.2837	0.2045	0.4864	0.2660	0.4435	2.3404	2.6423
2010	0.0904	0.0144	0.0678	0.0410	0.3752	0.1703	0.3383	1.8462	1.6851
2011	0.0907	0.0145	0.0684	0.0418	0.3676	0.1565	0.3226	1.8071	1.5465
2012	0.0841	0.0134	0.0633	0.0390	0.3353	0.1578	0.3288	1.6487	1.5684
2013	0.0812	0.0129	0.0613	0.0372	0.3180	0.1383	0.2721	1.5634	1.3682
2014	0.0755	0.0124	0.0567	0.0333	0.2871	0.1292	0.2226	1.4090	1.2752
2015	0.0775	0.0125	0.0581	0.0347	0.2909	0.1193	0.2266	1.4277	1.1770
2016	0.0735	0.0122	0.0550	0.0326	0.2775	0.1285	0.2385	1.3603	1.2718
2017	0.0722	0.0121	0.0548	0.0313	0.2792	0.1428	0.2013	1.3706	1.4089
2018	0.0695	0.0119	0.0531	0.0300	0.2655	0.1466	0.1905	1.3020	1.4461
2019	0.0630	0.0111	0.0485	0.0285	0.2263	0.0993	0.1650	1.1049	0.9771
2020	0.0536	0.0098	0.0418	0.0251	0.1802	0.0616	0.1259	0.8751	0.6074
2021	0.0491	0.0090	0.0395	0.0235	0.1591	0.0818	0.1133	0.7734	0.8162
2022	0.0478	0.0090	0.0367	0.0213	0.1491	0.0624	0.1172	0.7207	0.6260
2023	0.0435	0.0087	0.0335	0.0195	0.1265	0.0437	0.0997	0.6065	0.4308
1990/2023	**-100%**	**-99%**	**-95%**	**-96%**	**-87%**	**-93%**	**-98%**	**-87%**	**-94%**
2022/2023	**-9%**	**-4%**	**-9%**	**-8%**	**-15%**	**-30%**	**-15%**	**-16%**	**-31%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	628.9964	0.0014	0.0017	0.0012	0.0007	0.0050	1.1944	1.1419
1995	557.8771	0.0010	0.0010	0.0008	0.0003	0.0031	0.7103	0.9188
2000	770.9188	0.0012	0.0012	0.0010	0.0003	0.0037	0.8488	1.2311
2005	258.4235	0.0011	0.0011	0.0009	0.0003	0.0035	0.8142	1.0903
2010	0.8329	0.0011	0.0013	0.0010	0.0003	0.0038	0.7171	1.0763
2011	0.8801	0.0012	0.0014	0.0011	0.0003	0.0040	0.7330	1.1414
2012	0.7982	0.0011	0.0015	0.0010	0.0003	0.0040	0.6690	1.0135
2013	0.7983	0.0011	0.0015	0.0011	0.0003	0.0041	0.6542	1.0173
2014	0.8932	0.0013	0.0016	0.0011	0.0003	0.0043	0.6907	1.1737

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
2015	0.8607	0.0012	0.0016	0.0011	0.0004	0.0044	0.6697	1.1170
2016	0.9042	0.0013	0.0016	0.0011	0.0003	0.0043	0.6914	1.1965
2017	0.9550	0.0013	0.0016	0.0012	0.0003	0.0043	0.7273	1.2760
2018	1.0025	0.0014	0.0016	0.0012	0.0003	0.0045	0.7476	1.3467
2019	0.9803	0.0013	0.0016	0.0012	0.0003	0.0044	0.6959	1.3289
2020	0.9331	0.0013	0.0015	0.0011	0.0003	0.0041	0.6308	1.2774
2021	0.9303	0.0013	0.0016	0.0012	0.0003	0.0044	0.6221	1.2550
2022	0.9443	0.0013	0.0016	0.0011	0.0003	0.0043	0.6222	1.2985
2023	0.9859	0.0013	0.0015	0.0012	0.0002	0.0043	0.6281	1.3772
1990/2023	**-100%**	**-1%**	**-10%**	**-4%**	**-67%**	**-14%**	**-47%**	**21%**
2022/2023	**4%**	**3%**	**-3%**	**1%**	**-11%**	**-1%**	**1%**	**6%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.5*** below. Incineration of MSW is included in biomass (biomass fraction) or other fuels (non-biomass fraction).

Table 3.5: *Overview of activity data in category 1A1a*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	386.37	67 039.83	36 381.46	NO	NO
1995	368.67	67 608.67	36 386.08	NO	NO
2000	443.21	65 432.41	34 459.25	NO	1 096.91
2005	393.28	65 937.71	25 852.54	77.70	1 700.25
2010	471.08	48 138.63	20 379.21	2 385.24	1 693.49
2011	430.75	46 672.38	25 678.60	2 869.79	1 833.47
2012	522.43	44 238.33	23 100.57	3 841.03	1 619.98
2013	343.39	41 156.77	19 585.56	4 388.67	1 900.12
2014	210.28	37 326.16	12 489.39	4 567.79	2 243.08
2015	225.52	38 769.06	13 854.96	4 995.70	2 096.86
2016	291.55	36 753.64	13 274.54	4 271.98	2 244.23
2017	132.43	37 815.53	13 709.93	3 875.10	2 391.67
2018	112.58	35 175.81	14 600.15	4 138.96	2 504.49
2019	114.58	28 330.00	21 959.76	3 999.56	2 315.87
2020	72.16	21 365.92	26 783.40	3 722.41	2 241.11
2021	56.82	20 398.62	32 704.33	4 797.22	2 191.11
2022	99.11	18 141.84	18 109.02	4 460.94	2 268.80
2023	83.07	14 660.30	17 945.07	4 105.70	2 415.19
1990/2023	**-79%**	**-78%**	**-51%**	**-**	**-**
2022/2023	**-16%**	**-19%**	**-1%**	**-8%**	**6%**

3.4.2.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.6***).

Emissions of NH_3 are recorded only for the last four years. Emission presence is linked with the usage of DENOX abatements technologies.

Table 3.6: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	201.00	1.64	584.32	78.20	62.80%	75.39%	25.64

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023}, expert estimation and special source[1] (***Table 3.7***).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:

E_i = annual emission of pollutant *i*,

$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,

$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3.7: *Emission factors for calculating emissions of heavy metals and POPs*

TYPE OF FUELS		LIQUID FUELS		GASEOUS FUELS		
TYPE OF FIRE PLACES		ALL TYPES OF BOILERS	STATIONARY ENGINES	ALL TYPES OF BOILERS	STATIONARY ENGINES	GAS TURBINES
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth), (50 – 100 MWth), (> 100 MWth)	(-)	(≤ 5 MWth), (5 – 50 MWth), (50 – 100 MWth), (> 100 MWth)	(-)	(-)
Pb	[mg/GJ]	4.56	4.07	0.0015	0.04	0.0015
Cd	[mg/GJ]	1.2	1.36	0.00025	0.003	0.00025
Hg	[mg/GJ]	0.341	1.36	0.1	0.1	0.1
As	[mg/GJ]	3.98	1.81	0.12	0.05	0.12
Cr	[mg/GJ]	2.55	1.36	0.00076	0.05	0.00076
Cu	[mg/GJ]	5.31	2.72	0.000076	0.01	0.000076
Ni	[mg/GJ]	255	1.36	0.00051	0.05	0.00051
Se	[mg/GJ]	2.06	6.79	0.0112	0.2	0.0112
Zn	[mg/GJ]	87.8	1.81	0.0015	2.91	0.0015
PCDD/F	[ng I-TEQ/GJ]	2.5	0.99	0.5	0.57	0.5
B(a)P	[mg/GJ]	3.678	116	0.56	1.2	0.56
B(b)F	[mg/GJ]	12.673	502	0.84	9	0.84
B(k)F	[mg/GJ]	3.968	98.7	0.84	1.7	0.84
I()P	[mg/GJ]	6.484	187	0.84	1.8	0.84
PAHs	[mg/GJ]	26.803	903.7	3.08	13.7	3.08
HCB	[µg/GJ]	-	0.22	0.00308	-	0.00308
PCBs	[µg/GJ]	3.334	0.00013	-	-	-

TYPE OF FUELS		HARD COAL	BROWN COAL	BIOMASS
TYPE OF FIRE PLACES		FLUIDIZED BED BOILERS	FLUIDIZED BED BOILERS	FLUIDIZED BED BOILERS
		THERMAL CAPACITY		
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth), (50 – 100 MWth), (> 100 MWth)	(≤ 5 MWth), (5 – 50 MWth), (50 – 100 MWth), (> 100 MWth)	(≤ 5 MWth), (5 – 50 MWth), (50 – 100 MWth), (> 100 MWth)
Pb	[mg/GJ]	0.515	2.037	1.606
Cd	[mg/GJ]	0.048	0.282	0.169

[1] MODLÍK, M., 2017. Emission factors of heavy metals and POPs from combustion processes. Available at: http://portal.chmi.cz/files/portal/docs/uoco/oez/embil/EmisniFaktoryTKaPOPs.pdf

TYPE OF FUELS		HARD COAL	BROWN COAL	BIOMASS
Hg	[mg/GJ]	0.476	1.5	1.268
As	[mg/GJ]	0.122	0.922	0.871
Cr	[mg/GJ]	4.5	9.1	0.027
Cu	[mg/GJ]	9	1	0.106
Ni	[mg/GJ]	3.399	4.803	0.085
Se	[mg/GJ]	23	45	0.211
Zn	[mg/GJ]	90	8.8	1.991
PCDD/F	[ng I-TEQ/GJ]	2.055	2.778	11.348
B(a)P	[mg/GJ]	2.271	5.148	46.462
B(b)F	[mg/GJ]	5.066	7.621	144.329
B(k)F	[mg/GJ]	2.64	5.321	67.897
I()P	[mg/GJ]	2.232	5.559	33.073
PAHs	[mg/GJ]	12.209	23.649	291.761
HCB	[μg/GJ]	6.7	6.7	5
PCBs	[μg/GJ]	0.244	1.449	2.233

BC emissions were estimated in this submission based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.8***). The calculated BC emission values are presented in ***Table 3.4.***

Table 3.8: *Emission factors for calculating emissions of BC*

EF	UNIT	HEAVY FUEL OIL	GAS OIL	HARD COAL	BROWN COAL	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	35	7	11	11	1	172
PM_{10}	[g/GJ]	25	3	8	8	1	155
$PM_{2.5}$	[g/GJ]	19	1	3	3	1	133
BC	[% of $PM_{2.5}$]	6%	34%	2%	1%	3%	3%

3.4.2.3 Completeness

Emissions are well covered. Ammonia emissions in this category do not occur until 2014 and then in 2018 and 2023.

3.4.2.4 Source-specific Recalculations

Recalculations of BC, heavy metals and POPs emissions were made based on the use of detailed methodologies focused on the combinations of the installation types/fuels used in our country. Emission factors used for calculating emissions of heavy metals and POPs are a combination of default EF from EMEP/EEA GB_{2023}, expert estimation and special source. The differences in emissions in category **1A1a** between the previous and current submissions caused by recalculations are shown in ***Table 3.9***.

Table 3.9: *Differences in emissions (%) in category 1A1a between the previous and current submission caused by recalculations*

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1990	18%	-6%	-18%	-19%	-71%	3%	-14%	49%	0.3%	4%	-0.2%	-56%	-5%	20%
1991	18%	-5%	-16%	-16%	-68%	2%	-15%	48%	0.3%	3%	-0.1%	-54%	-5%	16%
1992	18%	-4%	-14%	-14%	-65%	2%	-15%	46%	0.3%	3%	-0.1%	-52%	-4%	13%
1993	18%	-4%	-11%	-12%	-61%	2%	-16%	42%	0.2%	1%	-0.1%	-50%	-4%	10%
1994	18%	-4%	-11%	-12%	-61%	2%	-17%	37%	0.2%	-0.2%	-0.1%	-50%	-4%	9%
1995	18%	-4%	-11%	-12%	-61%	1%	-18%	29%	0.2%	-2%	-0.1%	-50%	-4%	9%
1996	16%	-4%	-12%	-12%	-62%	1%	-19%	18%	0.1%	-4%	-0.1%	-51%	-4%	8%
1997	15%	-3%	-11%	-11%	-60%	1%	-20%	6%	0.1%	-6%	-0.1%	-49%	-4%	7%
1998	14%	-3%	-10%	-10%	-57%	1%	-21%	-6%	0.1%	-7%	-0.1%	-48%	-4%	6%
1999	12%	-3%	-10%	-11%	-59%	1%	-21%	-16%	0.03%	-8%	-0.1%	-49%	-4%	6%
2000	13%	-3%	-9%	-10%	-56%	0.5%	-21%	-21%	0.03%	-8%	-0.1%	-47%	-3%	5%

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
2001	9%	-5%	-15%	-15%	-69%	0.002%	-13%	-30%	-0.3%	-3%	-0.1%	-55%	-3%	10%
2002	12%	-4%	-12%	-12%	-63%	3%	-12%	-26%	3%	0.5%	-0.1%	-51%	-1%	8%
2003	7%	-9%	-26%	-22%	-79%	7%	-17%	-24%	7%	-7%	-0.2%	-51%	-0.1%	8%
2004	7%	-8%	-23%	-18%	-77%	16%	-11%	-14%	16%	0.2%	-0.2%	-47%	4%	7%
2005	8%	-8%	-22%	-19%	-76%	6%	-23%	-24%	6%	-13%	-0.2%	-48%	-2%	6%
2006	3%	-86%	-82%	-47%	-94%	2%	-30%	-34%	2%	-21%	-35%	-47%	-4%	5%
2007	3%	-86%	-82%	-46%	-93%	5%	-23%	-35%	5%	-8%	-35%	-45%	-1%	6%
2008	-4%	-87%	-84%	-51%	-94%	-6%	-23%	-39%	-4%	-8%	-37%	-47%	-5%	6%
2009	3%	-87%	-83%	-51%	-94%	-9%	-8%	-41%	-7%	16%	-33%	-39%	-2%	5%
2010	-0.1%	-87%	-82%	-47%	-93%	-6%	-20%	-39%	-0.4%	1%	-35%	-32%	-0.2%	6%
2011	-0.01%	-85%	-80%	-41%	-92%	4%	-17%	-34%	11%	8%	-30%	-23%	5%	5%
2012	0.3%	-81%	-75%	-23%	-90%	32%	-0.1%	-13%	45%	29%	-25%	-3%	17%	6%
2013	-0.1%	-74%	-67%	2%	-87%	73%	18%	7%	95%	58%	-16%	18%	28%	6%
2014	0.01%	-72%	-64%	8%	-86%	82%	20%	7%	109%	58%	-13%	25%	25%	5%
2015	1%	-78%	-71%	-12%	-89%	42%	-8%	-15%	63%	16%	-19%	18%	19%	5%
2016	0.4%	-57%	-46%	58%	-78%	182%	93%	74%	226%	142%	-3%	41%	35%	4%
2017	0.4%	-46%	-34%	91%	-72%	262%	161%	103%	320%	218%	1%	42%	38%	4%
2018	-0.01%	-29%	-16%	140%	-62%	382%	232%	162%	482%	291%	5%	50%	40%	3%
2019	-0.1%	-40%	-26%	106%	-66%	281%	130%	108%	364%	180%	3%	46%	31%	3%
2020	-0.1%	-44%	-29%	94%	-67%	238%	67%	78%	322%	107%	2%	45%	24%	3%
2021	-0.04%	-32%	-17%	132%	-56%	304%	120%	109%	453%	156%	5%	61%	27%	3%
2022	1%	-26%	-12%	131%	-56%	321%	104%	129%	470%	138%	4%	56%	24%	2%

3.4.3 Petroleum Refining (NFR 1A1b)

3.4.3.1 Overview

The emissions from the refineries are allocated in category **1A1b**. Refineries process crude oil into a variety of hydrocarbon products. The biggest refinery SLOVNAFT is the only petroleum refining company operating in Slovakia, processing approximately 5.7 million tons of crude oil a year. The company is the most important supplier of petrol and diesel fuels in Slovakia. Emissions from petroleum refining, classified by code **1A1b**, concern all combustion activities required to support the refining of petroleum products. A decrease in emissions of SO_x after 2010 was caused by the economic situation of Slovak's biggest refinery Slovnaft. This activity covers emissions released from production and combustion processes within a refinery.

The combustion processes include the heating of crude and petroleum products without contact between flame and products and also industrial waste incineration. Activities listed within this category are shown in ***Table 3.10***.

Table 3.10: *Activities according to national categorization included in category 1A1b*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE S., NACE: 19
5.1. Industrial waste incineration	combustion

Increasing of NH_3 emissions since 2022 is related to the increase in emitted emissions of ammonia from one source of the biggest refinery SLOVNAFT in Slovakia. The overview of emissions in this category is shown in ***Table 3.11***.

Table 3.11: *Overview of emissions in category 1A1b*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	3.7968	1.9928	11.2358	0.0231	0.2306	0.2518	0.2529	0.0424	0.4963

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH₃ [kt]	PM₂.₅ [kt]	PM₁₀ [kt]	TSP [kt]	BC [kt]	CO [kt]
1995	3.8022	1.9956	11.2517	0.0232	0.2309	0.2522	0.2532	0.0425	0.4970
2000	4.6652	2.5278	12.2614	0.0245	0.5848	0.6387	0.6414	0.1076	0.7964
2005	3.1916	1.5070	8.1885	0.0127	0.2439	0.2629	0.2911	0.0449	0.2913
2010	2.8144	1.3846	9.0583	0.0013	0.1499	0.1595	0.1600	0.0276	0.1756
2011	2.0950	1.1533	6.0985	0.0028	0.1043	0.1104	0.1107	0.0192	0.1797
2012	1.7081	1.1991	1.9754	0.0006	0.0814	0.0882	0.0886	0.0150	0.1053
2013	1.3770	1.2277	0.6966	0.0053	0.0834	0.0907	0.0912	0.0153	0.1104
2014	1.1687	1.0975	1.0279	0.0023	0.0456	0.0494	0.0497	0.0084	0.1074
2015	1.3197	1.2988	0.8994	0.0014	0.0445	0.0488	0.0490	0.0082	0.1149
2016	1.6853	0.9778	1.4934	0.0152	0.0690	0.0746	0.0749	0.0127	0.0646
2017	1.6510	0.7354	2.1356	0.0165	0.0810	0.0880	0.0884	0.0149	0.0633
2018	1.6297	0.9479	1.9923	0.0013	0.0914	0.0978	0.0982	0.0168	0.0562
2019	1.4300	0.7329	1.9337	0.0070	0.0824	0.0873	0.0876	0.0152	0.0515
2020	1.7207	0.7663	1.2027	0.0010	0.0664	0.0726	0.0730	0.0122	0.0487
2021	1.8186	0.6868	1.1806	0.0010	0.0723	0.0778	0.0781	0.0133	0.0392
2022	2.0828	0.6111	2.0391	0.0061	0.0943	0.1012	0.1015	0.0173	0.0513
2023	2.0128	0.5182	2.2833	0.0124	0.0647	0.0708	0.0711	0.0119	0.0515
1990/2023	**-47%**	**-74%**	**-80%**	**-46%**	**-72%**	**-72%**	**-72%**	**-72%**	**-90%**
2022/2023	**-3%**	**-15%**	**12%**	**105%**	**-31%**	**-30%**	**-30%**	**-31%**	**1%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0169	0.0013	0.0007	0.0002	IE	IE	0.0018	IE	IE
1995	0.0169	0.0013	0.0007	0.0002	IE	IE	0.0018	IE	IE
2000	0.0169	0.0013	0.0007	0.0002	IE	IE	0.0018	IE	IE
2005	0.0156	0.0012	0.0007	0.0002	IE	IE	0.0017	IE	IE
2010	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
2011	0.0002	0.0001	0.0003	0.0001	IE	IE	0.0002	IE	IE
2012	0.0002	0.0001	0.0002	0.0000	IE	IE	0.0001	IE	IE
2013	0.0006	0.0002	0.0007	0.0001	IE	IE	0.0006	IE	IE
2014	0.0002	0.0001	0.0002	0.0000	IE	IE	0.0002	IE	IE
2015	0.0002	0.0001	0.0002	0.0000	IE	IE	0.0002	IE	IE
2016	0.0002	0.0001	0.0002	0.0000	IE	IE	0.0001	IE	IE
2017	0.0002	0.0001	0.0002	0.0000	IE	IE	0.0002	IE	IE
2018	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
2019	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
2020	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
2021	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
2022	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
2023	0.0001	0.0000	0.0001	0.0000	IE	IE	0.0001	IE	IE
1990/2023	**-100%**	**-98%**	**-88%**	**-91%**	**-**	**-**	**-96%**	**-**	**-**
2022/2023	**-13%**	**-13%**	**-13%**	**-13%**	**-**	**-**	**-13%**	**-**	**-**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.1300	NE	NE	NE	NE	0.2601	0.0260	NA
1995	0.1302	NE	NE	NE	NE	0.2605	0.0260	NA
2000	0.1301	NE	NE	NE	NE	0.2602	0.0260	NA
2005	0.1198	NE	NE	NE	NE	0.2397	0.0240	NA
2010	0.0295	NE	NE	NE	NE	0.0295	0.0029	NA
2011	0.1078	NE	NE	NE	NE	0.1078	0.0108	NA
2012	0.0666	NE	NE	NE	NE	0.0666	0.0067	NA
2013	0.2502	NE	NE	NE	NE	0.2502	0.0250	NA

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
2014	0.0747	NE	NE	NE	NE	0.0747	0.0075	NA
2015	0.0709	NE	NE	NE	NE	0.0709	0.0071	NA
2016	0.0650	NE	NE	NE	NE	0.0650	0.0065	NA
2017	0.0767	NE	NE	NE	NE	0.0767	0.0077	NA
2018	0.0433	NE	NE	NE	NE	0.0433	0.0043	NA
2019	0.0478	NE	NE	NE	NE	0.0478	0.0048	NA
2020	0.0302	NE	NE	NE	NE	0.0302	0.0030	NA
2021	0.0296	NE	NE	NE	NE	0.0296	0.0030	NA
2022	0.0370	NE	NE	NE	NE	0.0370	0.0037	NA
2023	0.0321	NE	NE	NE	NE	0.0321	0.0032	NA
1990/2023	**-75%**	**-**	**-**	**-**	**-**	**-88%**	**-88%**	**-**
2022/2023	**-13%**	**-**	**-**	**-**	**-**	**-13%**	**-13%**	**-**

The overview of activity data (energy consumption) for this source category is in ***Table 3.12*** below.

Table 3.12: *Overview of activity data in category 1A1b*

YEAR	WASTE INCINERATED [kt]	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	13.00	29 694.17	1 069.06	10 467.17	NO	NO
1995	13.02	29 952.97	1 106.24	10 229.82	NO	NO
2000	13.01	30 828.03	1 197.97	8 842.78	NO	183.83
2005	11.98	29 601.35	1 958.62	6 438.24	NO	103.43
2010	1.47	31 575.66	1 282.94	5 749.07	NO	NO
2011	5.39	25 692.53	1 551.69	4 321.68	NO	10.05
2012	3.33	23 398.09	1 483.57	4 198.31	NO	NO
2013	12.51	19 474.46	1 833.24	5 752.59	NO	54.35
2014	3.73	15 698.77	1 278.42	5 209.24	NO	NO
2015	3.55	19 621.47	1 893.66	5 005.96	NO	NO
2016	3.25	20 417.54	1 727.90	4 960.58	NO	13.77
2017	3.84	19 465.74	1 925.76	5 171.72	NO	16.15
2018	2.16	19 948.10	1 776.06	4 579.83	NO	9.55
2019	2.39	18 868.78	1 225.26	4 425.81	0.00	0.00
2020	1.51	19 565.52	1 608.55	4 692.13	0.00	0.00
2021	1.48	19 428.73	1 754.03	4 857.35	NO	6.44
2022	1.85	20 629.80	1 880.53	4 113.09	NO	8.37
2023	1.60	20 408.41	1 535.69	4 465.75	NO	7.48
1990/2023	**-88%**	**-31%**	**44%**	**-57%**	**-**	**-**
2022/2023	**-13%**	**-1%**	**-18%**	**9%**	**-**	**-11%**

3.4.3.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.13***).

Table 3.13: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	NH_3 [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]	CO [g/tGJ]
EF	92.09	48.33	272.51	0.56	6.13	91.17%	99.58%	18.40%	12.04

*T1 EMEP/EEA GB_{2023} EF

HMs and POPs emissions from category **1A1b** were allocated to category **1B2aiv** because if using of Tier 1 approach is adopted for the process emissions, the combustion emissions are already covered and should not be reported again in Chapter **1A1b** since this would lead to double counting. Only industrial waste incineration emissions for HMs and POPs are allocated in this category and were calculated using Tier 1 emission factors from EMEP/EEA GB_{2023} (***Table 3.14***).

Table 3.14: *Emission factors for calculating emissions of heavy metals and POPs*

T1	UNIT	EF
Pb	[g/t]	1.3
Cd	[g/t]	0.1
Hg	[g/t]	0.056
As	[g/t]	0.016
Ni	[g/t]	0.14
PCDD/F	[µg/t I-TEQ]	10
PAHs	[g/t]	0.02
HCB	[g/t]	0.002

3.4.3.3 Completeness

Emissions are well covered.

3.4.3.4 Source-specific Recalculations

No recalculation in this submission.

3.4.4 Manufacture of Solid Fuels and Other Energy Industries (NFR 1A1c)

3.4.4.1 Overview

The activity covers coke production and emissions associated with combustion in the coke oven. Activities listed within this category are shown in ***Table 3.15***.

Table 3.15: *Activities according to national categorization included in category 1A1c*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
1.2. Sorting and treatment of coal, briquette production with projected output in t/h
1.3. Production of Coke

The overview of emissions in this category is shown in ***Table 3.16***.

Table 3.16: *Overview of emissions in category 1A1c*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.4307	1.2510	0.6901	0.0887	0.4264	0.7176	1.0773	0.2047	12.2804
1995	0.4279	1.2428	0.6855	0.0881	0.4236	0.7129	1.0702	0.2033	12.1997
2000	0.3519	1.8925	0.6866	0.1067	0.3097	0.5213	0.7825	0.1487	12.3868
2005	0.6081	1.0227	0.6376	0.0645	0.5719	0.9610	1.4396	0.2745	15.2868
2010	0.6990	0.3721	0.5342	0.0310	0.3124	0.5255	0.7884	0.1500	15.4326
2011	0.6540	0.3178	0.1996	0.0325	0.2953	0.4965	0.7443	0.1418	15.0236
2012	0.5827	0.2740	0.2144	0.0270	0.3002	0.5047	0.7567	0.1441	14.9857
2013	0.5846	0.3343	0.3310	0.0314	0.2936	0.4940	0.7413	0.1409	14.0761
2014	0.5514	0.3273	0.2054	0.0312	0.1703	0.2875	0.4331	0.0818	14.5471

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2015	0.6271	0.3609	0.2393	0.0311	0.1623	0.2739	0.4126	0.0779	14.4584
2016	0.5759	0.4290	0.2129	0.0323	0.1754	0.2957	0.4449	0.0842	13.2027
2017	0.5214	0.4100	0.1786	0.0308	0.1450	0.2446	0.3681	0.0696	12.6232
2018	0.6125	0.3708	0.2032	0.0296	0.1484	0.2499	0.3755	0.0712	12.9564
2019	0.6880	0.3231	0.1529	0.0256	0.1572	0.2646	0.3974	0.0755	13.6313
2020	0.8756	0.3051	0.1731	0.0167	0.0620	0.1048	0.1584	0.0297	15.7335
2021	0.6962	0.3153	0.1404	0.0296	0.0964	0.1625	0.2443	0.0463	17.7035
2022	0.7007	0.2762	0.1234	0.0242	0.0945	0.1594	0.2401	0.0453	22.3741
2023	0.7188	0.3267	0.1200	0.0263	0.1056	0.1778	0.2671	0.0507	17.2784
1990/2023	**67%**	**-74%**	**-83%**	**-70%**	**-75%**	**-75%**	**-75%**	**-75%**	**41%**
2022/2023	**3%**	**18%**	**-3%**	**9%**	**12%**	**12%**	**11%**	**12%**	**-23%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0050	0.0002	NA	0.0036	0.0081	0.0038	0.0020	0.0041	0.0172
1995	0.0050	0.0002	NA	0.0036	0.0081	0.0038	0.0020	0.0041	0.0172
2000	0.0052	0.0002	NA	0.0038	0.0085	0.0040	0.0021	0.0042	0.0179
2005	0.0054	0.0002	NA	0.0040	0.0089	0.0042	0.0022	0.0044	0.0188
2010	0.0039	0.0002	NA	0.0028	0.0064	0.0030	0.0016	0.0032	0.0135
2011	0.0046	0.0002	NA	0.0033	0.0075	0.0035	0.0019	0.0037	0.0158
2012	0.0044	0.0002	NA	0.0032	0.0073	0.0034	0.0018	0.0036	0.0153
2013	0.0044	0.0002	NA	0.0032	0.0071	0.0034	0.0018	0.0036	0.0151
2014	0.0045	0.0002	NA	0.0032	0.0073	0.0034	0.0018	0.0036	0.0154
2015	0.0047	0.0002	NA	0.0034	0.0077	0.0036	0.0019	0.0038	0.0162
2016	0.0047	0.0002	NA	0.0034	0.0077	0.0036	0.0019	0.0038	0.0162
2017	0.0045	0.0002	NA	0.0033	0.0074	0.0035	0.0018	0.0037	0.0156
2018	0.0046	0.0002	NA	0.0033	0.0075	0.0035	0.0019	0.0037	0.0158
2019	0.0040	0.0002	NA	0.0029	0.0065	0.0031	0.0016	0.0033	0.0138
2020	0.0034	0.0002	NA	0.0024	0.0055	0.0026	0.0014	0.0028	0.0116
2021	0.0047	0.0002	NA	0.0034	0.0076	0.0036	0.0019	0.0038	0.0161
2022	0.0043	0.0002	NA	0.0031	0.0070	0.0033	0.0017	0.0035	0.0147
2023	0.0044	0.0002	NA	0.0032	0.0073	0.0034	0.0018	0.0036	0.0153
1990/2023	**-11%**	**-11%**	**-**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**
2022/2023	**4%**	**4%**	**-**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	1.6671	0.0185	0.0002	0.0001	4.52E-05	0.0189	NA	NA
1995	1.6693	0.0185	0.0002	0.0001	4.52E-05	0.0189	NA	NA
2000	1.7411	0.0193	0.0002	0.0001	4.72E-05	0.0197	NA	NA
2005	1.8243	0.0203	0.0002	0.0001	4.94E-05	0.0206	NA	NA
2010	1.3114	0.0146	0.0002	0.0001	3.55E-05	0.0148	NA	NA
2011	1.5365	0.0171	0.0002	0.0001	4.16E-05	0.0174	NA	NA
2012	1.4893	0.0165	0.0002	0.0001	4.04E-05	0.0169	NA	NA
2013	1.4642	0.0163	0.0002	0.0001	3.97E-05	0.0166	NA	NA
2014	1.4959	0.0166	0.0002	0.0001	4.05E-05	0.0169	NA	NA
2015	1.5727	0.0175	0.0002	0.0001	4.26E-05	0.0178	NA	NA
2016	1.5734	0.0175	0.0002	0.0001	4.26E-05	0.0178	NA	NA
2017	1.5144	0.0168	0.0002	0.0001	4.10E-05	0.0171	NA	NA
2018	1.5328	0.0170	0.0002	0.0001	4.15E-05	0.0173	NA	NA
2019	1.3402	0.0149	0.0002	0.0001	3.63E-05	0.0152	NA	NA
2020	1.1291	0.0125	0.0002	0.0000	3.06E-05	0.0128	NA	NA
2021	1.5623	0.0174	0.0002	0.0001	4.23E-05	0.0177	NA	NA

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
2022	1.4266	0.0159	0.0002	0.0001	3.87E-05	0.0161	NA	NA
2023	1.4893	0.0165	0.0002	0.0001	4.04E-05	0.0169	NA	NA
1990/2023	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-**	**-**
2022/2023	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**-**	**-**

The overview of activity data (energy consumption) for this source category is in ***Table 3.17*** below.

Table 3.17: *Overview of activity data in category 1A1c*

YEAR	COAL TRANSFORMED [kt]	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	2 258.95	NO	7 109.30	NO	NO	NO
1995	2 261.97	NO	7 061.99	NO	NO	NO
2000	2 359.26	NO	7 431.88	0.93	NO	NO
2005	2 471.97	NO	7 231.65	1.85	NO	NO
2010	1 777.00	0.09	6 491.11	3.43	NO	NO
2011	2 082.00	0.08	6 187.55	1.76	NO	NO
2012	2 018.00	0.10	6 211.97	2.46	NO	NO
2013	1 984.00	0.07	6 130.61	2.48	NO	NO
2014	2 027.00	0.09	6 209.12	1.29	NO	NO
2015	2 131.00	0.10	6 456.99	1.23	NO	NO
2016	2 132.00	0.13	6 471.44	1.33	NO	NO
2017	2 052.00	0.05	5 934.80	6.83	NO	NO
2018	2 077.00	0.10	6 087.14	6.82	NO	NO
2019	1 816.00	0.08	5 585.03	7.02	NO	NO
2020	1 530.00	0.05	5 056.88	4.93	NO	NO
2021	2 117.00	0.12	6 038.13	6.37	NO	NO
2022	1 933.00	0.16	6 001.56	4.63	NO	NO
2023	2 018.00	0.14	6 540.67	29.85	NO	NO
1990/2023	**-11%**	**-**	**-8%**	**-**	**-**	**-**
2022/2023	**4%**	**-15%**	**9%**	**544%**	**-**	**-**

3.4.4.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.18***).

Table 3.18: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	NH_3 [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]	CO [g/tGJ]
EF	60.68	176.23	97.21	12.50	151.76	39.58%	66.62%	48.00%	1730.01

*T1 EMEP/EEA GB_{2023} EF

HMs and POPs emissions were calculated using Tier 2 emission factors with by-product recovery from EMEP/EEA GB_{2023} (***Table 3.19***).

Table 3.19: *Emission factors for calculating emissions of heavy metals and POPs*

T2	UNIT	COAL
Pb	[mg/GJ]	2.2
Cd	[mg/GJ]	0.1
Hg	[mg/GJ]	NA
As	[mg/GJ]	1.6
Cr	[mg/GJ]	3.6
Cu	[mg/GJ]	1.7
Ni	[mg/GJ]	0.9
Se	[mg/GJ]	1.8
Zn	[mg/GJ]	7.6
PCDD/F	[ng I-TEQ/GJ]	738
B(a)P	[µg/GJ]	8.2
B(b)F	[µg/GJ]	0.1
B(k)F	[µg/GJ]	0.03
I()P	[µg/GJ]	0.02
PAHs	[µg/GJ]	8.35

3.4.4.3 Completeness

Emissions are well covered.

3.4.4.3 Source-specific Recalculations

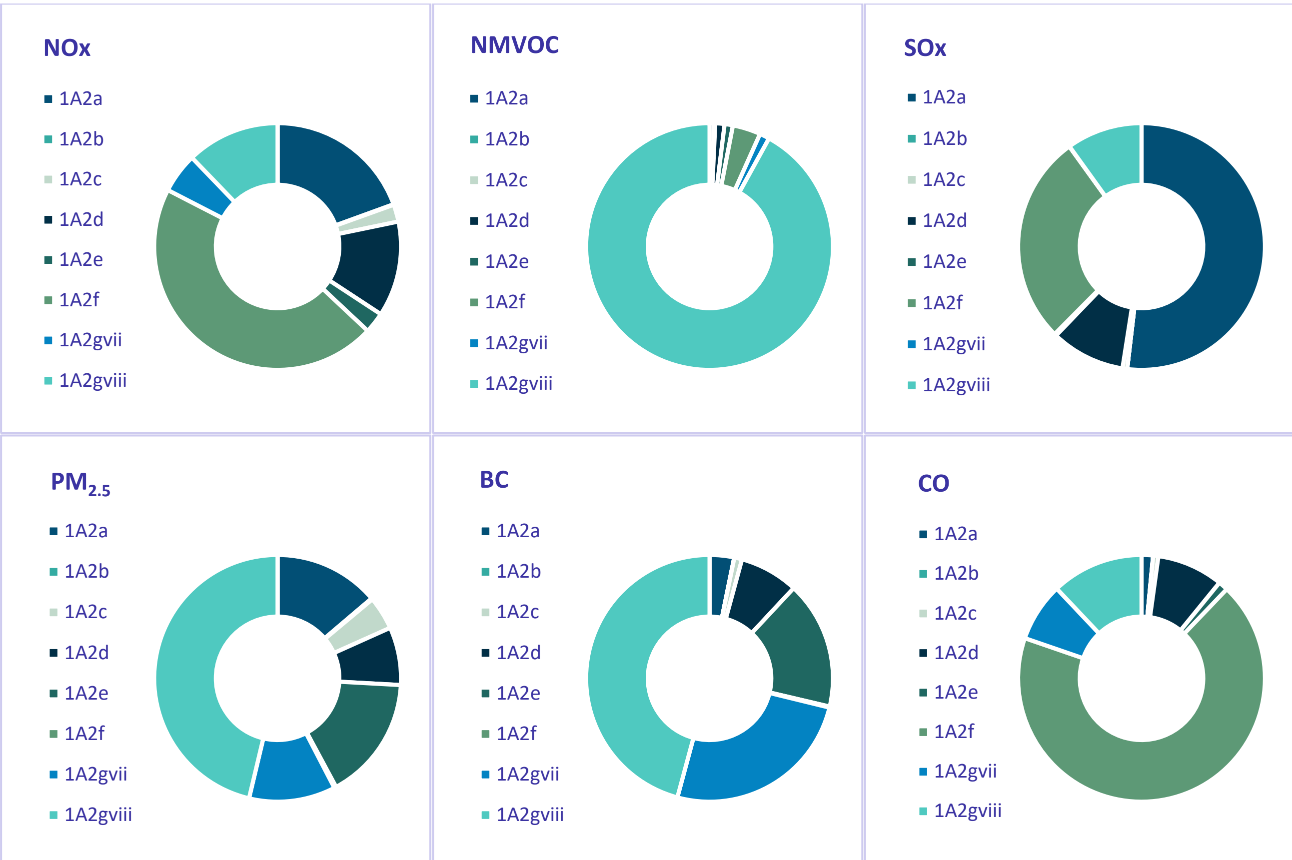
No recalculation in this submission.

3.5 MANUFACTURING INDUSTRIES AND CONSTRUCTION (NFR 1A2)

3.5.1 Overview

Category manufacturing industries and construction **1A2** is focused on the following combustion subcategories: Iron and steel (**1A2a**); Non-ferrous metals (**1A2b**); Chemicals (**1A2c**); Pulp, paper, and print (**1A2d**); Food processing, beverages, and tobacco (**1A2e**); Non-metallic minerals (**1A2f**); and Other (**1A2g**).
The emissions depend on fuel and process activity. Relevant pollutants are generally as described for combustion: SO_2, NOx, CO, NMVOC, particulate matter (TSP, PM_{10}, $PM_{2.5}$), black carbon (BC), heavy metals (HM), polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzo-dioxin and polychlorinated dibenzo-furans (PCDD/F) and, for some activities, polychlorinated biphenyls (PCB) and hexachlorobenzene (HCB).
Manufacturing industries and construction are substantial contributors to most air pollutants. Category **1A2a**, **1A2d**, **1A2f** and **1A2gviii** are the key categories for various air pollutants (***Figure 3.3***).

Figure 3.3: *Shares of main pollutants emissions in categories 1A2 in 2023*



3.5.2 Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel (NFR 1A2a)

3.5.2.1 Overview

The iron and steel industry is one of the most energy-intensive industrial branches in the Slovak Republic and it is represented by one biggest iron and steel companies in the Slovak Republic (U.S. Steel). The total volume of fuels allocated in **1A2a** expressed in energy units represented almost 19,300 TJ in 2023. Emissions of main pollutants are calculated using the Tier 3 method – facility data from the operator. Emissions have an overall decreasing trend except for SOx in 2000 when a single operator used to duel with a higher share of sulphur. Activities listed within this category are shown in ***Table 3.20***.

Table 3.20: *Activities according to national categorization included in category 1A2a*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 24.1-24.3; 24.51-24.52
2.99. Other industrial production and metal processing if: *a) the combustion of fuel with nominated thermal input in MW is a part of technology* *b) the share of mass flow of emissions before the separator and mass flow of air pollutants is defined in annex 3 in national legislation (carcinogenic effect, organic gases and other compounds)*	LARGE/MEDIUM S.: NACE 24.1-24.3; 24.51-24.53

The increase of NOx emissions in 2021 was caused by significantly higher combustion of blast furnace gas exhaust in one operator. One source producing energy for steel production used blast furnace gas as a secondary solid fuel which is included in solid fuels. Reported emissions from this source increased more than 27 times, and the amount of gas burned was approximately 30 times. This, after aggregating all the data, caused the different increases in emissions and fuel amounts. The decrease in NOx emissions between 2018 and 2019 was caused by a change, the operation of the heating plant source producing energy for steel production was terminated and a new source was opened (***Recommendations No SK-1A2a-2023-0002***).The overview of emissions in this category is shown in ***Table 3.21***.

Table 3.21: *Overview of emissions in category 1A2a*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	5.1282	0.0362	4.3832	NO	3.6566	3.9214	4.5386	0.2336	0.4202
1995	5.2063	0.0368	4.4499	NO	3.7123	3.9811	4.6077	0.2372	0.4266
2000	6.0894	0.0367	9.7871	NO	4.5250	4.8526	5.6164	0.2890	0.7581
2005	5.7510	0.0287	4.8804	NO	0.2555	0.2589	0.2870	0.0163	0.4317
2010	3.8203	0.0509	3.9807	NO	0.1790	0.1836	0.2007	0.0114	0.6545
2011	2.8316	0.0487	2.8248	NO	0.1209	0.1235	0.1360	0.0077	0.5703
2012	3.3872	0.0570	3.8774	NO	0.0642	0.0784	0.0979	0.0041	0.7353
2013	3.2981	0.0560	3.6654	NO	0.0503	0.0595	0.0746	0.0032	0.8143
2014	3.0680	0.0612	2.7901	NO	0.0616	0.0725	0.0890	0.0039	0.5220
2015	3.0669	0.0424	2.3135	NO	0.0418	0.0517	0.0728	0.0027	0.5840
2016	2.5749	0.0381	1.9776	0.0000	0.0377	0.0448	0.0539	0.0024	0.3735
2017	2.1911	0.0339	1.5720	NO	0.0299	0.0360	0.0481	0.0019	0.3239
2018	2.5348	0.0474	1.3473	NO	0.0347	0.0401	0.0545	0.0022	0.3129
2019	0.9780	0.0373	0.5527	NO	0.0328	0.0362	0.0387	0.0021	0.1024
2020	0.9744	0.0375	0.6027	NO	0.0206	0.0234	0.0254	0.0013	0.0991
2021	2.0873	0.0538	0.7029	NO	0.0366	0.0402	0.0424	0.0024	0.1848
2022	1.7550	0.0386	0.7405	NO	0.0308	0.0339	0.0357	0.0020	0.1628
2023	1.7255	0.0325	0.7857	NO	0.0360	0.0390	0.0408	0.0023	0.1803
1990/2023	**-66%**	**-10%**	**-82%**	**-**	**-99%**	**-99%**	**-99%**	**-99%**	**-57%**
2022/2023	**-2%**	**-16%**	**6%**	**-**	**17%**	**15%**	**14%**	**17%**	**11%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0325	0.0085	0.0190	0.0092	0.0494	0.0858	0.0571	0.2350	0.1975
1995	0.0334	0.0087	0.0195	0.0094	0.0507	0.0880	0.0585	0.2410	0.2026
2000	0.0344	0.0090	0.0202	0.0098	0.0523	0.0909	0.0603	0.2489	0.2091
2005	0.0425	0.0042	0.0118	0.0069	0.0702	0.1215	0.0709	0.3586	0.2968
2010	0.0283	0.0028	0.0085	0.0054	0.0468	0.0810	0.0472	0.2388	0.1977
2011	0.0285	0.0028	0.0086	0.0054	0.0470	0.0814	0.0477	0.2402	0.1989
2012	0.0314	0.0031	0.0092	0.0058	0.0519	0.0898	0.0563	0.2648	0.2204
2013	0.0310	0.0031	0.0091	0.0056	0.0512	0.0887	0.0517	0.2617	0.2165
2014	0.0280	0.0028	0.0084	0.0054	0.0462	0.0800	0.0466	0.2361	0.1952
2015	0.0276	0.0027	0.0083	0.0052	0.0456	0.0790	0.0460	0.2330	0.1926
2016	0.0194	0.0019	0.0063	0.0042	0.0320	0.0555	0.0323	0.1636	0.1354

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2017	0.0197	0.0020	0.0063	0.0042	0.0326	0.0564	0.0335	0.1665	0.1380
2018	0.0252	0.0025	0.0078	0.0051	0.0416	0.0720	0.0421	0.2124	0.1757
2019	0.0225	0.0022	0.0066	0.0042	0.0370	0.0642	0.0404	0.1891	0.1575
2020	0.0214	0.0022	0.0063	0.0040	0.0352	0.0606	0.0370	0.1785	0.1528
2021	0.0216	0.0022	0.0067	0.0046	0.0353	0.0610	0.0421	0.1793	0.1551
2022	0.0199	0.0020	0.0061	0.0039	0.0327	0.0565	0.0329	0.1665	0.1407
2023	0.0152	0.0016	0.0051	0.0035	0.0249	0.0428	0.0249	0.1263	0.1081
1990/2023	**-53%**	**-82%**	**-73%**	**-62%**	**-50%**	**-50%**	**-56%**	**-46%**	**-45%**
2022/2023	**-24%**	**-22%**	**-17%**	**-10%**	**-24%**	**-24%**	**-24%**	**-24%**	**-23%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0288	0.0001	0.0001	0.0001	0.0001	0.0003	0.0689	0.0045
1995	0.0295	0.0001	0.0001	0.0001	0.0001	0.0003	0.0707	0.0046
2000	0.0307	0.0001	0.0001	0.0001	0.0001	0.0003	0.0730	0.0048
2005	0.0270	0.0001	0.0001	0.0001	0.0001	0.0003	0.1044	0.0184
2010	0.0216	0.0000	0.0001	0.0001	0.0001	0.0002	0.0696	0.0122
2011	0.0216	0.0000	0.0001	0.0001	0.0001	0.0002	0.0700	0.0123
2012	0.0226	0.0000	0.0001	0.0001	0.0001	0.0002	0.0771	0.0136
2013	0.0222	0.0000	0.0001	0.0001	0.0001	0.0002	0.0762	0.0134
2014	0.0212	0.0000	0.0001	0.0001	0.0001	0.0002	0.0688	0.0121
2015	0.0208	0.0000	0.0001	0.0001	0.0000	0.0002	0.0679	0.0119
2016	0.0168	0.0000	0.0001	0.0000	0.0000	0.0002	0.0477	0.0084
2017	0.0168	0.0000	0.0001	0.0000	0.0000	0.0002	0.0485	0.0085
2018	0.0203	0.0000	0.0001	0.0000	0.0000	0.0002	0.0619	0.0109
2019	0.0165	0.0000	0.0001	0.0000	0.0000	0.0002	0.0551	0.0097
2020	0.0164	0.0001	0.0002	0.0001	0.0001	0.0005	0.0521	0.0092
2021	0.0188	0.0001	0.0002	0.0001	0.0001	0.0005	0.0523	0.0093
2022	0.0162	0.0001	0.0001	0.0001	0.0001	0.0003	0.0485	0.0085
2023	0.0148	0.0001	0.0002	0.0001	0.0001	0.0004	0.0368	0.0065
1990/2023	**-49%**	**63%**	**52%**	**-21%**	**-8%**	**21%**	**-47%**	**42%**
2022/2023	**-8%**	**15%**	**13%**	**4%**	**2%**	**10%**	**-24%**	**-24%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.22*** below.

Table 3.22: *Overview of activity data in the category 1A2a*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	5.93	18 622.60	1 451.96	NO	NO
1995	5.97	18 979.64	1 400.55	NO	NO
2000	5.50	20 111.83	1 465.23	NO	NO
2005	NO	27 089.95	1 319.92	NO	NO
2010	0.35	24 392.52	1 756.07	NO	NO
2011	2.82	23 921.25	2 160.77	NO	NO
2012	17.10	24 668.61	1 740.10	NO	NO
2013	2.23	23 780.86	2 085.08	NO	NO
2014	1.36	23 837.29	1 849.90	NO	NO
2015	0.60	23 489.52	1 561.83	NO	NO
2016	1.30	20 577.44	1 413.57	NO	NO
2017	4.64	20 294.87	1 446.04	NO	NO
2018	2.89	24 210.47	1 295.23	NO	NO
2019	14.44	18 054.40	1 401.57	NO	NO
2020	9.55	16 955.23	1 424.88	8.72	NO

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2021	28.80	21 631.33	1 301.52	8.91	NO
2022	1.53	18 447.22	944.67	5.61	NO
2023	0.23	18 326.22	939.93	7.24	NO
1990/2023	**-96%**	**-2%**	**-35%**	**-**	**-**
2022/2023	**-85%**	**-1%**	**-1%**	**29%**	**-**

3.5.2.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.
The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.23***).

Table 3.23: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	255.38	1.80	218.28	226.02	80.57%	86.40%	20.93

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023}, expert estimation and special source[1] (***Table 3.24***).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:
E_i = annual emission of pollutant *i*,
$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,
$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3.24: *Emission factors for calculating emissions of heavy metals and POPs*

TYPE OF FUEL		LIQUID FUELS		HARD COAL		
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	FIXED BED BOILERS	PULVERIZED COAL-FIRED BOILERS
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth), (> 100 MWth)	(-)	(≤ 5 MWth)	(> 100 MWth)	(> 100 MWth)
Pb	[mg/GJ]	4.56	4.07	13.687	2.656	2.722
Cd	[mg/GJ]	1.2	1.36	2.456	0.823	0.268
Hg	[mg/GJ]	0.341	1.36	9.051	1.744	0.668
As	[mg/GJ]	3.98	1.81	9.402	0.243	0.339
Cr	[mg/GJ]	2.55	1.36	15	4.5	4.5
Cu	[mg/GJ]	5.31	2.72	10	7.8	7.8
Ni	[mg/GJ]	255	1.36	10	4.9	4.537
Se	[mg/GJ]	2.06	6.79	2	23	23
Zn	[mg/GJ]	87.8	1.81	150	19	19
PCDD/F	[ng I-TEQ/GJ]	2.5	0.99	14.657	2.299	1.314
B(a)P	[mg/GJ]	3.678	116	10.975	2.4	2.844

TYPE OF FUEL		LIQUID FUELS		HARD COAL		
B(b)F	[mg/GJ]	12.673	502	18.54	4.768	5.433
B(k)F	[mg/GJ]	3.968	98.7	10.966	3.085	3.786
I()P	[mg/GJ]	6.484	187	5.956	2.08	3.662
PAHs	[mg/GJ]	26.803	903.7	46.437	12.33	15.725
HCB	[μg/GJ]	-	0.22	6.7	6.7	6.7
PCBs	[μg/GJ]	3.334	0.00013	8.073	0.395	1.176

TYPE OF FUEL		BROWN COAL		GASEOUS FUELS		BIOMASS
TYPE OF FIRE PLACE		FIXED BED BOILERS	FIXED BED BOILERS	ALL TYPES OF BOILERS	GAS TURBINES	FIXED BED BOILERS
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(5 – 50 MWth)	(≤ 5 MWth), (5 – 50 MWth), (> 100 MWth)	(-)	(≤ 5 MWth)
Pb	[mg/GJ]	59.471	6.67	0.0015	0.0015	27
Cd	[mg/GJ]	1.294	0.495	0.00025	0.00025	13
Hg	[mg/GJ]	2.382	1.924	0.1	0.1	0.56
As	[mg/GJ]	60.967	2.102	0.12	0.12	0.19
Cr	[mg/GJ]	38.383	9.1	0.00076	0.00076	23
Cu	[mg/GJ]	69.545	1	0.000076	0.000076	6
Ni	[mg/GJ]	62.104	27.67	0.00051	0.00051	2
Se	[mg/GJ]	5.192	45	0.0112	0.0112	0.5
Zn	[mg/GJ]	30.756	8.8	0.0015	0.0015	512
PCDD/F	[ng I-TEQ/GJ]	4.986	7.68	0.5	0.5	100
B(a)P	[mg/GJ]	320.061	3.147	0.56	0.56	10000
B(b)F	[mg/GJ]	518.482	7.973	0.84	0.84	16000
B(k)F	[mg/GJ]	518.482	4.047	0.84	0.84	5000
I()P	[mg/GJ]	400.322	4.203	0.84	0.84	4000
PAHs	[mg/GJ]	1757.347	19.37	3.08	3.08	35000
HCB	[μg/GJ]	6.7	6.7	0.00308	0.00308	5
PCBs	[μg/GJ]	5.059	0.757	-	-	0.007

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.25***). The calculated BC emission values are presented in ***Table 3.21.***

Table 3.25: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.2.3 Completeness

Emissions are well covered.

3.5.2.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (supplemented activity values for the years 2020-2022). Recalculations of HM and POPs emissions were made based on changes in activity data (supplemented activity values for the year 2022). The differences in emissions in category **1A2a** between the previous and current submissions caused by recalculations are shown in n ***Table 3.26***.

Table 3.26: Differences in emissions (%) in category 1A2a between the previous and current submission caused by recalculations

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
2020	1%	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	1%	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	0.4%	0.001%	0.002%	0.004%	0.01%	0.0003%	0.0003%	0.03%	0.0001%	0.002%	0.01%	0.002%	0.00002%	0.001%

3.5.3 Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals (NFR 1A2b)

3.5.3.1 Overview

This category is focused on combustion processes in the production of non-ferrous metals. Activities listed within this category are shown in ***Table 3.27***.

Table 3.27: *Activities according to national categorization included in category 1A2b*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 24.4-24.3; 24.53-24.54
2.99. Other industrial production and metal processing if: *a) the combustion of fuel with nominated thermal input in MW is a part of technology* *b) the share of mass flow of emissions before the separator and mass flow of air pollutants defined in annex 3 in national legislation (carcinogenic effect, organic gases and other compounds)*	LARGE/MEDIUM S.: NACE 24.4-24.3; 24.53-24.54

The overview of emissions in this category is shown in ***Table 3.28***.

Table 3.28: *Overview of emissions in category 1A2b*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.0040	0.0001	0.0002	NO	0.0002	0.0002	0.0003	0.0000	0.0014
1995	0.0044	0.0001	0.0002	NO	0.0002	0.0003	0.0003	0.0000	0.0016
2000	0.0011	0.0001	0.0000	NO	0.0000	0.0000	0.0001	0.0000	0.0004
2005	0.0036	0.0001	0.0004	NO	0.0002	0.0002	0.0006	0.0000	0.0015
2010	0.0033	0.0002	0.0000	NO	0.0002	0.0002	0.0002	0.0000	0.0013
2011	0.0035	0.0002	0.0000	NO	0.0001	0.0002	0.0002	0.0000	0.0016
2012	0.0036	0.0002	0.0000	NO	0.0002	0.0002	0.0002	0.0000	0.0014
2013	0.0035	0.0002	0.0000	NO	0.0002	0.0002	0.0002	0.0000	0.0014
2014	0.0039	0.0002	0.0000	NO	0.0002	0.0002	0.0002	0.0000	0.0016
2015	0.0041	0.0002	0.0000	NO	0.0002	0.0002	0.0002	0.0000	0.0017
2016	0.0042	0.0003	0.0000	NO	0.0002	0.0002	0.0002	0.0000	0.0017
2017	0.0050	0.0003	0.0000	NO	0.0002	0.0002	0.0003	0.0000	0.0020
2018	0.0053	0.0003	0.0000	NO	0.0002	0.0003	0.0003	0.0000	0.0021
2019	0.0050	0.0003	0.0000	NO	0.0002	0.0002	0.0003	0.0000	0.0020
2020	0.0057	0.0004	0.0000	NO	0.0002	0.0003	0.0003	0.0000	0.0023
2021	0.0062	0.0004	0.0000	NO	0.0003	0.0003	0.0003	0.0000	0.0025
2022	0.0055	0.0003	0.0000	NO	0.0003	0.0003	0.0003	0.0000	0.0022
2023	0.0055	0.0003	0.0000	NO	0.0004	0.0004	0.0005	0.0000	0.0022
1990/2023	**39%**	**358%**	**-70%**	**-**	**69%**	**81%**	**65%**	**84%**	**59%**
2022/2023	**-1%**	**-1%**	**37%**	**-**	**40%**	**45%**	**48%**	**50%**	**-1%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
1995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2013	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2016	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2017	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2018	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2019	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2020	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2021	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2022	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2023	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
1990/2023	**59%**	**59%**	**58%**	**58%**	**59%**	**62%**	**58%**	**58%**	**60%**
2022/2023	**-0.2%**	**-0.2%**	**-0.4%**	**-0.4%**	**-0.04%**	**2%**	**-0.4%**	**-0.3%**	**1%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0000	0.0001	0.0002	0.0001	0.0001	0.0005	NE	NE
1995	0.0000	0.0001	0.0003	0.0001	0.0001	0.0005	NE	NE
2000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0003	NE	NE
2005	0.0001	0.0001	0.0002	0.0001	0.0001	0.0005	0.0000	0.0001
2010	0.0000	0.0001	0.0002	0.0001	0.0001	0.0004	NE	NE
2011	0.0000	0.0001	0.0002	0.0001	0.0001	0.0005	NE	NE
2012	0.0000	0.0001	0.0002	0.0001	0.0001	0.0005	NE	NE
2013	0.0001	0.0001	0.0003	0.0001	0.0001	0.0006	NE	NE
2014	0.0000	0.0000	0.0002	0.0001	0.0001	0.0004	NE	NE
2015	0.0001	0.0001	0.0003	0.0001	0.0001	0.0006	NE	NE
2016	0.0001	0.0001	0.0003	0.0001	0.0001	0.0006	NE	NE
2017	0.0001	0.0001	0.0003	0.0001	0.0001	0.0007	NE	NE
2018	0.0001	0.0001	0.0004	0.0001	0.0001	0.0007	NE	NE
2019	0.0001	0.0001	0.0003	0.0001	0.0001	0.0007	NE	NE
2020	0.0001	0.0001	0.0004	0.0001	0.0001	0.0008	NE	NE
2021	0.0001	0.0001	0.0004	0.0002	0.0002	0.0008	NE	NE
2022	0.0001	0.0001	0.0004	0.0001	0.0001	0.0008	NE	NE
2023	0.0001	0.0001	0.0004	0.0001	0.0001	0.0008	NE	NE
1990/2023	**58%**	**58%**	**59%**	**58%**	**58%**	**59%**	**-**	**-**
2022/2023	**-0.3%**	**-0.3%**	**-0.3%**	**-0.4%**	**-0.4%**	**-0.3%**	**-**	**-**

The overview of activity data (energy consumption) for this source category is in ***Table 3.29*** below.

Table 3.29: *Overview of activity data in category 1A2b*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	NO	NO	82.27	NO	NO
1995	NO	NO	92.15	NO	NO
2000	NO	NO	50.36	NO	NO
2005	NO	0.48	74.88	NO	NO
2010	NO	NO	76.40	NO	NO
2011	NO	NO	81.65	NO	NO
2012	NO	NO	83.09	NO	NO
2013	0.01	NO	102.13	NO	NO

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2014	0.01	NO	61.46	NO	NO
2015	0.01	NO	97.30	NO	NO
2016	0.01	NO	99.67	NO	NO
2017	0.01	NO	116.37	NO	NO
2018	0.01	NO	123.28	NO	NO
2019	0.01	NO	117.47	NO	NO
2020	0.01	NO	134.22	NO	NO
2021	0.02	NO	144.64	NO	NO
2022	0.01	NO	130.80	NO	NO
2023	0.04	NO	130.29	NO	NO
1990/2023	**-**	**-**	**58%**	**-**	**-**
2022/2023	**436%**	**-**	**-0.4%**	**-**	**-**

3.5.3.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.
The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.30***).

Table 3.30: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	48.12	0.90	1.92	3.41	78.26%	84.83%	16.93

HMs and POPs emissions were calculated using Tier 1 emission factors from EMEP/EEA GB_{2023} (***Table 3.31***).

Table 3.31: *Emission factors for calculating emissions of heavy metals and POPs*

T1	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
Pb	[mg/GJ]	0.08	134	0.011	27
Cd	[mg/GJ]	0.006	1.8	0.0009	13
Hg	[mg/GJ]	0.12	7.9	0.54	0.56
As	[mg/GJ]	0.03	4	0.1	0.19
Cr	[mg/GJ]	0.2	13.5	0.013	23
Cu	[mg/GJ]	0.22	17.5	0.002600	6
Ni	[mg/GJ]	0.008	13	0.013	2
Se	[mg/GJ]	0.11	1.8	0.058	0.5
Zn	[mg/GJ]	29	200	0.73	512
PCDD/F	[ng I-TEQ/GJ]	1.4	203	0.52	100
B(a)P	[mg/GJ]	1.9	45.5	0.72	10
B(b)F	[mg/GJ]	15	58.9	2.9	16
B(k)F	[mg/GJ]	1.7	23.7	1.1	5
I()P	[mg/GJ]	1.5	18.5	1.08	4
PAHs	[mg/GJ]	20.1	146.6	5.8	35
HCB	[μg/GJ]	-	0.62	-	5
PCBs	[μg/GJ]	-	170	-	0.06

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.32***). The calculated BC emission values are presented in ***Table 3.28.***

Table 3.32: Emission factors for calculating emissions of BC

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.3.3 Completeness

POPs (HCB and PCB) are reported as NE except in the years 2003-2007, as only in this period solid fuels were used. For other used fuels, the emission factors are not available.

3.5.3.4 Source-specific Recalculations

No recalculations in this submission.

3.5.4 Stationary Combustion in Manufacturing Industries and Construction: Chemicals (NFR 1A2c)

3.5.4.1 Overview

Combustion in the chemicals sector ranges from conventional fuels in boiler plants and recovery of process by-products using thermal oxidisers to process-specific combustion activities. The category includes emissions from fuel combustion in the chemical industry. The production in the chemical industry is very wide and all sources with mixed emissions were allocated into **2B10a**.

Activities listed within this category are shown in ***Table 3.33***. The emissions from the combustion of industrial waste are included in this category because of the energy recovery from the combustion process.

Table 3.33: Activities according to national categorization included in category 1A2c

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 20-22; 24-25
5.1. Industrial waste incineration	combustion

The overview of emissions in this category is shown in ***Table 3.34***.

Table 3.34: Overview of emissions in category 1A2c

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.7208	0.0375	0.4394	NO	0.0311	0.0462	0.0687	0.0023	0.1880
1995	0.6853	0.0357	0.4178	NO	0.0296	0.0439	0.0653	0.0022	0.1787
2000	0.3992	0.0207	0.2715	NO	0.0232	0.0345	0.0513	0.0018	0.1221
2005	0.2958	0.0057	0.0595	NO	0.0165	0.0169	0.0206	0.0067	0.0472
2010	0.2064	0.0050	0.0092	NO	0.0108	0.0120	0.0153	0.0008	0.0606
2011	0.2299	0.0056	0.0128	NO	0.0119	0.0128	0.0162	0.0009	0.0649
2012	0.2375	0.0050	0.0119	NO	0.0120	0.0130	0.0162	0.0009	0.0667
2013	0.2275	0.0059	0.0120	NO	0.0116	0.0125	0.0151	0.0009	0.0655
2014	0.2301	0.0054	0.0125	NO	0.0100	0.0104	0.0107	0.0007	0.0651
2015	0.2402	0.0060	0.0145	NO	0.0107	0.0109	0.0112	0.0006	0.0807
2016	0.2368	0.0059	0.0150	NO	0.0117	0.0122	0.0127	0.0011	0.0787
2017	0.2372	0.0058	0.0274	NO	0.0121	0.0127	0.0133	0.0009	0.0741
2018	0.2534	0.0057	0.0197	NO	0.0113	0.0117	0.0121	0.0008	0.0708
2019	0.2343	0.0057	0.0209	NO	0.0106	0.0109	0.0116	0.0006	0.0685
2020	0.2105	0.0053	0.0068	NO	0.0101	0.0104	0.0108	0.0014	0.0675
2021	0.2121	0.0052	0.0033	NO	0.0124	0.0128	0.0132	0.0007	0.0614

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2022	0.1994	0.0047	0.0060	NO	0.0122	0.0127	0.0132	0.0009	0.0705
2023	0.1996	0.0049	0.0092	NO	0.0114	0.0118	0.0123	0.0007	0.0804
1990/2023	**-72%**	**-87%**	**-98%**	**-**	**-63%**	**-74%**	**-82%**	**-68%**	**-57%**
2022/2023	**0%**	**5%**	**52%**	**-**	**-7%**	**-7%**	**-7%**	**-15%**	**14%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.6213	0.0091	0.0408	0.0192	0.0616	0.0798	0.0605	0.0087	0.9311
1995	0.5526	0.0081	0.0367	0.0171	0.0548	0.0709	0.0538	0.0078	0.8296
2000	0.6193	0.0089	0.0403	0.0191	0.0617	0.0798	0.0603	0.0087	0.9339
2005	0.0102	0.0008	0.0026	0.0005	0.0002	0.0002	0.0011	0.0003	0.0155
2010	0.0096	0.0007	0.0025	0.0005	0.0002	0.0001	0.0011	0.0002	0.0060
2011	0.0095	0.0007	0.0027	0.0006	0.0002	0.0001	0.0011	0.0003	0.0060
2012	0.0078	0.0006	0.0027	0.0005	0.0002	0.0001	0.0009	0.0003	0.0060
2013	0.0069	0.0006	0.0027	0.0005	0.0002	0.0001	0.0008	0.0003	0.0063
2014	0.0052	0.0001	0.0027	0.0005	0.0001	0.0000	0.0006	0.0003	0.0051
2015	0.0061	0.0001	0.0030	0.0006	0.0001	0.0000	0.0007	0.0003	0.0051
2016	0.0064	0.0002	0.0029	0.0006	0.0002	0.0001	0.0007	0.0003	0.0075
2017	0.0072	0.0001	0.0029	0.0006	0.0002	0.0000	0.0008	0.0003	0.0060
2018	0.0068	0.0001	0.0029	0.0006	0.0001	0.0000	0.0008	0.0003	0.0050
2019	0.0054	0.0001	0.0041	0.0008	0.0001	0.0000	0.0007	0.0004	0.0063
2020	0.0060	0.0003	0.0026	0.0005	0.0004	0.0001	0.0007	0.0003	0.0112
2021	0.0039	0.0001	0.0026	0.0005	0.0001	0.0000	0.0005	0.0003	0.0044
2022	0.0043	0.0001	0.0022	0.0004	0.0001	0.0000	0.0005	0.0002	0.0040
2023	0.0036	0.0001	0.0021	0.0004	0.0001	0.0000	0.0004	0.0002	0.0037
1990/2023	**-99%**	**-99%**	**-95%**	**-98%**	**-100%**	**-100%**	**-99%**	**-98%**	**-100%**
2022/2023	**-15%**	**-13%**	**-5%**	**-5%**	**-8%**	**-9%**	**-14%**	**-4%**	**-7%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	4.0019	0.2138	0.2989	0.1175	0.0935	0.8992	0.0204	0.7736
1995	3.6495	0.1906	0.2686	0.1053	0.0840	0.8099	0.0186	0.6876
2000	3.3577	0.2136	0.2985	0.1169	0.0930	0.8607	0.0167	0.7741
2005	2.5939	0.0037	0.0175	0.0050	0.0048	0.1791	0.0148	0.0007
2010	2.3575	0.0031	0.0117	0.0045	0.0043	0.1581	0.0135	0.0009
2011	2.3660	0.0033	0.0128	0.0048	0.0047	0.1607	0.0135	0.0008
2012	1.9210	0.0034	0.0131	0.0050	0.0049	0.1359	0.0110	0.0007
2013	1.6988	0.0034	0.0133	0.0050	0.0049	0.1236	0.0097	0.0006
2014	0.0028	0.0033	0.0132	0.0050	0.0049	0.1035	0.0077	0.0001
2015	0.0030	0.0037	0.0146	0.0055	0.0054	0.1200	0.0091	0.0000
2016	0.0034	0.0036	0.0145	0.0055	0.0054	0.1224	0.0094	0.0000
2017	0.0031	0.0036	0.0141	0.0054	0.0053	0.1351	0.0107	0.0001
2018	0.0029	0.0035	0.0139	0.0053	0.0052	0.1298	0.0102	0.0000
2019	0.0040	0.0052	0.0207	0.0078	0.0077	0.1228	0.0082	0.0000
2020	0.0038	0.0033	0.0127	0.0048	0.0047	0.1103	0.0086	0.0000
2021	0.0026	0.0032	0.0129	0.0049	0.0048	0.0836	0.0058	0.0000
2022	0.0022	0.0027	0.0108	0.0041	0.0040	0.0857	0.0064	0.0000
2023	0.0021	0.0026	0.0104	0.0039	0.0039	0.0751	0.0054	0.0000
1990/2023	**-100%**	**-99%**	**-97%**	**-97%**	**-96%**	**-92%**	**-73%**	**-100%**
2022/2023	**-5%**	**-4%**	**-4%**	**-4%**	**-4%**	**-12%**	**-15%**	**-11%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.35*** below.

Table 3.35: *Overview of activity data in category 1A2c*

YEAR	WASTE INCINERATED [kt]	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	8.78	522.62	4 550.61	7 926.22	NO	NO
1995	8.07	516.75	4 044.80	7 796.65	NO	NO
2000	6.94	617.35	4 553.46	7 244.47	NO	564.77
2005	7.40	413.42	4.01	3 821.97	4.70	192.44
2010	6.73	1.20	5.58	3 887.23	23.81	161.41
2011	6.75	1.16	4.55	4 269.22	21.95	162.00
2012	5.48	14.03	4.30	4 372.33	21.09	131.48
2013	4.84	13.99	3.53	4 372.89	111.40	115.27
2014	3.85	14.45	0.58	4 295.01	219.22	91.42
2015	4.54	7.26	0.28	4 750.59	264.49	108.35
2016	4.67	3.18	0.24	4 625.45	320.25	108.42
2017	5.34	0.98	0.42	4 535.95	311.32	127.46
2018	5.10	3.48	0.17	4 490.38	271.79	122.38
2019	4.07	3.40	0.07	6 874.85	245.09	107.45
2020	4.24	8.97	0.00	4 133.26	170.60	106.90
2021	2.89	3.39	NO	4 280.55	154.65	72.12
2022	3.21	8.98	NO	3 484.55	205.14	80.22
2023	2.72	8.37	NO	3 297.53	259.71	67.94
1990/2023	**-69%**	**-98%**	**-**	**-58%**	**-**	**-**
2022/2023	**-15%**	**-7%**	**-**	**-5%**	**27%**	**-15%**

3.5.4.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.
The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.36***).

Table 3.36: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	55.45	2.89	33.80	5.29	45.26%	67.25%	14.46

HMs and POPs emissions were calculated using Tier 1 emission factors from EMEP/EEA GB_{2023} (***Table 3.37***).

Table 3.37: *Emission factors for calculating emissions of heavy metals and POPs*

T1	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
Pb	[mg/GJ]	0.08	134	0.011	27
Cd	[mg/GJ]	0.006	1.8	0.0009	13
Hg	[mg/GJ]	0.12	7.9	0.54	0.56
As	[mg/GJ]	0.03	4	0.1	0.19
Cr	[mg/GJ]	0.2	13.5	0.013	23
Cu	[mg/GJ]	0.22	17.5	0.002600	6
Ni	[mg/GJ]	0.008	13	0.013	2
Se	[mg/GJ]	0.11	1.8	0.058	0.5
Zn	[mg/GJ]	29	200	0.73	512
PCDD/F	[ng I-TEQ/GJ]	1.4	203	0.52	100
B(a)P	[mg/GJ]	1.9	45.5	0.72	10

T1	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
B(b)F	[mg/GJ]	15	58.9	2.9	16
B(k)F	[mg/GJ]	1.7	23.7	1.1	5
I()P	[mg/GJ]	1.5	18.5	1.08	4
PAHs	[mg/GJ]	20.1	146.6	5.8	35
HCB	[μg/GJ]	-	0.62	-	5
PCBs	[μg/GJ]	-	170	-	0.06

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.38***). The calculated BC emission values are presented in ***Table 3.34***.

Table 3.38: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.4.3 Completeness

Emissions are well covered.

3.5.4.4 Source-specific Recalculations

No recalculations in this submission.

3.5.5 Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print (NFR 1A2d)

3.5.5.1 Overview

The production of pulp and paper requires considerable amounts of steam and power. Most pulp and paper mills produce their own steam in one or more industrial boilers or combined heat and power (CHP) units which burn fossil fuels and/or wood residues. Activities listed within this category are shown in ***Table 3.39***.

Table 3.39: *Activities according to national categorization included in category 1A2d*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 17-18; 24-25
4.18. Manufacture of pulp and derivatives thereof, including the treatment of waste to products of this manufacture	
4.36. Production and refinement of paper, cardboard with projected output in t/d	

The category includes emissions from fuel combustion in the paper industry. The trends in emissions of pollutants, for which is this category key, are provided in the following figures. A decrease in 2004 and an increase in 2015 in emissions of HMs and POPs was caused by a single source which used almost 3x more biomass fuel in 2004 and in 2015, the same source used 2x less biomass fuel. A decrease in emissions of PCBs in 2010 is connected with a significant reduction in the use of solid fuels in this category. An overview of the emissions is shown in ***Table 3.40***.

Table 3.40: *Overview of emissions in category 1A2d*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	3.3048	0.0321	12.6102	NO	0.1983	0.2240	0.2985	0.0403	5.5380
1995	3.3055	0.0321	12.6132	NO	0.1983	0.2240	0.2986	0.0407	5.5393
2000	1.9772	0.1984	7.3805	NO	0.1261	0.1425	0.1899	0.0280	3.0044

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2005	2.1433	0.1611	3.3816	NO	0.0748	0.0887	0.1205	0.0187	2.1215
2010	1.2829	0.0725	0.2672	0.0039	0.0245	0.0279	0.0424	0.0068	1.8493
2011	1.2395	0.0679	0.2202	0.0038	0.0281	0.0315	0.0472	0.0079	2.0261
2012	1.1296	0.0707	0.1503	0.0029	0.0253	0.0292	0.0487	0.0071	1.7745
2013	1.0277	0.0253	0.1800	0.0029	0.0220	0.0254	0.0411	0.0062	1.8270
2014	0.9283	0.0264	0.2292	0.0026	0.0164	0.0164	0.0164	0.0046	1.6509
2015	1.0847	0.0364	0.1637	0.0002	0.0127	0.0134	0.0148	0.0036	0.9662
2016	1.1150	0.0462	0.0969	0.0031	0.0181	0.0181	0.0181	0.0051	1.9663
2017	1.0995	0.0749	0.2004	0.0072	0.0120	0.0121	0.0122	0.0033	0.4761
2018	0.9907	0.0763	0.0596	0.0079	0.0142	0.0142	0.0142	0.0040	0.2665
2019	1.0505	0.0494	0.1221	0.0033	0.0167	0.0169	0.0170	0.0047	0.3509
2020	1.1573	0.0770	0.1401	0.0105	0.0145	0.0147	0.0148	0.0041	0.6176
2021	1.3143	0.0521	0.0998	0.0030	0.0174	0.0174	0.0174	0.0049	1.1397
2022	1.1550	0.0681	0.1137	0.0080	0.0158	0.0158	0.0158	0.0044	1.0733
2023	1.1085	0.0623	0.1471	0.0136	0.0198	0.0198	0.0198	0.0056	1.0434
1990/2023	**-66%**	**94%**	**-99%**	**-**	**-90%**	**-91%**	**-93%**	**-86%**	**-81%**
2022/2023	**-4%**	**-8%**	**29%**	**71%**	**25%**	**25%**	**25%**	**25%**	**-3%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0375	0.0041	0.0231	0.0143	0.0439	0.0315	0.1357	0.2104	0.1390
1995	0.0376	0.0041	0.0233	0.0145	0.0434	0.0312	0.1351	0.2076	0.1383
2000	0.0433	0.0047	0.0280	0.0175	0.0430	0.0311	0.1217	0.2067	0.1407
2005	0.0449	0.0044	0.0315	0.0197	0.0274	0.0217	0.0310	0.1368	0.1007
2010	0.0421	0.0044	0.0324	0.0230	0.0035	0.0069	0.0173	0.0176	0.0629
2011	0.0400	0.0042	0.0315	0.0224	0.0011	0.0033	0.0060	0.0053	0.0503
2012	0.0385	0.0040	0.0300	0.0217	0.0012	0.0036	0.0101	0.0051	0.0494
2013	0.0401	0.0042	0.0312	0.0223	0.0012	0.0034	0.0068	0.0053	0.0511
2014	0.0361	0.0038	0.0285	0.0198	0.0007	0.0025	0.0073	0.0048	0.0481
2015	0.0177	0.0019	0.0141	0.0099	0.0005	0.0013	0.0087	0.0024	0.0265
2016	0.0332	0.0036	0.0262	0.0182	0.0007	0.0024	0.0134	0.0044	0.0464
2017	0.0337	0.0036	0.0265	0.0184	0.0008	0.0024	0.0102	0.0045	0.0467
2018	0.0332	0.0036	0.0262	0.0182	0.0007	0.0024	0.0103	0.0044	0.0459
2019	0.0309	0.0033	0.0244	0.0170	0.0007	0.0022	0.0097	0.0041	0.0425
2020	0.0340	0.0036	0.0268	0.0186	0.0008	0.0024	0.0101	0.0045	0.0470
2021	0.0369	0.0039	0.0291	0.0202	0.0008	0.0026	0.0096	0.0049	0.0500
2022	0.0338	0.0036	0.0266	0.0184	0.0007	0.0024	0.0091	0.0045	0.0454
2023	0.0286	0.0031	0.0225	0.0157	0.0006	0.0021	0.0099	0.0038	0.0391
1990/2023	**-24%**	**-26%**	**-2%**	**9%**	**-99%**	**-93%**	**-93%**	**-98%**	**-72%**
2022/2023	**-15%**	**-15%**	**-15%**	**-15%**	**-12%**	**-13%**	**9%**	**-15%**	**-14%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.1076	0.0004	0.0013	0.0006	0.0003	0.0026	0.0822	0.0246
1995	0.1102	0.0004	0.0013	0.0006	0.0003	0.0027	0.0829	0.0250
2000	0.1532	0.0006	0.0018	0.0009	0.0005	0.0038	0.1016	0.0333
2005	0.2257	0.0009	0.0028	0.0013	0.0007	0.0057	0.1231	0.0467
2010	0.2854	0.0012	0.0036	0.0017	0.0008	0.0073	0.1279	0.0564
2011	0.2804	0.0011	0.0035	0.0017	0.0008	0.0072	0.1228	0.0549
2012	0.2668	0.0011	0.0034	0.0016	0.0008	0.0068	0.1169	0.0523
2013	0.2788	0.0012	0.0036	0.0017	0.0008	0.0072	0.1225	0.0548
2014	0.2550	0.0011	0.0033	0.0015	0.0008	0.0066	0.1118	0.0500
2015	0.1254	0.0005	0.0016	0.0008	0.0004	0.0033	0.0544	0.0244

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
2016	0.2336	0.0010	0.0030	0.0014	0.0007	0.0061	0.1024	0.0459
2017	0.2371	0.0010	0.0031	0.0014	0.0007	0.0062	0.1039	0.0465
2018	0.2338	0.0010	0.0030	0.0014	0.0007	0.0061	0.1025	0.0459
2019	0.2182	0.0009	0.0028	0.0013	0.0006	0.0057	0.0955	0.0428
2020	0.2394	0.0010	0.0031	0.0014	0.0007	0.0063	0.1049	0.0469
2021	0.2602	0.0011	0.0034	0.0016	0.0008	0.0068	0.1141	0.0510
2022	0.2380	0.0010	0.0031	0.0014	0.0007	0.0062	0.1045	0.0467
2023	0.2015	0.0008	0.0026	0.0012	0.0006	0.0052	0.0884	0.0396
1990/2023	**87%**	**99%**	**106%**	**99%**	**86%**	**101%**	**8%**	**61%**
2022/2023	**-15%**	**-15%**	**-15%**	**-15%**	**-15%**	**-15%**	**-15%**	**-15%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.41*** below.

Table 3.41: *Overview of activity data in category 1A2d*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	427.07	6 103.22	3 755.85	8 262.26	NO
1995	426.01	6 021.67	3 598.35	8 506.75	NO
2000	373.34	5 972.66	3 699.16	12 318.58	NO
2005	50.66	4 026.33	1 791.17	19 253.13	NO
2010	49.14	491.85	3 811.88	24 913.19	NO
2011	13.17	9.27	3 677.97	24 536.73	NO
2012	28.40	14.06	3 274.23	23 350.60	NO
2013	15.83	10.93	1 720.44	24 477.14	NO
2014	21.25	NO	1 631.78	22 333.75	34.71
2015	30.36	NO	2 800.74	10 852.98	34.56
2016	45.65	NO	1 818.05	20 471.67	NO
2017	33.17	NO	1 513.20	20 765.72	19.78
2018	35.04	NO	1 609.60	20 468.21	23.75
2019	31.82	NO	2 020.11	19 081.44	22.69
2020	34.31	NO	1 843.13	20 943.86	29.79
2021	31.78	NO	1 870.16	22 778.01	31.44
2022	44.16	NO	1 117.16	20 869.41	25.35
2023	43.56	NO	1 202.28	17 652.26	26.59
1990/2023	**-90%**	**-**	**-68%**	**114%**	**-**
2022/2023	**-1%**	**-**	**8%**	**-15%**	**5%**

3.5.5.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.42***).

Table 3.42: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	178.17	1.73	679.85	16.09	66.43%	75.03%	298.57

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023}, expert estimation and special source[Chyba! Záložka nie je definovaná.] (*Table 3.43*).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:
E_i = annual emission of pollutant *i*,
$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,
$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3. 43: *Emission factors for calculating emissions of heavy metals and POPs*

TYPE OF FUEL		LIQUID FUELS		HARD COAL		BROWN COAL	
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	PULVERIZED COAL-FIRED BOILERS	FIXED BED BOILERS	PULVERIZED COAL-FIRED BOILERS
		THERMAL CAPACITY					
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth), (> 100 MWth)	(-)	(> 100 MWth)	(> 100 MWth)	(≤ 5 MWth)	(> 100 MWth)
Pb	[mg/GJ]	4.56	4.07	2.656	2.722	59.471	4.071
Cd	[mg/GJ]	1.2	1.36	0.823	0.268	1.294	0.292
Hg	[mg/GJ]	0.341	1.36	1.744	0.668	2.382	2.965
As	[mg/GJ]	3.98	1.81	0.243	0.339	60.967	0.76
Cr	[mg/GJ]	2.55	1.36	4.5	4.5	38.383	9.1
Cu	[mg/GJ]	5.31	2.72	7.8	7.8	69.545	1
Ni	[mg/GJ]	255	1.36	4.9	4.537	62.104	3.374
Se	[mg/GJ]	2.06	6.79	23	23	5.192	45
Zn	[mg/GJ]	87.8	1.81	19	19	30.756	8.8
PCDD/	[ng I-	2.5	0.99	2.299	1.314	4.986	1.925
B(a)P	[mg/GJ]	3.678	116	2.4	2.844	320.061	4.653
B(b)F	[mg/GJ]	12.673	502	4.768	5.433	518.482	6.187
B(k)F	[mg/GJ]	3.968	98.7	3.085	3.786	518.482	4.915
I()P	[mg/GJ]	6.484	187	2.08	3.662	400.322	5.664
PAHs	[mg/GJ]	26.803	903.7	12.33	15.725	1757.347	21.419
HCB	[µg/GJ]	-	0.22	6.7	6.7	6.7	6.7
PCBs	[µg/GJ]	3.334	0.00013	0.395	1.176	5.059052	0.547

TYPE OF FUEL		GASEOUS FUELS		BIOMASS				
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	GAS TURBINES	FIXED BED BOILERS			FLUIDIZED BED BOILERS	PULVERIZED COAL-FIRED BOILERS
		THERMAL CAPACITY						
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth), (50 – 100 MWth), (> 100 MWth)	(-)	(≤ 5 MWth)	(5 – 50 MWth)	(> 100 MWth)	(5 – 50 MWth), (> 100 MWth)	(> 100 MWth)
Pb	[mg/GJ]	0.0015	0.0015	27	1.606	4.56	1.606	1.606
Cd	[mg/GJ]	0.00025	0.00025	13	0.169	1.2	0.169	0.169
Hg	[mg/GJ]	0.1	0.1	0.56	1.268	0.341	1.268	1.268
As	[mg/GJ]	0.12	0.12	0.19	0.871	3.98	0.871	0.871
Cr	[mg/GJ]	0.00076	0.00076	23	0.027	2.55	0.027	0.027
Cu	[mg/GJ]	0.000076	0.000076	6	0.106	5.31	0.106	0.106
Ni	[mg/GJ]	0.00051	0.00051	2	0.085	255	0.085	0.085
Se	[mg/GJ]	0.0112	0.0112	0.5	0.211	2.06	0.211	0.211

TYPE OF FUEL		GASEOUS FUELS		BIOMASS				
Zn	[mg/GJ]	0.0015	0.0015	512	1.991	87.8	1.991	1.991
PCDD	[ng I-	0.5	0.5	100	11.348	2.5	11.348	11.348
B(a)P	[mg/GJ]	0.56	0.56	10000	46.462	3.678	46.462	46.462
B(b)F	[mg/GJ]	0.84	0.84	16000	144.329	12.673	144.329	144.329
B(k)F	[mg/GJ]	0.84	0.84	5000	67.897	3.968	67.897	67.897
I()P	[mg/GJ]	0.84	0.84	4000	33.073	6.484	33.073	33.073
PAHs	[mg/GJ]	3.08	3.08	35000	291.761	26.803	291.761	291.761
HCB	[µg/GJ]	0.00308	0.00308	5	5	-	5	5
PCBs	[µg/GJ]	-	-	0.007	2.233	3.334	2.233	2.233

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.44***). The calculated BC emission values are presented in ***Table 3.40***.

Table 3.44: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.5.3 Completeness

Emissions are well covered.

3.5.5.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (supplemented activity values for the years 2011-2022). Recalculations of HM and POPs emissions were made based on changes in emission factor values (incorrect values in the previous submission, the specific technology occurred in the years 1990-2013). Recalculations of HM and POPs emissions were made based on changes in activity data (supplemented activity values for the years 2014, 2015, 2017, 2018 and 2022). The differences in emissions in category **1A2d** between the previous and current submissions caused by recalculations are shown in ***Table 3.5***

Table 3.45: *Differences in emissions (%) in category 1A2d between the previous and current submission caused by recalculations*

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1990	-	4%	1%	0.1%	13%	2%	7%	1%	-1%	0.4%	-0.1%	2%		0.5%
1991	-	4%	1%	0.1%	13%	2%	7%	1%	-1%	0.4%	-0.1%	2%		0.5%
1992	-	4%	1%	0.1%	13%	2%	7%	1%	-1%	0.4%	-0.1%	2%		0.5%
1993	-	4%	1%	0.1%	13%	2%	7%	1%	-1%	0.4%	-0.1%	2%		0.5%
1994	-	4%	1%	0.1%	13%	2%	6%	1%	-1%	0.4%	-0.1%	2%		0.5%
1995	-	4%	1%	0.1%	13%	2%	6%	1%	-1%	0.4%	-0.1%	2%		0.5%
1996	-	4%	1%	0.1%	13%	2%	6%	1%	-1%	0.4%	-0.1%	2%		0.5%
1997	-	4%	1%	0.1%	12%	2%	6%	1%	-1%	0.4%	-0.1%	2%		0.4%
1998	-	4%	1%	0.0%	11%	2%	6%	1%	-1%	0.4%	-0.1%	2%		0.4%
1999	-	4%	1%	0.1%	12%	2%	6%	1%	-1%	0.4%	-0.1%	2%		0.4%
2000	-	3%	0.5%	0.05%	10%	2%	6%	1%	-1%	0.4%	-0.05%	1%		0.4%
2001	-	3%	0.5%	0.04%	9%	2%	8%	1%	-1%	0.4%	-0.04%	1%		0.3%
2002	-	2%	0.3%	0.03%	5%	1%	5%	0%	-0.3%	0.3%	-0.03%	1%		0.2%
2003	-	1%	0.2%	0.02%	3%	1%	3%	0%	-0.2%	0.2%	-0.02%	0.4%		0.1%
2004	-	1%	0.1%	0.01%	2%	1%	3%	1%	-0.2%	0.1%	-0.01%	0.1%		0.05%
2005	-	1%	0.1%	0.01%	2%	1%	2%	1%	-0.2%	0.1%	-0.01%	0.2%		0.1%

2006	-	1%	0.1%	0.01%	1%	0%	2%	0%	-0.1%	0.1%	-0.01%	0.1%		0.04%
2007	-	1%	0.1%	0.01%	1%	1%	2%	1%	-0.1%	0.1%	-0.01%	0.1%		0.04%
2008	-	1%	0.1%	0.01%	2%	1%	3%	1%	-0.2%	0.2%	-0.01%	0.2%		0.1%
2009	-	1%	0.1%	0.01%	2%	1%	2%	1%	-0.2%	0.1%	-0.01%	0.2%		0.1%
2010	-	1%	0.1%	0.01%	2%	7%	8%	2%	-2%	0.3%	-0.01%	0.2%		0.1%
2011	-0.000002%	1%	0.2%	0.01%	2%	35%	24%	6%	-7%	0.4%	-0.01%	0.2%	-	0.1%
2012	-0.00002%	2%	0.3%	0.02%	4%	49%	37%	5%	-10%	1%	-0.01%	0.4%	-	0.1%
2013	-0.00002%	1%	0.2%	0.02%	3%	39%	28%	6%	-8%	0.5%	-0.01%	0.3%	-	0.1%
2014	-0.00004%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.04%	0.2%	0.1%	0.2%	0.2%	0.2%	0.2%
2015	-0.00006%	0.3%	0.3%	0.3%	0.3%	0.2%	0.3%	0.03%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
2016	-0.00003%	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	-0.00002%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.02%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
2018	-0.00001%	0.1%	0.1%	0.1%	0.1%	0.09%	0.1%	0.02%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
2019	-0.00002%	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	0.02%	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	0.02%	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	0.02%	0.2%	1%	0.01%	0.003%	9%	1%	0.1%	0.04%	3%	0.1%	1%	0.01%	0.00004%

3.5.6 Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco (NFR 1A2e)

3.5.6.1 Overview

Food processing can require considerable amounts of heat, steam and power. Many foods and beverage processes produce their own steam in one or more industrial boilers which burn fossil fuel and/or biomass. The NFR category **1A2e** covers more activities in the Slovak Republic. Emission from activities of the food industry was clearly identified as combustion emissions. Therefore the industrial categories of national classification according to the following ***Table 3.46*** were included here.

Table 3.46: *Activities according to national categorization included in category 1A2e*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 10-12
6.13. Slaughterhouses with a projected capacity of live weight in t/d in the monthly average	combustion
a) poultry, lagomorphs	
b) domestic ungulates	
c) Others (e.g. fish)	
6.14. Sugar refineries with a projected production capacity of sugar t/h	combustion
6.15. Canneries and other food manufacturing with projected production capacity t/d:	combustion
a) meat products	
b) plant products (average per quarter)	
6.16. Distilleries with a projected production capacity of 100 per cent alcohol in t/y	combustion
6.17. Breweries with a projected production v hl/y	combustion
6.18. Food mills with a projected output in t/h	combustion
6.19. Production of industrial feed and organic fertilizer with a projected output in t/h	combustion
6.21. Roasting plants with a projected capacity in kg/h	combustion
a) coffee, coffee substitutes	
b) cocoa beans or nuts	
6.22. Smoking devices food products with a projected capacity of smoking in kg/week	combustion

The overview of emissions is shown in ***Table 3.47***. Emissions of main pollutants in this category show an overall decreasing trend, especially emissions of SOx, heavy metals and POPs are decreasing due to the decrease of using solid fuels within this category (one source of Slovenské cukrovary is out of operation).

Table 3.47: *Overview of emissions in category 1A2e*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.7790	0.0520	0.8731	0.0075	0.0651	0.1039	0.1734	0.0093	0.4200
1995	0.7739	0.0516	0.8674	0.0075	0.0646	0.1032	0.1723	0.0094	0.4173
2000	0.7063	0.0230	0.9341	0.0001	0.0649	0.1036	0.1729	0.0099	0.3813
2005	0.5258	0.0259	0.5047	0.0075	0.0755	0.0829	0.0958	0.0143	0.2446
2010	0.3418	0.0600	0.1481	0.0094	0.0154	0.0244	0.0406	0.0014	0.3559
2011	0.3358	0.0602	0.1785	0.0037	0.0138	0.0227	0.0385	0.0009	0.3644
2012	0.2992	0.0572	0.1815	0.0039	0.0127	0.0208	0.0355	0.0008	0.2884
2013	0.2949	0.0605	0.2061	0.0040	0.0152	0.0257	0.0414	0.0010	0.2416
2014	0.2987	0.0577	0.2037	0.0040	0.0155	0.0270	0.0434	0.0010	0.2626
2015	0.3406	0.0596	0.2015	0.0040	0.0182	0.0309	0.0472	0.0012	0.2730
2016	0.2989	0.0407	0.1783	0.0039	0.0353	0.0445	0.0569	0.0024	0.2577
2017	0.3289	0.0425	0.2551	0.0096	0.0362	0.0462	0.0597	0.0024	0.2766
2018	0.3095	0.0414	0.1979	0.0117	0.0371	0.0472	0.0601	0.0025	0.2651
2019	0.3240	0.0464	0.1549	0.0115	0.0361	0.0403	0.0639	0.0045	0.2486
2020	0.3174	0.0482	0.1357	0.0131	0.0444	0.0548	0.0678	0.0056	0.1602
2021	0.2372	0.0432	0.0196	0.0123	0.0351	0.0391	0.0457	0.0073	0.1510
2022	0.2320	0.0428	0.0050	0.0134	0.0376	0.0417	0.0487	0.0094	0.1389
2023	0.2429	0.0557	0.0039	0.0097	0.0426	0.0478	0.0570	0.0121	0.1519
1990/2023	**-69%**	**7%**	**-100%**	**30%**	**-35%**	**-54%**	**-67%**	**29%**	**-64%**
2022/2023	**5%**	**30%**	**-23%**	**-28%**	**13%**	**15%**	**17%**	**28%**	**9%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0611	0.0012	0.0086	0.0027	0.0070	0.0082	0.0060	0.0014	0.1261
1995	0.0609	0.0012	0.0086	0.0027	0.0070	0.0081	0.0060	0.0014	0.1262
2000	0.0526	0.0011	0.0079	0.0024	0.0061	0.0071	0.0052	0.0013	0.1131
2005	0.0448	0.0013	0.0059	0.0019	0.0057	0.0061	0.0044	0.0010	0.1128
2010	0.0630	0.0015	0.0059	0.0023	0.0074	0.0084	0.0061	0.0011	0.1206
2011	0.0667	0.0010	0.0061	0.0024	0.0069	0.0087	0.0065	0.0011	0.1056
2012	0.0557	0.0008	0.0053	0.0020	0.0057	0.0073	0.0055	0.0010	0.0875
2013	0.0617	0.0008	0.0055	0.0022	0.0063	0.0081	0.0060	0.0010	0.0957
2014	0.0734	0.0010	0.0062	0.0025	0.0075	0.0096	0.0072	0.0012	0.1136
2015	0.0967	0.0013	0.0076	0.0032	0.0098	0.0126	0.0094	0.0015	0.1483
2016	0.0739	0.0010	0.0063	0.0026	0.0075	0.0097	0.0072	0.0012	0.1145
2017	0.0882	0.0012	0.0071	0.0030	0.0090	0.0115	0.0086	0.0014	0.1364
2018	0.0792	0.0011	0.0066	0.0027	0.0081	0.0104	0.0077	0.0013	0.1227
2019	0.0728	0.0030	0.0059	0.0024	0.0106	0.0099	0.0070	0.0012	0.1866
2020	0.0679	0.0029	0.0057	0.0023	0.0100	0.0093	0.0065	0.0011	0.1769
2021	0.0104	0.0018	0.0025	0.0006	0.0037	0.0017	0.0010	0.0004	0.0789
2022	0.0042	0.0020	0.0020	0.0004	0.0035	0.0009	0.0004	0.0003	0.0794
2023	0.0043	0.0020	0.0020	0.0004	0.0037	0.0010	0.0004	0.0003	0.0870
1990/2023	**-93%**	**68%**	**-77%**	**-86%**	**-47%**	**-88%**	**-94%**	**-79%**	**-31%**
2022/2023	**5%**	**5%**	**-0.01%**	**0.3%**	**6%**	**8%**	**4%**	**6%**	**10%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0996	0.0283	0.0610	0.0218	0.0191	0.1302	0.0004	0.0762
1995	0.0993	0.0282	0.0609	0.0217	0.0191	0.1298	0.0004	0.0760

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
2000	0.0865	0.0251	0.0559	0.0198	0.0175	0.1182	0.0004	0.0655
2005	0.0747	0.0207	0.0465	0.0156	0.0137	0.0966	0.0005	0.0549
2010	0.1005	0.0244	0.0397	0.0156	0.0131	0.0928	0.0005	0.0782
2011	0.1035	0.0255	0.0410	0.0162	0.0136	0.0964	0.0003	0.0843
2012	0.0865	0.0216	0.0355	0.0140	0.0117	0.0828	0.0003	0.0706
2013	0.0952	0.0234	0.0373	0.0147	0.0122	0.0875	0.0003	0.0782
2014	0.1132	0.0275	0.0426	0.0169	0.0140	0.1009	0.0004	0.0930
2015	0.1484	0.0354	0.0531	0.0211	0.0172	0.1268	0.0005	0.1225
2016	0.1139	0.0277	0.0430	0.0170	0.0141	0.1018	0.0004	0.0936
2017	0.1357	0.0326	0.0496	0.0196	0.0161	0.1179	0.0004	0.1118
2018	0.1220	0.0295	0.0454	0.0179	0.0147	0.1075	0.0004	0.1004
2019	0.1214	0.0272	0.0423	0.0166	0.0137	0.0998	0.0011	0.0868
2020	0.1138	0.0256	0.0403	0.0157	0.0131	0.0947	0.0011	0.0808
2021	0.0252	0.0064	0.0161	0.0061	0.0056	0.0342	0.0007	0.0087
2022	0.0169	0.0041	0.0128	0.0047	0.0045	0.0261	0.0007	0.0001
2023	0.0178	0.0044	0.0149	0.0049	0.0047	0.0289	0.0008	0.0001
1990/2023	**-82%**	**-84%**	**-76%**	**-77%**	**-76%**	**-78%**	**82%**	**-100%**
2022/2023	**5%**	**7%**	**16%**	**5%**	**4%**	**11%**	**5%**	**-23%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.48*** below.

Table 3.48: *Overview of activity data in category 1A2e*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	486.58	448.38	9 248.51	40.84	NO
1995	498.01	447.23	9 171.20	40.84	NO
2000	488.85	385.14	8 774.43	40.84	NO
2005	604.59	323.08	6 093.54	53.97	NO
2010	0.80	459.72	4 066.54	68.66	NO
2011	1.23	496.14	4 024.59	18.37	NO
2012	12.95	415.15	3 717.15	17.44	NO
2013	29.59	459.88	3 343.55	20.63	NO
2014	6.00	547.16	3 517.81	21.56	NO
2015	11.92	720.47	3 570.57	31.39	NO
2016	27.23	550.43	3 520.30	25.33	NO
2017	30.26	657.52	3 547.82	51.78	NO
2018	42.21	590.46	3 382.68	97.01	NO
2019	13.97	510.69	3 281.77	189.35	NO
2020	11.21	475.44	3 334.02	179.71	NO
2021	13.51	51.08	3 784.04	151.98	NO
2022	16.14	0.57	3 544.39	171.91	NO
2023	188.37	0.42	3 477.95	173.32	NO
1990/2023	**-61%**	**-100%**	**-62%**	**324%**	**-**
2022/2023	**1067%**	**-26%**	**-2%**	**1%**	**-**

3.5.6.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.49***).

Table 3.49: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	76.18	5.08	85.39	0.73	16.96	37.52%	59.90%

HMs and POPs emissions were calculated using Tier 1 emission factors from EMEP/EEA GB_{2023} (***Table 3.50***).

Table 3.50: *Emission factors for calculating emissions of heavy metals and POPs*

T1	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
Pb	[mg/GJ]	0.08	134	0.011	27
Cd	[mg/GJ]	0.006	1.8	0.0009	13
Hg	[mg/GJ]	0.12	7.9	0.54	0.56
As	[mg/GJ]	0.03	4	0.1	0.19
Cr	[mg/GJ]	0.2	13.5	0.013	23
Cu	[mg/GJ]	0.22	17.5	0.002600	6
Ni	[mg/GJ]	0.008	13	0.013	2
Se	[mg/GJ]	0.11	1.8	0.058	0.5
Zn	[mg/GJ]	29	200	0.73	512
PCDD/F	[ng I-TEQ/GJ]	1.4	203	0.52	100
B(a)P	[mg/GJ]	1.9	45.5	0.72	10
B(b)F	[mg/GJ]	15	58.9	2.9	16
B(k)F	[mg/GJ]	1.7	23.7	1.1	5
I()P	[mg/GJ]	1.5	18.5	1.08	4
PAHs	[mg/GJ]	20.1	146.6	5.8	35
HCB	[µg/GJ]	-	0.62	-	5
PCBs	[µg/GJ]	-	170	-	0.06

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.51***). The calculated BC emission values are presented in ***Table 3.47***.

Table 3.51: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.6.3 Completeness

Emissions are well covered.

3.5.6.4 Source-specific Recalculations

No recalculations in this submission.

3.5.7 Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals (NFR 1A2f)

3.5.7.1 Overview

Emissions in this category include combustion processes within the cement, lime, glass and glass wool production in the Slovak Republic. The emissions depend on fuel and process activity. Relevant pollutants are generally described for combustion: SOx, NOx, CO, NMVOC, particulate matter (TSP, PM_{10}, $PM_{2.5}$), black carbon (BC), heavy metals (HM), polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzo-dioxin and polychlorinated dibenzo-furans (PCDD/F) and, for some activities, polychlorinated biphenyls (PCB) and hexachlorobenzene (HCB). This category is key for NOx emissions.

Sources within this category are a combination of combustion and process sources, therefore, emissions of particulate matter from the cement, lime and glass production are reported under the particular IPPU categories and combustion emissions from those categories are reported in **1A2f**. Particular matter emissions included in this category originate only from sources allocated by national law to category 1.1 and NACE division 23. Activities listed within this category are shown in ***Table 3.52***.

Table 3.52: *Activities according to national categorization included in category 1A2f*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 23
3.2. Manufacture of cement with a projected production capacity in t/d	
3.3. Manufacture of lime with a designed production capacity of cement clinker in t/d	
3.7. Manufacture of glass, glass products, including glass fibre with projected melting capacity in t/d	

The reason for the decrease in HM and POPs emissions, especially PCDD/F, is the transition from rotary kilns to shaft kilns at one operator's source, i.e. there was a change in the type of fuel used. The overview of emissions is shown in ***Table 3.53***.

Table 3.53: *Overview of emissions in category 1A2f*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	5.6738	0.0741	0.6594	NO	0.0245	0.0345	0.0386	0.0019	11.3766
1995	5.6543	0.0739	0.6571	NO	0.0244	0.0344	0.0385	0.0019	11.3375
2000	5.3727	0.0741	0.7341	0.0031	0.0285	0.0401	0.0449	0.0022	9.0429
2005	5.0294	0.0662	0.4997	0.0000	0.0044	0.0063	0.0162	0.0004	10.2890
2010	4.5594	0.1898	0.3220	NO	0.0029	0.0045	0.0124	0.0003	12.8343
2011	4.8866	0.2473	0.3462	NO	0.0022	0.0033	0.0088	0.0002	11.3292
2012	4.2019	0.1520	0.4290	0.0000	0.0030	0.0040	0.0074	0.0003	9.3928
2013	4.3940	0.1198	0.3624	0.0006	0.0027	0.0036	0.0074	0.0003	7.9731
2014	4.4765	0.1498	0.3841	0.0006	0.0024	0.0032	0.0067	0.0003	9.7134
2015	4.6022	0.1757	0.3421	0.0240	0.0024	0.0031	0.0059	0.0003	7.6889
2016	4.4955	0.1665	0.3008	0.0428	0.0023	0.0026	0.0031	0.0003	7.8489
2017	4.3187	0.1655	0.2779	0.0439	0.0018	0.0019	0.0020	0.0002	8.8505
2018	3.7363	0.1677	0.2133	0.0384	0.0017	0.0019	0.0022	0.0002	10.9896
2019	4.3699	0.1439	0.2975	0.0383	0.0017	0.0019	0.0022	0.0002	9.3890
2020	4.2351	0.1845	0.2994	0.0415	0.0014	0.0015	0.0015	0.0002	9.9209
2021	4.2879	0.1525	0.4194	0.0484	0.0013	0.0014	0.0014	0.0002	10.5219
2022	4.5632	0.1769	0.3478	0.0587	0.0009	0.0009	0.0009	0.0001	9.8394
2023	4.0454	0.1884	0.4184	0.0399	0.0006	0.0007	0.0007	0.0001	8.1800
1990/2023	**-29%**	**154%**	**-37%**	**-**	**-97%**	**-98%**	**-98%**	**-95%**	**-28%**
2022/2023	**-11%**	**7%**	**20%**	**-32%**	**-26%**	**-26%**	**-25%**	**-33%**	**-17%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.2779	0.0227	0.1390	0.0751	0.1163	0.1835	0.1390	0.0717	1.2024
1995	0.2191	0.0179	0.1096	0.0592	0.0917	0.1447	0.1096	0.0566	0.9480
2000	0.2267	0.0185	0.1134	0.0613	0.0949	0.1497	0.1134	0.0585	0.9810
2005	0.2306	0.0188	0.1153	0.0623	0.0965	0.1522	0.1153	0.0595	0.9975
2010	0.1621	0.0132	0.0810	0.0438	0.0678	0.1070	0.0810	0.0418	0.7011
2011	0.2414	0.0197	0.1194	0.0645	0.0998	0.1575	0.1196	0.0616	1.0320
2012	0.2219	0.0180	0.1048	0.0565	0.0872	0.1376	0.1056	0.0538	0.9015
2013	0.2290	0.0186	0.1066	0.0575	0.0886	0.1398	0.1078	0.0547	0.9164
2014	0.2550	0.0207	0.1191	0.0642	0.0990	0.1563	0.1203	0.0611	1.0241
2015	0.2566	0.0209	0.1233	0.0665	0.1028	0.1621	0.1240	0.0634	1.0626
2016	0.2712	0.0221	0.1281	0.0691	0.1066	0.1682	0.1291	0.0658	1.1021
2017	0.2823	0.0230	0.1330	0.0717	0.1107	0.1746	0.1342	0.0683	1.1443
2018	0.2917	0.0237	0.1333	0.0718	0.1105	0.1744	0.1351	0.0682	1.1430
2019	0.3082	0.0250	0.1411	0.0760	0.1170	0.1847	0.1429	0.0722	1.2104
2020	0.3147	0.0256	0.1454	0.0784	0.1207	0.1905	0.1471	0.0745	1.2487
2021	0.3242	0.0263	0.1455	0.0783	0.1204	0.1901	0.1479	0.0743	1.2456
2022	0.3099	0.0252	0.1495	0.0807	0.1247	0.1968	0.1503	0.0769	1.2895
2023	0.2633	0.0215	0.1314	0.0711	0.1100	0.1735	0.1315	0.0679	1.1372
1990/2023	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**
2022/2023	**-15%**	**-15%**	**-12%**	**-12%**	**-12%**	**-12%**	**-13%**	**-12%**	**-12%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0116	0.0000	0.0008	0.0002	0.0001	0.0012	0.0130	0.2921
1995	0.0092	0.0000	0.0006	0.0002	0.0001	0.0009	0.0103	0.2303
2000	0.0095	0.0000	0.0006	0.0002	0.0001	0.0009	0.0106	0.2383
2005	0.0096	0.0000	0.0007	0.0002	0.0001	0.0010	0.0108	0.2423
2010	0.0068	0.0000	0.0005	0.0001	0.0001	0.0007	0.0076	0.1703
2011	0.7947	0.0000	0.0007	0.0002	0.0001	0.0010	0.0112	0.2507
2012	3.6462	0.0000	0.0006	0.0002	0.0001	0.0011	0.0098	0.2190
2013	4.6273	0.0000	0.0006	0.0002	0.0001	0.0011	0.0100	0.2226
2014	4.9267	0.0000	0.0007	0.0002	0.0001	0.0013	0.0111	0.2488
2015	2.9831	0.0000	0.0007	0.0002	0.0001	0.0012	0.0115	0.2581
2016	4.4538	0.0000	0.0007	0.0002	0.0001	0.0013	0.0120	0.2677
2017	4.8012	0.0000	0.0008	0.0002	0.0001	0.0014	0.0124	0.2780
2018	7.4282	0.0000	0.0008	0.0002	0.0001	0.0015	0.0124	0.2777
2019	7.6730	0.0000	0.0008	0.0002	0.0001	0.0016	0.0132	0.2940
2020	7.0438	0.0000	0.0008	0.0002	0.0001	0.0016	0.0136	0.3033
2021	9.7928	0.0000	0.0008	0.0002	0.0001	0.0018	0.0136	0.3026
2022	3.1910	0.0000	0.0009	0.0002	0.0001	0.0014	0.0140	0.3133
2023	0.1426	0.0000	0.0008	0.0002	0.0001	0.0011	0.0123	0.2763
1990/2023	**1126%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**	**-5%**
2022/2023	**-96%**	**-12%**	**-12%**	**-12%**	**-12%**	**-23%**	**-12%**	**-12%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.54*** below.

Table 3.43: *Overview of activity data in category 1A2f*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	582.03	6 388.61	10 817.05	95.99	17.10
1995	520.34	6 454.60	10 751.21	95.99	17.11
2000	638.78	6 842.71	9 544.20	95.99	20.25
2005	259.17	10 026.78	7 170.93	506.78	792.00

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2010	276.51	6 590.37	4 520.81	655.05	3 439.86
2011	296.85	6 565.93	4 512.34	658.54	3 378.13
2012	88.98	6 057.41	3 663.32	617.42	3 675.01
2013	1 332.87	4 158.81	4 246.25	395.71	4 316.48
2014	1 450.24	4 264.56	4 048.12	277.21	5 221.75
2015	2 361.15	4 444.44	3 776.08	308.63	4 982.50
2016	2 407.44	4 115.03	4 661.18	483.15	5 223.98
2017	2 462.64	4 390.73	4 841.37	481.78	7 003.06
2018	2 219.04	4 159.07	4 673.82	623.07	4 974.97
2019	2 358.09	3 635.78	4 720.09	590.78	5 967.80
2020	2 409.22	3 776.24	4 401.23	1.35	6 359.26
2021	2 595.59	3 155.22	4 906.93	5.04	7 270.81
2022	2 704.33	2 056.11	4 695.25	85.10	5 138.24
2023	2 222.14	2 219.40	4 109.69	123.78	5 766.10
1990/2023	**282%**	**-65%**	**-62%**	**29%**	**33629%**
2022/2023	**-18%**	**8%**	**-12%**	**45%**	**12%**

3.5.7.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.55***).

Table 3.55: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	316.96	4.14	36.83	0.17	2.16	63.43%	89.30%

HMs and POPs emissions from the categories **2A1** (Cement production), **2A2** (Lime production) and **2A3** (Glass production) were allocated in this category because most of these emissions originate during the combustion processes.

Tier 2 EMEP/EEA GB_{2023} emission factors for the manufacture of cement (**2A1**) and Tier 1 EMEP/EEA GB_{2023} emission factors for industrial waste incineration (**2A2**) were used for the calculation of HMs and POPs emissions (***Table 3.56***).

Table 3.56: *Emission factors for calculating emissions of heavy metals and POPs*

T2/T1	UNIT	MANUFACTURE OF CEMENT	INDUSTRIAL WASTE INCINERATION
Pb	[mg/GJ]	0.098	1.3
Cd	[mg/GJ]	0.008	0.1
Hg	[mg/GJ]	0.049	0.056
As	[mg/GJ]	0.0265	0.016
Cr	[mg/GJ]	0.041	-
Cu	[mg/GJ]	0.0647	-
Ni	[mg/GJ]	0.049	0.14
Se	[mg/GJ]	0.0253	-
Zn	[mg/GJ]	0.424	-
PCDD/F	[ng I-TEQ/GJ]	4.1	350
B(a)P	[mg/GJ]	6.5E-06	-

T2/T1	UNIT	MANUFACTURE OF CEMENT	INDUSTRIAL WASTE INCINERATION
B(b)F	[mg/GJ]	0.00028	-
B(k)F	[mg/GJ]	0.000077	-
I()P	[mg/GJ]	0.000043	-
PAHs	[mg/GJ]	0.000407	0.02
HCB	[µg/GJ]	4.6	0.002
PCBs	[µg/GJ]	103	-

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.57***). The calculated BC emission values are presented in ***Table 3.53***.

Table 3.57: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.7.3 Completeness

Emissions are well covered.

3.5.7.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (supplemented activity values for the years 2016-2022). The differences in emissions in category **1A2f** between the previous and current submissions caused by recalculations are shown in ***Table 3.58***.

Table 3.58: *Differences in emissions (%) in the category 1A2f between the previous and current submission caused by recalculations*

YEAR	BC
2016	-0.0003%
2017	-0.0002%
2018	-0.0003%
2019	-0.0001%
2020	0.008%

3.5.8 Mobile Combustion in Manufacturing Industries and Construction (NFR 1A2gvii)

3.5.8.1 Overview

According to ***Recommendations No SK-1A4cii-2018-0001*** and ***SK-1A4cii-2021-0002*** Slovakia after receiving the most necessary data was able to disaggregate all non-road mobile combustion categories (**1A2gvii**, **1A4aii**, **1A4bii** and **1A4cii**). The results of the separation are shown in ***Table 3.59***. In the year 2023, an increase in energy consumption was observed.

Table 3.59: *Overview of emissions in category 1A2gvii*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.5025	0.0852	0.0003	0.0001	0.0318	0.0318	0.0318	0.0196	1.5714
1995	0.4836	0.0872	0.0003	0.0001	0.0306	0.0306	0.0306	0.0188	1.7316
2000	0.4648	0.0892	0.0003	0.0001	0.0293	0.0293	0.0293	0.0180	1.8917
2005	0.4459	0.0912	0.0003	0.0001	0.0280	0.0280	0.0280	0.0172	2.0519

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2010	0.4271	0.0932	0.0003	0.0001	0.0267	0.0267	0.0267	0.0163	2.2121
2011	0.4233	0.0936	0.0003	0.0001	0.0265	0.0265	0.0265	0.0162	2.2441
2012	0.4195	0.0940	0.0003	0.0001	0.0262	0.0262	0.0262	0.0160	2.2762
2013	0.4129	0.0972	0.0003	0.0001	0.0257	0.0257	0.0257	0.0157	2.4404
2014	0.5760	0.1141	0.0004	0.0001	0.0362	0.0362	0.0362	0.0222	2.4943
2015	0.3987	0.0594	0.0003	0.0001	0.0254	0.0254	0.0254	0.0157	0.8997
2016	0.3334	0.0527	0.0002	0.0001	0.0212	0.0212	0.0212	0.0131	0.8781
2017	0.5547	0.0574	0.0003	0.0001	0.0358	0.0358	0.0358	0.0222	0.1832
2018	0.7505	0.0777	0.0005	0.0002	0.0484	0.0484	0.0484	0.0300	0.2478
2019	0.5363	0.0918	0.0004	0.0001	0.0340	0.0340	0.0340	0.0209	1.7131
2020	0.4313	0.0628	0.0003	0.0001	0.0275	0.0275	0.0275	0.0170	0.9104
2021	0.8881	0.1101	0.0006	0.0002	0.0570	0.0570	0.0570	0.0353	1.0613
2022	0.3008	0.0493	0.0002	0.0001	0.0191	0.0191	0.0191	0.0118	0.8673
2023	0.4639	0.0662	0.0003	0.0001	0.0296	0.0296	0.0296	0.0183	0.9212
1990/2023	**-8%**	**-22%**	**-11%**	**-9%**	**-7%**	**-7%**	**-7%**	**-7%**	**-41%**
2022/2023	**54%**	**34%**	**50%**	**53%**	**55%**	**55%**	**55%**	**56%**	**6%**

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
1990	0.0002	0.0008	0.0286	0.0012	0.0002	0.0168	0.0005	0.0008	0.0013
1995	0.0002	0.0008	0.0279	0.0011	0.0002	0.0164	0.0005	0.0008	0.0013
2000	0.0002	0.0008	0.0272	0.0011	0.0002	0.0160	0.0005	0.0008	0.0013
2005	0.0002	0.0008	0.0265	0.0011	0.0002	0.0156	0.0005	0.0008	0.0012
2010	0.0002	0.0008	0.0258	0.0011	0.0002	0.0152	0.0005	0.0007	0.0012
2011	0.0002	0.0008	0.0257	0.0011	0.0002	0.0151	0.0005	0.0007	0.0012
2012	0.0002	0.0008	0.0256	0.0011	0.0002	0.0150	0.0005	0.0007	0.0012
2013	0.0002	0.0008	0.0255	0.0011	0.0002	0.0150	0.0005	0.0007	0.0012
2014	0.0002	0.0010	0.0340	0.0014	0.0002	0.0200	0.0006	0.0010	0.0016
2015	0.0001	0.0007	0.0221	0.0009	0.0001	0.0130	0.0004	0.0006	0.0010
2016	0.0001	0.0006	0.0187	0.0008	0.0001	0.0110	0.0003	0.0005	0.0009
2017	0.0002	0.0009	0.0289	0.0012	0.0002	0.0170	0.0005	0.0009	0.0014
2018	0.0002	0.0012	0.0391	0.0016	0.0002	0.0230	0.0007	0.0012	0.0018
2019	0.0002	0.0009	0.0306	0.0013	0.0002	0.0180	0.0006	0.0009	0.0014
2020	0.0001	0.0007	0.0238	0.0010	0.0001	0.0140	0.0004	0.0007	0.0011
2021	0.0003	0.0014	0.0476	0.0020	0.0003	0.0280	0.0009	0.0014	0.0022
2022	0.0001	0.0005	0.0170	0.0007	0.0001	0.0100	0.0003	0.0005	0.0008
2023	0.0002	0.0008	0.0255	0.0011	0.0002	0.0150	0.0005	0.0007	0.0012
1990/2023	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-12%**	**-10%**	**-11%**
2022/2023	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**48%**	**51%**	**50%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.60*** below. Small irregularities were found during checking activity data (the year 2011 and 2020). It was caused by incorrect data flow but did not affect the emissions calculations.

Table 3.60: *Overview of activity data in category 1A2gvii*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	716.73	NA	NA	NO	NA
1995	693.64	NA	NA	NO	NA
2000	683.63	NA	NA	NO	NA
2005	662.60	NA	NA	NO	NA
2010	594.54	NA	NA	23.53	NA
2011	583.63	NA	NA	27.40	NA

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2012	582.43	NA	NA	26.39	NA
2013	603.27	NA	NA	28.96	NA
2014	789.97	NA	NA	49.93	NA
2015	511.73	NA	NA	34.88	NA
2016	432.97	NA	NA	29.49	NA
2017	663.78	NA	NA	49.36	NA
2018	903.10	NA	NA	61.73	NA
2019	710.20	NA	NA	46.74	NA
2020	547.48	NA	NA	40.14	NA
2021	1 092.45	NA	NA	81.34	NA
2022	392.67	NA	NA	29.00	NA
2023	589.41	NA	NA	40.65	NA
1990/2023	**-18%**	**-**	**-**	**-**	**-**
2022/2023	**50%**	**-**	**-**	**40%**	**-**

3.5.8.2 Methodological Issues

Slovakia was able to receive statistical data about fuel combustion from the year 2013. The years 1990-2012 were estimated using expert judgment and a linear regression model back to the base year. This model caused the trend to be clearly linear up to 2013. After this year we can observe deviations in fuel consumption, as well as in estimated emissions. For the emission estimation, EMEP/EEA GB_{2023} Tier 1 emission factors were used.

3.5.8.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2023}.

3.5.8.4 Source-specific Recalculations

No recalculations in this submission.

3.5.9 Stationary Combustion in Manufacturing Industries and Construction: Other (NFR 1A2gviii)

3.5.9.1 Overview

This category covers the sources that cannot be clearly identified to a particular activity but generally, it is the combustion process. Activities listed within this category are shown in ***Table 3.61***.

Table 3.61: *Activities according to national categorization included in category 1A2gviii*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	LARGE/MEDIUM S.: NACE 01-09; 13-16; 19; 25-33; 36-47; 50-99
2.99. Other industrial production and metal processing if the combustion of fuel with nominated thermal input in MW is a part of technology	combustion
3.99. Other industrial production and processing of non-mineral products if the combustion of fuel with nominated thermal input in MW is a part of technology	combustion
4.99. Other chemical industrial production and processing if the combustion of fuel with nominated thermal input in MW is a part of technology	combustion
6.99. Other industrial technologies, production and processing if the combustion of fuel with nominated thermal input in MW is a part of technology	combustion

Emissions of PCDD/F and HCB are influenced mostly by the amount of industrial waste incinerated with energy recovery and abatement technology of ISW incineration plants reported within this category. A significant increase in 2005 was caused by the fact that operators of obsolete plants used the last year before the introduction of stricter emission limits associated with the accession of the Slovak Republic to the EU and burned three times higher amount of waste than in the previous year. Subsequently, in 2006, non-compliance plants ceased their activities. The increase in HMs and PAHs in 2017 correlates with the consumption of solid fuels. The decrease in SOx emissions since 2022 was caused by the installation of separators which help to reduce these emissions (operator Bukocel) (***Recommendation No SK-1A2gviii-2024-0001***). The decrease in PCDD/F, HCB and PCB emissions in 2023 was due to the incineration of less waste at one operator source. The overall trend of these emissions is connected with the trend of biomass fuels used. The overview of the emissions is shown in ***Table 3.62***.

Table 3.62: *Overview of emissions in category 1A2gviii*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	2.5797	0.1227	2.3689	0.0270	0.7010	0.9572	1.4711	0.1060	3.7165
1995	2.5338	0.1205	2.3268	0.0266	0.6885	0.9402	1.4450	0.1050	3.6505
2000	2.4824	3.5369	1.6422	0.0080	0.5623	0.7679	1.1802	0.0989	3.0044
2005	1.1298	4.9561	0.6837	0.0076	0.2662	0.3538	0.6150	0.0633	2.1215
2010	1.0966	4.4405	0.2108	0.0051	0.1490	0.2055	0.3073	0.0404	1.8493
2011	1.1755	4.6571	0.2331	0.0072	0.1360	0.1876	0.2795	0.0360	2.0261
2012	1.1063	4.8403	0.2118	0.0074	0.1529	0.2006	0.2837	0.0415	1.7745
2013	0.9920	5.0664	0.2472	0.0062	0.1183	0.1648	0.2453	0.0318	1.8270
2014	0.9397	5.1977	0.2377	0.0064	0.1141	0.1695	0.2670	0.0303	1.6509
2015	1.1158	5.3408	0.2587	0.0066	0.1190	0.1806	0.2909	0.0318	1.7669
2016	1.1770	5.5870	0.2670	0.0067	0.1271	0.1757	0.2565	0.0346	1.1496
2017	1.4359	5.9146	0.4311	0.0081	0.1362	0.1866	0.2713	0.0315	1.2729
2018	1.1863	6.0538	0.2591	0.0087	0.1310	0.1837	0.2716	0.0356	1.2487
2019	1.1007	6.1370	0.2649	0.0084	0.1345	0.1863	0.2781	0.0364	1.1994
2020	1.0764	5.2788	0.2876	0.0076	0.1328	0.1830	0.2648	0.0360	1.1603
2021	1.1546	5.1439	0.2749	0.0047	0.1390	0.1912	0.2752	0.0377	1.3213
2022	1.1422	4.8782	0.1153	0.0027	0.1265	0.1672	0.2293	0.0344	1.5360
2023	1.0833	4.7199	0.1504	0.0030	0.1210	0.1635	0.2287	0.0330	1.4464
1990/2023	**-58%**	**3747%**	**-94%**	**-89%**	**-83%**	**-83%**	**-84%**	**-69%**	**-61%**
2022/2023	**-5%**	**-3%**	**30%**	**13%**	**-4%**	**-2%**	**0%**	**-4%**	**-6%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0193	0.0056	0.0066	0.0098	0.0121	0.0090	0.2765	0.0166	0.2411
1995	0.0064	0.0018	0.0031	0.0043	0.0043	0.0030	0.0855	0.0071	0.0772
2000	0.0028	0.0007	0.0020	0.0029	0.0026	0.0015	0.0357	0.0072	0.0299
2005	0.0086	0.0025	0.0039	0.0040	0.0054	0.0024	0.0364	0.0075	0.0952
2010	0.0215	0.0067	0.0082	0.0066	0.0115	0.0043	0.0339	0.0068	0.2419
2011	0.0313	0.0112	0.0089	0.0068	0.0196	0.0061	0.0219	0.0085	0.4167
2012	0.0238	0.0075	0.0088	0.0071	0.0128	0.0046	0.0215	0.0068	0.2677
2013	0.0219	0.0072	0.0078	0.0059	0.0124	0.0040	0.0142	0.0067	0.2600
2014	0.0225	0.0077	0.0072	0.0054	0.0132	0.0041	0.0110	0.0054	0.2826
2015	0.0207	0.0068	0.0074	0.0056	0.0117	0.0037	0.0175	0.0066	0.2478
2016	0.0211	0.0070	0.0073	0.0055	0.0121	0.0039	0.0202	0.0064	0.2585
2017	0.0227	0.0074	0.0082	0.0063	0.0128	0.0042	0.0159	0.0072	0.2694
2018	0.0207	0.0065	0.0080	0.0062	0.0110	0.0038	0.0200	0.0063	0.2323
2019	0.0205	0.0063	0.0082	0.0062	0.0107	0.0037	0.0161	0.0068	0.2238
2020	0.0166	0.0056	0.0057	0.0043	0.0099	0.0030	0.0102	0.0062	0.2056
2021	0.0206	0.0063	0.0082	0.0064	0.0108	0.0038	0.0158	0.0074	0.2237
2022	0.0175	0.0050	0.0079	0.0059	0.0083	0.0030	0.0146	0.0065	0.1739
2023	0.0150	0.0049	0.0055	0.0043	0.0084	0.0029	0.0186	0.0045	0.1795
1990/2023	**-22%**	**-12%**	**-17%**	**-56%**	**-31%**	**-68%**	**-93%**	**-73%**	**-26%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2022/2023	**-14%**	**-2%**	**-30%**	**-27%**	**1%**	**-3%**	**27%**	**-31%**	**3%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0752	0.0029	0.0049	0.0016	0.0012	0.0105	0.0207	0.0118
1995	0.0292	0.0009	0.0016	0.0005	0.0004	0.0035	0.0070	0.0038
2000	0.0144	0.0003	0.0006	0.0002	0.0002	0.0013	0.0032	0.0016
2005	0.0435	0.0016	0.0027	0.0009	0.0007	0.0059	0.0116	0.0051
2010	0.1097	0.0045	0.0076	0.0025	0.0019	0.0166	0.0306	0.0130
2011	0.1489	0.0080	0.0133	0.0043	0.0033	0.0289	0.0346	0.0137
2012	0.1203	0.0051	0.0086	0.0028	0.0022	0.0188	0.0331	0.0138
2013	0.1110	0.0050	0.0084	0.0027	0.0021	0.0183	0.0293	0.0120
2014	0.1112	0.0055	0.0091	0.0030	0.0023	0.0198	0.0277	0.0112
2015	0.1052	0.0047	0.0079	0.0026	0.0020	0.0172	0.0279	0.0115
2016	0.1055	0.0049	0.0082	0.0027	0.0020	0.0178	0.0272	0.0112
2017	0.1145	0.0052	0.0086	0.0028	0.0022	0.0188	0.0300	0.0123
2018	0.1071	0.0044	0.0075	0.0025	0.0019	0.0162	0.0299	0.0125
2019	0.1065	0.0043	0.0072	0.0024	0.0018	0.0157	0.0303	0.0127
2020	0.0829	0.0039	0.0066	0.0021	0.0016	0.0143	0.0210	0.0085
2021	0.1066	0.0043	0.0072	0.0024	0.0018	0.0157	0.0303	0.0126
2022	0.0948	0.0033	0.0057	0.0019	0.0014	0.0122	0.0290	0.0123
2023	0.0760	0.0034	0.0057	0.0019	0.0014	0.0123	0.0199	0.0083
1990/2023	**1%**	**18%**	**16%**	**15%**	**15%**	**17%**	**-4%**	**-29%**
2022/2023	**-20%**	**3%**	**0.01%**	**-2%**	**0.2%**	**0.4%**	**-31%**	**-32%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.63*** below.

Table 3.63: *Overview of activity data in category 1A2gviii*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	422.68	2 318.63	20 227.45	1 119.73	NO
1995	410.23	2 345.02	19 731.99	1 173.23	NO
2000	489.74	1 859.07	17 487.13	1 415.42	NO
2005	420.07	927.89	9 748.14	2 541.02	11.66
2010	168.73	242.57	7 253.84	3 754.19	9.91
2011	181.78	423.59	7 378.02	4 020.46	NO
2012	197.54	250.28	7 462.88	3 863.99	NO
2013	142.49	252.31	7 496.96	3 002.44	NO
2014	143.18	276.46	6 430.89	2 793.73	NO
2015	216.29	256.39	7 219.92	2 916.27	NO
2016	182.82	175.15	7 831.62	3 388.56	NO
2017	231.51	2 363.12	8 008.58	3 314.50	NO
2018	185.38	173.66	7 756.01	3 273.00	NO
2019	206.92	172.50	7 779.31	3 068.83	NO
2020	184.96	179.94	7 114.92	3 008.66	NO
2021	334.19	192.74	8 067.25	3 018.37	NO
2022	326.45	180.04	7 111.44	2 769.49	NO
2023	313.61	149.81	6 730.28	2 591.56	NO
1990/2023	**-26%**	**-94%**	**-67%**	**131%**	**-**
2022/2023	**-4%**	**-17%**	**-5%**	**-6%**	**-**

3.5.9.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.64***).

Table 3.64: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	107.09	5.09	98.34	1.12	61.07	47.65%	65.06%

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023}, expert estimation and special source[Chyba! Záložka nie je definovaná.] (***Table 3.65***).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:

E_i = annual emission of pollutant *i*,

$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,

$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3.65: *Emission factors for calculating emissions of heavy metals and POPs*

TYPE OF FUEL		LIQUID FUELS		HARD COAL	BROWN COAL	
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	FIXED BED BOILERS	FLUIZED BED BOILERS
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth)	(-)	(≤ 5 MWth)	(≤ 5 MWth)	(≤ 5 MWth) (5 – 50 MWth)
Pb	[mg/GJ]	4.56	4.07	13.687	59.471	2.037
Cd	[mg/GJ]	1.2	1.36	2.456	1.294	0.282
Hg	[mg/GJ]	0.341	1.36	9.051	2.382	1.5
As	[mg/GJ]	3.98	1.81	9.402	60.967	0.922
Cr	[mg/GJ]	2.55	1.36	15	38.383	9.1
Cu	[mg/GJ]	5.31	2.72	10	69.545	1
Ni	[mg/GJ]	255	1.36	10	62.104	4.803
Se	[mg/GJ]	2.06	6.79	2	5.192	45
Zn	[mg/GJ]	87.8	1.81	150	30.756	8.8
PCDD/F	[ng I-TEQ/GJ]	2.5	0.99	14.657	4.986	2.778
B(a)P	[mg/GJ]	3.678	116	10.975	320.061	5.148
B(b)F	[mg/GJ]	12.673	502	18.54	518.482	7.621
B(k)F	[mg/GJ]	3.968	98.7	10.966	518.482	5.321
I()P	[mg/GJ]	6.484	187	5.956	400.322	5.559
PAHs	[mg/GJ]	26.803	903.7	46.437	1757.347	23.649
HCB	[µg/GJ]	-	0.22	6.7	6.7	6.7
PCBs	[µg/GJ]	3.334	0.00013	8.073	5.059	1.449

TYPE OF FUEL		GASEOUS FUELS			BIOMASS		
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	GAS TURBINES	STATIONARY ENGINES	FIXED BED BOILERS		FLUIDIZED BED BOILERS
		THERMAL CAPACITY					
T2	UNIT	(≤ 5 MWth), (5 – 50 MWth)	(-)	(-)	(≤ 5 MWth)	(5 – 50 MWth)	(≤ 5 MWth), (5 – 50 MWth)
Pb	[mg/GJ]	0.0015	0.0015	0.04	27	1.606	1.606
Cd	[mg/GJ]	0.00025	0.00025	0.003	13	0.169	0.169
Hg	[mg/GJ]	0.1	0.1	0.1	0.56	1.268	1.268
As	[mg/GJ]	0.12	0.12	0.05	0.19	0.871	0.871
Cr	[mg/GJ]	0.00076	0.00076	0.05	23	0.027	0.027
Cu	[mg/GJ]	0.000076	0.000076	0.01	6	0.106	0.106
Ni	[mg/GJ]	0.00051	0.00051	0.05	2	0.085	0.085
Se	[mg/GJ]	0.0112	0.0112	0.2	0.5	0.211	0.211
Zn	[mg/GJ]	0.0015	0.0015	2.91	512	1.991	1.991
PCDD/F	[ng I-TEQ/GJ]	0.5	0.5	0.57	100	11.348	11.348
B(a)P	[mg/GJ]	0.56	0.56	1.2	10000	46.462	46.462
B(b)F	[mg/GJ]	0.84	0.84	9	16000	144.329	144.329
B(k)F	[mg/GJ]	0.84	0.84	1.7	5000	67.897	67.897
I()P	[mg/GJ]	0.84	0.84	1.8	4000	33.073	33.073
PAHs	[mg/GJ]	3.08	3.08	13.7	35000	291.761	291.761
HCB	[µg/GJ]	0.00308	0.00308	-	5	5	5
PCBs	[µg/GJ]	-	-	-	0.007	2.233	2.233

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.66***). The calculated BC emission values are presented in ***Table 3.62***.

Table 3.66: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.5.9.3 Completeness

Emissions are well covered.

3.5.9.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (supplemented activity values for the years 2011-2022). The differences in emissions in category **1A2gviii** between the previous and current submissions caused by recalculations are shown in ***Table 3.67***.

Table 3.67: *Differences in emissions (%) in category 1A2gviii between the previous and current submission caused by recalculations*

YEAR	BC
2011	0.00001%
2012	0.0001%
2013	0.0002%
2014	0.0003%
2015	0.0002%
2016	0.0007%
2017	0.0004%

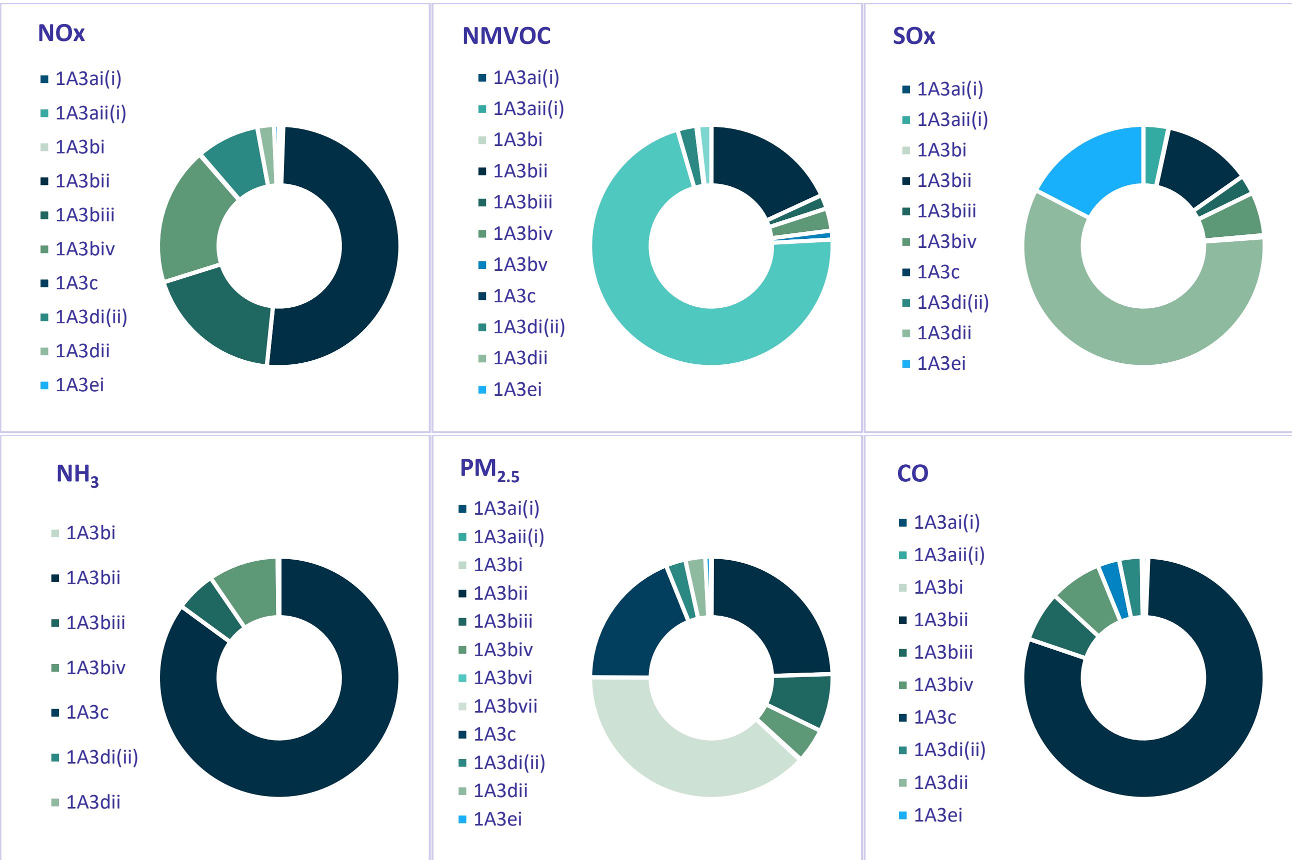
YEAR	BC
2018	0.0005%
2019	0.0003%
2020	-0.2%
2021	-0.2%
2022	-0.2%

3.6 TRANSPORT (NFR 1A3)

3.6.1 Overview

The emissions from the category **1A3** Transport include subcategories Domestic aviation (**1A3a**), Road transportation (**1A3b**), Railways (**1A3c**), Domestic navigation (**1A3d**) and Pipeline transport (**1A3ei**). As mentioned in previous reports there is still an observed shift from public transportation to individual passenger cars in Slovakia. After a decrease in fuel consumption and emissions in the 2020pandemic, a rise can be observed again. In road transport, the passenger cars category is still declining and the only category to rise are heavy duty vehicles and buses (public transport). Total aggregated pollutants in transport decreased against the base year in the range of 35.52% (TSP) and 93.45% (SO_x), although emission of ammonia has increased by 1 350.84% and PAH increased by 101.51%, in comparison with the base year. More information about the current status of emissions is in ***Figure 3.4***. Ammonia mostly comes from road transportation, exactly 99.91% of it and the rest is from railways and navigation (0.09%). The emissions from road and non-road transport were calculated by using models, default methodologies and the consistent data series from 1990 to 2023.

Figure 3.4: *Shares of main pollutants emissions in categories 1A3 in 2023*



Category-specific QA/QC plan is based on the general QA/QC plan described in **Chapter 1.6.1** of this report. The emissions inventory in the transport categories was prepared by the sectoral expert. Slovakia has been dealing with data inconsistency from several statistical sources in the last few years regarding fuel consumption in transport. Therefore, in agreement with our QA/QC Plan, the extensive analyses of the available statistical information on liquid fuels in transport began in 2017. The results were published in the statistical journal[2] in Slovak.

[2] Slovak Statistics and Demography: https://slovak.statistics.sk/wps/wcm/connect/fcafaa22-6de1-44ce-bd6b-83fb377d84fc/Slovenska_statistika_a_demografia_1_2021.pdf?MOD=AJPERES&CVID=nvIXiB0

QA/QC procedures for the transport sector follow basic rules and activities of QA/QC as defined in the EMEP/EEA GB_{2023}. The QC checks were done during the NFR and IIR compilation, general QC questionnaire was filled in and archived.

Due to frequent questions for data consistency between the IEA statistics and the national inventory, the data sources were investigated. Comparison of activity data and their sources is also crucial for the evaluation of consistency in reporting. Gasoline, diesel oil and biofuel consumption are key activity data in the transport sector, thus the comparison was focused on these statistical data across several sources. Datasets for this analysis are the years 2014-2023:

- The Statistical Office of the Slovak Republic (ŠÚ SR) inserts data also from the State Material Reserve of the Slovak Republic;
- Ministry of Economy (MH SR);
- Finance Administration of the Slovak Republic (FR SR);
- Ministry of Environment (MŽP SR) (***Table 3.68***).

Each source has specific forms or questionnaires, CN codes and different reporting rules, methodologies and dates of publication or collection. Different institutions further process these data. The ŠÚ SR used the import/export and production data, the FR SR used data from taxes on sales of products of crude oil and taxes on sales of biofuels.[3, 4]

Table 3.68: *Crude oil and crude oil products data flow and utilisation (final user is the SHMÚ)*

ORIGIN OF DATA	PRIMARY USER	SECONDARY USER
Import-export data (ŠÚ SR - Depart.	Statistical Office of Slovak Republic (Depart. of Energy Statistics)	EUROSTAT
Data regarding production and sales		Slovak Hydrometeorological Institute
Data from taxes on sales of biofuels	Financial Administration of the Slovak Republic	Ministry of Economy
Data from taxes on sales of products		SK - BIO[5]
Confirmation (certificate) of the sustainability	Slovak Hydrometeorological Institute	European Environmental Agency
Data on production and sales (companies)	Slovak State Material Reserves	International Energy Agency (data on crude
		EUROSTAT (natural gas)
Data on fuel sales at gas stations (NEIS)	Ministry of Environment (according to Art. 8)	European Environmental Agency

As shown in ***Table 3.68*** and in ***Figure 3.5***, discrepancies occurred between major data sources – providers. During discussions with the main authorities, information was collected by the sectoral experts, which was further analysed:

- Each authority reports different data in different forms for different institutions or requirements (**ANNEX VII**);
- The conversion factors (e.g. density) differ throughout all data suppliers not only between authorities and companies but also for each delivered supply has its own characteristics;
- Dates of collection for tax reports and reports to the ŠÚ SR differ.

The main outcome of this analysis is the harmonisation of fuel consumption in the country on the most possible level and the lowering of the differences in reporting by different subjects in 2023. Full consistency of data on national level is not possible. This is due to different legislation that each authority is required to fulfil (e.g. statistical reporting to EU institutions, tax collection, etc.).[6]

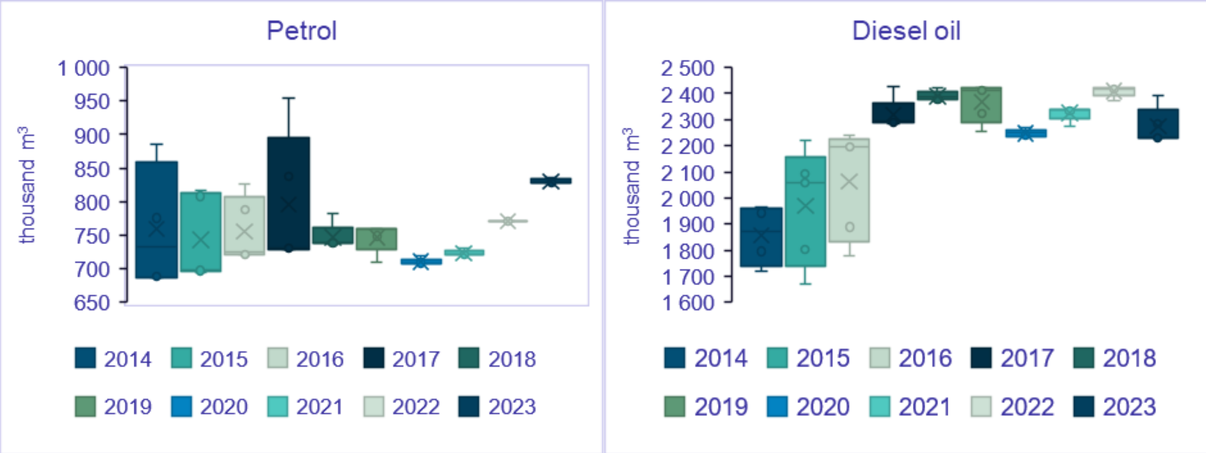
[3] Council Directive (EU) 2015/652 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels

[4] Act 309/2009 Coll. on the Promotion of renewable energy sources and high-efficiency cogeneration and on amendments to certain acts as amended, http://www.minzp.sk/en/areas/renewable-energy-sources/biofuels-bioliquids/

[5] SK-BIO is the national register for biofuels and bioliquids (https://oeab.shmu.sk/en/biofuels-and-bioliquids.html)

[6] Regulation (EC) 1099/2008 of the European Parliament and of the Council, Act No. 268/2017, which amend Act No. 98/2004 Coll. on the Excise Duty on mineral oil as amended, which amends Act No. 309/2009 Coll. on the Promotion of renewable energy sources and high-efficiency cogeneration and on amendments to certain acts as amended (only § 14a), https://www.financnasprava.sk/en/businesses/taxes-businesses/excise-duties-businesses#TaxRatesMineralOil

Figure 3.5: *Results of fuels consumption comparison according to different sources (thousand m³)*



3.6.2 International Aviation LTO (NFR 1A3ai(i)) and Domestic Aviation LTO (NFR 1A3aii(i))

3.6.2.1 Overview

These categories are not key categories. In the absence of national data on the exact numbers of domestic and international LTO cycles (only total numbers of LTO cycles are available), summary information from the EUROCONTROL database was used. The Slovak Management of Airports manages Slovak airports, except for the airport in Žilina, where exercises with light aircrafts of the Žilina University predominate. Other smaller civil airports (Nitra, Prievidza, Ružomberok and Lučenec) are operated by aero-clubs with a predomination of sports flights. Emissions estimation was calculated based on the data directly provided by the individual airports based on LTO cycles and fuel consumption (without fuel type differentiation). The described approach is maintained for a time series from 1990-2004. For the time series 2005-2023, EUROCONTROL data on the number of flights, fuel consumption and share of domestic and international flights were used. The emissions of NO_x, SO_x, PMs and CO were taken from the EUROCONTROL file for LTO and Cruise separately and reported in International (***Table 3.69***) and Domestic aviation LTO cycles (***Table 3.70***). The fuel consumption in category **1A3ai(i)** increased compared to the base year 1990 by 157% (***Table 3.71***). The total consumption of jet kerosene was 322.19 TJ and the consumption of aviation gasoline was 0.17 TJ allocated in the international aviation LTO cycle in 2023. After a decrease in 2020, there can be observed a rise in international aviation as a part of the recovery of the sector after the COVID-19 pandemic. From 2005 until 2019, international aviation emissions were increasing. The increase in fuel consumption and emissions was influenced by the arrival of low-cost airlines (Ryanair – based in Bratislava andWizzAir – based in Košice) and charter flights.

The fuel consumption in category **1A3aii(i)** decreased compared to the base year 1990 by 57%. The total consumption of jet kerosene was 6.15 TJ and the consumption of aviation gasoline was 0.21 TJ in the domestic aviation LTO cycle in 2023 (***Table 3.71***). Since 2005, domestic aviation emissions have been decreasing. This decrease and the whole category is influenced by the fact, that the Slovak Republic has no official national airlines as Slovak Airlines has been out of business since 2007, SkyEurope since 2009 and close distance of other big international airports in Vienna and Budapest.

Table 3.69: *Overview of emissions from international aviation 1A3ai(i)*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]	Pb [t]
1990	0.1020	0.0012	0.0271	0.0007	0.0007	0.0007	0.0003	0.0680	NE
1995	0.0677	0.0008	0.0180	0.0005	0.0005	0.0005	0.0002	0.0458	NE
2000	0.0776	0.0009	0.0205	0.0005	0.0005	0.0005	0.0002	0.0510	NE
2005	0.0698	0.0008	0.0051	0.0011	0.0011	0.0011	0.0005	0.0632	NE
2010	0.0771	0.0011	0.0049	0.0008	0.0008	0.0008	0.0004	0.0541	NE

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]	Pb [t]
2011	0.0782	0.0010	0.0050	0.0008	0.0008	0.0008	0.0004	0.0557	NE
2012	0.0722	0.0010	0.0046	0.0007	0.0007	0.0007	0.0004	0.0564	NE
2013	0.0686	0.0011	0.0044	0.0008	0.0008	0.0008	0.0004	0.0560	NE
2014	0.0700	0.0012	0.0043	0.0008	0.0008	0.0008	0.0004	0.0531	NE
2015	0.0834	0.0012	0.0051	0.0009	0.0009	0.0009	0.0005	0.0613	NE
2016	0.0917	0.0016	0.0056	0.0010	0.0010	0.0010	0.0005	0.0693	NE
2017	0.0997	0.0015	0.0060	0.0009	0.0009	0.0009	0.0004	0.0676	NE
2018	0.1113	0.0015	0.0068	0.0011	0.0011	0.0011	0.0005	0.0747	NE
2019	0.1127	0.0013	0.0069	0.0011	0.0011	0.0011	0.0005	0.0747	0.0024
2020	0.0364	0.0006	0.0022	0.0005	0.0005	0.0005	0.0002	0.0291	0.0017
2021	0.0424	0.0009	0.0026	0.0004	0.0004	0.0004	0.0002	0.0348	0.0019
2022	0.0827	0.0011	0.0049	0.0007	0.0007	0.0007	0.0003	0.0544	0.0017
2023	0.0968	0.0014	0.0063	0.0008	0.0008	0.0008	0.0004	0.0829	0.0022
1990/2023	**-5%**	**23%**	**-77%**	**15%**	**15%**	**15%**	**15%**	**22%**	**-**
2022/2023	**17%**	**35%**	**28%**	**20%**	**20%**	**20%**	**20%**	**52%**	**27%**

Table 3.70: *Overview of emissions from domestic aviation 1A3aii(i)*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]	Pb [t]
1990	0.0809	0.0007	0.0226	0.0004	0.0004	0.0004	0.0002	0.0199	NE
1995	0.0537	0.0004	0.0150	0.0003	0.0003	0.0003	0.0001	0.0132	NE
2000	0.0614	0.0005	0.0172	0.0003	0.0003	0.0003	0.0002	0.0151	NE
2005	0.0079	0.0001	0.0006	0.0002	0.0002	0.0002	0.0001	0.0108	NE
2010	0.0043	0.0002	0.0004	0.0002	0.0002	0.0002	0.0001	0.0121	NE
2011	0.0034	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0112	NE
2012	0.0032	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0127	NE
2013	0.0027	0.0001	0.0002	0.0002	0.0002	0.0002	0.0001	0.0113	NE
2014	0.0030	0.0001	0.0003	0.0002	0.0002	0.0002	0.0001	0.0094	NE
2015	0.0032	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0123	NE
2016	0.0029	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0095	NE
2017	0.0032	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001	0.0097	NE
2018	0.0026	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0086	NE
2019	0.0017	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0044	0.0008
2020	0.0007	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0030	0.0009
2021	0.0012	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0047	0.0018
2022	0.0012	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0060	0.0024
2023	0.0014	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0066	0.0027
1990/2023	**-98%**	**-64%**	**-99%**	**-96%**	**-96%**	**-96%**	**-96%**	**-67%**	**-**
2022/2023	**14%**	**82%**	**15%**	**17%**	**17%**	**17%**	**17%**	**10%**	**12%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.71***.

Table 3.71: *Overview of activity data from international aviation 1A3ai(i) and domestic aviation 1A3aii(i)*

YEAR	LIQUID FUELS [TJ NCV]_CATEGORY 1A3ai(i)	LIQUID FUELS [TJ NCV]_CATEGORY 1A3aii(i)
1990	125.37	14.80
1995	89.44	10.51
2000	88.48	10.49
2005	263.97	31.99
2010	251.22	19.25
2011	251.22	19.25
2012	235.74	14.50
2013	226.71	12.58
2014	224.15	13.30

YEAR	LIQUID FUELS [TJ NCV]_CATEGORY 1A3ai(i)	LIQUID FUELS [TJ NCV]_CATEGORY 1A3aii(i)
2015	264.49	14.02
2016	289.64	13.06
2017	309.96	13.41
2018	349.00	11.01
2019	354.75	7.21
2020	114.61	2.93
2021	133.52	5.13
2022	252.32	5.54
2023	322.36	6.36
1990/2023	**157%**	**-57%**
2022/2023	**28%**	**15%**

3.6.2.2 Methodological Issues

The airport traffic in Slovakia is determined only by the origin of the airlines. It means, that there is no direct information about the number of domestic and international flights in statistics. Tier 1 methodology for emission estimation in aviation, both for aviation gasoline and jet kerosene was used for time series 1990-2004. Tier 1 methodology is based on fuel sold in the airports. For this period, only the total number of LTO cycles is known, therefore the average disaggregation of activities between national and international aviation was revised. The share for national and international aviation activities for the period 1990-2004 was improved based on the real data used for the time series 2005-2017. The share is a constant value. The real share of national and international activities for the period 2005-2023 was taken from the EUROCONTROL database directly. Data regarding disaggregation to LTO and cruise phase for the period 1990-2004 (***Table 3.72***) is taken from EUROCONTROL and the share is based on the real data used for time series 2005-2017.

Table 3.72: *Shares of fuel consumption in international and domestic aviation for the period 1990-2004*

FUELS	INTERNATIONAL AVIATION 1A3ai(i)	DOMESTIC AVIATION 1A3aii(i)
	1990-2004	
Aviation gasoline	70%	30%
Jet kerosene	95%	5%

The implied emission factors for jet kerosene applied in these submissions for the years 1990-2004 were calculated as average EFs from available EUROCONTROL data for 2005-2017. These average emission factors (***Table 3.72***) for all pollutants were used for the years 1990-2004 in national and international aviation. Emission factors applied for aviation gasoline, for the period 1990-2004, were from EMEP/EEA GB$_{2023}$.

Activity data for the years 1990-1993 are not available and were estimated as expert judgment according to real LTO cycles in this period. For the period 1994-2004, activity data were directly provided by the airports on an annual basis.

From 2005 onwards, Slovakia decided to use the EUROCONTROL data. The decision is based on the analysis of the national data and the data obtained from the EUROCONTROL. Results showed that the EUROCONTROL data are more consistent and accurate in line with the QA/QC rules. The Ministry of Transport of the Slovak Republic thereafter approved these results. EUROCONTROL data used tier 3 methodology applying the Advanced Emissions Model (AEM). The following data were taken from the EUROCONTROL data published in 2020 into the national inventory:

- fuel consumption of aviation gasoline for domestic flights (LTO and cruise);
- fuel consumption of aviation gasoline for international flights (LTO and cruise);
- fuel consumption of jet kerosene for domestic flights (LTO and cruise);
- fuel consumption of jet kerosene for international flights (LTO and cruise);
- pollutants for all subcategories.

In 2024, Slovakia made ananalysis of jet kerosene and aviation gasoline for heavy metals content. According to this analysis was able to define a new emission factor for lead (Pb) for this inventory (***Table 3.73***).

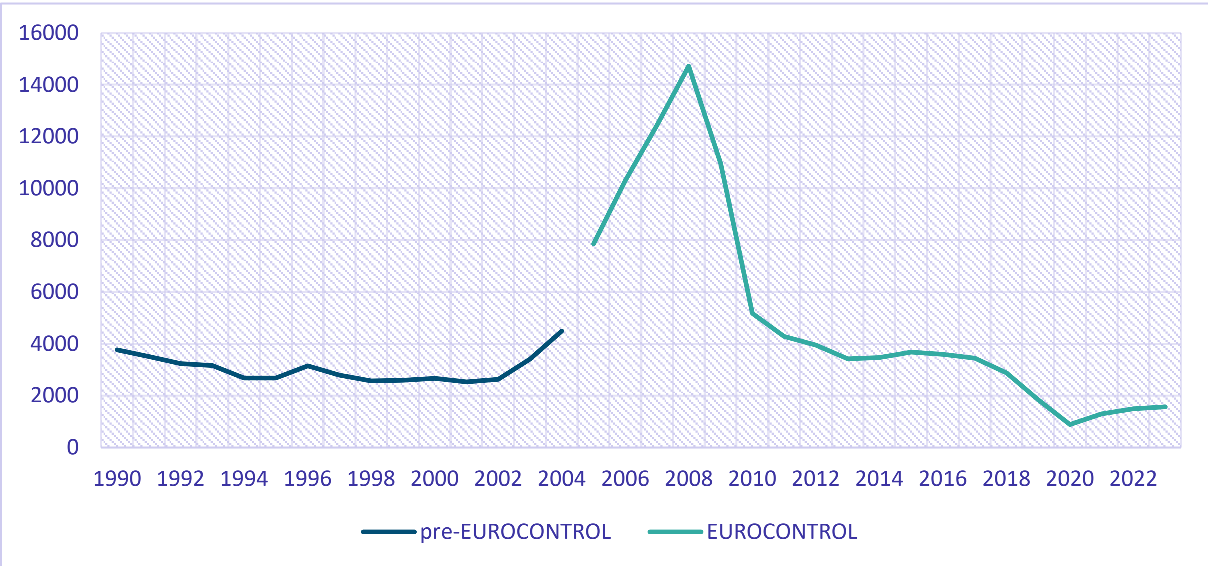
Table 3.73: *Average emission factors for the pollutants in civil aviation according to EUROCONTROL*

FUEL TYPE		EMISSION FACTORS						
		NOx	NMVOC	SOx	TSP	CO	BC	Pb
		[kg/t]						[g/t]
Aviation gasoline	national	4.00	19.00	1.00	0.03	1200.00	0.48	0.56
	international	4.00	19.00	1.00	0.03	1200.00	0.48	0.56
Jet kerosene	national	14.38	0.08	0.84	0.08	6.26	0.48	0.00
	international	13.66	0.04	0.84	0.16	3.08	0.48	0.00

3.6.2.3 Completeness

Since 2011, the agreement between the European Commission (the EC) and the EUROCONTROL has been in place. Based on this agreement, an annual comparison of aviation fuel consumption and the emissions data with AEM model calculations is prepared. The individual EU Member State provides the comparison of the EUROCONTROL and the UNFCCC reporting data in aviation. The information and data provided in this evaluation are intended to be used for QA/QC activities regarding emissions from aviation. The EC works towards making data from the EUROCONTROL available to the EU MS regularly, for quality checks, however, this information is not possible to make publicly available. Consistency of the time-series (***Figure 3.6***) is maintained by using calculated average EFs from EUROCONTROL. The methodology is explained in **Chapter 3.6.2.1**.

Figure 3.6: *Demonstration of time-series consistency between pre-EUROCONTROL methodology and EUROCONTROL methodology (in TJ)*



The verification process is also based on cross-checking of the input data from the Slovak airports by sectoral experts and the comparison with the sectoral statistical indicators from the Ministry of Transport, Construction and Regional Development of the Slovak Republic. The sectoral experts in the central archiving system at the SHMÚ archive the background documents.

3.6.2.4 Source-specific Recalculations

No recalculations in this submission.

3.6.3 Road Transportation (NFR 1A3b)

3.6.3.1 Overview

Short distance passenger transport is an important part of road transportation. It is the most exploited type of transport in the Slovak Republic due to the high density and quality of the road network and interconnection of all municipalities. In recent years, road transport has expanded significantly in the transport of goods and persons. In 2023, the transport network included 545 km of highways, 320 km of motorways and 3 335 km of the category 1st class roads. The total road network represented 18 143 km of roads in the Slovak Republic[7] in 2023. Road transportation is the most important and key category with the highest share of emissions and the continually increasing trend in fuels consumption within transport. There is a huge increase in the emission of ammonia compared to the base year – almost 1 410% (***Table 3.74***). This is caused by the expansion of light commercial vehicles in category EURO 5 and onwards, which have higher EFs than vehicles in category EURO 2, 3 and 4.

Table 3.74: *Overview of emissions in road transport (1A3b)*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	43.8129	26.0657	2.4180	0.0249	2.8064	3.0529	3.3440	1.3470	193.0129
1995	37.2257	26.6181	1.9042	0.0874	1.9271	2.1443	2.4035	0.9119	209.2321
2000	31.5863	20.1830	0.6929	0.3490	1.4436	1.6694	1.9412	0.7016	168.3104
2005	43.2728	19.8301	0.1934	0.5261	2.2405	2.5892	3.0084	1.1622	170.1213
2010	36.8401	11.7866	0.0285	0.4700	2.1781	2.5618	3.0272	1.1963	89.2107
2011	29.5004	8.1419	0.0267	0.4110	1.6056	1.9666	2.4052	0.8453	58.4767
2012	30.9457	7.9975	0.0283	0.4179	1.6633	2.0481	2.5170	0.8758	56.2936
2013	23.6915	5.1949	0.0274	0.4165	1.3383	1.7830	2.2557	0.6082	33.7914
2014	21.7637	4.3870	0.0294	0.3592	1.2098	1.6635	2.1470	0.5338	27.4712
2015	22.8358	4.4999	0.0307	0.3342	1.3378	1.8392	2.3674	0.5859	25.5600
2016	22.0937	3.4678	0.0314	0.3874	1.2316	1.7706	2.3403	0.5452	17.7471
2017	21.1565	4.2965	0.0351	0.3430	1.2600	1.7838	2.3399	0.5157	24.4512
2018	20.8987	3.3990	0.0337	0.3697	1.1750	1.7403	2.3404	0.4912	14.9112
2019	20.0805	3.3520	0.0361	0.3713	1.1561	1.7344	2.3477	0.4708	14.0723
2020	18.4866	2.8811	0.0340	0.3251	1.0513	1.5752	2.1103	0.4346	11.9148
2021	17.7732	3.0198	0.0368	0.3364	1.0641	1.6191	2.2110	0.4139	12.5682
2022	17.7488	4.9533	0.0386	0.3610	1.0891	1.6790	2.3075	0.4135	12.7311
2023	15.7522	5.0410	0.0380	0.3754	1.0541	1.6360	2.2552	0.3927	13.4191
1990/2023	**-64%**	**-81%**	**-98%**	**1406%**	**-62%**	**-46%**	**-33%**	**-71%**	**-93%**
2022/2023	**-11%**	**2%**	**-1%**	**4%**	**-3%**	**-3%**	**-2%**	**-5%**	**5%**

YEAR	Priority HMs [t]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	9.1513	0.6144	0.0126	0.0299	0.0272	0.0164	0.0860	0.0002
1995	7.8600	0.5496	0.0103	0.0245	0.0213	0.0146	0.0707	0.0003
2000	0.4447	0.5701	0.0103	0.0236	0.0209	0.0139	0.0687	0.0005
2005	0.6860	0.8826	0.0174	0.0382	0.0355	0.0211	0.1121	0.0007
2010	0.7471	1.1145	0.0262	0.0463	0.0421	0.0281	0.1428	0.0010
2011	0.7025	0.8894	0.0266	0.0442	0.0399	0.0278	0.1386	0.0008
2012	0.7460	0.9430	0.0290	0.0478	0.0431	0.0301	0.1500	0.0009
2013	2.4898	0.9367	0.0296	0.0484	0.0439	0.0303	0.1523	0.0009
2014	2.5362	0.8251	0.0315	0.0509	0.0460	0.0321	0.1605	0.0008
2015	2.8300	0.8934	0.0370	0.0571	0.0509	0.0372	0.1822	0.0009
2016	3.0327	0.8738	0.0393	0.0609	0.0544	0.0396	0.1943	0.0008

[7] Slovak Road Database 2023

YEAR	Priority HMs [t]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
2017	2.9352	0.7848	0.0381	0.0598	0.0536	0.0385	0.1901	0.0008
2018	3.1679	0.7832	0.0410	0.0647	0.0580	0.0416	0.2053	0.0008
2019	3.2442	0.7470	0.0415	0.0649	0.0576	0.0425	0.2064	0.0007
2020	3.0396	0.7063	0.0419	0.0575	0.0480	0.0423	0.1897	0.0007
2021	3.0972	0.6369	0.0387	0.0617	0.0547	0.0402	0.1953	0.0006
2022	3.2950	0.6369	0.0398	0.0643	0.0570	0.0417	0.2029	0.0006
2023	3.2567	0.6176	0.0380	0.0614	0.0542	0.0403	0.1939	0.0006
1990/2023	**-64%**	**1%**	**203%**	**106%**	**99%**	**146%**	**125%**	**180%**
2022/2023	**-1%**	**-3%**	**-4%**	**-4%**	**-5%**	**-4%**	**-4%**	**-2%**

The major share of emissions belongs to passenger cars (***Table 3.75***). Most of the priority HMs (Pb, Cd and Hg) come from tyre and brake wear abrasion. The majority of NOx, NMVOC and CO emissions are emitted in the cities (***Table 3.76***).

Table 3.75: *Overview of total emissions according to the type of vehicles in 2023*

VEHICLE CATEGORY	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	TSP [kt]	CO [kt]	Priority HMs [t]	PAHs [t]
Passenger cars	9.1291	0.9555	0.0222	0.3196	0.2745	11.1085	0.0116	0.11258
Light duty vehicles	3.3088	0.0979	0.0048	0.0202	0.0865	0.9313	0.0019	0.02549
Heavy duty vehicles and buses	3.2955	0.1575	0.0108	0.0352	0.0513	0.9739	0.0042	0.05553
Mopeds & motorcycles	0.0189	0.0631	0.0001	0.0004	0.0013	0.4055	0.0001	0.0003
Gasoline evaporation	NA	3.7670	NA	NA	NA	NA	NA	NA
Automobile tyre and brake wear abrasion	NA	NA	NA	NA	1.0578	NA	3.2389	NE
Automobile road abrasion	NA	NA	NA	NA	0.7838	NA	NE	NE

Table 3.76: *Results from COPERT in the distribution for agglomeration mode in 2023*

	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	CO [kt]
Urban	7.5181	0.9554	0.0168	0.1001	0.4791	8.9371
Rural	5.6453	0.2475	0.0150	0.1801	0.4188	2.8918
Highway	2.5888	0.0710	0.0061	0.0953	0.1561	1.5902

3.6.3.2 Methodological Issues

COPERT model 5 (v5.8) was used for the estimation of road transport emissions. The model distinguishes vehicle categories and emission factors reflecting the recent development and research. These data are not available before 2000. The methodology is often referred to the name of the program (methodology "COPERT"). Calculation in model COPERT 5 is based on EMEP/EEA GB_{2023} methodology. This methodology balances fifteen different emissions including greenhouse gases from road transport. The preparation of basic pollutants inventory is based on the sequence calculation for each vehicle category and summing. Emission factors are set by the model and they differ for all types of fuel, different vehicle categories and different technological levels. Statistically recorded fuel consumption and fuel consumption calculated through the COPERT 5 model are equal, except for fossil petrol. There is a statistically insignificant difference on the level up to 2%. The COPERT 5 defined new vehicle categories for the calculation of pollutants, with the disaggregation into 5 base categories and 379 subcategories. Further disaggregation was applied according to the operation of road vehicles in the agglomeration, road and highway traffic mode. In COPERT 5, buses were divided into 8 sub-districts and 2 subgroups (urban and coaches). Heavy duty vehicles are divided into 2 basic groups (rigid and articulated). Rigid vehicles are further divided by weight into 8 subgroups and articulated into 6 subgroups. This methodology uses technical parameters of different vehicle types and country characteristics, such as the composition of the car fleet, the age of the cars, the parameters of operation and fuels or climate conditions.
The estimation is provided for the main 6 groups of input data:

- Total fuel consumption;

- Composition of vehicles fleet;
- Driving mode;
- Driving speed;
- Emission factors;
- Annual mileage.

Based on these input parameters the emissions can be estimated. Information about the vehicle fleet is based on the database operated by the Police Presidium of the Slovak Republic. The SHMÚ has access to the database and can download the necessary information directly from the IS EVO (Information System for Vehicle Evidence) website.[8]

Exhaust emissions from road transport are divided into two types:

- so-called "cold emissions", which are additional emissions with the start of a cold motor;
- so-called "hot emissions", which are produced by the engine of a vehicle warmed at the operating temperature.

The EFs values for air pollutants in COPERT are defined separately for the different types of fuels, types of vehicles and the different technological levels of vehicles. The emission factors for pollutants such as SO_x, NO_x, NH_3, PMs and partially CH_4 can be obtained by the simple formula of driving mode and consumed fuel. Emission factors are then calculated automatically by the model based on the input parameters such as the average speed, the quality of fuels, the age of vehicles, the weight of vehicles and the volume of cylinders.

Accurate and actual data on distance-based values and parameters are necessary to run the COPERT 5 model (***Table 3.77***). Particularly kilometres (km) travelled are not available in Slovakia. Therefore, new input data on mileages were requested from TID (odometers) and NCR (from the Police). As the unique key for binding data from these two registries, the VIN number (vehicle identification number) was used. Using MS Access, the average number of mileages was produced. Further data needed were: first registration of the vehicle, VIN, vehicle type, engine volume, weight of the vehicle, emission category and data from the odometer. At least that many years as are between two technical controls are needed. The mileages in those years can be calculated and if the mileages are divided by the number of years, the average annual mileages can be obtained. To distribute the number of vehicles to their appropriate COPERT category, the data on mileages were used from the estimation mentioned above. The recommendations provided within the framework of the COPERT 5 model, including consistency with fuel consumption, were used in addition. The main source of activity data such as intensity on urban, rural and highways is the Traffic Census of Slovakia, conducted every five years (2000, 2005, 2010 and 2015[9]).

Table 3.77: *Overview of input data used in COPERT 5 model in 2023*

CATEGORY OF ROAD VEHICLE	ACTIVITY DATA		CATEGORY OF ROAD VEHICLE	ACTIVITY DATA	
	NUMBER OF VEHICLES	AVERAGE MILEAGE [km/VEH]		NUMBER OF VEHICLES	AVERAGE MILEAGE [km/VEH]
Passenger Cars	**2 464 256**	**12 244**	Diesel N1-III	148 890	15 444
Petrol Mini	7014	4 868	Battery electric N1-I	14	27 284
Petrol Small	785 499	4 803	Battery electric N1-II	150	15 045
Petrol Medium	388 454	5 729	Battery electric N1-III	362	16524
Petrol Large-SUV-Executive	47 536	5 968	**Heavy Duty Trucks**	**69 317**	**22 513**
Petrol 2-Stroke	154	1 163	Petrol >3,5 t	110	471
Petrol Hybrid Mini	35	6 478	Diesel Rigid <=7,5 t	21 519	18 232
Petrol Hybrid Small	10 193	9 972	Diesel Rigid 7,5 - 12 t	12 277	24 043
Petrol Hybrid Medium	40 203	12 363	Diesel Rigid 12 - 14 t	3 328	16 465
Petrol Hybrid Large-SUV-Executive	11 351	13 975	Diesel Rigid 14 - 20 t	4466	15 430

[8] http://www.minv.sk/?celkovy-pocet-evidovanych-vozidiel-v-sr

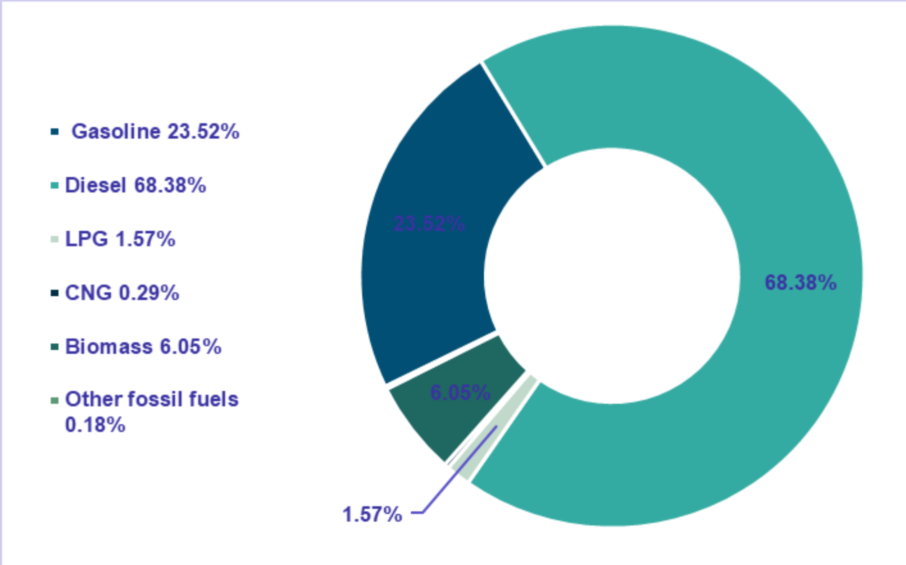
[9] Traffic Census of Slovakia 2015, http://www.ssc.sk/sk/cinnosti/rozvoj-cestnej-siete/dopravne-inzinierstvo.ssc

CATEGORY OF ROAD VEHICLE	ACTIVITY DATA		CATEGORY OF ROAD VEHICLE	ACTIVITY DATA	
	NUMBER OF VEHICLES	AVERAGE MILEAGE [km/VEH]		NUMBER OF VEHICLES	AVERAGE MILEAGE [km/VEH]
Petrol PHEV Small	1396	15 405	Diesel Rigid 20 - 26 t	1123	7 567
Petrol PHEV Medium	3 490	15 409	Diesel Rigid 26 - 28 t	47	20 342
Petrol PHEV Large-SUV-Executive	1900	18 043	Diesel Rigid 28 - 32 t	190	13 706
Diesel Mini	389	5 503	Diesel Rigid >32 t	171	3 942
Diesel Small	24 549	9 991	Diesel Articulated 14 - 20 t	25989	55 321
Diesel Medium	884 091	15 175	Diesel Articulated 50 - 60 t	17	72 972
Diesel Large-SUV-Executive	197 635	13 483	CNG Articulated < 40 t	40	6 702
Diesel PHEV Large-SUV-Executive	68	23 406	LNG Articulated < 40 t	40	110 954
LPG Bifuel Mini	19	10 822	**Buses**	**6 552**	**44 934**
LPG Bifuel Small	24 844	21 625	Diesel Urban Buses Midi <=15 t	620	26 585
LPG Bifuel Medium	19 373	19 271	Diesel Urban Buses Standard 15 - 18 t	236	57 890
LPG Bifuel Large-SUV-Executive	4 939	19 372	Diesel Urban Buses Articulated >18 t	13	30 248
CNG Bifuel Mini	29	10 316	Diesel Coaches Standard <=18 t	5 340	30 672
CNG Bifuel Small	874	14 882	Diesel Coaches Articulated >18 t	37	107 099
CNG Bifuel Medium	484	18 949	Urban Buses Diesel Hybrid	16	52 400
CNG Bifuel Large-SUV-Executive	55	14 262	Urban CNG Buses	247	44 990
Battery electric Mini	452	7 500	Battery electric -	43	25 394
Battery electric Small	1 303	11 650	**L-Category**	**173 054**	**959**
Battery electric Medium	2 902	11 624	Petrol Mopeds 2-stroke <50 cm³	1 347	692
Battery electric Large-SUV-	5 025	20 576	Petrol Mopeds 4-stroke <50 cm³	27309	672
Light Commercial Vehicles	**276 982**	**11 929**	Petrol Motorcycles 2-stroke >50 cm³	2819	691
Petrol N1-I	23 909	18 949	Petrol Motorcycles 4-stroke <250 cm³	49681	824
Petrol N1-II	9 239	14 262	Petrol Motorcycles 4-stroke 250 - 750	50418	1 308
Petrol N1-III	2 141	12 838	Petrol Motorcycles 4-stroke >750 cm³	41353	1 840
Diesel N1-I	16 910	12 209	Petrol Quad & ATVs	59	332
Diesel N1-II	75 367	14 405	Micro-car	68	1 257

Input parameters for the CNG buses have been known only since 2000. Before the year 2000, CNG consumption in transport was negligible (close to zero). The consumption of the CNG as a fuel can neither be used for a diesel engine nor for a gasoline engine without modifications. The CNG buses have completely different combustion and after-treatment technology despite using the same fuel as the passenger cars for CNG. The CNG buses need to fulfil a specific emission standard (Euro II, Euro III, etc.) because their emissions performance may vary significantly. Due to the low NOx and PM emissions compared to diesel oil, an additional emission standard has been set for the CNG vehicles, known as the standard for Enhanced Environmental Vehicles (EEV). The emission limits imposed for EEV are even below Euro V and usually, EEVs benefit from tax exemptions and free entrance to low emission zones. New stoichiometry buses are able to fulfil the EEV requirements, while older buses were usually registered as Euro II, Euro III, Euro IV or Euro V.

The statistical consumptions of petrol, diesel oil and biofuels were received from data reported under the Fuel Quality Directive art. 7a by SHMU and cross-checked according to data received from the Ministry of Economy (MH SR). According to the latest QA/QC these consumptions are the most accurate (for more see **Chapter 3.6.4.2** Data about LPG distribution and sales were obtained from the Slovak Association of Petrochemical Industry (SAPPO). CNG consumption was obtained directly from transport companies for the city and regional bus transportation that operate CNG fueled vehicles. All documents available are in the Slovak language and they are official. Share of diesel oil represents 68.38%, followed by petrol with 23.52% share, then LPG (1.57%), CNG (0.29%), biomass (6.05%) and other fossil fuels (fossil part of biofuels) (0.18%) in 2023 (***Figure 3.7)***.

Figure 3.7: Fuels balance in road transportation in 2023



The blending of biomass in liquid fuels was considered and the bio-emissions have been calculated since 2007 (the first year of using blended fuels in transport in Slovakia). The information about fuel quality is provided by the Ministry of Economy of the Slovak Republic in terms of implementing Directive No 2009/29/EC and Directive No 2009/30/EC on the replacement of fossil fuels with bio-component. The share of biomass in liquid fuels in transport was calculated as a bio-component percentage (***Table 3.78***).

Table 3.78: *Estimated activity data and share of biomass for the time series 2007-2023*

YEAR	GASOLINE		DIESEL OIL	
	BIOMASS SHARE % (energy)	BIOMASS [TJ]	BIOMASS SHARE % (energy)	BIOMASS [TJ]
2007	2.30%	652.26	4.09%	2 677.29
2008	1.23%	358.17	4.77%	2 795.75
2009	2.58%	706.72	5.14%	3 090.30
2010	2.95%	779.13	5.28%	3 577.88
2011	2.97%	715.87	6.05%	3 741.68
2012	2.94%	710.56	5.79%	3 846.12
2013	3.21%	726.60	6.43%	4 107.36
2014	3.88%	859.33	5.65%	3 766.08
2015	3.33%	747.87	5.74%	4 342.97
2016	3.10%	725.62	6.68%	5 158.95
2017	4.06%	943.49	6.92%	5 464.18
2018	4.52%	1 018.32	6.97%	5 697.80
2019	4.46%	1042.07	6.45%	5 371.36
2020	6.20%	1390.40	7.27%	5 401.90
2021	6.20%	1 419.47	6.96%	5 617.89
2022	6.04%	1 645.29	6.95%	5 779.55
2023	5.96%	1 644.39	6.46%	5 231.16

In ETBE, the bio-component is considered only 47% by mass in the calculation of total bio-components in fuel. From the biomass (biodiesel) is also subtracted the 5.33% fossil methanol part and all emissions from the bio-parts of biofuels are reported as biomass emissions, and the fossil part (ETBE, FAME) is reported in its associated fossil fuel (ETBE – petrol; FAME – diesel). The fossil part of FAME was calculated as the national average according to data from the report under Fuel Quality Directive art. 7a (***Table 3.79***).

Table 3.79: National fossil carbon content in FAME in 2023

FEEDSTOCK	VOLUME [m³]	C FOSSIL PART	CARBON CONTENT	g FOSSIL CO_2/g FAME
Rapeseed	76 757.10	5.30%	75.50%	0.147
Palm oil	188.72	5.50%	71.80%	0.145
Sunflower seed	10 291.44	5.30%	77.20%	0.150
Used cooking oil[10]	52 278.82	5.40%	74.40%	0.147
National average	-	5.34%	75.21%	0.147

Requirements for the quality of motor fuels containing bio-component must be at the level of the specifications listed in the STN EN 228:2004 and STN EN 590:2004, respectively. The quality of blending in bio-liquid fuels must meet the requirements specified in the STN EN 14 214, STN EN 15 376.

According to ***Recommendation No SK-1A3b-2018-0001***, Slovakia managed to distinguish lube oil consumption in 2-stroke vehicles and 4-stroke vehicles (***Table 3.80***). The emissions from lube oil are allocated according to EMEP/EEA GB_{2023} and recommendations:

- from 2-stroke vehicles accordingly in the **1A3b** categories;
- from 4-stroke vehicles in the **2D3i** category.

Table 3.80: Overview of lube oil consumption in particular years

YEAR	2-STROKE LUBE OIL [t]	4-STROKE [t]
1990	128.7	1999.9
1995	65.7	1 887.9
2000	25.6	1 999.7
2005	26.5	2 979.8
2010	14.8	3 616.1
2011	14.8	3 451.6
2012	14.4	3 712.7
2013	0.7	3 763.0
2014	0.7	3 848.7
2015	0.8	4 379.5
2016	0.8	4 726.2
2017	0.8	4 554.6
2018	0.8	4 931.1
2019	0.8	5 103.3
2020	0.9	4 995.6
2021	1.1	4 914.6
2022	1.4	5 221.1
2023	1.5	5 123.8

Lube oil composition, including HMs, was analysed and used for emission estimation for the years 2000-2023 (more info in **Chapter 3.6.4.3**). For the years 1990-1999 were used reconstructed data for fuel composition (***Table 3.79***), vehicle fleet and estimations in line with ***Recommendations No SK-1A3b-2018-0003***, ***SK-1A3b-2018-0004*** and ***SK-1A3b-2018-0005***.

The emissions of all heavy metals are dependent on content level (***Table 3.81***) and fuel consumption, thus all irregularities are caused by a change in content and statistical fuel consumption in the appropriate vehicle category.

The emission factors for lead (Pb) after 2000 are estimated as the maximum allowed content (natural lead) in the FQD[11] (Fuel Quality Directive) and reported under article 8 (***Recommendation No SK-1A3b-2018-0002***). Lead emissions are allocated according to the previous paragraph.

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[10] For Used cooking oil are no available data of carbon content, thus data for lard were used

[11] Directive 2009/30/EC of the European Parliament and of the Council amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the

Table 3.81: *Overview of HMs and sulphur content in the time series 1990-1999*

YEAR	S [ppm]		Pb [ppm]		Cd [ppm]		Cu [ppm]		Cr [ppm]	
	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL
1990	324.00	1080.00	20.00	0.0005	0.010	0.0001	1.70	1.70	0.05	0.05
1991	324.00	1080.00	18.40	0.0005	0.009	0.0001	1.53	1.53	0.05	0.05
1992	324.00	1080.00	16.96	0.0005	0.008	0.0001	1.36	1.36	0.04	0.04
1993	324.00	1080.00	15.66	0.0005	0.007	0.0001	1.19	1.19	0.04	0.04
1994	324.00	1080.00	14.50	0.0005	0.006	0.0001	1.02	1.02	0.03	0.03
1995	324.00	1080.00	13.45	0.0005	0.005	0.0001	0.85	0.85	0.03	0.03
1996	324.00	1080.00	12.50	0.0005	0.004	0.0001	0.68	0.68	0.02	0.03
1997	324.00	1080.00	11.65	0.0005	0.003	0.0001	0.51	0.51	0.02	0.02
1998	324.00	1080.00	10.89	0.0005	0.002	0.0001	0.34	0.34	0.02	0.02
1999	120.00	400.00	10.20	0.0005	0.001	0.0001	0.17	0.18	0.01	0.01

YEAR	Ni [ppm]		Se [ppm]		Zn [ppm]		Hg [ppm]		As [ppm]	
	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL
1990	0.07	0.07	0.0002	0.0001	1.00	1.00	0.009	0.005	0.0003	0.0001
1991	0.06	0.06	0.0002	0.0001	0.90	0.90	0.009	0.005	0.0003	0.0001
1992	0.06	0.06	0.0002	0.0001	0.81	0.80	0.009	0.005	0.0003	0.0001
1993	0.05	0.05	0.0002	0.0001	0.71	0.71	0.009	0.005	0.0003	0.0001
1994	0.04	0.04	0.0002	0.0001	0.61	0.61	0.009	0.005	0.0003	0.0001
1995	0.04	0.04	0.0002	0.0001	0.52	0.51	0.009	0.005	0.0003	0.0001
1996	0.03	0.03	0.0002	0.0001	0.42	0.41	0.009	0.005	0.0003	0.0001
1997	0.02	0.02	0.0002	0.0001	0.32	0.31	0.009	0.005	0.0003	0.0001
1998	0.02	0.01	0.0002	0.0001	0.23	0.21	0.009	0.005	0.0003	0.0001
1999	0.01	0.01	0.0002	0.0001	0.13	0.12	0.009	0.005	0.0003	0.0001

3.6.3.3 Completeness

QC activities ensuring the quality standards for the preparation of the emissions inventory in road transportation are based on the cooperation of several experts and institutions. The activity data and the input parameters provided from the different data sources are collected and then checked for the basic quality criteria (consistency, transparency, etc.) and archived by the sectoral experts. The Transport Research Institute in Žilina is responsible for the data collection from different subjects in transport. Transport sectoral expert is responsible for the verification of these input parameters and the emissions calculation by the COPERT model. The QA verification process includes the exercise of statistical and calculated data on fuel consumption. The Statistical Office of the Slovak Republic provides statistical data on fuel consumption. The calculated data on fuel consumption is a direct outcome of the COPERT model.

The process of verification is based on cross-checking input data from the Statistical Office of the Slovak Republic and the comparison with the fuel balance from the COPERT. The background documents are archived by sectoral experts and in the central archiving system of SNE at SHMÚ.

Analysis of fuels and lube oils composition

Slovakia is analysing the composition of fuels on a regular basis. Delivering actual and the most recent data on the composition of fuels is crucial for the correct calculation and estimation of country-specific emission factors. The last data update on fuel composition was made in 2020. In this update, the subject of analysis was not only the most used fuels but also the most used lube oils. This analysis is also a part of the implementation of ***Recommendations No SK-1A3b-2018-0001***, ***SK-1A3b-2018-0002*** and ***SK-1A3b-2018-0003***.

specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32009L0030&from=EN)

Table 3.82 presents the fuels from the three greatest sellers in Slovakia. These sellers also represent different refineries that affect the Slovak market.

Table 3.82: *Composition of diesel oil and petrol needed for estimation of country-specific emission factors*

SUPPLIER	DIESEL OIL	PETROL			
	PCS % vol	AROMATICS % vol	OLEFINS % vol	H:C RATIO	O:C RATIO
Slovnaft	3.7	32.9	13.6	1.878	0.027
OMV	1.9	33.0	10.0	1.861	0.027
Unipetrol	3.1	33.4	11.4	1.871	0.030
Average	2.9	33.1	11.7	1.870	0.028

As it was mentioned above, lube oil is more important for the estimation of air pollutants, especially for HMs and sulphur oxides. Lube oils are the biggest source of HMs and sulphur oxides by brake wear and engine abrasions. The results of most sold lube oil brands are displayed in ***Table 3.83***. These data were used to estimate heavy metal emissions.

Table 3.83: *Composition of lube oil needed for estimation of country-specific emission factors*

LUBE OIL BRANDS	[ppm/wt]										
	Pb	Cd	Cu	Cr	Ni	Se	Zn	Hg	As	S	H:C RATIO
Shell helix	0.098	0.039	0.063	0.069	0.065	0.037	1 523	0.097	0.126	2166	2.069
Shell rimula	0.100	0.039	0.101	0.083	0.087	0.037	1 503	0.026	0.156	2353	2.095
Castrol edge	0.017	0.298	0.010	0.044	0.030	0.037	1 149	0.021	0.159	2198	2.066
Average	0.072	0.125	0.058	0.065	0.061	0.037	1 392	0.048	0.147	2239	2.077

Time-series consistency – Scrapping Subsidy Program (SSP)

In 2009, a Scrap Subsidy Program was launched in Slovakia to support the exchange of old passenger cars (PC) for new cars – at that time (EURO 4). During two phases of this program, 44 200 vehicles were handed over for scrapping and 39 275 of EURO 4 vehicles were bought. This caused a decrease in the number of passenger cars in all categories in the frame of the SSP (4 475 cars older than 10 years). After the analyses made by the SHMÚ, it can be seen (***Table 3.84***), that most of the deregistered cars were in EURO 1 emission category or older categories.

Table 3.84: *Number of scrapped passenger cars by age (according to the Automotive Industry Association statistics) in 2009*

AGE OF SCRAPPED CARS	EMISSION CATEGORY	TOTAL NUMBER	SHARE OF SCRAPPED VEHICLES
10-15 years	EURO 1 and EURO 2	7 366	-
15-20 years	ECE 1504 and EURO 1	9 684	55.8%
20-25 years	ECE 1503 and ECE 1504	17 310	54.6%
>25 years	pre-ECE till ECE 1503	9 840	23.8%
New registrations	EURO 4	39 275	-

Through deeper analysis (***Table 3.85***) it was discovered, that reduction of registered cars wasn´t present in all emission categories (EURO). Despite the rules of the SSP, it supported only new vehicles and purchases of 10-years-old cars and older (outside of this program) occurred. This concerns two categories:

1. Conventional diesel passenger cars;
2. EURO 2 passenger cars (petrol and diesel oil).

An inter-annual increase of 14 365 passenger cars in the category of conventional diesel PC was recorded (instead of degreasing). A similar situation was recorded also in the category EURO 2 PC (diesel and petrol), where the number of passenger cars rose by 16 653. These anomalies potentially reduce the potential positive impact of the SSP on emissions reduction by 80%. The insufficient rules and control of the SSP started up and accelerated the annual rise of new registration of passenger cars with a small positive impact on air quality and climate change in Slovakia.

On the other hand, the SSP was possibly one of the factors causing a decrease in fuel consumption (FC) in the year 2009. The exact effect cannot be calculated as exact data from the SSP are missing. However, a small positive effect on GHG emissions and air pollutants is visible. The main positive outcomes of the SSP are:

- The SSP caused fuel consumption decrease;
- The SSP has a moderate effect on air quality.
- On the other hand, negative outcomes are also important:
- The SSP failed in intention to decrease the number of pre-EURO 4 vehicles;
- The SSP accelerate registration of additional vehicles (not only new or modern ones);
- The SSP has no significant effect on GHG emissions.

Table 3.85: *Yearly change (2008-2009) in the number of passenger cars by emission category (according to the Police statistics)*

TOTAL NUMBER OF PC IN 2008		TOTAL NUMBER	DIFFERENCE	AVERAGE	AVERAGE	DIFFERENCE
Conventional	38 908	53 273	14 365	10 240.11	8 024.19	-2 215.92
PRE ECE	86 778	73 350	-13 428	3 415.64	3 300.58	-115.05
ECE 15/00-01	93 514	79 725	-13 789	3 080.74	2 976.97	-103.77
ECE 15/02	94 546	80 701	-13 845	4 312.89	4 167.62	-145.27
ECE 15/03	110 107	95 425	-14 682	5 028.18	4 858.81	-169.37
ECE 15/04	153 137	136 141	-16 996	6 087.41	5 882.36	-205.05
Euro 1	195 607	195 263	-344	9 660.12	8 227.15	-1 432.97
Euro 2	321 717	338 370	16 653	11 555.38	9 811.85	-1 743.52
Average	-	-	**-5 258**	-	-	**-766.37**

NMVOC time-series inconsistency

Non-methane volatile organic compounds in road transportation originate from petrol evaporation. Evaporative emissions of VOCs come from the fuel systems (tanks, injection systems and fuel lines) of petrol vehicles. NMVOCs from diesel vehicles are considered negligible due to the presence of heavier hydrocarbons with a lower vapour pressure of diesel fuel.

According to the EMEP/EEA GB_{2023}, emissions from petrol evaporation are the most important sources:

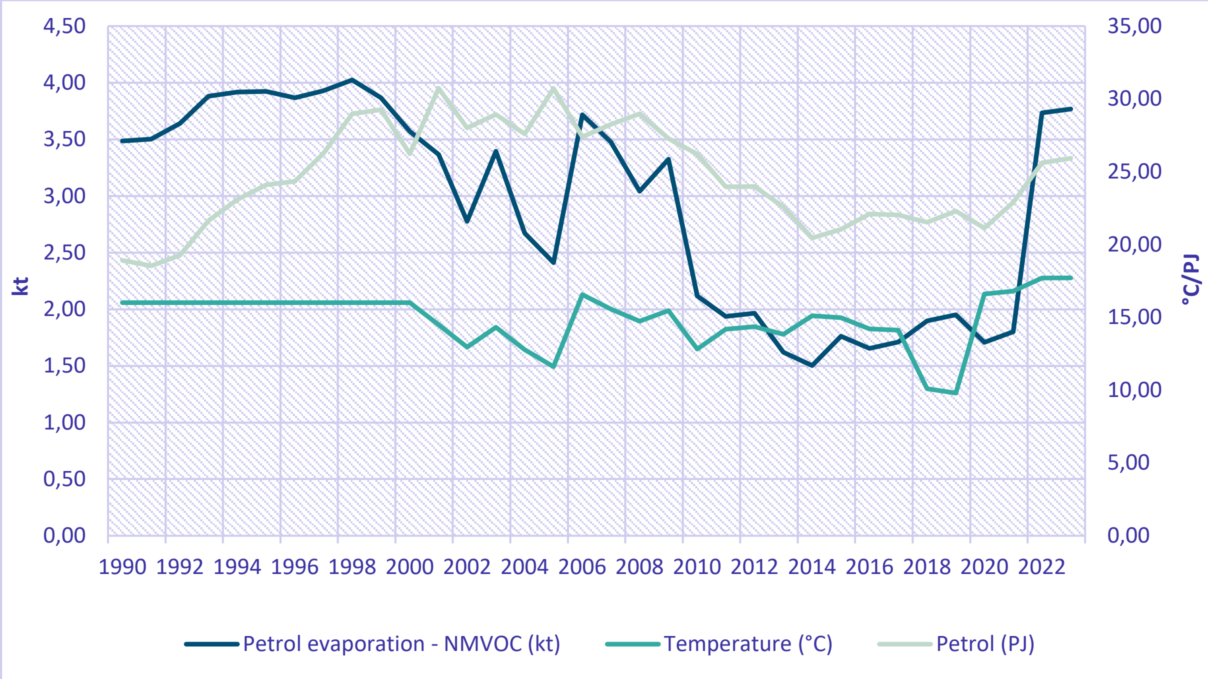
- Breathing losses through the tank vent. Breathing losses are due to the evaporation of fuel in the tank during driving and parking, as a result of normal diurnal temperature variation;
- Fuel permeation/leakage. Various studies (e.g. CRC, 2004; Reuter et al., 1994) indicate that liquid fuel seepage and permeation through plastic and rubber components of the fuel and vapour control system contribute significantly to the total evaporative emissions.

Also, three separate mechanisms are considered:

- diurnal emissions;
- running losses;
- hot-soak emissions.

All three mechanisms are directly connected and dependent on temperature (ambient and vehicle). The dependence is possible to lower with newer technologies that recirculate the petrol vapour and minimalize its emissions. All inconsistencies in category **1A3bv** can be explained by ambient temperature (***Figure 3.8***) (according to ***Recommendation No SK-1A3bv-2018-0001***).

Figure 3.8: *Ambient air temperature and evaporation emissions correlation*



3.6.3.4 Source-specific Recalculations

In the IIR 2025, a recalculation was performed due to the need to update the COPERT model (based on ***recommendation SK-1A3b-2024-0001***). The recalculation reflects the transition to COPERT 5 version 8.1 used for the latest submission. Several modifications were implemented in the model, primarily related to the update of emission factors and corrections of certain erroneous calculation procedures. Additionally, the latest version introduced new vehicle categories. Detailed information on the changes between versions 5.1 and 8.1 can be found on the COPERT website: https://copert.emisia.com/copert/versions/.
Due to insufficiently detailed data on the vehicle fleet, which has been available only since 2013, it was possible to perform the recalculation only from that year. The results of the recalculation can be seen in ***Tables 3.86-3.92***.

Table 3.86: *Differences in emissions (%) in the category 1A3bi between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
2013	-0.27%	-5.12%	-0.54%	-3.41%	1.72%	1.72%	1.72%	-23.31%	-3.36%	-0.44%	-0.43%
2014	-0.48%	-5.97%	-0.82%	-3.66%	1.19%	1.19%	1.19%	-20.94%	-4.23%	-0.36%	-0.48%
2015	-1.54%	-8.06%	-1.52%	-4.38%	0.02%	0.02%	0.02%	-22.64%	-8.36%	-0.92%	-0.82%
2016	-0.04%	-7.97%	-0.57%	-4.60%	0.66%	0.66%	0.66%	-10.71%	-6.22%	-0.37%	-0.33%
2017	-0.16%	-11.33%	-0.64%	-4.68%	1.09%	1.09%	1.09%	-23.20%	-8.67%	-0.38%	-0.34%
2018	-0.49%	-13.13%	-0.88%	-4.75%	-0.22%	-0.22%	-0.22%	-10.36%	-9.74%	-0.51%	-0.44%
2019	-0.17%	-16.87%	-0.63%	-5.20%	-0.15%	-0.15%	-0.15%	-9.72%	-12.40%	-0.33%	-0.29%
2020	0.33%	-20.03%	-0.61%	-4.64%	-0.11%	-0.11%	-0.11%	-9.73%	-13.98%	-0.34%	-0.29%
2021	-0.13%	-20.67%	-0.74%	-4.76%	-0.39%	-0.39%	-0.39%	-10.99%	-13.95%	-0.40%	-0.34%
2022	-0.10%	-22.17%	-0.77%	-5.05%	-0.59%	-0.59%	-0.59%	-9.61%	-14.67%	-0.39%	-0.33%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	HCB	PCB
2013	-0.50%	-0.45%	-0.56%	-0.55%	-0.38%	-0.48%	-0.49%	-0.03%	-0.27%	-0.27%
2014	-0.65%	-0.53%	-0.81%	-0.79%	-0.35%	-0.61%	-0.63%	-0.26%	-0.52%	-0.52%
2015	-1.25%	-0.95%	-1.62%	-1.60%	-0.46%	-1.15%	-1.21%	-0.99%	-1.18%	-1.18%
2016	-0.48%	-0.38%	-0.61%	-0.60%	-0.21%	-0.45%	-0.47%	0.13%	-0.20%	-0.20%
2017	-0.51%	-0.39%	-0.66%	-0.65%	-0.19%	-0.47%	-0.49%	0.13%	-0.22%	-0.22%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	HCB	PCB
2018	-0.71%	-0.52%	-0.93%	-0.92%	-0.22%	-0.65%	-0.68%	-0.21%	-0.56%	-0.56%
2019	-0.48%	-0.35%	-0.65%	-0.64%	-0.12%	-0.44%	-0.47%	0.09%	-0.38%	-0.38%
2020	-0.49%	-0.35%	-0.64%	-0.63%	-0.12%	-0.44%	-0.47%	0.62%	0.14%	0.14%
2021	-0.58%	-0.41%	-0.79%	-0.78%	-0.14%	-0.53%	-0.56%	0.24%	-0.25%	-0.25%
2022	-0.60%	-0.41%	-0.83%	-0.81%	-0.12%	-0.53%	-0.57%	0.19%	-0.35%	-0.35%

***Table 3.87**: Differences in emissions(%) in the category 1A3bii between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
2013	-2.87%	3.11%	1.06%	-3.06%	-3.89%	-3.89%	-3.89%	-28.69%	-25.74%	2.02%	2.27%
2014	-2.66%	2.58%	0.51%	-3.16%	-4.05%	-4.05%	-4.05%	-26.29%	-23.36%	2.79%	1.66%
2015	-3.14%	0.90%	-0.26%	-3.84%	-4.53%	-4.53%	-4.53%	-27.78%	-27.61%	0.41%	0.60%
2016	-1.71%	-2.30%	0.94%	-3.67%	-3.42%	-3.42%	-3.42%	-15.66%	-23.00%	1.37%	1.50%
2017	-1.48%	3.76%	0.88%	-3.42%	-3.17%	-3.17%	-3.17%	-28.30%	-22.05%	1.25%	1.36%
2018	-1.84%	-3.30%	0.52%	-3.16%	-3.75%	-3.75%	-3.75%	-15.13%	-22.90%	0.85%	0.95%
2019	-1.35%	-2.87%	0.88%	-2.95%	-3.33%	-3.33%	-3.33%	-14.47%	-21.35%	1.05%	1.10%
2020	-0.75%	-2.68%	1.33%	-2.15%	-2.66%	-2.66%	-2.66%	-14.23%	-19.86%	1.41%	1.43%
2021	-1.01%	-2.23%	1.04%	-2.40%	-2.96%	-2.96%	-2.96%	-15.55%	-21.64%	1.18%	1.22%
2022	-0.55%	-2.00%	1.08%	-2.15%	-2.88%	-2.88%	-2.88%	-14.06%	-21.62%	1.18%	1.21%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	HCB	PCB
2013	1.40%	1.95%	0.95%	0.97%	3.65%	1.56%	1.49%	0.38%	0.38%	0.38%
2014	0.92%	1.38%	0.55%	0.57%	2.94%	1.05%	0.99%	0.10%	0.09%	0.09%
2015	-0.03%	0.36%	-0.32%	-0.31%	1.74%	0.08%	0.03%	-0.69%	-0.69%	-0.69%
2016	1.09%	1.34%	0.89%	0.90%	2.24%	1.16%	1.13%	0.59%	0.58%	0.58%
2017	1.02%	1.23%	0.86%	0.87%	1.98%	1.08%	1.05%	0.61%	0.59%	0.59%
2018	0.64%	0.83%	0.49%	0.50%	1.57%	0.69%	0.67%	0.26%	0.23%	0.23%
2019	0.94%	1.04%	0.87%	0.88%	1.41%	0.97%	0.96%	0.70%	0.66%	0.66%
2020	1.36%	1.40%	1.33%	1.33%	1.59%	1.37%	1.37%	1.20%	1.16%	1.16%
2021	1.09%	1.17%	1.03%	1.03%	1.48%	1.11%	1.10%	0.87%	0.83%	0.83%
2022	1.12%	1.17%	1.08%	1.08%	1.39%	1.13%	1.13%	0.93%	0.87%	0.87%

***Table 3.88**: Differences in emissions(%) in the category 1A3biii between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
2013	2.07%	2.18%	0.53%	5.13%	27.67%	27.67%	27.67%	30.73%	2.93%	0.52%	0.52%
2014	2.84%	2.34%	1.20%	6.26%	33.08%	33.08%	33.08%	35.31%	3.00%	1.17%	1.19%
2015	3.00%	2.26%	3.61%	9.62%	25.31%	25.31%	25.31%	25.58%	2.71%	3.61%	3.61%
2016	5.05%	3.42%	0.79%	2.78%	30.49%	30.49%	30.49%	29.35%	3.74%	0.79%	0.79%
2017	6.43%	4.20%	0.94%	2.55%	34.17%	34.17%	34.17%	31.21%	4.12%	0.94%	0.94%
2018	7.07%	4.19%	1.56%	2.61%	35.57%	35.57%	35.57%	31.02%	4.10%	1.56%	1.56%
2019	7.72%	4.43%	0.97%	1.95%	37.18%	37.18%	37.18%	30.79%	4.23%	0.97%	0.97%
2020	7.31%	4.28%	1.54%	3.13%	30.39%	30.39%	30.39%	26.73%	4.81%	1.54%	1.54%
2021	9.10%	5.02%	1.17%	2.00%	41.06%	41.06%	41.06%	32.05%	4.77%	1.17%	1.17%
2022	9.69%	5.06%	1.21%	3.67%	42.73%	42.73%	42.73%	31.43%	4.99%	1.21%	1.21%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	HCB	PCB
2013	0.53%	0.52%	0.53%	0.53%	0.50%	0.53%	0.53%	0.52%	0.51%	0.50%
2014	1.20%	1.19%	1.20%	1.20%	1.16%	1.20%	1.20%	1.16%	0.22%	0.22%
2015	3.61%	3.61%	3.61%	3.61%	3.61%	3.61%	3.61%	3.77%	-0.53%	-0.53%
2016	0.79%	0.79%	0.79%	0.79%	0.79%	0.79%	0.79%	0.71%	0.70%	0.70%
2017	0.94%	0.94%	0.94%	0.94%	0.94%	0.94%	0.94%	0.80%	0.73%	0.73%

2018	1.56%	1.56%	1.56%	1.56%	1.56%	1.56%	1.56%	2.80%	0.44%	0.44%
2019	0.97%	0.97%	0.97%	0.97%	0.96%	0.97%	0.97%	0.87%	0.80%	0.82%
2020	1.54%	1.54%	1.54%	1.54%	1.54%	1.54%	1.54%	1.37%	1.29%	1.33%
2021	1.17%	1.17%	1.17%	1.17%	1.17%	1.17%	1.17%	1.01%	0.93%	0.93%
2022	1.21%	1.21%	1.21%	1.21%	1.21%	1.21%	1.21%	1.05%	1.04%	1.04%

Table 3.89: *Differences in emissions (%) in the category 1A3biv between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
2013	-3.46%	-3.62%	-3.74%	-3.68%	-3.67%	-3.67%	-3.67%	-4.39%	-3.57%	-3.76%	-3.75%
2014	-3.76%	-3.95%	-4.08%	-4.02%	-4.02%	-4.02%	-4.02%	-4.61%	-3.90%	-4.10%	-4.09%
2015	-4.78%	-4.84%	-4.90%	-4.88%	-4.85%	-4.85%	-4.85%	-5.50%	-4.83%	-4.91%	-4.91%
2016	-5.11%	-5.18%	-5.25%	-5.23%	-5.20%	-5.20%	-5.20%	-5.35%	-5.17%	-5.26%	-5.26%
2017	-5.44%	-5.53%	-5.62%	-5.60%	-5.56%	-5.56%	-5.56%	-6.03%	-5.50%	-5.63%	-5.63%
2018	-5.57%	-5.68%	-5.82%	-5.77%	-5.74%	-5.74%	-5.74%	-5.87%	-5.63%	-5.82%	-5.82%
2019	-6.32%	-6.45%	-6.60%	-6.56%	-6.53%	-6.53%	-6.53%	-6.62%	-6.40%	-6.60%	-6.60%
2020	-6.01%	-6.30%	-6.63%	-6.52%	-6.51%	-6.51%	-6.51%	-6.61%	-6.15%	-6.64%	-6.63%
2021	-5.41%	-5.74%	-6.70%	-6.42%	-6.53%	-6.53%	-6.53%	-6.65%	-5.15%	-6.72%	-6.70%
2022	-4.75%	-6.11%	-7.12%	-6.69%	-6.96%	-6.96%	-6.96%	-7.10%	-5.49%	-7.14%	-7.10%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	HCB	PCB
2013	-3.75%	-3.75%	-3.75%	-3.75%	-3.76%	-3.75%	-3.68%	-3.63%	-3.63%	-3.60%
2014	-4.09%	-4.09%	-4.09%	-4.09%	-4.10%	-4.09%	-4.03%	-3.98%	-3.98%	-4.03%
2015	-4.91%	-4.91%	-4.90%	-4.90%	-4.91%	-4.91%	-4.89%	-4.85%	-4.84%	-4.84%
2016	-5.26%	-5.26%	-5.25%	-5.25%	-5.26%	-5.26%	-5.24%	-5.19%	-5.21%	-5.24%
2017	-5.63%	-5.63%	-5.62%	-5.62%	-5.63%	-5.63%	-5.60%	-5.56%	-5.56%	-5.65%
2018	-5.82%	-5.82%	-5.82%	-5.82%	-5.82%	-5.82%	-5.78%	-5.73%	-5.75%	-5.80%
2019	-6.60%	-6.60%	-6.60%	-6.60%	-6.61%	-6.60%	-6.57%	-6.52%	-6.52%	-6.51%
2020	-6.63%	-6.63%	-6.63%	-6.63%	-6.64%	-6.63%	-6.53%	-6.47%	-6.47%	-6.48%
2021	-6.72%	-6.70%	-6.72%	-6.72%	-6.72%	-6.71%	-6.46%	-6.39%	-6.38%	-6.42%
2022	-7.14%	-7.11%	-7.14%	-7.14%	-7.14%	-7.13%	-6.74%	-6.67%	-6.67%	-6.71%

Table 3.90: *Differences in emissions (%) in the category 1A3bv between the previous and current submission caused by recalculations*

YEAR	NMVOC
2013	-1.48%
2014	-1.66%
2015	-2.17%
2016	-2.41%
2017	-2.54%
2018	-2.56%
2019	-3.00%
2020	-2.83%
2021	-3.03%
2022	-2.01%

Table 3.91: *Differences in emissions (%) in the category 1A3bvi between the previous and current submission caused by recalculations*

YEAR	$PM_{2.5}$	PM_{10}	TSP	BC	Pb	Cd	As	Cr	Cu	Ni	Se	Zn
2013	12.32%	17.59%	13.00%	143.52%	241.93%	218.73%	237.66%	245.06%	246.26%	232.63%	177.16%	181.45%
2014	12.78%	18.06%	13.45%	144.54%	243.37%	220.02%	239.07%	246.51%	247.72%	234.01%	178.26%	182.57%
2015	13.77%	19.31%	14.48%	145.71%	248.48%	224.20%	244.01%	251.75%	253.00%	238.74%	180.78%	185.26%
2016	13.42%	18.93%	14.13%	145.06%	247.47%	223.19%	243.00%	250.75%	252.01%	237.73%	179.89%	184.34%

YEAR	$PM_{2.5}$	PM_{10}	TSP	BC	Pb	Cd	As	Cr	Cu	Ni	Se	Zn
2017	13.42%	18.86%	14.12%	145.41%	246.68%	222.68%	242.26%	249.92%	251.16%	237.05%	179.87%	184.28%
2018	13.50%	18.95%	14.20%	145.55%	247.01%	222.96%	242.57%	250.25%	251.50%	237.36%	180.07%	184.48%
2019	13.60%	19.15%	14.31%	145.40%	248.54%	223.93%	244.00%	251.87%	253.15%	238.66%	180.29%	184.77%
2020	16.44%	22.82%	17.25%	148.23%	264.90%	236.86%	259.71%	268.70%	270.16%	253.62%	187.45%	192.50%
2021	13.89%	19.38%	14.59%	146.41%	248.80%	224.30%	244.28%	252.12%	253.40%	238.96%	180.96%	185.40%
2022	13.72%	19.16%	14.41%	146.18%	247.70%	223.49%	243.23%	250.98%	252.23%	237.98%	180.54%	184.94%

Table 3.92: *Differences in emissions (%) in the category 1A3bvii between the previous and current submission caused by recalculations*

YEAR	$PM_{2.5}$	PM_{10}	TSP	BC
2013	1.51%	1.51%	1.51%	1.51%
2014	1.76%	1.76%	1.76%	1.76%
2015	2.69%	2.69%	2.69%	2.69%
2016	1.61%	1.61%	1.61%	1.61%
2017	1.63%	1.63%	1.63%	1.63%
2018	1.68%	1.68%	1.68%	1.68%
2019	1.43%	1.43%	1.43%	1.43%
2020	2.50%	2.50%	2.50%	2.50%
2021	1.71%	1.71%	1.71%	1.71%
2022	1.75%	1.75%	1.75%	1.75%

3.6.4 Railways (NFR 1A3c)

3.6.4.1 Overview

Railways are the second most important source of emissions in transport (except for pipeline transport), despite the decreasing character of this transport mode. Railways and rail transport are modernised with the support of EU funds. Improved quality and ecology of rail transport and the increase in passengers' number are the results of this modernisation. Modernisation of rail infrastructure results in an increase in operational speed to 160 km/h and an increase in safety. According to the Annual Report of Slovak Railways[12] in 2023, the length of managed railways was 3,630 km. The length of the electric railways was 1 585 km. Total NO_x emissions from railways transport decreased by 1.6% compared to the previous year and by 76% compared to the base year (***Table 3.93***).

Table 3.93: *Overview of emissions in railways (1A3c)*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	6.1928	0.5496	0.0016	0.0008	0.1619	0.1702	0.1796	0.1052	1.2646
1995	3.3542	0.2977	0.0009	0.0004	0.0877	0.0922	0.0973	0.0570	0.6849
2000	2.5601	0.2272	0.0007	0.0003	0.0669	0.0704	0.0743	0.0435	0.5228
2005	1.7520	0.1555	0.0005	0.0002	0.0458	0.0481	0.0508	0.0298	0.3578
2010	1.5837	0.1405	0.0004	0.0002	0.0414	0.0435	0.0459	0.0269	0.3234
2011	1.3928	0.1236	0.0004	0.0002	0.0364	0.0383	0.0404	0.0237	0.2844
2012	1.1791	0.1046	0.0003	0.0002	0.0308	0.0324	0.0342	0.0200	0.2408
2013	1.4511	0.1288	0.0004	0.0002	0.0379	0.0399	0.0421	0.0247	0.2963
2014	1.3789	0.1224	0.0004	0.0002	0.0361	0.0379	0.0400	0.0234	0.2816
2015	1.6565	0.1383	0.0004	0.0003	0.0311	0.0340	0.0499	0.0202	0.4689
2016	1.6936	0.1417	0.0004	0.0003	0.0319	0.0349	0.0511	0.0207	0.4793
2017	1.6500	0.1385	0.0004	0.0003	0.0312	0.0341	0.0499	0.0202	0.4668
2018	1.6123	0.1357	0.0004	0.0003	0.0305	0.0333	0.0488	0.0198	0.4560

[12] Annual Report of Slovak Railway 2023, p. 18

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2019	1.5336	0.1335	0.0004	0.0003	0.0298	0.0326	0.0474	0.0194	0.4322
2020	1.3609	0.1191	0.0003	0.0003	0.0266	0.0291	0.0422	0.0173	0.3833
2021	1.5483	0.1378	0.0004	0.0003	0.0307	0.0335	0.0485	0.0199	0.4352
2022	1.5223	0.1349	0.0004	0.0003	0.0300	0.0329	0.0476	0.0195	0.4281
2023	1.4986	0.1332	0.0004	0.0003	0.0296	0.0324	0.0469	0.0193	0.4213
1990/2023	**-76%**	**-76%**	**-76%**	**-66%**	**-82%**	**-81%**	**-74%**	**-82%**	**-67%**
2022/2023	**-2%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-2%**

YEAR	PRIORITY HMs [t]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0012	0.0035	0.0059	0.0000	0.0000	0.0095	0.0009	1.1818
1995	0.0006	0.0019	0.0032	0.0000	0.0000	0.0051	0.0005	0.6401
2000	0.0005	0.0015	0.0024	0.0000	0.0000	0.0039	0.0004	0.4886
2005	0.0003	0.0010	0.0017	0.0000	0.0000	0.0027	0.0003	0.3344
2010	0.0003	0.0009	0.0015	0.0000	0.0000	0.0024	0.0002	0.3022
2011	0.0003	0.0008	0.0013	0.0000	0.0000	0.0021	0.0002	0.2658
2012	0.0002	0.0007	0.0011	0.0000	0.0000	0.0018	0.0002	0.2250
2013	0.0003	0.0008	0.0014	0.0000	0.0000	0.0022	0.0002	0.2769
2014	0.0003	0.0008	0.0013	0.0000	0.0000	0.0021	0.0002	0.2632
2015	0.0003	0.0009	0.0014	0.0000	0.0000	0.0023	0.0002	0.2896
2016	0.0003	0.0009	0.0015	0.0000	0.0000	0.0024	0.0002	0.2969
2017	0.0003	0.0009	0.0015	0.0000	0.0000	0.0023	0.0002	0.2902
2018	0.0003	0.0009	0.0014	0.0000	0.0000	0.0023	0.0002	0.2843
2019	0.0003	0.0008	0.0014	0.0000	0.0000	0.0022	0.0002	0.2801
2020	0.0002	0.0008	0.0013	0.0000	0.0000	0.0020	0.0002	0.2500
2021	0.0003	0.0009	0.0014	0.0000	0.0000	0.0023	0.0002	0.2895
2022	0.0003	0.0009	0.0014	0.0000	0.0000	0.0023	0.0002	0.2835
2023	0.0003	0.0008	0.0014	0.0000	0.0000	0.0022	0.0002	0.2798
1990/2023	**-76%**	**-76%**	**-76%**	**-76%**	**-76%**	**-76%**	**-76%**	**-76%**
2022/2023	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**

3.6.4.2 Methodological Issues

The emissions of the pollutants are calculated from the consumed fuels according to the powertrain and multiplied by the appropriate emission factor. The consumption of diesel oil for motor traction in the Slovak Republic was obtained from the railways companies for all years in time-series and the years 2015-2023 also for each powertrain.

3.6.4.3 Completeness

The verification process is based on cross-checking the input data on fuel consumption from the Railways Company, Ltd. and the Statistical Office of the Slovak Republic. The preliminary results of the emissions inventory are sent to other subjects (Ministry of the Environment of the Slovak Republic, Ministry of Transport and Construction of the Slovak Republic) for valuation and QA activities. The QC verification process includes the comparison of statistical and calculated data on fuel consumption. Notation key NE is used for solid fuels as the emissions from steam locomotives are under the threshold.

3.6.4.4 Source-specific Recalculations

The emissions were recalculated due to the calculation error and data flow. The emission factor for calculations of SOx emissions was also updated. The differences in emissions in category **1A3c** between the previous and current submissions caused by recalculations are shown in ***Table 3.94***.

***Table 3.94**: Differences in emissions (%) in the category 1A3c between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	-0.000002%	-0.000002%	-30%	-0.000002%	-0.000002%	-0.000002%	-0.000002%	-0.000002%	-0.000002%
1991	-0.000004%	-0.000004%	-30%	-0.000004%	-0.000004%	-0.000004%	-0.000004%	-0.000004%	-0.000004%
1992	0.00002%	0.00002%	-30%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.000015%
1993	-0.001%	-0.0005%	-30%	-0.001%	-0.0005%	-0.0005%	-0.001%	-0.0005%	-0.001%
1994	0.000004%	0.000004%	-30%	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%
1995	-	-	-30%	-	-	-	-	-	-
1996	0.001%	0.0005%	-30%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
1997	0.001%	0.0007%	-30%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
1998	0.0001%	0.0001%	-30%	0.0001%	0.000%	0.0001%	0.0001%	0.0001%	0.0001%
1999	-0.0002%	-0.0002%	-30%	-0.0002%	0.000%	-0.0002%	-0.0002%	-0.0002%	-0.0002%
2000	0.001%	0.0009%	-30%	0.001%	0.001%	0.001%	0.0009%	0.001%	0.001%
2001	-0.001%	-0.0006%	-30%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%
2002	0.000%	0.0001%	-30%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%
2003	0.000%	-0.0003%	-30%	-0.0003%	-0.0003%	-0.0003%	-0.0003%	-0.0003%	-0.0003%
2004	0.001%	0.001%	-30%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
2005	0.001%	0.0007%	-30%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
2006	-0.001%	-0.0007%	-30%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%
2007	-	-	-30%	-	-	-	-	-	-
2008	-0.0003%	-0.0003%	-30%	-0.0003%	-0.0003%	-0.0003%	-0.0003%	-0.0003%	-0.0003%
2009	-0.001%	-0.001%	-30%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%
2010	10%	10%	-23%	10%	10%	10%	10%	10%	10%
2011	0.001%	0.001%	-30%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
2012	-0.001%	-0.001%	-30%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%
2013	-0.001%	-0.001%	-30%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%
2014	-	-	-30%	-	-	-	-	-	-
2015	-	-	-30%	-	-	-	-	-	-
2018	-	-	5%	-	-	-	-	-	-
2019	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	1%	0.5%	1%
2020	0.04%	0.03%	0.03%	0.03%	0.04%	0.04%	0.04%	0.04%	0.04%
2021	2%	3%	3%	3%	3%	3%	2%	9%	38%

YEAR	Cd	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1990	-0.000002%	-0.000002%	-0.000002%	-0.000002%	-0.000002%	-0.000002%	-0.000002%	-0.004%	-0.000002%	-0.000002%
1991	-0.000004%	-0.000004%	-0.000004%	-0.000004%	-0.000004%	-0.000004%	-0.000004%	-0.004%	-0.000004%	-0.000004%
1992	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	-0.004%	0.00002%	0.00002%
1993	-0.0005%	-0.001%	-0.001%	-0.001%	-0.001%	-0.0005%	-0.001%	-0.005%	-0.001%	-0.0005%
1994	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%	-0.004%	0.000004%	0.000004%
1995	-	-	-	-	-	-	-	-0.004%	-	-
1996	0.0005%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	-0.004%	0.001%	0.001%
1997	0.0007%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	-0.004%	0.001%	0.001%
1998	0.00007%	0.000%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	-0.004%	0.0001%	0.0001%
1999	-0.0002%	0.000%	-0.0002%	-0.0002%	-0.0002%	-0.0002%	-0.0002%	-0.005%	-0.0002%	-0.0002%
2000	0.0009%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	-0.003%	0.001%	0.001%
2001	-0.0006%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.005%	-0.001%	-0.001%
2002	0.00006%	0.0001%	0.0001%	0.000%	0.0001%	0.0001%	0.0001%	-0.004%	0.0001%	0.0001%
2003	-0.0003%	-0.0003%	-0.0003%	0.000%	-0.0003%	-0.0003%	-0.0003%	-0.005%	-0.0003%	-0.0003%
2004	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	-0.003%	0.001%	0.001%
2005	0.0007%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	-0.004%	0.001%	0.001%

YEAR	Cd	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
2006	-0.0007%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.005%	-0.001%	-0.001%
2007	-	-	-	-	-	-	-	-0.004%	-	-
2008	-0.0003%	-0.0003%	-0.0003%	-0.0003%	0%	-0.0003%	-0.0003%	-0.005%	-0.0003%	0.000%
2009	-0.001%	-0.001%	-0.001%	-0.001%	0%	-0.001%	-0.001%	-0.005%	-0.001%	-0.001%
2010	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
2011	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	-0.003%	0.001%	0.001%
2012	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.005%	-0.001%	-0.001%
2013	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.001%	-0.006%	-0.001%	-0.001%
2014	-	-	-	-	-	-	-	-0.004%	-	-
2015	-	-	-	-	-	-	-	-0.004%	-	-
2018	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
2019	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
2020	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%
2021	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%

3.6.5 International Inland Waterways (NFR 1A3di(ii)) and National Navigation (NFR 1A3dii)

3.6.5.1 Overview

The major share of emissions from inland shipping in Slovakia is realized as transit on the Danube River. Due to a lack of data, these two categories were reported together as national emissions until 2016. Based on the information from the State Navigation Administration (the SNA), there are movements realized between the Gabčíkovo and Komárno ports on the Slovak territory (national transport). Due to the international character of shipping transportation on the Danube River, the ships do not stop their operation on the Slovak territory, but the transit continues to Austria or Hungary. The experts from the Slovak Shipping and Ports Company confirmed that before 2005, a negligible number of movements were between the Slovak ports registered. Inland shipping transportation on small lakes for tourist purposes was also estimated and added to the total emissions in this category.

Decreasing trends of emission of air pollutants were recognized compared to the previous years and compared to the base year (***Table 3.95***), despite an increase in tourist activities in Slovakia. The emissions for the years 2000 and 2005 were estimated to be negligible, because of the increasing prices of diesel oil in the Slovak Republic and decreasing prices of fuels in the neighbouring countries (market discrepancies).

Table 3.95: *Overview of emissions in navigation (international 1A3di(ii) and national 1A3dii)*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	1.4170	0.0342	0.3937	0.0001	0.1066	0.1066	0.1066	0.0019	0.0753
1995	1.2488	0.0302	0.3470	0.0001	0.0940	0.0940	0.0940	0.0016	0.0663
2000	0.0005	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0155	0.0004	0.0043	0.0000	0.0012	0.0012	0.0012	0.0000	0.0008
2010	0.7293	0.0176	0.2027	0.0001	0.0549	0.0549	0.0549	0.0010	0.0387
2011	0.6472	0.0156	0.1798	0.0001	0.0487	0.0487	0.0487	0.0008	0.0344
2012	0.2257	0.0055	0.0627	0.0000	0.0170	0.0170	0.0170	0.0003	0.0120
2013	0.3554	0.0086	0.0987	0.0000	0.0267	0.0267	0.0267	0.0005	0.0189
2014	0.4132	0.0100	0.1148	0.0000	0.0311	0.0311	0.0311	0.0005	0.0219
2015	0.6218	0.0150	0.1728	0.0001	0.0468	0.0468	0.0468	0.0008	0.0330
2016	0.5202	0.0126	0.1446	0.0001	0.0391	0.0391	0.0391	0.0007	0.0276
2017	0.5126	0.0124	0.1424	0.0001	0.0386	0.0386	0.0386	0.0007	0.0272
2018	0.2972	0.0072	0.0826	0.0000	0.0224	0.0224	0.0224	0.0004	0.0158
2019	0.4425	0.0107	0.1229	0.0000	0.0333	0.0333	0.0333	0.0006	0.0235

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2020	0.4476	0.0108	0.1244	0.0000	0.0337	0.0337	0.0337	0.0006	0.0238
2021	0.5056	0.0122	0.1405	0.0001	0.0380	0.0380	0.0380	0.0007	0.0269
2022	0.5011	0.0121	0.1392	0.0001	0.0377	0.0377	0.0377	0.0007	0.0266
2023	0.5144	0.0124	0.1429	0.0001	0.0387	0.0387	0.0387	0.0007	0.0273
1990/2023	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**
2022/2023	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**

YEAR	PRIORITY HMs [t]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0045	0.0010	0.0006	0.0004	0.0002	0.0022	0.0029	0.0117
1995	0.0040	0.0009	0.0005	0.0004	0.0002	0.0020	0.0025	0.0103
2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2010	0.0023	0.0005	0.0003	0.0002	0.0001	0.0012	0.0015	0.0060
2011	0.0021	0.0005	0.0003	0.0002	0.0001	0.0010	0.0013	0.0053
2012	0.0007	0.0002	0.0001	0.0001	0.0000	0.0004	0.0005	0.0019
2013	0.0011	0.0003	0.0002	0.0001	0.0000	0.0006	0.0007	0.0029
2014	0.0013	0.0003	0.0002	0.0001	0.0001	0.0007	0.0008	0.0034
2015	0.0020	0.0004	0.0003	0.0002	0.0001	0.0010	0.0013	0.0051
2016	0.0017	0.0004	0.0002	0.0002	0.0001	0.0008	0.0011	0.0043
2017	0.0016	0.0004	0.0002	0.0001	0.0001	0.0008	0.0010	0.0042
2018	0.0009	0.0002	0.0001	0.0001	0.0000	0.0005	0.0006	0.0025
2019	0.0014	0.0003	0.0002	0.0001	0.0001	0.0007	0.0009	0.0036
2020	0.0014	0.0003	0.0002	0.0001	0.0001	0.0007	0.0009	0.0037
2021	0.0016	0.0004	0.0002	0.0001	0.0001	0.0008	0.0010	0.0042
2022	0.0016	0.0004	0.0002	0.0001	0.0001	0.0008	0.0010	0.0041
2023	0.0016	0.0004	0.0002	0.0001	0.0001	0.0008	0.0010	0.0042
1990/2023	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**	**-64%**
2022/2023	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**

3.6.5.2 Methodological Issues

These subcategories include all emissions from national and international shipping between the ports on the Danube River on the Slovak territory and domestic shipping on lakes and dams for touristic purposes.

Shipping between the Slovak ports on the Danube River: The Slovak Shipping and Ports Company is providing detailed information on diesel oil consumption on the Danube River. The consumption is allocated between national and international companies. It was assumed that total fuel sold to international companies is reported in the international inland waterways (**1A3di(ii)**) and total fuel sold to national companies (Slovak Water Management Enterprise) is reported in the national navigation (**1A3dii**). This activity represents the movements of ships between Slovak ports (Bratislava, Devin and Komárno). This approach was introduced in IIR 2018 first time.

Shipping on lakes: The State Navigation Administration was officially requested to check the availability of information about the shipping activity in the Slovak Republic except for the Danube River movements. The expert was informed that they register a total number of ships and boats operated except the Danube River but without information about their activity or fuel consumption. Based on expert research, three other relevant shipping routes, except the shipping routes on the Danube River, occur in Slovakia, however to a limited extent. The three shipping routes are:

- River – basin of the Váh (Pieštany, Trenčín, Liptovská Mara dam);
- The tributary River of the Váh (Oravská priehrada dam);
- River – basin of the Bodrog (Zemplínska Šírava dam).

While the public and tourist shipping activities in the Slovak Republic are not very frequent and have expanded only in recent years (due to the increase in tourism), it was necessary to propose an appropriate methodological approach for emissions estimation. The chosen activity data were:

- The number of trips per year:

The number of trips per year is limited by the daily schedule of trips mostly in the summer months (May-October).

- The duration of trips (in hours):

The duration can differ according to the type of trip (mostly short or long tours).

- The technical parameters of the most populated ships:

The technical parameters of vessels can be found on the webpage. The engines are mostly with 100 kilowatts of power, which is a common type of engine used in non-road mechanisms, or in agricultural machinery (type Zetor). The engines run on diesel oil.

- The average consumption of diesel oil in litres per hour:

The average consumption based on the technical description of the engines is 12 litres of diesel oil per hour of work. The consumption of diesel oil in tons was calculated using the average density of diesel oil is **0.84 kg/dm^3**. The emissions are calculated from the consumed fuel by diesel motor boats multiplied by the emission factor. The emission factors are taken from the EMEP/EEA GB$_{2023}$. Activity data for domestic navigation are shown in ***Table 3.96***.

Table 3.96: *The amount of diesel oil sold by shipping companies and allocation to the categories 1A3di(ii) and 1A3dii in selected years 2005-2023*

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL [t]		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1D1b	1A3d + 1D1b
2005	Slovak Shipping and Ports (Danube)	1.3	128.7	130.0
	International shipping companies	0.0	84.0	84.0
	Total	**1.3**	**212.7**	**214.0**
2010	Slovak Shipping and Ports (Danube)	91.8	9 087.2	9 179.0
	International shipping companies	0.0	1 363.0	1 363.0
	Total	**91.8**	**10 450.2**	**10 542.0**
2011	Slovak Shipping and Ports (Danube)	79.7	7 895.3	7 975.0
	Slovak Water Management Enterprise	175.0	0.0	175.0
	Other Companies	1.0	102.0	103.0
	International shipping companies	0.0	1 104.0	1 104.0
	Total	**255.8**	**9 101.2**	**9 357.0**
2012	Slovak Shipping and Ports (Danube)	21.0	2 080.0	2 101.00
	Slovak Water Management Enterprise	321.0	0.0	321.0
	Other companies	0.7	69.3	70.0
	International shipping companies	0.0	764.0	764.0
	Total	**342.7**	**2 913.3**	**3 256.0**
2013	Slovak Shipping and Ports (Danube)	1 083.1	3 249.3	4 332.4
	Slovak Water Management Enterprise	0.0	0.0	0.0
	Other companies	0.0	0.0	0.0
	International shipping companies	0.0	801.0	801.0
	Total	**1 083.1**	**4 050.3**	**5 133.4**
2014	Slovak Shipping and Ports (Danube)	1 244.0	3 732.0	4 976.0
	Slovak Water Management Enterprise	149.0	0.0	149.0
	Other companies	0.0	0.0	0.0

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL [t]		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1D1b	1A3d + 1D1b
	International shipping companies	0.0	844.0	844.0
	Total	**1 393.0**	**4 576.0**	**5 969.0**
2015	Slovak Shipping and Ports (Danube)	1 981.8	5 945.4	7 927.2
	Slovak Water Management Enterprise	0.0	0.0	0.0
	Other companies	0.5	47.5	48.0
	International shipping companies	0.0	1 016.0	1 016.0
	Total	**1 982.3**	**7 008.9**	**8 991.2**
2016	Slovak Shipping and Ports (Danube)	1 515.1	4 545.4	6 060.5
	Slovak Water Management Enterprise	0.0	0.0	0.0
	Other companies	2.0	189.0	191.0
	International shipping companies	0.0	1 272.0	1 272.0
	Total	**1 517.0**	**6 006.5**	**7 523.5**
2017	Slovak Shipping and Ports (Danube)	1 492.9	4 478.7	5 971.6
	Slovak Water Management Enterprise	0.0	0.0	0.0
	Other companies	2.4	236.6	239.0
	Morsevo (Komárno)	0.0	1034.0	1034.0
	International shipping companies	0.0	168.5	168.5
	Total	**1 495.3**	**5 917.8**	**7 413.1**
2018	Slovak Shipping and Ports (Danube)	3 239.00	809.75	2 429.25
	Slovak Water Management Enterprise	0.00	0.00	0.00
	Other companies	232.00	2.32	229.68
	Morsevo (Komárno)	824.00	0.00	824.00
	International shipping companies	0.00	0.00	0.00
	Total	**4 295.00**	**812.07**	**3 482.93**
2019	Slovak Shipping and Ports (Danube)	1 327.00	3 981.00	5 308.00
	Slovak Water Management Enterprise	0.00	0.00	0.00
	Other companies	3.26	322.74	326.00
	Morsevo (Komárno)	0.00	760.00	760.00
	International shipping companies	0.00	0.00	0.00
	Total	**1 330.26**	**5 063.74**	**6 394.00**
2020	Slovak Shipping and Ports (Danube)	6 223.00	1 555.75	4 667.25
	Slovak Water Management Enterprise	0.00	0.00	0.00
	Other companies	161.00	161.00	0.00
	Morsevo (Komárno)	94.00	0.00	94.00
	International shipping companies	0.00	0.00	0.00
	Total	**6 478.00**	**1 716.75**	**4 761.25**
2021	Slovak Shipping and Ports (Danube)	1 764.25	5 292.75	7 057.00
	Slovak Water Management Enterprise	0.00	0.00	0.00
	Other companies	95.00	0.00	95.00
	T a M Terminal[13] (Komárno)	0.00	0.00	0.00
	International shipping companies	0.00	165.00	165.00
	Total	**1 859.25**	**5 457.75**	**7 317.00**
2022	Slovak Shipping and Ports (Danube)	1 569.25	4 707.75	6 277.00
	Slovak Water Management Enterprise	0	0	0
	Other companies	120	0	120
	T a M Terminal[14] (Komárno)	0	855	855

[13] Previous name Morsevo
[14] Previous name Morsevo

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL [t]		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1D1b	1A3d + 1D1b
	International shipping companies	0	0	0
	Total	**1 689.25**	**5 562.75**	**7 252.00**
2023	Slovak Shipping and Ports (Danube)	1 614.50	4 843.50	6 458.00
	Slovak Water Management Enterprise	0	0	0
	Other companies	85	0	85
	T a M Terminal[15] (Komárno)	0	902	902
	International shipping companies	0	0	0
	Total	**1 699.50**	**5 745.50**	**7 445.00**

In 2020, shipping on lakes did not occur as a result of the COVID pandemic.

3.6.5.3 Completeness

Verification of the activity data on fuels sold for shipping activities was performed by the sectoral expert and compared with the statistical information from requested institutions and companies as mentioned in this chapter above.

3.6.5.4 Source-specific Recalculations

The emissions were recalculated due to the corrections of activity data (the year 2022). The differences in emissions in category **1A3dii** between the previous and current submission caused by recalculations are shown in ***Table 3.97***.

Table 3.97: *Differences in emissions (%) in the category 1A3dii between the previous and current submission caused by recalculations*

YEAR	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
2022	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	HCB	PCB
2022	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%

3.6.6 Pipeline Transport (NFR 1A3ei)

3.6.6.1 Overview

There is a significant decrease in fuel consumption in recent years and this trend is related to the decrease in natural gas transit through the Slovak Republic. The overview of emissions in this category is shown in ***Table 3.98***.

Table 3.98: *Overview of emissions in category 1A3ei*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	3.1069	0.1220	0.0009	0.0001	0.0001	0.0001	0.0000	0.3638
1995	3.0858	0.1211	0.0008	0.0001	0.0001	0.0001	0.0000	0.3613
2000	3.1252	0.0871	0.0010	0.0001	0.0001	0.0001	0.0000	0.4181
2005	3.9738	0.2380	0.0010	0.0000	0.0000	0.0000	0.0000	0.3650
2010	2.3498	0.1996	0.0039	0.0000	0.0000	0.0000	0.0000	0.1940
2011	2.4936	0.2109	0.0143	0.0000	0.0000	0.0000	0.0000	0.1710
2012	0.6886	0.1318	0.0000	0.0000	0.0000	0.0000	0.0000	0.0823
2013	0.6576	0.1489	0.0000	0.0000	0.0000	0.0000	0.0000	0.0662
2014	0.1859	0.2599	0.0000	0.0000	0.0000	0.0000	0.0000	0.0628

[15] Previous name Morsevo

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2015	0.2273	0.2333	0.0000	0.0001	0.0001	0.0001	0.0000	0.0486
2016	0.2893	0.2634	0.0000	0.0000	0.0000	0.0000	0.0000	0.0598
2017	0.2520	0.2149	0.0000	0.0001	0.0001	0.0001	0.0000	0.0892
2018	0.2089	0.1487	0.0000	0.0036	0.0036	0.0036	0.0001	0.1216
2019	0.2880	0.1268	0.0000	0.0046	0.0046	0.0046	0.0002	0.0886
2020	0.1492	0.2162	0.0000	0.0026	0.0026	0.0026	0.0001	0.0445
2021	0.1314	0.1702	0.0000	0.0016	0.0016	0.0016	0.0001	0.0252
2022	0.0171	0.1388	0.0000	0.0002	0.0002	0.0002	0.0000	0.0052
2023	0.0055	0.0925	0.0000	0.0001	0.0001	0.0001	0.0000	0.0032
1990/2023	**-100%**	**-24%**	**-100%**	**-19%**	**-19%**	**-19%**	**34%**	**-99%**
2022/2023	**-68%**	**-33%**	**-10%**	**-56%**	**-56%**	**-56%**	**-47%**	**-38%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.99*** below.

Table 3.99: *Overview of activity data in category 1A3ei*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	NO	NO	17 438.08	NO	NO
1995	NO	NO	17 319.30	NO	NO
2000	NO	NO	19 155.22	NO	NO
2005	0.18	NO	23 705.18	NO	NO
2010	1.19	NO	14 802.40	NO	NO
2011	0.82	NO	16 376.63	NO	NO
2012	0.51	NO	7 297.20	NO	NO
2013	0.61	NO	7 629.69	NO	NO
2014	0.19	NO	2 860.05	NO	NO
2015	NO	NO	2 983.61	NO	NO
2016	0.24	NO	4 923.82	NO	NO
2017	0.24	NO	5 287.33	NO	NO
2018	0.23	NO	4 869.17	NO	NO
2019	0.28	NO	6 535.92	NO	NO
2020	0.19	NO	2 763.62	NO	NO
2021	0.23	NO	1 886.90	NO	NO
2022	0.21	NO	163.77	NO	NO
2023	0.27	NO	119.61	NO	NO
1990/2023	**-**	**-**	**-99%**	**-**	**-**
2022/2023	**28%**	**-**	**-27%**	**-**	**-**

3.6.6.2 Methodological Issues

The activity data on the consumption of natural gas used for energy to drive turbines were obtained from the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.100***).

Table 3.100: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	178.169	6.994	0.049	0.01	100%	100%	20.86

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.101***). The calculated BC emission values are presented in ***Table 3.98***.

Table 3.101: *Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.6.6.3 Completeness

Emissions are well covered. Emissions of NH_3, HMs and POPs are reported as NA.

3.6.6.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (corrections for activity values for the years 2000-2004). The differences in emissions in category **1A3ei** between the previous and current submissions caused by recalculations are shown in ***Table 3.102***.

Table 3.102: *Differences in emissions (%) in the category 1A3ei between the previous and current submission caused by recalculations*

YEAR	BC
2000	-3%
2001	-0.4%
2002	-0.3%
2003	-1%
2004	-1%

3.6.7 Other (NFR 1A3eii)

This category is not occurring in the Slovak Republic.

3.7 SMALL COMBUSTION (NFR 1A4, 1A5)

3.7.1 Overview

Small combustion appliances are used to provide thermal energy for heating and cooking. In small combustion installations, a wide variety of fuels are used and several combustion technologies are applied. In residential activity, smaller combustion appliances, especially older single household installations are of very simple design, while some modern installations of all capacities are significantly improved. Emissions strongly depend on fuel, and combustion technologies as well as on operational practices and maintenance.

For the combustion of liquid and gaseous fuels, the technologies used are similar to those for the production of thermal energy in larger combustion activities, except for the simple design of smaller appliances like fireplaces and stoves.

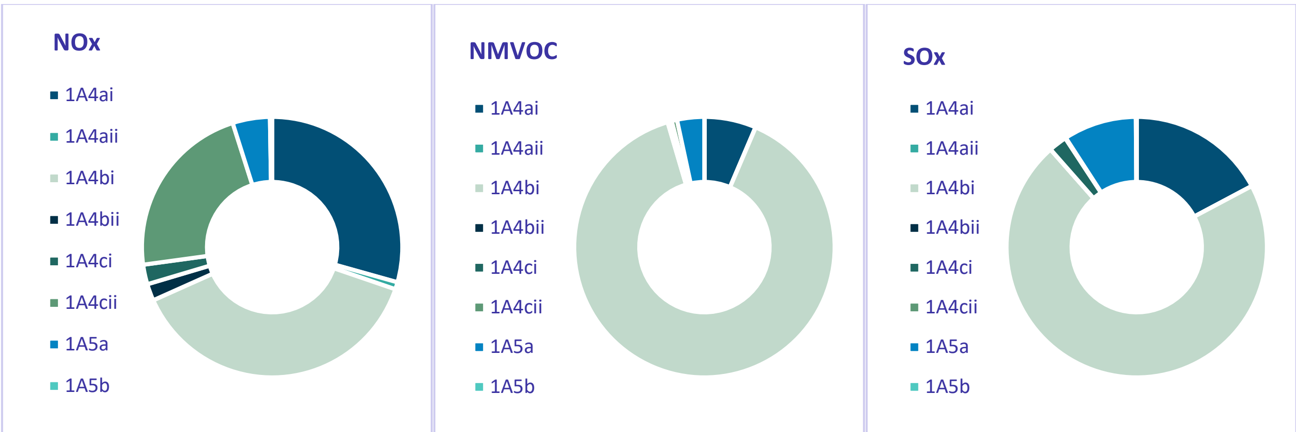
Relevant pollutants are SOx, NOx, CO, NMVOC, particulate matter (PM), black carbon (BC), heavy metals, PAH, polychlorinated dibenzo-dioxins and furans (PCDD/F) and hexachlorobenzene (HCB). For solid fuels, generally, the emissions due to incomplete combustion are many times greater in small appliances than in bigger plants. This is particularly valid for manually-fed appliances and poorly controlled automatic installations.

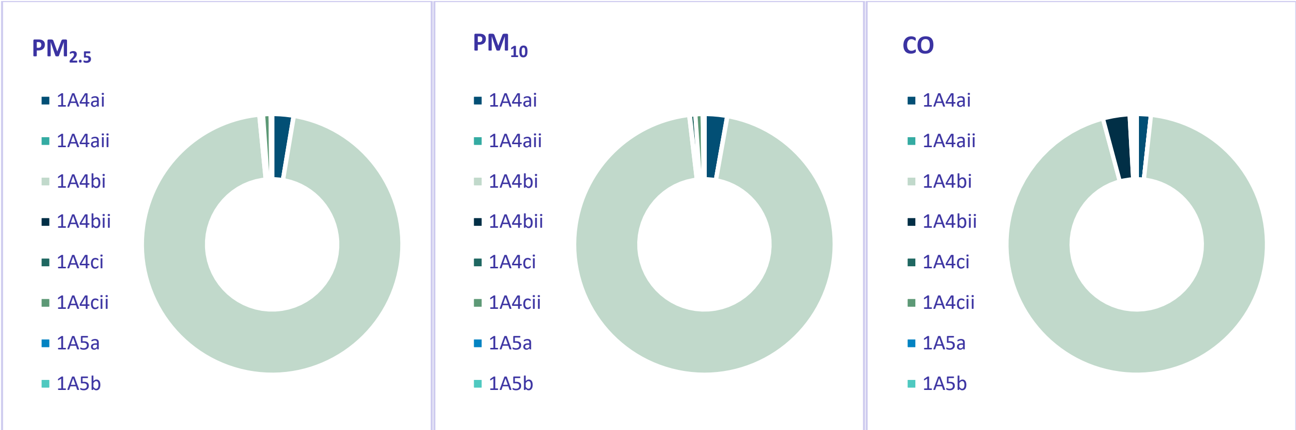
This chapter is focused on emission data from stationary sources with total nominal heat consumption from 0.3 MW to 50 MW (Technological units containing combustion plants having total rated thermal input between 0.3-50 MW and other technological units with a capacity under the defined limit for the large sources but over the defined limit for the medium sources) and household heating. These sources are divided by NACE code into categories:

- **1A4a** – Commercial/institutional;
- **1A4b** – Residential;
- **1A4c** – Agriculture/forestry; and
- **1A5** – Other (stationary combustion).

From the figures below is clear that the main contributor to emissions in this subsector is category **1A4bi** (***Figure 3.9***).

Figure 3.9: *Shares of main pollutants emissions in categories 1A4 and 1A5 in 2023*





3.7.2 Commercial/institutional: Stationary (NFR 1A4ai)

3.7.2.1 Overview

This category covers the sources that cannot be clearly identified to a particular activity but generally, it is the combustion process. Activities listed within this category are shown in ***Table 3.103***.

Table 3.103: *Activities according to national categorization included in category 1A4ai*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	MEDIUM S.: NACE 35.1; 35.3; 45-66; 68; 69-99
1.4. Facilities for fuel gasification or liquefaction with a total rated thermal input in MW *a) coal* *b) other fuels except for biogas production facilities and thermal treatment of waste in cat. 5.7*	combustion

The overview of the emissions is shown in ***Table 3.104***. Most of the emissions have an overall decreasing trend due to the decrease in the volume of use of coal. Emissions of NMVOC, Cd, Cr, Zn and HCB increased significantly due to the preference for biomass fuels as a renewable source and political support of this fuel.

Table 3.104: *Overview of emissions in category 1A4ai*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	2.7458	0.2274	2.1826	NO	0.8341	1.0078	1.4835	0.0711	4.3300
1995	2.7473	0.2275	2.1838	NO	0.8345	1.0084	1.4843	0.0708	4.3323
2000	2.7491	0.1819	2.8190	NO	1.0416	1.2586	1.8527	0.0915	5.3649
2005	1.9757	0.0940	0.9169	NO	0.2511	0.3374	0.6377	0.0301	2.1883
2010	2.0710	0.7784	0.5606	NO	0.2450	0.3000	0.4388	0.0570	2.3221
2011	2.2152	0.9788	0.4986	NO	0.2597	0.3108	0.4357	0.0647	2.5274
2012	2.3288	1.2330	0.4348	NO	0.2945	0.3445	0.4586	0.0756	2.9270
2013	2.4146	1.5068	0.3968	NO	0.3166	0.3627	0.4524	0.0826	3.1083
2014	2.6183	1.5829	0.3815	0.0001	0.3008	0.3378	0.4052	0.0800	2.9019
2015	2.7388	1.7181	0.4286	0.0001	0.3118	0.3471	0.4124	0.0838	2.8848
2016	2.6993	1.7454	0.3609	0.0001	0.3150	0.3507	0.4131	0.0850	2.8042
2017	2.7854	1.7891	0.3608	0.0001	0.3287	0.3664	0.4278	0.0886	2.7492
2018	2.6311	1.6964	0.2901	0.0001	0.2985	0.3305	0.3766	0.0803	2.4489
2019	2.5737	1.8088	0.2527	0.0001	0.2799	0.3100	0.3593	0.0759	2.4490
2020	2.6426	1.9572	0.3634	0.0001	0.2787	0.3101	0.3489	0.0766	2.4159
2021	2.7199	1.9950	0.3335	0.0001	0.3076	0.3421	0.3796	0.0845	2.4759
2022	2.3788	1.6667	0.3284	0.0001	0.2611	0.2877	0.3207	0.0714	2.1543
2023	2.1357	1.6217	0.1883	NO	0.2562	0.2801	0.3056	0.0705	2.0673
1990/2023	**-22%**	**613%**	**-91%**	**-**	**-69%**	**-72%**	**-79%**	**-1%**	**-52%**
2022/2023	**-10%**	**-3%**	**-43%**	**-**	**-2%**	**-3%**	**-5%**	**-1%**	**-4%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0542	0.0063	0.0118	0.0469	0.0465	0.0616	0.0658	0.0627	0.3398
1995	0.0222	0.0020	0.0058	0.0216	0.0194	0.0269	0.0290	0.0278	0.1232
2000	0.0082	0.0007	0.0032	0.0094	0.0072	0.0101	0.0102	0.0105	0.0445
2005	0.0056	0.0013	0.0041	0.0068	0.0041	0.0044	0.0085	0.0051	0.0484
2010	0.0392	0.0102	0.0097	0.0213	0.0300	0.0256	0.0221	0.0229	0.4260
2011	0.0397	0.0111	0.0100	0.0191	0.0295	0.0230	0.0192	0.0205	0.4565
2012	0.0390	0.0108	0.0113	0.0180	0.0272	0.0201	0.0164	0.0195	0.4378
2013	0.0435	0.0126	0.0122	0.0186	0.0298	0.0208	0.0161	0.0185	0.5034
2014	0.0313	0.0078	0.0120	0.0157	0.0185	0.0140	0.0118	0.0138	0.3074
2015	0.0352	0.0096	0.0128	0.0157	0.0212	0.0141	0.0115	0.0142	0.3745
2016	0.0374	0.0111	0.0121	0.0150	0.0237	0.0139	0.0111	0.0127	0.4329
2017	0.0390	0.0120	0.0126	0.0148	0.0249	0.0140	0.0104	0.0137	0.4681
2018	0.0328	0.0097	0.0116	0.0130	0.0202	0.0118	0.0086	0.0123	0.3834
2019	0.0339	0.0103	0.0122	0.0126	0.0205	0.0109	0.0080	0.0119	0.4029
2020	0.0279	0.0075	0.0125	0.0121	0.0138	0.0072	0.0056	0.0065	0.2752
2021	0.0277	0.0078	0.0122	0.0113	0.0142	0.0067	0.0051	0.0059	0.2926
2022	0.0249	0.0073	0.0103	0.0098	0.0136	0.0065	0.0049	0.0072	0.2764
2023	0.0243	0.0071	0.0107	0.0091	0.0122	0.0050	0.0037	0.0049	0.2633
1990/2023	**-55%**	**14%**	**-10%**	**-81%**	**-74%**	**-92%**	**-94%**	**-92%**	**-22%**
2022/2023	**-2%**	**-2%**	**3%**	**-7%**	**-10%**	**-23%**	**-25%**	**-32%**	**-5%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0676	0.0029	0.0048	0.0017	0.0014	0.0109	0.0265	0.0101
1995	0.0264	0.0007	0.0013	0.0005	0.0004	0.0029	0.0102	0.0039
2000	0.0144	0.0002	0.0004	0.0002	0.0001	0.0010	0.0038	0.0014
2005	0.0264	0.0007	0.0012	0.0004	0.0003	0.0027	0.0031	0.0012
2010	0.1228	0.0070	0.0115	0.0037	0.0029	0.0251	0.0262	0.0097
2011	0.1362	0.0077	0.0127	0.0041	0.0032	0.0278	0.0294	0.0109
2012	0.1478	0.0075	0.0124	0.0041	0.0031	0.0271	0.0353	0.0136
2013	0.1699	0.0088	0.0146	0.0048	0.0037	0.0319	0.0399	0.0153
2014	0.1372	0.0052	0.0088	0.0030	0.0022	0.0193	0.0384	0.0157
2015	0.1569	0.0066	0.0110	0.0036	0.0028	0.0240	0.0417	0.0168
2016	0.1632	0.0078	0.0130	0.0042	0.0033	0.0283	0.0390	0.0155
2017	0.1740	0.0085	0.0141	0.0046	0.0035	0.0306	0.0413	0.0162
2018	0.1507	0.0068	0.0113	0.0037	0.0028	0.0246	0.0377	0.0150
2019	0.1597	0.0072	0.0120	0.0039	0.0030	0.0262	0.0399	0.0160
2020	0.1439	0.0050	0.0086	0.0029	0.0021	0.0186	0.0405	0.0171
2021	0.1443	0.0053	0.0091	0.0030	0.0023	0.0197	0.0390	0.0163
2022	0.1262	0.0050	0.0085	0.0028	0.0021	0.0184	0.0329	0.0135
2023	0.1296	0.0049	0.0083	0.0028	0.0021	0.0181	0.0349	0.0146
1990/2023	**92%**	**71%**	**72%**	**58%**	**46%**	**66%**	**32%**	**44%**
2022/2023	**3%**	**-2%**	**-2%**	**-1%**	**-2%**	**-2%**	**6%**	**8%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.105*** below.

Table 3.105: *Overview of activity data in category 1A4ai*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	375.15	3 778.73	43 061.49	225.84	375.15
1995	361.45	3 664.15	43 224.36	216.44	361.45
2000	404.13	3 326.20	41 228.63	225.84	404.13
2005	164.99	1 176.35	37 589.84	332.87	164.99

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2010	138.98	1 306.13	28 860.16	3 917.21	138.98
2011	115.82	1 011.43	25 399.22	5 151.81	115.82
2012	87.79	911.25	24 388.98	6 639.92	87.79
2013	60.40	892.57	24 507.10	8 078.16	60.40
2014	51.64	615.17	22 211.10	10 867.04	51.64
2015	49.81	489.84	23 292.66	11 325.35	49.81
2016	40.06	418.85	24 016.88	10 877.96	40.06
2017	41.44	450.99	24 660.76	11 105.85	41.44
2018	29.51	402.26	22 711.85	9 373.46	29.51
2019	71.43	351.29	22 524.90	9 842.97	71.43
2020	38.85	137.65	21 982.57	10 333.35	38.85
2021	30.19	118.83	23 369.43	10 075.90	30.19
2022	31.37	157.88	21 338.48	8 571.72	31.37
2023	28.46	72.47	19 316.52	8 340.65	28.46
1990/2023	**-92%**	**-98%**	**-55%**	**3593%**	**-92%**
2022/2023	**-9%**	**-54%**	**-9%**	**-3%**	**-9%**

3.7.2.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023. NH_3 emissions from solid biomass combustion are reported as 'NO' because measurements show that NH_3 is not relevant (***Recommendation No 1A4ai-SK-2022-0001***).

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.106***).

Table 3.106: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	57.88	4.79	46.01	31.27	56.22%	67.93%	91.27

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023} (***Table 3.107***).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:

E_i = annual emission of pollutant *i*,

$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,

$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3.107: Emission factors for calculating emissions of heavy metals and POPs

TYPE OF FUEL		LIQUID FUELS		HARD COAL		BROWN COAL	
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	FLUIDIZED BED BOILERS	FIXED BED BOILERS	FLUIDIZED BED BOILERS
		THERMAL CAPACITY					
T2	UNIT	(≤ 5 MWth)	(-)	(≤ 5 MWth)	(≤ 5 MWth), (5 – 50 MWth)	(≤ 5 MWth)	(≤ 5 MWth), (5 – 50 MWth)
Pb	[mg/GJ]	4.56	4.07	13.687	0.515	59.471	2.037
Cd	[mg/GJ]	1.2	1.36	2.456	0.048	1.294	0.282
Hg	[mg/GJ]	0.341	1.36	9.051	0.476	2.382	1.5
As	[mg/GJ]	3.98	1.81	9.402	0.122	60.967	0.922
Cr	[mg/GJ]	2.55	1.36	15	4.5	38.383	9.1
Cu	[mg/GJ]	5.31	2.72	10	9	69.545	1
Ni	[mg/GJ]	255	1.36	10	3.399	62.104	4.803
Se	[mg/GJ]	2.06	6.79	2	23	5.192	45
Zn	[mg/GJ]	87.8	1.81	150	90	30.756	8.8
PCDD/	[ng I-	2.5	0.99	14.657	2.055	4.986	2.778
B(a)P	[mg/GJ]	3.678	116	10.975	2.271	320.061	5.148
B(b)F	[mg/GJ]	12.673	502	18.54	5.066	518.482	7.621
B(k)F	[mg/GJ]	3.968	98.7	10.966	2.64	518.482	5.321
I()P	[mg/GJ]	6.484	187	5.956	2.232	400.322	5.559
PAHs	[mg/GJ]	26.803	903.7	46.437	12.209	1757.347	23.649
HCB	[µg/GJ]	-	0.22	6.7	6.7	6.7	6.7
PCBs	[µg/GJ]	3.334	0.00013	8.073	0.244	5.059	1.449

TYPE OF FUELS		BIOMASS		GASEOUS FUELS		
TYPE OF FIRE PLACES		FIXED BED BOILERS	FLUIDIZED BED BOILERS	ALL TYPES OF BOILERS	STATIONARY ENGINES	GAS TURBINES
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(≤ 5 MWth), (5 – 50 MWth)	(≤ 5 MWth), (5 – 50 MWth)	(-)	(-)
Pb	[mg/GJ]	27	1.606	0.0015	0.04	0.0015
Cd	[mg/GJ]	13	0.169	0.00025	0.003	0.00025
Hg	[mg/GJ]	0.56	1.268	0.1	0.1	0.1
As	[mg/GJ]	0.19	0.871	0.12	0.05	0.12
Cr	[mg/GJ]	23	0.027	0.00076	0.05	0.00076
Cu	[mg/GJ]	6	0.106	0.000076	0.01	0.000076
Ni	[mg/GJ]	2	0.085	0.00051	0.05	0.00051
Se	[mg/GJ]	0.5	0.211	0.0112	0.2	0.0112
Zn	[mg/GJ]	512	1.991	0.0015	2.91	0.0015
PCDD/F	[ng I-TEQ/GJ]	100	11.348	0.5	0.57	0.5
B(a)P	[mg/GJ]	10000	46.462	0.56	1.2	0.56
B(b)F	[mg/GJ]	16000	144.329	0.84	9	0.84
B(k)F	[mg/GJ]	5000	67.897	0.84	1.7	0.84
I()P	[mg/GJ]	4000	33.073	0.84	1.8	0.84
PAHs	[mg/GJ]	35000	291.761	3.08	13.7	3.08
HCB	[µg/GJ]	5	5	0.00308	-	0.00308
PCBs	[µg/GJ]	0.007	2.233	-	-	-

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.108***). The calculated BC emission values are presented in ***Table 3.104***.

__Table 3.108:__ Emission factors for calculation of BC emissions

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.7.2.3 Completeness

Ammonia emissions are not occurring in this category until 2014.

3.7.2.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (the year 2020), recalculations of heavy metals and POPs emissions were made based on use of detailed methodologies focused on the combinations of the installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are combination of default EF from EMEP/EEA GB_{2023}, of expert estimation and of special source.[1] The differences in emissions in the category **1A4ai** between the previous and current submission caused by recalculations are shown in ***Table 3.109***.

__Table 3.109__: Differences in emissions (%) in category 1A4ai between the previous and current submission caused by recalculations

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1990	-	-93%	-88%	-68%	99%	-67%	-45%	-49%	503%	-87%	-96%	-99%	39%	-99%
1991	-	-93%	-88%	-68%	98%	-66%	-45%	-49%	509%	-87%	-96%	-99%	47%	-99%
1992	-	-93%	-87%	-68%	97%	-64%	-44%	-48%	515%	-87%	-96%	-99%	57%	-99%
1993	-	-93%	-87%	-68%	94%	-63%	-43%	-47%	520%	-86%	-96%	-99%	70%	-99%
1994	-	-93%	-86%	-67%	93%	-61%	-42%	-48%	529%	-86%	-96%	-99%	86%	-99%
1995	-	-93%	-86%	-66%	91%	-59%	-41%	-48%	536%	-85%	-96%	-99%	104%	-99%
1996	-	-93%	-85%	-65%	87%	-57%	-41%	-47%	536%	-85%	-95%	-99%	125%	-99%
1997	-	-93%	-83%	-73%	98%	-46%	-38%	-38%	567%	-82%	-97%	-100%	286%	-99%
1998	-	-93%	-83%	-68%	90%	-49%	-38%	-40%	551%	-83%	-96%	-100%	238%	-99%
1999	-	-93%	-84%	-65%	83%	-51%	-39%	-41%	536%	-83%	-96%	-100%	200%	-99%
2000	-	-93%	-85%	-58%	71%	-56%	-40%	-45%	500%	-85%	-94%	-100%	135%	-99%
2001	-	-93%	-87%	-52%	65%	-66%	-45%	-52%	464%	-87%	-92%	-99%	47%	-99%
2002	-	-93%	-84%	-61%	81%	-57%	-40%	-51%	540%	-85%	-95%	-99%	126%	-99%
2003	-	-88%	-87%	1%	28%	-88%	-69%	-70%	290%	-91%	-79%	-98%	-46%	-92%
2004	-	-92%	-87%	-47%	69%	-73%	-48%	-60%	475%	-88%	-91%	-99%	11%	-98%
2005	-	-91%	-89%	-23%	36%	-83%	-60%	-64%	299%	-90%	-84%	-98%	-29%	-97%
2006	-	-92%	-89%	-30%	40%	-80%	-57%	-61%	319%	-90%	-86%	-99%	-21%	-98%
2007	-	-93%	-90%	-50%	59%	-73%	-50%	-44%	382%	-89%	-91%	-99%	7%	-98%
2008	-	-87%	-84%	-30%	134%	-64%	-26%	-24%	601%	-82%	-86%	-97%	44%	-96%
2009	-	-84%	-81%	-37%	200%	-59%	-1%	18%	725%	-79%	-84%	-96%	64%	-96%
2010	-	-84%	-82%	-29%	145%	-73%	-39%	-13%	401%	-82%	-80%	-93%	23%	-94%
2011	-	-84%	-83%	-23%	143%	-77%	-48%	-22%	334%	-83%	-80%	-93%	16%	-93%
2012	-	-85%	-87%	-11%	139%	-82%	-59%	-34%	275%	-87%	-81%	-93%	13%	-90%
2013	-	-85%	-87%	-5%	149%	-83%	-62%	-38%	223%	-87%	-80%	-93%	11%	-88%
2014	-	-88%	-92%	12%	152%	-89%	-73%	-48%	144%	-92%	-83%	-96%	5%	-82%
2015	-	-87%	-91%	16%	147%	-89%	-74%	-52%	137%	-91%	-82%	-95%	6%	-80%
2016	-	-86%	-89%	16%	145%	-87%	-74%	-51%	118%	-89%	-81%	-94%	1%	-78%
2017	-	-86%	-89%	13%	130%	-87%	-75%	-56%	119%	-89%	-81%	-94%	-1%	-79%
2018	-	-87%	-90%	14%	122%	-89%	-77%	-60%	108%	-90%	-82%	-95%	-1%	-78%
2019	-	-87%	-90%	22%	124%	-89%	-80%	-64%	93%	-91%	-82%	-94%	-2%	-73%

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
2020	-0.001%	-88%	-93%	58%	162%	-93%	-86%	-70%	16%	-93%	-83%	-96%	2%	-27%
2021	-	-88%	-92%	58%	146%	-92%	-86%	-72%	9%	-93%	-82%	-95%	2%	-19%
2022	-	-87%	-91%	45%	133%	-91%	-84%	-69%	51%	-92%	-81%	-95%	3%	-50%

3.7.3 Commercial/institutional: Mobile (NFR 1A4aii)

3.7.3.1 Overview

According to ***Recommendations No SK-1A4cii-2018-0001*** and ***SK-1A4cii-2021-0002*** Slovakia after receiving the most necessary data, was able to disaggregate all non-road mobile combustion categories (**1A2gvii**, **1A4aii**, **1A4bii** and **1A4cii**). The results of the separation are shown in ***Table 3.110***.

Table 3.110: *Overview of emissions in category 1A4aii*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.1142	0.0118	0.0001	0.0000	0.0074	0.0074	0.0074	0.0046	0.0377
1995	0.1244	0.0129	0.0001	0.0000	0.0080	0.0080	0.0080	0.0050	0.0411
2000	0.1346	0.0139	0.0001	0.0000	0.0087	0.0087	0.0087	0.0054	0.0444
2005	0.1448	0.0150	0.0001	0.0000	0.0093	0.0093	0.0093	0.0058	0.0478
2010	0.1550	0.0160	0.0001	0.0000	0.0100	0.0100	0.0100	0.0062	0.0512
2011	0.1570	0.0163	0.0001	0.0000	0.0101	0.0101	0.0101	0.0063	0.0518
2012	0.1591	0.0165	0.0001	0.0000	0.0103	0.0103	0.0103	0.0064	0.0525
2013	NO	NO	NO	NO	NO	NO	NO	NO	NO
2014	0.1631	0.0169	0.0001	0.0000	0.0105	0.0105	0.0105	0.0065	0.0539
2015	0.1958	0.0203	0.0001	0.0000	0.0126	0.0126	0.0126	0.0078	0.0646
2016	0.1305	0.0135	0.0001	0.0000	0.0084	0.0084	0.0084	0.0052	0.0431
2017	0.0979	0.0101	0.0001	0.0000	0.0063	0.0063	0.0063	0.0039	0.0323
2018	0.0653	0.0068	0.0000	0.0000	0.0042	0.0042	0.0042	0.0026	0.0215
2019	0.1631	0.0169	0.0001	0.0000	0.0105	0.0105	0.0105	0.0065	0.0539
2020	0.0979	0.0101	0.0001	0.0000	0.0063	0.0063	0.0063	0.0039	0.0323
2021	0.0979	0.0101	0.0001	0.0000	0.0063	0.0063	0.0063	0.0039	0.0323
2022	0.1305	0.0135	0.0001	0.0000	0.0084	0.0084	0.0084	0.0052	0.0431
2023	0.0653	0.0068	0.0000	0.0000	0.0042	0.0042	0.0042	0.0026	0.0215
1990/2023	**-43%**	**-43%**	**-43%**	**-43%**	**-43%**	**-43%**	**-43%**	**-43%**	**-43%**
2022/2023	**-50%**	**-50%**	**-50%**	**-50%**	**-50%**	**-50%**	**-50%**	**-50%**	**-50%**

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
1990	0.0000	0.0002	0.0060	0.0002	0.0000	0.0616	0.0001	0.0002	0.0003
1995	0.0000	0.0002	0.0065	0.0003	0.0000	0.0269	0.0001	0.0002	0.0003
2000	0.0000	0.0002	0.0070	0.0003	0.0000	0.0101	0.0001	0.0002	0.0003
2005	0.0000	0.0002	0.0075	0.0003	0.0000	0.0044	0.0001	0.0002	0.0004
2010	0.0000	0.0002	0.0081	0.0003	0.0000	0.0256	0.0001	0.0002	0.0004
2011	0.0000	0.0002	0.0082	0.0003	0.0000	0.0230	0.0001	0.0002	0.0004
2012	0.0000	0.0002	0.0083	0.0003	0.0000	0.0201	0.0001	0.0002	0.0004
2013	NO	NO	NO	NO	NO	0.0208	NO	NO	NO
2014	0.0001	0.0003	0.0085	0.0004	0.0001	0.0140	0.0002	0.0003	0.0004
2015	0.0001	0.0003	0.0102	0.0004	0.0001	0.0141	0.0002	0.0003	0.0005
2016	0.0000	0.0002	0.0068	0.0003	0.0000	0.0139	0.0001	0.0002	0.0003
2017	0.0000	0.0002	0.0051	0.0002	0.0000	0.0140	0.0001	0.0002	0.0002
2018	0.0000	0.0001	0.0034	0.0001	0.0000	0.0118	0.0001	0.0001	0.0002
2019	0.0001	0.0003	0.0085	0.0004	0.0001	0.0109	0.0002	0.0003	0.0004
2020	0.0000	0.0002	0.0051	0.0002	0.0000	0.0072	0.0001	0.0002	0.0002

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
2021	0.0000	0.0002	0.0051	0.0002	0.0000	0.0067	0.0001	0.0002	0.0002
2022	0.0000	0.0002	0.0068	0.0003	0.0000	0.0065	0.0001	0.0002	0.0003
2023	0.0000	0.0001	0.0034	0.0001	0.0000	0.0050	0.0001	0.0001	0.0002
1990/2023	**-43%**	**-43%**	**-43%**	**-43%**	**-43%**	**-92%**	**-43%**	**-43%**	**-43%**
2022/2023	**-50%**	**-50%**	**-50%**	**-50%**	**-50%**	**-23%**	**-50%**	**-50%**	**-50%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.111*** below. Small irregularities were found during checking activity data (the year 2011). It was caused by incorrect data flow but did not affect the emissions calculations.

Table 3.111: *Overview of activity data in category 1A4aii*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	148.79	NA	NA	NO	NA
1995	160.41	NA	NA	NO	NA
2000	175.68	NA	NA	NO	NA
2005	187.30	NA	NA	NO	NA
2010	181.12	NA	NA	8.94	NA
2011	180.85	NA	NA	10.33	NA
2012	184.20	NA	NA	9.97	NA
2013	NO	NA	NA	NO	NA
2014	195.30	NA	NA	13.64	NA
2015	234.58	NA	NA	17.03	NA
2016	156.59	NA	NA	11.20	NA
2017	117.14	NA	NA	8.71	NA
2018	78.53	NA	NA	5.37	NA
2019	196.34	NA	NA	13.46	NA
2020	116.95	NA	NA	8.80	NA
2021	116.98	NA	NA	8.75	NA
2022	156.72	NA	NA	11.71	NA
2023	78.30	NA	NA	5.43	NA
1990/2023	**-47%**	-	-	-	-
2022/2023	**-50%**	-	-	**-54%**	-

3.7.3.2 Methodological Issues

Slovakia was able to receive statistical data about fuel combustion from the year 2012. The years 1990-2011 were estimated using expert judgment and a linear regression model back to the base year. This model caused the trend to be clearly linear up to 2012. After this year we can observe deviations in fuel consumption, as well as in estimated emissions. For the emission estimation, EMEP/EEA GB_{2023} Tier 1 emission factors were used.

3.7.3.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2023}.

3.7.3.4 Source-specific Recalculations

No recalculations in this submission.

3.7.4 Residential: Stationary (NFR 1A4bi)

3.7.4.1 Overview

Households are generally the key sector in the emission inventory. Therefore, continuous improvement of methodology has been undergone. Households' heating is a very significant contributor to particulate matter (approximately 80% as well as other emissions in Slovakia). The trend in emissions, as well as fuel consumption, is relatively stable with a slight downward trend. A small decrease in emissions and fuel consumption in the year 2023 was driven by the winter season, which was warmer than normal. The climatic factor was on the level of warm winter in the year 2018.

This category is key for most of the pollutants (NOx, SOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Cd, Hg, As, Cr, Ni, Zn, PCDD/F, PAHs, HCB, PCBs). The emission trend of all pollutants shows a very similar trend which correlates with the trend of biomass burning (wood) in Slovak households.

The overview of the emissions is shown in ***Table 3.112***.

Table 3.112: *Overview of emissions in category 1A4bi*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	5.1971	136.8648	28.8620	0.0401	78.0516	79.2766	87.0018	5.6817	690.2921
1995	3.6223	63.0227	11.1223	0.0848	33.9134	34.4959	37.6469	2.6490	315.4333
2000	3.8857	47.1180	6.7151	0.1076	24.1816	24.6318	26.7375	2.0141	229.6318
2005	4.1456	48.6813	2.3431	0.2442	21.2167	21.7231	23.1274	2.1639	226.4921
2010	4.0201	46.3647	1.7528	0.2483	19.7923	20.2770	21.5338	2.0660	215.1242
2011	3.6592	43.4006	1.6277	0.2322	18.4853	18.9373	20.1152	1.9278	201.6142
2012	3.7587	47.0031	1.7415	0.2479	19.9385	20.4267	21.6933	2.0831	218.5896
2013	3.6595	43.4082	1.6150	0.2223	18.3873	18.8357	20.0100	1.9162	201.7557
2014	2.7308	25.7014	1.2083	0.1160	11.1513	11.4136	12.1628	1.1293	119.2216
2015	3.2322	35.7571	1.4128	0.1743	15.1971	15.5649	16.5459	1.5760	167.6001
2016	3.4269	38.3712	1.4311	0.1918	15.6133	15.9985	16.9750	1.6418	181.8626
2017	3.5681	36.5970	1.5957	0.1678	15.6954	16.0702	17.1003	1.6158	174.2116
2018	3.0805	28.2144	1.2823	0.1218	12.1321	12.4204	13.2208	1.2464	135.6463
2019	3.1823	29.4394	1.2590	0.1284	12.6520	12.9556	13.7788	1.3057	142.5483
2020	3.2329	29.3184	1.1654	0.1240	12.4586	12.7600	13.5610	1.3000	142.6604
2021	3.4321	28.3786	1.2029	0.1607	11.9556	12.2422	13.0163	1.1655	139.1554
2022	3.0733	27.2661	1.1738	0.1547	11.5361	11.8145	12.5581	1.1209	135.0051
2023	2.7700	22.4983	0.7784	0.1348	9.3155	9.5469	10.1201	0.9235	111.8124
1990/2023	**-47%**	**-84%**	**-97%**	**237%**	**-88%**	**-88%**	**-88%**	**-84%**	**-84%**
2022/2023	**-10%**	**-17%**	**-34%**	**-13%**	**-19%**	**-19%**	**-19%**	**-18%**	**-17%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	1.0447	0.0684	0.3578	0.6257	2.3932	0.4375	0.3237	0.1510	3.9820
1995	0.4997	0.1126	0.1634	0.2516	1.1664	0.2287	0.1553	0.0661	3.0831
2000	0.4016	0.1376	0.1279	0.1589	0.8867	0.1895	0.1195	0.0521	3.1385
2005	0.4777	0.3042	0.0889	0.0746	1.0087	0.2517	0.1349	0.0528	5.7984
2010	0.4771	0.3089	0.0806	0.0618	0.9751	0.2512	0.1308	0.0514	5.9301
2011	0.4516	0.2888	0.0740	0.0582	0.9147	0.2367	0.1229	0.0487	5.5733
2012	0.4928	0.3141	0.0761	0.0623	0.9948	0.2584	0.1338	0.0529	6.0724
2013	0.4592	0.2883	0.0743	0.0590	0.9184	0.2393	0.1239	0.0497	5.5948
2014	0.2735	0.1598	0.0573	0.0418	0.5340	0.1388	0.0728	0.0311	3.1564
2015	0.3921	0.2387	0.0658	0.0520	0.7688	0.2025	0.1042	0.0426	4.6930
2016	0.4246	0.2577	0.0677	0.0509	0.8217	0.2207	0.1133	0.0454	4.9006
2017	0.4202	0.2445	0.0738	0.0588	0.8073	0.2138	0.1101	0.0463	4.8788
2018	0.3308	0.1892	0.0633	0.0485	0.6329	0.1678	0.0863	0.0365	3.8021
2019	0.3514	0.2036	0.0643	0.0490	0.6713	0.1790	0.0915	0.0384	4.0819
2020	0.3519	0.2066	0.0646	0.0481	0.6764	0.1802	0.0920	0.0382	4.1231
2021	0.3554	0.2014	0.0676	0.0502	0.6647	0.1798	0.0906	0.0375	4.1396
2022	0.3262	0.1907	0.0617	0.0491	0.6462	0.1679	0.0864	0.0338	3.8878
2023	0.2701	0.1660	0.0524	0.0368	0.5406	0.1412	0.0717	0.0267	3.3531

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990/2023	**-74%**	**143%**	**-85%**	**-94%**	**-77%**	**-68%**	**-78%**	**-82%**	**-16%**
2022/2023	**-17%**	**-13%**	**-15%**	**-25%**	**-16%**	**-16%**	**-17%**	**-21%**	**-14%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	7.2341	13.0128	9.1373	5.4515	6.8838	34.4854	13.2872	0.6582
1995	5.0417	6.3108	4.3872	2.6327	3.3305	16.6612	4.0829	0.2632
2000	5.0213	5.0609	3.5942	2.0664	2.6671	13.3886	3.5156	0.1773
2005	8.6865	6.0544	4.3476	2.4055	3.1740	15.9816	2.0659	0.1128
2010	8.6880	5.8444	4.2371	2.3137	3.0733	15.4685	2.1280	0.1021
2011	8.1192	5.4624	3.9876	2.1627	2.8820	14.4947	2.1496	0.0974
2012	8.7881	5.9109	4.3273	2.3412	3.1246	15.7040	2.3392	0.1054
2013	8.0849	5.4525	4.0294	2.1586	2.8945	14.5350	2.4368	0.1003
2014	4.6611	3.1974	2.4089	1.2644	1.7097	8.5804	2.0066	0.0673
2015	6.7568	4.4951	3.3625	1.7840	2.4111	12.0528	2.2878	0.0878
2016	7.2421	4.7664	3.5649	1.9127	2.5670	12.8110	2.0317	0.1022
2017	7.1096	4.6140	3.5429	1.8405	2.5329	12.5303	2.8782	0.0999
2018	5.5628	3.5564	2.7600	1.4244	1.9749	9.7157	2.3085	0.0801
2019	5.9315	3.7381	2.9002	1.4989	2.0844	10.2216	2.3495	0.0827
2020	5.9742	3.7299	2.9020	1.4994	2.0920	10.2233	2.2373	0.0815
2021	5.6810	3.5514	2.7851	1.4354	2.0037	9.7757	2.1509	0.0788
2022	5.4258	3.3746	2.6350	1.3750	1.9199	9.3046	1.4799	0.0681
2023	4.5754	2.7878	2.1469	1.1383	1.5783	7.6514	0.7635	0.0508
1990/2023	**-37%**	**-79%**	**-77%**	**-79%**	**-77%**	**-78%**	**-94%**	**-92%**
2022/2023	**-16%**	**-17%**	**-19%**	**-17%**	**-18%**	**-18%**	**-48%**	**-25%**

Fuels are allocated to the respective fuel type for emissions calculations. The overview of activity data (energy consumption) for this source category is in ***Table 3.113*** below and shows relatively big decrease in solid fuels consumption. There are probably two reasons for this change. The first is the natural fuel switch and natural equipment replacement, the second is a legislative change that has caused a different way of reporting solid fuel sales. Fuels in the template are allocated following principles from IPCC 2006 Guidelines.

Table 3.113: *Overview of activity data in the category 1A4bi*

YEAR	HC [TJ NCV]	Coke [TJ NCV]	BC [TJ NCV]	CB [TJ NCV]	NG [TJ NCV]	LF [TJ NCV]	FW [TJ NCV]	P&WB [TJ NCV]
1990	2 391.54	3 919.58	42 706.76	0.00	28 588.64	1 472.00	4 786.82	0.00
1995	776.15	1 124.53	16 578.16	0.00	42 360.63	1 058.00	10 554.05	0.00
2000	520.51	1 135.69	9 566.68	28.78	60 243.02	552.00	13 401.63	23.44
2005	652.91	305.54	2 660.03	51.78	59 225.83	322.00	30 702.27	96.75
2010	706.47	293.34	1 588.60	185.17	55 629.42	552.00	31 445.73	357.29
2011	802.14	216.50	1 390.84	288.50	49 133.79	276.00	29 376.04	523.34
2012	887.42	222.68	1 418.31	392.86	47 192.12	460.00	31 872.81	778.25
2013	942.90	230.19	1 177.86	506.85	48 200.08	368.00	29 172.59	925.55
2014	828.07	170.77	913.26	414.61	43 395.60	184.00	16 258.07	419.52
2015	982.83	147.10	955.40	570.61	43 903.00	184.00	24 259.42	869.96
2016	1 025.72	204.57	804.37	641.48	44 697.43	368.00	26 845.53	1 087.12
2017	1 252.68	217.24	863.90	936.44	49 339.18	368.00	24 834.57	1 170.13
2018	1 056.04	131.98	652.26	862.55	45 735.20	322.00	19 203.87	1 033.62
2019	1 100.86	106.96	556.82	899.92	45 951.45	276.00	20 714.47	1 255.64
2020	1 084.83	63.95	412.97	958.40	47 205.23	276.00	20 938.30	1 269.21
2021	1 055.43	53.72	453.17	1 082.14	51 715.57	368.00	20 807.33	1 261.27
2022	644.55	56.67	702.01	1 018.33	45 498.76	322.00	19 534.43	1 184.11
2023	297.19	40.48	400.73	765.87	43 453.53	322.00	17 025.85	1 032.05

YEAR	HC [TJ NCV]	Coke [TJ NCV]	BC [TJ NCV]	CB [TJ NCV]	NG [TJ NCV]	LF [TJ NCV]	FW [TJ NCV]	P&WB [TJ NCV]
1990/2023	-88%	-99%	-99%	-	52%	-78%	256%	-
2022/2023	-54%	-29%	-43%	-25%	-4%	0%	-13%	-13%

HC – Hard coal
BC – Brown coal
CB – Coal briquettes
NG – Natural gas
LF – Liquid fuels
FW – Firewood
P&WB – Pellets and wooden briquettes

3.7.4.2 Methodological Issues

Category **1A4bi** balanced mostly gaseous (natural gas), solid (coal) and biomass (wood) fuels. Whereas the gaseous fuels consumption is consistent and accurate due to statistics made directly by the natural gas suppliers, solid fuels and biomass statistics are not fully covered by the ŠÚ SR. Direct statistics are missing or very complicated to obtain. Due to these reasons, several inconsistencies between fuels consumption reported in this category were recorded and commented on in the previous inventory. Major differences occurred between the data reported in the national energy balance provided by the ŠÚ SR and data reported by the companies selling solid fuels and biomass to households (data reported in the NEIS database). The Slovak NIS experts, therefore, planned to focus on better input data collection and removing these inconsistancies and harmonise national statistics in this field.

In 2018, the Project Grant "Quality Improvement of Air Emission Accounts and Extension of Provided Time Series" launched by the European Commission – EUROSTAT was successfully finished. Results were published online in several partial reports http://www.shmu.sk/sk/?page=2339 and on the international conference "Air Protection in Slovakia" held in the High Tatras on 11-13 November 2020. The Project Grant was carried out in cooperation with the Statistical Office of the Slovak Republic.

Cooperation with the Statistical Office of the Slovak Republic continued and resulted in the second statistical survey in households. This activity, together with the help and interest of other relevant national authorities, confirmed and improved the previous estimation of biomass consumption in households.

Statistical data and time series were corrected based on improved methodology and inputs were also provided to the ŠÚ SR for energy balance. According to the information provided by the ŠÚ SR, the revision of households energy statistics to the EUROSTAT was done for the year 2019. The revision will be focused on solid fuels and biomass (non-fossil fuels) and will be performed since the year 2012. With this revision, consistency in the reporting data in households will be improved.

Time series on fuel consumption (solid and biomass) from households reconstructed in the frame of the EUROSTAT project and published on the SHMÚ website[16] were further corrected and improved for the inventory balance considering the effect of regional-climatological data. The principle of the new methodological approach was supported by a second statistical survey and further estimation of "total energy demand for heating" in households calculated using data from questionnaires and climatological data in different regions. In principle, the average value of "energy demand" is a parameter on heating demand (including preparation of hot water) for 1 m^2 of housing area for 1 year. Total housing area, energy effectivity of houses and climatological factors in regional scaling were taken into consideration for the calculation of total energy demand for heating in houses without a central heating system.

We expect a further improvement of the methodology thanks to the ongoing Life project focused on clean air in the most critical and most polluted areas of Slovakia, but also throughout Slovakia with a focus on households and transport. As part of this project, another statistical survey was already realized in households.

Boiler structure

Data on the household's equipment structure are one of the most important outputs of the statistical surveys. The results of the surveys included data such as age, type, power, fuel consumption for each device. The last survey was carried out as part of the project LIFE IP – Improvement of Air Quality supported by the European Union, The OEaB experts in cooperation with the Statistical Office of the Slovak Republic have prepared a report

[16] Detail information is provided in the Final Report "SK_AEA_Methodology_HH".

that describes the structured distribution of small sources of pollution. Based on data from the third survey, we obtained the improved structure of combustion equipment in Households. ***Table 3.114*** shows the boiler structure for 2023.

Table 3.114: *Households share by type of fuels and type of equipment for the year 2023*

2023	TYPE OF EQUIPMENT	BC	HC & COKE	CB	PELLETS & WOOD BRIQUETTES	FIREWOOD	OTHER
1	Over-fire boilers	55.9%	68.4%	91.4%	85.4%	32.7%	45.1%
2	Under-fire boilers	25.4%	15.0%	8.3%	5.5%	9.1%	12.7%
3	Gasification boilers	2.3%	4.0%	0.4%	3.2%	12.4%	7.6%
4	Automatic boilers	6.8%	7.2%	0.0%	1.9%	32.3%	2.6%
5	Fireplaces, stoves, masonry stoves	9.5%	5.4%	0.0%	3.9%	9.9%	28.7%
6	Modern masonry stoves and pellets stoves	0.1%	0.0%	0.0%	0.1%	3.4%	3.3%
Sum		**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

BC – Brown coal, **HC** – Hard coal, **CB** – Coal briquettes

Based on data on the installation year, we reconstructed the structure of the equipment until 1990. We estimated the trend of the structure of the equipment from the present to 1990. Each year we gradually counted new equipment in the categories of gasification boilers and automatic boilers and subsequently redistributed into the category of over-fire and under-fire boilers in a ratio of 1:1. And from the category of modern masonry stoves and pellets stoves, we moved the share to the category of fireplaces, stoves, masonry stoves. By this procedure, we obtained tables of the updated structure of combustion equipment from the second survey for all years since 1990. ***Table 3.115*** shows the share of plants in 2005 and ***Table 3.116*** in 1990.

Table 3.115: *Households share by type of fuels and type of equipment for the year 2005*

2005	TYPE OF EQUIPMENT	BC	HC & COKE	CB	PELLETS & WOOD BRIQUETTES	FIREWOOD	OTHER
1	Over-fire boilers	58.3%	71.8%	80.3%	54.2%	50.5%	50.7%
2	Under-fire boilers	32.2%	18.6%	11.6%	29.5%	15.8%	33.7%
3	Gasification boilers	1.0%	0.2%	0.4%	1.1%	1.3%	0.0%
4	Automatic boilers	2.5%	0.0%	0.0%	1.7%	0.8%	2.4%
5	Fireplaces, stoves, masonry stoves	5.9%	9.3%	7.7%	13.0%	31.3%	9.5%
6	Modern masonry stoves and pellets stoves	0.0%	0.0%	0.0%	0.5%	0.3%	3.8%
Sum		**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

BC – Brown coal, **HC** – Hard coal, **CB** – Coal briquettes

Table 3.116: *Households share by type of fuels and type of equipment for the year 1990*

1990	TYPE OF EQUIPMENT	BC	HC & COKE	CB	PELLETS & WOOD BRIQUETTES	FIREWOOD	OTHER
1	Over-fire boilers	59.1%	71.9%	-	-	51.4%	50.7%
2	Under-fire boilers	33.0%	18.7%	-	-	16.7%	33.7%
3	Gasification boilers	0.0%	0.0%	-	-	0.1%	0.0%
4	Automatic boilers	1.9%	0.0%	-	-	0.2%	2.4%
5	Fireplaces, stoves, masonry stoves	5.9%	9.3%	-	-	31.7%	13.3%
6	Modern masonry stoves and pellets stoves	0.0%	0.0%	-	-	0.0%	0.0%
Sum		**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

BC – Brown coal, **HC** – Hard coal, **CB** – Coal briquettes

Emission factors

The country specific emission factors for the combustion of solid fuels (hard and brown coal, briquettes, coal and wood), natural gas and fuel oil were obtained from results of VEC VŠB[17] measurement at low and nominal heat ratings. These data were provided in cooperation with the air quality modellers´ team (Air Quality Department, SHMÚ) throughout their active participation in the project *LIFE Integrated Project: Implementation of Air Quality Plan for Małopolska Region – Małopolska in a healthy atmosphere*.[5] The values were set for over-fire boilers, under-fire boilers, gasification boilers and automatic boilers.

Emission factors of air pollutants for two additional categories for fireplaces, stoves, masonry/built-in tile stoves (Tables 3-40) modern masonry/built-in tile stoves and pellets stoves (Table 3-44) were obtained from the EMEP/EEA GB_{2023} (Tier 2). The GHGs emission factors for relevant fuel types were taken from IPCC Guidelines, Tier 1 methodology. For the category Modern masonry/built-in tile stoves and pellets stoves, emission factors only for combustion of wood, wooden pellets and briquettes were available.

A description of all EF is available in the **Final report on the implementation of the action**.

3.7.4.3 Completeness

Emissions are well covered.

3.7.4.4 Source-specific Recalculations

There were 2 types of recalculations that were performed in the emissions inventory in the households category. The first isa change in EF, and the second, an error correction or clarification in the calculation. Based on the methodology in was made changes in EFs of NH_3 for biomass combustion. Based on the observation (**1A4bi Residential: Stationary**) from review process in 2024, there is also changes in emissions factors for emissions of $PM_{2.5}$, PM_{10} and TSP for pellet stoves to the modern appliance category. Now they are in line with EMEP/EEA GB_{2023}. Second, as part of the review and continuous improvement of the methodology, we discovered an error in the data on the floor area of inhabited apartments, which comes from the 2021 Census. The heating area has decreased. The process of optimizing data flows regarding the number of inhabited apartments with the Statistical Office of the Slovak Republic is still ongoing. The differences in emissions in category **1A4bi** between the previous and current submissions caused by recalculations are shown in ***Table 3.117***.

Table 3.117: *Differences in emissions (%) in the category 1A4bi between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
1990	-	-	-	-88%	-0.2%	-0.2%	-0.1%	-	-	-	-
1991	-	-	-	-88%	-0.3%	-0.3%	-0.3%	-	-	-	-
1992	-	-	-	-88%	-0.3%	-0.2%	-0.2%	-	-	-	-
1993	-	-	-	-88%	-0.5%	-0.5%	-0.4%	-	-	-	-
1994	-	-	-	-88%	-0.6%	-0.6%	-0.6%	-	-	-	-
1995	-	-	-	-88%	-0.8%	-0.8%	-0.7%	-	-	-	-
1996	-	-	-	-88%	-1%	-1%	-1%	-	-	-	-
1997	-	-	-	-88%	-1%	-1%	-1%	-	-	-	-
1998	-	-	-	-88%	-1%	-1%	-1%	-	-	-	-
1999	-	-	-	-88%	-1%	-1%	-1%	-	-	-	-
2000	-	-	-	-88%	-1%	-1%	-1%	-	-	-	-
2001	-	-	-	-88%	-2%	-2%	-1%	-	-	-	-
2002	-	-	-	-88%	-2%	-2%	-2%	-	-	-	-
2003	-	-	-	-88%	-2%	-2%	-2%	-	-	-	-
2004	-	-	-	-88%	-3%	-3%	-3%	-	-	-	-

[17] https://powietrze.malopolska.pl/en/life-project/

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
2005	-	-	-	-88%	-3%	-3%	-3%	-	-	-	-
2006	-	-	-	-88%	-3%	-3%	-3%	-	-	-	-
2007	-	-	-	-88%	-4%	-4%	-3%	-	-	-	-
2008	-	-	-	-88%	-4%	-4%	-3%	-	-	-	-
2009	-	-	-	-88%	-4%	-4%	-3%	-	-	-	-
2010	-	-	-	-88%	-4%	-4%	-3%	-	-	-	-
2011	-	-	-	-88%	-4%	-4%	-3%	-	-	-	-
2012	-	-	-	-88%	-4%	-4%	-3%	-	-	-	-
2013	-	-	-	-89%	-4%	-4%	-3%	-	-	-	-
2014	-	-	-	-89%	-3%	-3%	-3%	-	-	-	-
2015	-	-	-	-89%	-4%	-3%	-3%	-	-	-	-
2016	-	-	-	-89%	-4%	-4%	-3%	-	-	-	-
2017	-	-	-	-90%	-3%	-3%	-3%	-	-	-	-
2018	-	-	-	-90%	-3%	-3%	-3%	-	-	-	-
2019	-	-	-	-91%	-3%	-3%	-3%	-	-	-	-
2020	-	-	-	-91%	-4%	-4%	-3%	-	-	-	-
2021	-10%	-20%	-6%	-91%	-22%	-22%	-22%	-25%	-20%	-20%	-24%
2022	-7%	-14%	-4%	-90%	-17%	-17%	-16%	-20%	-14%	-15%	-17%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
2021	-7%	-9%	-21%	-21%	-20%	-17%	-23%	-100%	-20%	-2%	-13%
2022	-5%	-6%	-14%	-15%	-14%	-12%	-16%	-100%	-14%	-1%	-10%

3.7.5 Residential: Mobile (NFR 1A4bii)

3.9.4.1 Overview

According to ***Recommendations No SK-1A4cii-2018-0001*** and ***SK-1A4cii-2021-0002*** Slovakia after receiving the most necessary data was able to disaggregate all non-road mobile combustion categories (**1A2gvii**, **1A4aii**, **1A4bii** and **1A4cii**). The results of the separation are shown in ***Table 3.118***. Data for this category is based on the results from the project "Quality Improvement of Air Emission Accounts and Extension of Provided Time Series" (2017-2018) and the subsequent second survey in 2019.

Table 3.118: *Overview of emissions in category 1A4bii*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.0561	0.0274	0.0001	0.0000	0.0033	0.0033	0.0033	0.0019	0.9325
1995	0.0731	0.0426	0.0001	0.0000	0.0041	0.0041	0.0041	0.0024	1.5080
2000	0.0902	0.0579	0.0001	0.0000	0.0050	0.0050	0.0050	0.0029	2.0835
2005	0.1072	0.0731	0.0001	0.0000	0.0059	0.0059	0.0059	0.0033	2.6589
2010	0.1242	0.0884	0.0001	0.0000	0.0068	0.0068	0.0068	0.0038	3.2344
2011	0.1276	0.0914	0.0001	0.0000	0.0069	0.0069	0.0069	0.0039	3.3495
2012	0.1310	0.0944	0.0001	0.0000	0.0071	0.0071	0.0071	0.0040	3.4646
2013	0.1344	0.0975	0.0002	0.0000	0.0073	0.0073	0.0073	0.0041	3.5797
2014	0.1412	0.1036	0.0002	0.0000	0.0076	0.0076	0.0076	0.0043	3.8099
2015	0.1412	0.1036	0.0002	0.0000	0.0076	0.0076	0.0076	0.0043	3.8099
2016	0.1412	0.1036	0.0002	0.0000	0.0076	0.0076	0.0076	0.0043	3.8099
2017	0.1412	0.1036	0.0002	0.0000	0.0076	0.0076	0.0076	0.0043	3.8099
2018	0.1412	0.1036	0.0002	0.0000	0.0076	0.0076	0.0076	0.0043	3.8099
2019	0.1647	0.1065	0.0002	0.0001	0.0091	0.0091	0.0091	0.0052	3.8384
2020	0.1647	0.1065	0.0002	0.0001	0.0091	0.0091	0.0091	0.0052	3.8384
2021	0.1718	0.1254	0.0002	0.0001	0.0093	0.0093	0.0093	0.0052	4.6088

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2022	0.1509	0.1070	0.0002	0.0000	0.0082	0.0082	0.0082	0.0046	3.9169
2023	0.1521	0.1075	0.0002	0.0000	0.0083	0.0083	0.0083	0.0047	3.9303
1990/2023	**171%**	**292%**	**225%**	**196%**	**154%**	**154%**	**154%**	**145%**	**321%**
2022/2023	**1%**	**0%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**0%**

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
1990	0.0000	0.0001	0.0045	0.0002	0.0000	0.0027	0.0001	0.0001	0.0002
1995	0.0000	0.0002	0.0064	0.0003	0.0000	0.0038	0.0001	0.0002	0.0003
2000	0.0000	0.0002	0.0083	0.0003	0.0000	0.0049	0.0002	0.0002	0.0004
2005	0.0001	0.0003	0.0101	0.0004	0.0001	0.0060	0.0002	0.0003	0.0005
2010	0.0001	0.0004	0.0120	0.0005	0.0001	0.0071	0.0003	0.0003	0.0006
2011	0.0001	0.0004	0.0124	0.0005	0.0001	0.0073	0.0003	0.0003	0.0006
2012	0.0001	0.0004	0.0127	0.0005	0.0001	0.0075	0.0003	0.0003	0.0006
2013	0.0001	0.0004	0.0131	0.0005	0.0001	0.0077	0.0003	0.0003	0.0006
2014	0.0001	0.0004	0.0139	0.0006	0.0001	0.0082	0.0003	0.0004	0.0007
2015	0.0001	0.0004	0.0139	0.0006	0.0001	0.0082	0.0003	0.0004	0.0007
2016	0.0001	0.0004	0.0139	0.0006	0.0001	0.0082	0.0003	0.0004	0.0007
2017	0.0001	0.0004	0.0139	0.0006	0.0001	0.0082	0.0003	0.0004	0.0007
2018	0.0001	0.0004	0.0139	0.0006	0.0001	0.0082	0.0003	0.0004	0.0007
2019	0.0001	0.0004	0.0151	0.0006	0.0001	0.0089	0.0003	0.0004	0.0007
2020	0.0001	0.0004	0.0151	0.0006	0.0001	0.0089	0.0003	0.0004	0.0007
2021	0.0001	0.0005	0.0168	0.0007	0.0001	0.0099	0.0004	0.0004	0.0008
2022	0.0001	0.0004	0.0146	0.0006	0.0001	0.0086	0.0003	0.0004	0.0007
2023	0.0001	0.0004	0.0146	0.0006	0.0001	0.0086	0.0003	0.0004	0.0007
1990/2023	**225%**	**225%**	**225%**	**225%**	**225%**	**225%**	**238%**	**215%**	**225%**
2022/2023	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.118*** below. Small irregularities were found during checking activity data (the year 2011 and 2020). It was caused by incorrect data flow but did not affect the emissions calculations.

Table 3.119: *Overview of activity data in category 1A4bii*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	113.48	NA	NA	NO	NA
1995	160.40	NA	NA	NO	NA
2000	208.67	NA	NA	NO	NA
2005	256.83	NA	NA	NO	NA
2010	292.40	NA	NA	5.46	NA
2011	298.07	NA	NA	7.70	NA
2012	306.40	NA	NA	8.36	NA
2013	321.14	NA	NA	9.72	NA
2014	333.05	NA	NA	14.69	NA
2015	336.09	NA	NA	13.26	NA
2016	330.90	NA	NA	16.43	NA
2017	327.34	NA	NA	18.73	NA
2018	328.81	NA	NA	17.64	NA
2019	357.78	NA	NA	19.73	NA
2020	350.35	NA	NA	24.56	NA
2021	390.00	NA	NA	27.12	NA
2022	339.82	NA	NA	23.69	NA
2023	348.06	NA	NA	22.90	NA

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990/2023	207%	-	-	-	-
2022/2023	2%	-	-	-3%	-

3.7.5.2 Methodological Issues

The data collected by questionnaires in households in the frame of the project "Quality Improvement of Air Emission Accounts and Extension of Provided Time-series" were used for the estimation of emissions from residential machinery for the first time in the 2018 inventory. After the second questionnaire in 2019, Slovakia was able to estimate the time series back to the base year 1990. The years 1990-2013 were estimated using expert judgment and a linear regression model back to the base year. This model caused the trend to be clearly linear up to 2013. After this year we can observe deviations in fuel consumption, as well as in estimated emissions. For the emission estimation, EMEP/EEA GB_{2023} Tier 1 emission factors were used.

3.7.5.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2023}.

3.7.5.4 Source-specific Recalculations

No recalculations in this submission.

3.7.6 Agriculture/Forestry/Fishing: Stationary (NFR 1A4ci)

3.7.6.1 Overview

Activities listed within this category are shown in ***Table 3.120***.

Table 3.120: *Activities according to national categorization included in category 1A4ci*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	MEDIUM S.: NACE 01-03
6.12. Livestock farming with a projected number of breeding sites	combustion
6.20. Agricultural and food products driers with a projected production capacity in t/h	combustion

The overview of the emissions is shown in ***Table 3.121.*** The calculation of NH_3 emissions from solid biomass was implemented in this submission (***Recommendation No 1A4ci-SK-2022-0001***).

Table 3.121: *Overview of emissions in category 1A4ci*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.1088	0.0282	0.1466	0.0001	0.0307	0.0701	0.1533	0.0044	0.2780
1995	0.1156	0.0299	0.1557	0.0001	0.0326	0.0744	0.1628	0.0048	0.2952
2000	0.1124	0.0056	0.1689	0.0001	0.0418	0.0955	0.2089	0.0061	0.4136
2005	0.1542	0.0092	0.1420	0.0001	0.0462	0.0948	0.2044	0.0097	0.2216
2010	0.1022	0.0108	0.0266	0.0001	0.0329	0.0795	0.1791	0.0067	0.1218
2011	0.1020	0.0128	0.0194	0.0001	0.0357	0.0892	0.1984	0.0085	0.1267
2012	0.1129	0.0129	0.0292	0.0001	0.0303	0.0713	0.1543	0.0072	0.1518
2013	0.1258	0.0144	0.0336	0.0001	0.0276	0.0689	0.1528	0.0065	0.1589
2014	0.2434	0.0395	0.0698	0.0003	0.0313	0.0862	0.1967	0.0083	0.2094
2015	0.2736	0.0196	0.0908	0.0001	0.0297	0.0678	0.1451	0.0072	0.2131
2016	0.2515	0.0157	0.0722	0.0001	0.0308	0.0754	0.1648	0.0070	0.2072
2017	0.2266	0.0147	0.0555	0.0001	0.0269	0.0602	0.1265	0.0061	0.1891
2018	0.2215	0.0256	0.0564	0.0002	0.0363	0.0699	0.1343	0.0094	0.2005
2019	0.2276	0.0201	0.0552	0.0001	0.0389	0.0696	0.1312	0.0096	0.2027
2020	0.2664	0.0243	0.0415	0.0001	0.0388	0.0813	0.1634	0.0096	0.2010

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2021	0.2543	0.0319	0.0412	0.0002	0.0437	0.0881	0.1733	0.0112	0.2333
2022	0.1810	0.0229	0.0307	0.0001	0.0351	0.0610	0.1090	0.0090	0.1555
2023	0.1775	0.0254	0.0247	0.0001	0.0370	0.0676	0.1249	0.0097	0.1647
1990/2023	**63%**	**-10%**	**-83%**	**51%**	**21%**	**-4%**	**-19%**	**120%**	**-41%**
2022/2023	**-2%**	**11%**	**-20%**	**11%**	**6%**	**11%**	**15%**	**8%**	**6%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0010	0.0000	0.0001	0.0011	0.0006	0.0011	0.0023	0.0001	0.0012
1995	0.0173	0.0005	0.0010	0.0176	0.0114	0.0200	0.0201	0.0016	0.0145
2000	0.0118	0.0005	0.0008	0.0118	0.0078	0.0133	0.0176	0.0012	0.0178
2005	0.0059	0.0005	0.0005	0.0056	0.0040	0.0063	0.0111	0.0007	0.0175
2010	0.0020	0.0005	0.0003	0.0013	0.0015	0.0015	0.0041	0.0004	0.0196
2011	0.0020	0.0006	0.0002	0.0011	0.0016	0.0013	0.0017	0.0003	0.0225
2012	0.0018	0.0005	0.0002	0.0010	0.0014	0.0011	0.0012	0.0001	0.0198
2013	0.0020	0.0006	0.0003	0.0010	0.0015	0.0012	0.0013	0.0001	0.0231
2014	0.0068	0.0030	0.0004	0.0008	0.0057	0.0020	0.0012	0.0004	0.1212
2015	0.0030	0.0012	0.0003	0.0009	0.0025	0.0013	0.0010	0.0003	0.0482
2016	0.0018	0.0006	0.0003	0.0007	0.0014	0.0009	0.0010	0.0003	0.0267
2017	0.0017	0.0006	0.0003	0.0006	0.0014	0.0007	0.0009	0.0003	0.0269
2018	0.0039	0.0017	0.0003	0.0005	0.0032	0.0011	0.0011	0.0003	0.0698
2019	0.0026	0.0011	0.0003	0.0005	0.0022	0.0008	0.0014	0.0003	0.0463
2020	0.0019	0.0008	0.0004	0.0004	0.0016	0.0006	0.0005	0.0003	0.0344
2021	0.0023	0.0010	0.0005	0.0005	0.0018	0.0006	0.0003	0.0003	0.0400
2022	0.0018	0.0008	0.0003	0.0003	0.0014	0.0005	0.0003	0.0002	0.0322
2023	0.0020	0.0009	0.0003	0.0003	0.0017	0.0005	0.0003	0.0002	0.0371
1990/2023	**107%**	**2776%**	**117%**	**-74%**	**158%**	**-55%**	**-89%**	**93%**	**2916%**
2022/2023	**15%**	**17%**	**-11%**	**-14%**	**15%**	**9%**	**-2%**	**-12%**	**15%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
1995	0.0021	0.0001	0.0001	0.0001	0.0001	0.0005	0.0021	0.0017
2000	0.0033	0.0002	0.0003	0.0002	0.0001	0.0008	0.0015	0.0012
2005	0.0037	0.0003	0.0004	0.0002	0.0001	0.0009	0.0008	0.0006
2010	0.0045	0.0004	0.0006	0.0002	0.0001	0.0012	0.0004	0.0002
2011	0.0052	0.0004	0.0007	0.0002	0.0002	0.0015	0.0004	0.0001
2012	0.0047	0.0004	0.0006	0.0002	0.0002	0.0013	0.0004	0.0001
2013	0.0055	0.0004	0.0007	0.0002	0.0002	0.0015	0.0004	0.0001
2014	0.0243	0.0023	0.0037	0.0012	0.0009	0.0081	0.0013	0.0001
2015	0.0101	0.0009	0.0014	0.0004	0.0004	0.0031	0.0006	0.0001
2016	0.0058	0.0005	0.0007	0.0002	0.0002	0.0016	0.0004	0.0001
2017	0.0058	0.0005	0.0007	0.0002	0.0002	0.0016	0.0004	0.0001
2018	0.0143	0.0013	0.0021	0.0007	0.0005	0.0046	0.0008	0.0001
2019	0.0096	0.0008	0.0013	0.0004	0.0003	0.0029	0.0005	0.0001
2020	0.0079	0.0006	0.0010	0.0003	0.0003	0.0022	0.0006	0.0001
2021	0.0097	0.0007	0.0012	0.0004	0.0003	0.0026	0.0008	0.0002
2022	0.0074	0.0006	0.0009	0.0003	0.0002	0.0021	0.0005	0.0001
2023	0.0082	0.0007	0.0011	0.0003	0.0003	0.0024	0.0006	0.0001
1990/2023	**1714%**	**12524%**	**12440%**	**3874%**	**3924%**	**7988%**	**396%**	**5%**
2022/2023	**12%**	**18%**	**18%**	**17%**	**17%**	**18%**	**9%**	**-2%**

The overview of the activity data (energy consumption) for this source category is in ***Table 3.122*** below.

Table 3.122: *Overview of activity data in category 1A4ci*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	42.65	210.52	1 015.84	73.46	NO
1995	58.78	206.46	1 086.01	74.42	NO
2000	47.35	197.46	1 060.56	72.61	NO
2005	159.91	100.24	1 930.10	85.17	NO
2010	50.35	38.59	1 677.71	69.99	NO
2011	36.71	18.80	1 500.25	119.47	NO
2012	29.40	14.09	1 356.93	249.89	NO
2013	36.01	13.29	1 590.77	299.07	NO
2014	66.47	9.08	1 755.51	1 240.14	NO
2015	40.08	10.86	1 502.22	1 520.94	NO
2016	98.12	9.76	1 805.38	1 271.10	NO
2017	87.89	10.67	1 537.70	1 164.30	NO
2018	86.26	6.45	1 399.74	1 187.64	NO
2019	115.71	7.73	1 595.10	1 025.93	NO
2020	204.99	5.40	2 189.06	804.42	NO
2021	215.82	2.37	2 582.76	867.13	NO
2022	97.51	2.51	1 361.36	783.71	NO
2023	115.31	1.98	1 205.17	661.37	NO
1990/2023	**170%**	**-99%**	**19%**	**800%**	**-**
2022/2023	**18%**	**-21%**	**-11%**	**-16%**	**-**

3.7.6.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023. The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.123***).

Table 3.123: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	81.05	20.98	109.20	114.17	20.03%	45.72%	207.06

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023} (***Table 3.124***).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:
E_i = annual emission of pollutant *i*,
$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,
$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3.124: Emission factors for calculating emissions of heavy metals and POPs

TYPE OF FUEL		LIQUID FUELS		HARD COAL	BROWN COAL	
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	FIXED BED BOILERS	FLUIDIZED BED BOILERS
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(-)	(≤ 5 MWth)	(≤ 5 MWth)	(≤ 5 MWth)
Pb	[mg/GJ]	4.56	4.07	13.687	59.471	2.037
Cd	[mg/GJ]	1.2	1.36	2.456	1.294	0.282
Hg	[mg/GJ]	0.341	1.36	9.051	2.382	1.5
As	[mg/GJ]	3.98	1.81	9.402	60.967	0.922
Cr	[mg/GJ]	2.55	1.36	15	38.383	9.1
Cu	[mg/GJ]	5.31	2.72	10	69.545	1
Ni	[mg/GJ]	255	1.36	10	62.104	4.803
Se	[mg/GJ]	2.06	6.79	2	5.192	45
Zn	[mg/GJ]	87.8	1.81	150	30.756	8.8
PCDD/F	[ng I-TEQ/GJ]	2.5	0.99	14.657	4.986	2.778
B(a)P	[mg/GJ]	3.678	116	10.975	320.061	5.148
B(b)F	[mg/GJ]	12.673	502	18.54	518.482	7.621
B(k)F	[mg/GJ]	3.968	98.7	10.966	518.482	5.321
I()P	[mg/GJ]	6.484	187	5.956	400.322	5.559
PAHs	[mg/GJ]	26.803	903.7	46.437	1757.347	23.649
HCB	[µg/GJ]	-	0.22	6.7	6.7	6.7
PCBs	[µg/GJ]	3.334	0.00013	8.073	5.059	1.449

TYPE OF FUELS		BIOMASS		GASEOUS FUELS		
TYPE OF FIRE PLACES		FIXED BED BOILERS	FLUIDIZED BED BOILERS	ALL TYPES OF BOILERS	STATIONARY ENGINES	GAS TURBINES
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(≤ 5 MWth)	(≤ 5 MWth), (5 – 50 MWth)	(-)	(-)
Pb	[mg/GJ]	27	1.606	0.0015	0.04	0.0015
Cd	[mg/GJ]	13	0.169	0.00025	0.003	0.00025
Hg	[mg/GJ]	0.56	1.268	0.1	0.1	0.1
As	[mg/GJ]	0.19	0.871	0.12	0.05	0.12
Cr	[mg/GJ]	23	0.027	0.00076	0.05	0.00076
Cu	[mg/GJ]	6	0.106	0.000076	0.01	0.000076
Ni	[mg/GJ]	2	0.085	0.00051	0.05	0.00051
Se	[mg/GJ]	0.5	0.211	0.0112	0.2	0.0112
Zn	[mg/GJ]	512	1.991	0.0015	2.91	0.0015
PCDD/F	[ng I-TEQ/GJ]	100	11.348	0.5	0.57	0.5
B(a)P	[mg/GJ]	10000	46.462	0.56	1.2	0.56
B(b)F	[mg/GJ]	16000	144.329	0.84	9	0.84
B(k)F	[mg/GJ]	5000	67.897	0.84	1.7	0.84
I()P	[mg/GJ]	4000	33.073	0.84	1.8	0.84
PAHs	[mg/GJ]	35000	291.761	3.08	13.7	3.08
HCB	[µg/GJ]	5	5	0.00308	-	0.00308
PCBs	[µg/GJ]	0.007	2.233	-	-	-

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.125***). The calculated BC emission values are presented in ***Table 3.121***.

***Table 3.125:** Emission factors for calculating emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

NH_3 emissions were calculated in this submission for this category based on activity data (solid biomass in TJ) – using EF for NH_3 = 1 g/GJ (EMEP/EEA GB_{2023}). The calculated ammonia emissions are presented in ***Table 3.119***.

3.7.6.3 Completeness

Emissions are well covered. The calculation of NH_3 emissions from solid biomass was implemented in this submission (***Recommendation No 1A4ci-SK-2022-0001***).

3.7.6.4 Source-specific Recalculations

Recalculations of BC emissions were made based on changes in activity data (the year 2020) and recalculations of heavy metals and POPs emissions were made based on the use of detailed methodologies focused on the combinations of the installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are acombination of default EF from EMEP/EEA GB_{2023}, expert estimation and special source.[1] The differences in emissions in category **1A4ci** between the previous and current submissions caused by recalculations are shown in ***Table 3.126***.

***Table 3.126**: Differences in emissions (%) in category 1A4ci between the previous and current submission caused by recalculations*

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1990	-	-72%	-39%	-41%	478%	28%	92%	-37%	119%	-77%	-93%	-100%	912%	-96%
1991	-	-71%	-47%	-56%	897%	111%	125%	56%	134%	-84%	-98%	-99%	946%	-97%
1992	-	-71%	-48%	-57%	954%	119%	127%	89%	135%	-84%	-98%	-99%	948%	-97%
1993	-	-71%	-48%	-58%	971%	120%	127%	93%	136%	-84%	-98%	-99%	948%	-97%
1994	-	-71%	-48%	-58%	974%	119%	127%	84%	136%	-84%	-98%	-99%	947%	-97%
1995	-	-71%	-47%	-58%	970%	116%	126%	71%	137%	-84%	-98%	-99%	946%	-97%
1996	-	-71%	-48%	-58%	961%	110%	125%	57%	137%	-83%	-98%	-99%	906%	-97%
1997	-	-71%	-50%	-57%	948%	99%	122%	42%	139%	-82%	-98%	-99%	728%	-97%
1998	-	-71%	-52%	-57%	931%	88%	119%	29%	140%	-81%	-97%	-99%	589%	-97%
1999	-	-71%	-53%	-56%	910%	76%	116%	17%	142%	-80%	-97%	-99%	477%	-97%
2000	-	-71%	-55%	-55%	840%	52%	108%	-6%	145%	-78%	-96%	-99%	342%	-97%
2001	-	-71%	-59%	-53%	798%	29%	98%	-16%	152%	-75%	-94%	-98%	197%	-97%
2002	-	-71%	-59%	-53%	770%	19%	93%	-22%	155%	-74%	-94%	-98%	158%	-97%
2003	-	-71%	-61%	-51%	734%	9%	87%	-25%	159%	-73%	-92%	-98%	114%	-97%
2004	-	-72%	-61%	-48%	619%	-16%	65%	-42%	170%	-70%	-90%	-97%	75%	-96%
2005	-	-71%	-61%	-48%	645%	1%	80%	-31%	157%	-72%	-91%	-97%	99%	-96%
2006	-	-72%	-62%	-40%	430%	-40%	34%	-50%	183%	-67%	-85%	-96%	15%	-95%
2007	-	-71%	-64%	-41%	476%	-20%	64%	-17%	161%	-70%	-85%	-95%	11%	-96%
2008	-	-70%	-52%	-39%	405%	-12%	60%	-38%	172%	-61%	-81%	-95%	39%	-97%
2009	-	-71%	-56%	-36%	394%	-21%	46%	0%	181%	-62%	-80%	-94%	11%	-97%
2010	-	-67%	-38%	-28%	291%	-17%	33%	5%	261%	-44%	-71%	-91%	25%	-96%
2011	-	-64%	-44%	-25%	279%	-24%	28%	38%	171%	-49%	-66%	-89%	8%	-96%
2012	-	-58%	-41%	-18%	294%	-19%	46%	66%	26%	-46%	-61%	-89%	18%	-95%
2013	-	-53%	-32%	-18%	274%	-10%	58%	71%	33%	-37%	-55%	-88%	22%	-95%
2014	-	109%	290%	21%	225%	276%	235%	137%	63%	249%	143%	-59%	328%	-96%
2015	-	-37%	-14%	-7%	244%	-3%	37%	55%	9%	-17%	-33%	-88%	14%	-95%

YEAR	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
2016	-	-49%	-24%	-7%	201%	-11%	32%	42%	16%	-27%	-46%	-93%	20%	-94%
2017	-	-55%	-27%	-4%	153%	-16%	5%	14%	5%	-29%	-49%	-93%	21%	-94%
2018	-	-27%	-14%	-2%	121%	-11%	2%	23%	4%	-15%	-23%	-81%	5%	-91%
2019	-	-37%	-13%	1%	115%	-11%	3%	22%	13%	-15%	-30%	-87%	11%	-93%
2020	-0.01%	-52%	-42%	11%	60%	-40%	-33%	-13%	6%	-42%	-44%	-90%	7%	-84%
2021	-	-52%	-53%	14%	52%	-51%	-41%	-20%	0%	-52%	-46%	-89%	3%	-51%
2022	-	-47%	-44%	12%	58%	-42%	-33%	-12%	3%	-43%	-41%	-89%	4%	-72%

3.7.7 Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery (NFR 1A4cii)

3.7.7.1 Overview

In this category are reported emissions from off-road vehicles in the agriculture sector e.g. tractors and harvesters and it is not considered as a key category. The overview of the emissions is shown in ***Table 3.127***. Only diesel oil is occurring in this category in 2023 and according to statistical consumption, the amount of diesel oil consumed is the same as 2022 (47 kt).

Table 3.127: *Overview of emissions in the category 1A4cii*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	8.5506	1.2249	0.0053	0.0020	0.4702	0.4702	0.4702	0.2715	17.4750
1995	3.7524	0.5490	0.0023	0.0009	0.2062	0.2062	0.2062	0.1190	8.1523
2000	2.6186	0.3962	0.0016	0.0006	0.1437	0.1437	0.1437	0.0829	6.2438
2005	2.6627	0.3645	0.0016	0.0006	0.1466	0.1466	0.1466	0.0847	4.7263
2010	2.4200	0.3221	0.0015	0.0006	0.1334	0.1334	0.1334	0.0771	3.9074
2011	2.4355	0.3202	0.0015	0.0006	0.1343	0.1343	0.1343	0.0777	3.7649
2012	2.4289	0.3160	0.0015	0.0006	0.1340	0.1340	0.1340	0.0775	3.6151
2013	2.3319	0.2991	0.0014	0.0005	0.1287	0.1287	0.1287	0.0745	3.2875
2014	2.6420	0.3310	0.0016	0.0006	0.1459	0.1459	0.1459	0.0845	3.3907
2015	2.2974	0.2956	0.0014	0.0005	0.1268	0.1268	0.1268	0.0734	3.2761
2016	2.2630	0.2920	0.0014	0.0005	0.1249	0.1249	0.1249	0.0722	3.2646
2017	2.0907	0.2743	0.0013	0.0005	0.1153	0.1153	0.1153	0.0667	3.2072
2018	2.0907	0.2743	0.0013	0.0005	0.1153	0.1153	0.1153	0.0667	3.2072
2019	1.9529	0.2601	0.0012	0.0005	0.1076	0.1076	0.1076	0.0622	3.1614
2020	1.9640	0.2019	0.0011	0.0005	0.1090	0.1090	0.1090	0.0633	0.6537
2021	1.7918	0.1842	0.0010	0.0004	0.0995	0.0995	0.0995	0.0578	0.5964
2022	1.6195	0.1665	0.0009	0.0004	0.0899	0.0899	0.0899	0.0522	0.5390
2023	1.6195	0.1665	0.0009	0.0004	0.0899	0.0899	0.0899	0.0522	0.5390
1990/2023	**-81%**	**-86%**	**-82%**	**-81%**	**-81%**	**-81%**	**-81%**	**-81%**	**-97%**
2022/2023	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
1990	0.0026	0.0132	0.4476	0.0184	0.0026	0.2633	0.0081	0.0130	0.0211
1995	0.0012	0.0058	0.1973	0.0081	0.0012	0.1160	0.0036	0.0057	0.0093
2000	0.0008	0.0041	0.1386	0.0057	0.0008	0.0815	0.0025	0.0040	0.0065
2005	0.0008	0.0041	0.1381	0.0057	0.0008	0.0812	0.0025	0.0040	0.0065
2010	0.0007	0.0037	0.1248	0.0051	0.0007	0.0734	0.0022	0.0036	0.0059
2011	0.0007	0.0037	0.1253	0.0052	0.0007	0.0737	0.0023	0.0036	0.0059
2012	0.0007	0.0037	0.1248	0.0051	0.0007	0.0734	0.0022	0.0036	0.0059
2013	0.0007	0.0035	0.1195	0.0049	0.0007	0.0703	0.0021	0.0035	0.0056
2014	0.0008	0.0040	0.1348	0.0055	0.0008	0.0793	0.0024	0.0039	0.0063

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
2015	0.0007	0.0035	0.1178	0.0048	0.0007	0.0693	0.0021	0.0034	0.0055
2016	0.0007	0.0034	0.1161	0.0048	0.0007	0.0683	0.0021	0.0034	0.0055
2017	0.0006	0.0032	0.1076	0.0044	0.0006	0.0633	0.0019	0.0031	0.0051
2018	0.0006	0.0032	0.1076	0.0044	0.0006	0.0633	0.0019	0.0031	0.0051
2019	0.0006	0.0030	0.1008	0.0041	0.0006	0.0593	0.0018	0.0029	0.0047
2020	0.0006	0.0029	0.0969	0.0040	0.0006	0.0570	0.0017	0.0029	0.0046
2021	0.0005	0.0026	0.0884	0.0036	0.0005	0.0520	0.0016	0.0026	0.0042
2022	0.0005	0.0024	0.0799	0.0033	0.0005	0.0470	0.0014	0.0024	0.0038
2023	0.0005	0.0024	0.0799	0.0033	0.0005	0.0470	0.0014	0.0024	0.0038
1990/2023	**-82%**	**-82%**	**-82%**	**-82%**	**-82%**	**-82%**	**-83%**	**-82%**	**-82%**
2022/2023	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

Slovakia was able to separate the consumption in this report for category **1A4cii** from other categories previously reported within this category. It is according to ***Recommendations No SK-1A4cii-2018-0001, SK-1A4cii-2021-0002*** and ***SK-1A4cii-2021-0002***. Based on the separation, in agriculture non-road mobile machinery was in the year 2023 was used 1 840.07 TJ of liquid fuels. The overview of activity data (energy consumption) for this source category is in ***Table 3.128*** below. Small irregularities were found during checking activity data (the year 2011). It was caused by incorrect data flow but did not affect the emissions calculations.

Table 3.128: *Overview of activity data in the category 1A4cii*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	11 205.00	NA	NA	NO	NA
1995	4 894.00	NA	NA	NO	NA
2000	3 478.00	NA	NA	NO	NA
2005	3 437.00	NA	NA	NO	NA
2010	2 822.78	NA	NA	130.63	NA
2011	2 792.78	NA	NA	151.16	NA
2012	2 791.86	NA	NA	144.36	NA
2013	2 788.41	NA	NA	153.94	NA
2014	3 105.83	NA	NA	211.21	NA
2015	2 719.59	NA	NA	190.03	NA
2016	2 680.30	NA	NA	186.86	NA
2017	2 476.26	NA	NA	180.39	NA
2018	2 489.92	NA	NA	166.96	NA
2019	2 332.96	NA	NA	156.74	NA
2020	2 222.08	NA	NA	167.26	NA
2021	2 027.59	NA	NA	151.60	NA
2022	1 841.49	NA	NA	137.58	NA
2023	1 840.07	NA	NA	127.67	NA
1990/2023	**-84%**	-	-	-	-
2022/2023	**-0.1%**	-	-	**-7%**	-

3.7.7.2 Methodological Issues

Slovakia used to estimate fuel consumption in category **1A4cii** statistical data from EUROSTAT as national data are not available for the whole time series. According to ***Recommendations No SK-1A4cii-2018-0001***, ***SK-1A4cii-2021-0002*** and ***SK-1A4cii-2021-0002***, Slovakia is reporting in this category only emission described in EMEP/EEA GB_{2023} and for the emission estimation, EMEP/EEA GB_{2023} Tier 1 emission factors were used.

3.7.7.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2023}.

3.7.7.4 Source-specific Recalculations

No recalculations in this submission.

3.7.8 Agriculture/Forestry/Fishing: National Fishing (NFR 1A4ciii)

The category is reported as NO – no activity in SR.

3.7.9 Other Stationery (including Military) (NFR 1A5a)

3.7.9.1 Overview

Activities listed within this category are shown in ***Table 3.129***.

Table 3.129: *Activities according to national categorization included in category 1A5a*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW	MEDIUM S.: NACE 05-09; 35.2; 36-43
1.5. Biogas production with projected production capacity: quantity of processed raw material or biological waste in t/d	

The overview of emissions is shown in ***Table 3.130***.

Table 3.130: *Overview of emissions in category 1A5a*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.1893	1.0216	0.3207	0.0415	0.0459	0.0592	0.1011	0.0030	0.2263
1995	0.1965	1.1103	0.3325	0.0449	0.0480	0.0618	0.1051	0.0032	0.2347
2000	0.1586	1.6329	0.3804	0.0088	0.0638	0.0836	0.1498	0.0043	0.3005
2005	0.2006	1.3149	0.3202	0.0644	0.0223	0.0326	0.0804	0.0020	0.1846
2010	0.1378	0.8525	0.1033	0.0698	0.0127	0.0180	0.0358	0.0016	0.1419
2011	0.1822	0.7419	0.1217	0.0743	0.0150	0.0204	0.0399	0.0022	0.1796
2012	0.3709	0.8735	0.2371	0.0661	0.0248	0.0306	0.0514	0.0068	0.2454
2013	0.6246	0.9950	0.2999	0.0705	0.0277	0.0331	0.0528	0.0076	0.3637
2014	0.4541	0.9600	0.2396	0.0677	0.0239	0.0277	0.0396	0.0066	0.2411
2015	0.4118	1.0267	0.2113	0.0769	0.0230	0.0270	0.0403	0.0064	0.2165
2016	0.5171	1.0504	0.2887	0.0811	0.0269	0.0314	0.0460	0.0074	0.2641
2017	0.6564	1.1507	0.3700	0.0829	0.0176	0.0217	0.0362	0.0048	0.2731
2018	0.6208	1.1442	0.3500	0.0887	0.0159	0.0213	0.0446	0.0043	0.2662
2019	0.6420	1.1224	0.3613	0.0901	0.0146	0.0170	0.0216	0.0040	0.3624
2020	0.4040	0.8109	0.1913	0.0886	0.0147	0.0170	0.0207	0.0025	0.3523
2021	0.3872	0.8102	0.1569	0.0895	0.0160	0.0186	0.0228	0.0029	0.3676
2022	0.3478	0.8501	0.1358	0.0850	0.0161	0.0190	0.0232	0.0029	0.3348
2023	0.3374	0.8546	0.0989	0.0878	0.0183	0.0215	0.0268	0.0033	0.3262
1990/2023	**78%**	**-16%**	**-69%**	**111%**	**-60%**	**-64%**	**-74%**	**10%**	**44%**
2022/2023	**-3%**	**1%**	**-27%**	**3%**	**14%**	**13%**	**16%**	**17%**	**-3%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0909	0.0038	0.0113	0.0890	0.0717	0.1007	0.1267	0.0611	0.1616
1995	0.0365	0.0016	0.0046	0.0358	0.0287	0.0404	0.0638	0.0245	0.0703
2000	0.0096	0.0006	0.0013	0.0093	0.0073	0.0105	0.0554	0.0064	0.0320
2005	0.0037	0.0003	0.0005	0.0035	0.0028	0.0040	0.0272	0.0024	0.0161
2010	0.0019	0.0002	0.0003	0.0018	0.0015	0.0019	0.0051	0.0012	0.0069
2011	0.0019	0.0001	0.0003	0.0019	0.0013	0.0020	0.0039	0.0005	0.0067
2012	0.0043	0.0004	0.0022	0.0033	0.0015	0.0023	0.0042	0.0011	0.0121

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2013	0.0049	0.0006	0.0028	0.0033	0.0016	0.0020	0.0036	0.0014	0.0219
2014	0.0044	0.0004	0.0028	0.0029	0.0010	0.0014	0.0034	0.0013	0.0135
2015	0.0048	0.0005	0.0031	0.0031	0.0010	0.0015	0.0036	0.0013	0.0133
2016	0.0043	0.0005	0.0029	0.0027	0.0010	0.0012	0.0029	0.0020	0.0160
2017	0.0051	0.0005	0.0037	0.0032	0.0009	0.0011	0.0021	0.0021	0.0157
2018	0.0022	0.0002	0.0015	0.0015	0.0007	0.0007	0.0015	0.0015	0.0111
2019	0.0020	0.0004	0.0013	0.0010	0.0007	0.0003	0.0010	0.0014	0.0175
2020	0.0016	0.0002	0.0014	0.0010	0.0004	0.0002	0.0008	0.0013	0.0109
2021	0.0016	0.0002	0.0014	0.0010	0.0004	0.0002	0.0008	0.0013	0.0107
2022	0.0018	0.0002	0.0016	0.0012	0.0004	0.0002	0.0015	0.0012	0.0107
2023	0.0016	0.0002	0.0014	0.0011	0.0003	0.0002	0.0010	0.0010	0.0097
1990/2023	**-98%**	**-95%**	**-87%**	**-99%**	**-100%**	**-100%**	**-99%**	**-98%**	**-94%**
2022/2023	**-9%**	**-8%**	**-11%**	**-12%**	**-16%**	**-14%**	**-30%**	**-22%**	**-9%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0218	0.0004	0.0007	0.0007	0.0006	0.0024	0.0211	0.0141
1995	0.0095	0.0002	0.0003	0.0003	0.0002	0.0011	0.0084	0.0058
2000	0.0034	0.0001	0.0001	0.0001	0.0001	0.0004	0.0020	0.0019
2005	0.0019	0.0001	0.0001	0.0000	0.0000	0.0003	0.0007	0.0008
2010	0.0015	0.0001	0.0001	0.0000	0.0000	0.0002	0.0004	0.0003
2011	0.0017	0.0001	0.0001	0.0000	0.0000	0.0003	0.0003	0.0002
2012	0.0186	0.0001	0.0003	0.0001	0.0001	0.0007	0.0075	0.0034
2013	0.0244	0.0003	0.0006	0.0002	0.0001	0.0013	0.0091	0.0041
2014	0.0246	0.0002	0.0004	0.0002	0.0001	0.0008	0.0101	0.0045
2015	0.0268	0.0002	0.0004	0.0002	0.0001	0.0009	0.0111	0.0050
2016	0.0249	0.0002	0.0004	0.0002	0.0001	0.0009	0.0101	0.0045
2017	0.0319	0.0002	0.0005	0.0002	0.0001	0.0010	0.0132	0.0059
2018	0.0124	0.0001	0.0002	0.0001	0.0000	0.0004	0.0048	0.0021
2019	0.0126	0.0002	0.0004	0.0002	0.0001	0.0009	0.0043	0.0018
2020	0.0114	0.0001	0.0002	0.0001	0.0001	0.0004	0.0042	0.0018
2021	0.0116	0.0001	0.0002	0.0001	0.0001	0.0004	0.0042	0.0018
2022	0.0133	0.0001	0.0002	0.0001	0.0001	0.0004	0.0049	0.0022
2023	0.0121	0.0001	0.0002	0.0001	0.0000	0.0004	0.0045	0.0020
1990/2023	**-44%**	**-82%**	**-72%**	**-88%**	**-91%**	**-83%**	**-79%**	**-86%**
2022/2023	**-9%**	**-3%**	**-6%**	**-6%**	**-6%**	**-5%**	**-9%**	**-9%**

The overview of activity data (energy consumption) for this source category is in ***Table 3.131*** below.

Table 3.131: *Overview of activity data in category 1A5a*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	10.04	318.74	1 867.55	201.96	NO
1995	10.71	315.99	1 958.98	199.46	NO
2000	13.05	300.32	1 841.01	200.73	NO
2005	4.50	199.38	2 846.78	267.09	49.83
2010	20.21	57.35	1 630.65	472.22	43.57
2011	12.64	36.82	1 561.37	1 060.63	13.29
2012	13.77	37.03	1 715.44	3 425.48	NO
2013	12.58	29.40	1 434.60	5 966.51	NO
2014	14.76	23.53	1 361.15	4 235.23	NO
2015	35.00	26.30	1 588.89	4 022.90	NO
2016	12.53	33.60	1 598.70	4 639.14	13.29

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2017	20.03	32.70	1 549.59	6 168.42	13.29
2018	15.67	25.26	1 336.08	3 592.36	NO
2019	8.32	18.37	1 517.25	3 328.13	NO
2020	15.67	15.74	1 267.72	2 382.70	NO
2021	15.95	14.93	1 414.83	2 260.37	NO
2022	14.72	12.27	1 734.86	2 117.27	NO
2023	12.91	8.16	1 213.62	2 110.72	NO
1990/2023	**29%**	**-97%**	**-35%**	**945%**	**-**
2022/2023	**-12%**	**-34%**	**-30%**	**-0.3%**	**-**

3.7.9.2 Methodological Issues

Emission data is compiled in the NEIS, therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. PMs are provided in the percentage share of PMs from TSP due to the integrated way of compilation in the NEIS and were calculated in available years from 2005 to 2023.

The historical data (1990-1999) are not covered by the NEIS, therefore the emission factors used for reconstruction of historical years 1990-1999 (1990-2004 for $PM_{2.5}$, PM_{10}) were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 3.132***).

Table 3.132: *Emission factors for calculating emissions of main pollutants in historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	TSP [g/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/tGJ]
EF	75.93	2.78	131.88	2.17	39.68	39.59%	52.78%

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore these detailed methodologies could be used focused on the combinations of the main installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are default EF from EMEP/EEA GB_{2023} (***Table 3.133***).

The annual emission is determined by activity data and an emission factor:

$$E_i = \sum EF_{i,j,k} \times A_{j,k}$$

Where:

E_i = annual emission of pollutant *i*,

$EF_{i,j,k}$ = default emission factor of pollutant *i* for source type *j* and fuel *k*,

$A_{j,k}$ = annual consumption of fuel *k* in source type *j*.

Table 3.133: *Emission factors for calculating emissions of heavy metals and POPs*

TYPE OF FUEL		LIQUID FUELS		HARD COAL	BROWN COAL	
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	FIXED BED BOILERS	FLUIDIZED BED BOILERS
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(-)	(≤ 5 MWth)	(≤ 5 MWth)	(≤ 5 MWth)
Pb	[mg/GJ]	4.56	4.07	13.687	59.471	2.037
Cd	[mg/GJ]	1.2	1.36	2.456	1.294	0.282
Hg	[mg/GJ]	0.341	1.36	9.051	2.382	1.5
As	[mg/GJ]	3.98	1.81	9.402	60.967	0.922
Cr	[mg/GJ]	2.55	1.36	15	38.383	9.1
Cu	[mg/GJ]	5.31	2.72	10	69.545	1
Ni	[mg/GJ]	255	1.36	10	62.104	4.803
Se	[mg/GJ]	2.06	6.79	2	5.192	45

TYPE OF FUEL		LIQUID FUELS		HARD COAL	BROWN COAL	
TYPE OF FIRE PLACE		ALL TYPES OF BOILERS	STATIONARY ENGINES	FIXED BED BOILERS	FIXED BED BOILERS	FLUIDIZED BED BOILERS
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(-)	(≤ 5 MWth)	(≤ 5 MWth)	(≤ 5 MWth)
Zn	[mg/GJ]	87.8	1.81	150	30.756	8.8
PCDD/F	[ng I-TEQ/GJ]	2.5	0.99	14.657	4.986	2.778
B(a)P	[mg/GJ]	3.678	116	10.975	320.061	5.148
B(b)F	[mg/GJ]	12.673	502	18.54	518.482	7.621
B(k)F	[mg/GJ]	3.968	98.7	10.966	518.482	5.321
I()P	[mg/GJ]	6.484	187	5.956	400.322	5.559
PAHs	[mg/GJ]	26.803	903.7	46.437	1757.347	23.649
HCB	[µg/GJ]	-	0.22	6.7	6.7	6.7
PCBs	[µg/GJ]	3.334	0.00013	8.073	5.059	1.449

TYPE OF FUELS		BIOMASS		GASEOUS FUELS		
TYPE OF FIRE PLACES		FIXED BED BOILERS	FLUIDIZED BED BOILERS	ALL TYPES OF BOILERS	STATIONARY ENGINES	GAS TURBINES
		THERMAL CAPACITY				
T2	UNIT	(≤ 5 MWth)	(≤ 5 MWth), (5 – 50 MWth)	(≤ 5 MWth), (5 – 50 MWth)	(-)	(-)
Pb	[mg/GJ]	27	1.606	0.0015	0.04	0.0015
Cd	[mg/GJ]	13	0.169	0.00025	0.003	0.00025
Hg	[mg/GJ]	0.56	1.268	0.1	0.1	0.1
As	[mg/GJ]	0.19	0.871	0.12	0.05	0.12
Cr	[mg/GJ]	23	0.027	0.00076	0.05	0.00076
Cu	[mg/GJ]	6	0.106	0.000076	0.01	0.000076
Ni	[mg/GJ]	2	0.085	0.00051	0.05	0.00051
Se	[mg/GJ]	0.5	0.211	0.0112	0.2	0.0112
Zn	[mg/GJ]	512	1.991	0.0015	2.91	0.0015
PCDD/F	[ng I-TEQ/GJ]	100	11.348	0.5	0.57	0.5
B(a)P	[mg/GJ]	10000	46.462	0.56	1.2	0.56
B(b)F	[mg/GJ]	16000	144.329	0.84	9	0.84
B(k)F	[mg/GJ]	5000	67.897	0.84	1.7	0.84
I()P	[mg/GJ]	4000	33.073	0.84	1.8	0.84
PAHs	[mg/GJ]	35000	291.761	3.08	13.7	3.08
HCB	[µg/GJ]	5	5	0.00308	-	0.00308
PCBs	[µg/GJ]	0.007	2.233	-	-	-

BC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2023}) (***Table 3.134***). The calculated BC emission values are presented in ***Table 3.130.***

Table 3.134: *Emission factors for calculation emissions of BC*

EF	UNIT	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
TSP	[g/GJ]	20	124	0.78	150
PM_{10}	[g/GJ]	20	117	0.78	143
$PM_{2.5}$	[g/GJ]	20	108	0.78	140
BC	[% of $PM_{2.5}$]	56%	6.4%	4%	28%

3.7.9.3 Completeness

Emissions are well covered.

3.7.9.4 Source-specific Recalculations

Data from the NEIS database for the incineration of residual gases, previously reported under the **5D1** category, were reallocated to the energy category **1A5a** in compliance with the GHG inventory. These emissions were reviewed and according to the VÚVH database, all the residual gases in Slovakia are incinerated with energy recovery.

Recalculations of heavy metals and POPs emissions were made based on the use of detailed methodologies focused on the combinations of the installation types/fuels used in our country. Emission factors used for the calculation of emissions of heavy metals and POPs are a combination of default EF from EMEP/EEA GB_{2023}, expert estimation and special source.[1] The differences in emissions in category **1A5a** between the previous and current submissions caused by recalculations are shown in ***Table 3.135***.

Table 3.135: *Differences in emissions (%) in category 1A5a between the previous and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
1990	4%	15234%	1%	698%	22%	18%	6%	22%	3%	-75%	-15%
1991	3%	13667%	1%	626%	19%	16%	6%	19%	2%	-75%	-15%
1992	4%	16124%	1%	739%	23%	19%	7%	23%	3%	-75%	-16%
1993	4%	15058%	1%	690%	21%	18%	6%	21%	3%	-75%	-16%
1994	4%	16125%	1%	739%	23%	19%	7%	23%	3%	-75%	-15%
1995	4%	15984%	1%	733%	23%	19%	6%	23%	3%	-75%	-15%
1996	5%	19325%	2%	886%	28%	23%	8%	28%	3%	-75%	-14%
1997	5%	18114%	2%	830%	26%	21%	7%	26%	3%	-75%	-14%
1998	4%	17296%	1%	793%	25%	20%	7%	25%	3%	-75%	-12%
1999	4%	16236%	1%	744%	23%	19%	7%	23%	3%	-75%	-11%
2000	1%	5256%	0%	72%	11%	9%	3%	11%	2%	-73%	10%
2001	6%	209%	1%	244%	60%	49%	17%	60%	4%	-73%	8%
2002	4%	221%	1%	948%	9%	8%	3%	9%	2%	-74%	-13%
2003	4%	163%	2%	1301%	10%	8%	3%	10%	3%	-73%	-8%
2004	3%	175%	2%	1135%	12%	10%	3%	12%	2%	-72%	-11%
2005	2%	177%	1%	1400%	2%	1%	1%	2%	1%	-73%	-24%
2006	6%	142%	1%	13291%	5%	3%	1%	5%	4%	-72%	-27%
2007	9%	118%	2%	4705%	3%	2%	1%	3%	6%	-75%	-50%
2008	10%	87%	2%	6551%	4%	3%	1%	4%	3%	-84%	-78%
2009	6%	51%	4%	13316%	5%	4%	2%	5%	2%	-77%	-67%
2010	6%	51%	3%	4165%	6%	4%	2%	6%	2%	-78%	-56%
2011	5%	43%	3%	4821%	5%	4%	2%	5%	1%	-66%	-62%
2012	2%	30%	1%	4842%	2%	1%	1%	2%	1%	-90%	-98%
2013	1%	36%	1%	4255%	2%	2%	1%	2%	1%	-91%	-97%
2014	1%	25%	1%	21893%	4%	3%	2%	4%	2%	-92%	-98%
2015	1%	26%	2%	3728%	5%	4%	3%	5%	3%	-92%	-98%
2016	1%	31%	1%	14872%	2%	1%	1%	2%	1%	-93%	-98%
2017	1%	29%	1%	14106%	3%	2%	1%	3%	1%	-93%	-98%
2018	1%	30%	1%	8057%	3%	2%	1%	3%	1%	-92%	-98%
2019	1%	31%	1%	4855%	3%	3%	2%	3%	1%	-92%	-96%
2020	2%	48%	1%	16221%	3%	3%	2%	3%	1%	-94%	-98%
2021	2%	49%	2%	15574%	3%	3%	2%	3%	1%	-94%	-98%
2022	2%	41%	2%	238921%	3%	2%	2%	3%	1%	-94%	-98%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1990	-54%	605%	64%	122%	171%	957%	-71%	-96%	-96%	1088%	-97%
1991	-54%	605%	63%	122%	172%	957%	-71%	-96%	-96%	1078%	-97%

YEAR	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs	HCB	PCB
1992	-54%	604%	63%	122%	173%	957%	-70%	-96%	-96%	1066%	-97%
1993	-53%	605%	62%	122%	175%	957%	-70%	-96%	-96%	1053%	-97%
1994	-54%	609%	61%	122%	177%	959%	-70%	-96%	-96%	1037%	-97%
1995	-53%	598%	59%	122%	181%	955%	-69%	-96%	-96%	1019%	-97%
1996	-52%	589%	58%	123%	184%	952%	-68%	-95%	-95%	998%	-97%
1997	-51%	585%	55%	123%	188%	952%	-66%	-95%	-95%	971%	-97%
1998	-50%	576%	53%	123%	192%	950%	-64%	-95%	-95%	939%	-97%
1999	-50%	578%	49%	124%	197%	953%	-62%	-95%	-95%	897%	-97%
2000	-46%	582%	30%	129%	211%	978%	-46%	-94%	-94%	793%	-96%
2001	-44%	577%	24%	129%	213%	979%	-42%	-93%	-93%	698%	-96%
2002	-47%	573%	31%	124%	207%	957%	-54%	-93%	-93%	656%	-96%
2003	-43%	551%	23%	126%	211%	956%	-47%	-92%	-92%	599%	-96%
2004	-41%	546%	12%	126%	214%	957%	-41%	-91%	-91%	467%	-95%
2005	-41%	544%	8%	121%	213%	942%	-46%	-91%	-91%	360%	-95%
2006	-31%	460%	-1%	120%	215%	897%	-41%	-87%	-87%	281%	-95%
2007	-39%	451%	20%	109%	196%	848%	-65%	-89%	-89%	321%	-97%
2008	-64%	264%	-39%	32%	109%	446%	-82%	-93%	-93%	59%	-98%
2009	-35%	396%	-21%	68%	7%	629%	-72%	-88%	-88%	135%	-97%
2010	-46%	358%	-7%	67%	21%	584%	-68%	-89%	-89%	218%	-97%
2011	-41%	481%	6%	153%	47%	172%	-68%	-84%	-84%	115%	-97%
2012	57%	378%	-96%	-76%	-25%	3%	-98%	-88%	-88%	3%	-48%
2013	68%	330%	-96%	-83%	-38%	-7%	-98%	-87%	-87%	1%	-19%
2014	80%	337%	-98%	-88%	-46%	-11%	-99%	-88%	-88%	1%	13%
2015	82%	337%	-98%	-89%	-47%	-10%	-99%	-88%	-88%	1%	12%
2016	69%	268%	-98%	-91%	-52%	27%	-98%	-88%	-88%	2%	-22%
2017	77%	265%	-98%	-93%	-68%	11%	-99%	-88%	-88%	2%	6%
2018	44%	192%	-97%	-88%	-50%	51%	-98%	-87%	-87%	3%	-51%
2019	47%	112%	-96%	-95%	-62%	52%	-96%	-86%	-86%	3%	-41%
2020	54%	123%	-98%	-96%	-66%	49%	-97%	-87%	-87%	2%	-31%
2021	53%	111%	-98%	-96%	-66%	46%	-98%	-87%	-87%	2%	-27%
2022	62%	124%	-98%	122%	-54%	26%	-98%	-87%	-87%	2%	4%

3.7.10 Other, Mobile (Including Military, Land Based and Recreational Boats) (NFR 1A5b)

3.7.10.1 Overview

This category was first time reported in the year 2018. Total fuel consumption was 58.32 TJ in 2023. This consumption includes petrol, diesel oil and jet fuel. Emissions of mobile combustion in the military are shown in ***Table 3.136***.

Table 3.136: *Overview of emissions in category 1A5b*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]	Pb [t]
1990	0.3197	0.0018	0.0187	NO	0.0018	0.0018	0.0018	0.0009	0.1391	NO
1995	0.2927	0.0016	0.0171	NO	0.0017	0.0017	0.0017	0.0008	0.1274	NO
2000	0.0768	0.0004	0.0045	NO	0.0004	0.0004	0.0004	0.0002	0.0334	NO
2005	0.0850	0.0005	0.0050	NO	0.0005	0.0005	0.0005	0.0002	0.0370	NO
2010	0.0703	0.0004	0.0041	NO	0.0004	0.0004	0.0004	0.0002	0.0306	NO
2011	0.0725	0.0004	0.0042	NO	0.0004	0.0004	0.0004	0.0002	0.0315	NO
2012	0.0653	0.0004	0.0038	NO	0.0004	0.0004	0.0004	0.0002	0.0284	NO
2013	0.0636	0.0004	0.0037	NO	0.0004	0.0004	0.0004	0.0002	0.0277	NO

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]	Pb [t]
2014	0.0618	0.0003	0.0036	NO	0.0004	0.0004	0.0004	0.0002	0.0269	NO
2015	0.0771	0.0004	0.0045	NO	0.0004	0.0004	0.0004	0.0002	0.0336	NO
2016	0.0721	0.0004	0.0042	NO	0.0004	0.0004	0.0004	0.0002	0.0314	NO
2017	0.0454	0.0003	0.0027	NO	0.0003	0.0003	0.0003	0.0001	0.0198	NO
2018	0.0563	0.0003	0.0033	NO	0.0003	0.0003	0.0003	0.0002	0.0245	NO
2019	0.0501	0.0003	0.0029	NO	0.0003	0.0003	0.0003	0.0001	0.0218	NO
2020	0.0494	0.0003	0.0029	NO	0.0003	0.0003	0.0003	0.0001	0.0215	NO
2021	0.0498	0.0003	0.0029	NO	0.0003	0.0003	0.0003	0.0001	0.0217	NO
2022	0.0385	0.0002	0.0022	1.3E-07	0.0002	0.0002	0.0002	0.0001	0.0168	1.4E-10
2023	0.0194	0.0001	0.0011	1.1E-07	0.0001	0.0001	0.0001	0.0001	0.0085	1.2E-10
1990/2023	**-94%**	**-94%**	**-94%**	**-**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-**
2022/2023	**-50%**	**-49%**	**-50%**	**-16%**	**-49%**	**-49%**	**-49%**	**-49%**	**-50%**	**-14%**

3.7.10.2 Methodological Issues

For the emission estimation, EMEP/EEA GB_{2023} Tier 1 emission factors were used. Data are provided directly by the Ministry of Defence of the Slovak Republic (MoD) and include only fuels used for military purposes. Fuels used for passenger transport of the MoD are excluded from this category and are included in category **1A3b** Road transport.

3.7.10.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2023}.

3.7.10.4 Source-specific Recalculations

Slovakia was able to separate petrol and diesel oil from the transport sector and allocate it to the correct **1A5b** category. The differences in emissions in category **1A5b** between the previous and current submissions caused by recalculations are shown in ***Table 3.137***.

Table 3.137: *Differences in emissions (%) in the category 1A5b between the previous and current submission caused by recalculations*

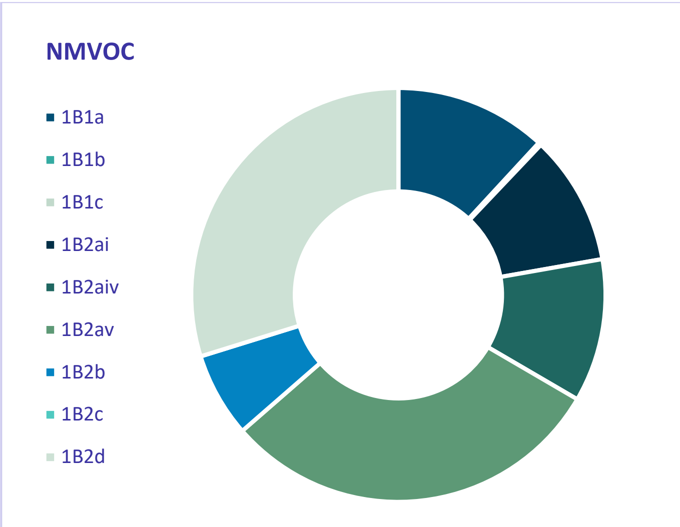
YEAR	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2015	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0%	-0.1%
2016	-7%	-7%	-7%	-7%	-7%	-7%	-7%	-7%
2017	-37%	-37%	-37%	-37%	-37%	-37%	-37%	-37%
2018	-	-	-	-	-	-	0.1%	-
2019	-	-	-	-	-	-	0.1%	-
2020	-	-	-	-	-	-	0.05%	-
2021	1%	1%	1%	1%	1%	1%	1%	1%

3.8 FUGITIVE EMISSIONS (NFR 1B)

3.8.1 Overview

This chapter covers emissions from leaks and other irregular releases of gases or vapours from a pressurized containment, such as appliances, storage tanks, pipelines, wells, or other pieces of equipment mostly from industrial activities. Categories included in the chapter are fugitive emission (**1B**) from solid fuels: Coal mining and handling (**1B1a**), Fugitive emission from solid fuels: Solid fuel transformation (**1B1b**), Fugitive emissions oil: Exploration, production, transport (**1B2ai**), Fugitive emissions oil: Refining/storage (**1B2aiv**), Distribution of oil products (**1B2av**) and Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other) (**1B2b**). Fugitive emissions are an important source of NMVOC emissions.
The trend is steadily decreasing as an outcome of the introduction of new technologies, methodologies and closing part of mines. Fugitive emissions from the transport and distribution of fossil fuels (oil and natural gas) are significant because Slovakia is an important transit country for oil and natural gas from East-European countries to the European Union. Raw materials are transported through high-pressure pipelines and distribution networks and are pumped by pipeline compressors. The trend in fugitive emissions from the transport and distribution of oil and natural gas in the Slovak Republic was stabilized and since 2000 slightly decreased. The increase in the past was caused by the expansion of the distribution system for natural gas and the growth of its consumption. Since 2000, fugitive emissions from oil have decreased due to the decrease in production and distribution. Shares of emissions of NMVOC from each category are presented in ***Figure 3.10***.

Figure 3.10: *Shares of NMVOC emissions in categories 1B in 2023*



3.8.2 Fugitive Emission from Solid Fuels: Coal Mining and Handling (NFR 1B1a)

3.8.1.1 Overview

The category reports the emissions of NMVOC and particulates from mining activities. This category is a key category for emissions of NMVOC and TSP. Emissions in this category have a decreasing trend due to the decrease in activity in the Slovak Republic. The overview of the emissions and activity data is shown in ***Table 3.138***.

Table 3.138: *Overview of emissions and activity data in category 1B1a*

YEAR	COAL PRODUCED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]]	TSP [kt]
1990	3.46	2.7648	0.0173	0.1452	0.3076
1995	3.76	3.0073	0.0188	0.1579	0.3346

YEAR	COAL PRODUCED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]]	TSP [kt]
2000	3.65	2.9194	0.0182	0.1533	0.3248
2005	2.51	2.0090	0.0126	0.1055	0.2235
2010	2.38	1.9020	0.0119	0.0999	0.2116
2011	2.38	1.9008	0.0119	0.0998	0.2115
2012	2.29	1.8338	0.0115	0.0963	0.2040
2013	2.35	1.8822	0.0118	0.0988	0.2094
2014	2.19	1.7502	0.0109	0.0919	0.1947
2015	1.94	1.5515	0.0097	0.0815	0.1726
2016	1.85	1.4777	0.0092	0.0776	0.1644
2017	1.83	1.4672	0.0092	0.0770	0.1632
2018	1.50	1.2016	0.0075	0.0631	0.1337
2019	1.50	1.2016	0.0075	0.0631	0.1337
2020	0.98	0.7844	0.0049	0.0412	0.0873
2021	1.07	0.8593	0.0054	0.0451	0.0956
2022	0.87	0.6948	0.0043	0.0365	0.0773
2023	0.76	0.6096	0.0038	0.0320	0.0678
1990/2023	**-78%**	**-78%**	**-78%**	**-78%**	**-78%**
2022/2023	**-12%**	**-12%**	**-12%**	**-12%**	**-12%**

3.8.1.2 Methodological Issues

Tier 1 emission factors for Underground mining from EMEP/EEA GB_{2023} were used for calculations of NMVOC, TSP and PM emissions (***Table 3.139***).

Table 3.139: *Emission factors in the category 1B1a*

T1	UNIT	EF
NMVOC	[kg/Mg coal]	0.8
$PM_{2.5}$	[kg/Mg coal]	0.005
PM_{10}	[kg/Mg coal]	0.042
TSP	[kg/Mg coal]	0.089

3.8.1.3 Completeness

Notation keys were used following EMEP/EEA GB_{2023}.

3.8.1.4 Source-specific Recalculations

No recalculations in this submission.

3.8.2 Fugitive Emission from Solid Fuels: Solid Fuel Transformation (NFR 1B1b)

3.8.2.1 Overview

Production of coke shows a slightly decreasing trend that reflects also the emissions within this category. This category is key for emissions of PM_{10}, Ni and PCDD/F. An overview of the emissions and activity data is shown in ***Table 3.140***.

Table 3.140: *Overview of emissions and activity data in category 1B1b*

YEAR	SOLID FUEL TRANSFORMED [Mt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	2.34	0.0021	0.0180	0.0019	0.0087	0.1427	0.3416	0.8120
1995	1.86	0.0019	0.0143	0.0015	0.0069	0.1131	0.2707	0.6433
2000	1.60	0.0018	0.0123	0.0013	0.0059	0.0974	0.2332	0.5541
2005	1.79	0.0049	0.0134	0.0014	0.0064	0.1061	0.2540	0.6038
2010	1.55	0.0016	0.0119	0.0012	0.0057	0.0946	0.2263	0.5379

YEAR	SOLID FUEL TRANSFORMED [Mt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
2011	1.52	0.0017	0.0117	0.0012	0.0056	0.0927	0.2219	0.5274
2012	1.47	0.0016	0.0113	0.0012	0.0054	0.0897	0.2146	0.5101
2013	1.44	0.0016	0.0111	0.0012	0.0053	0.0878	0.2102	0.4997
2014	1.47	0.0016	0.0113	0.0012	0.0054	0.0897	0.2146	0.5101
2015	1.53	0.0017	0.0118	0.0012	0.0057	0.0933	0.2234	0.5309
2016	1.54	0.0015	0.0119	0.0012	0.0057	0.0939	0.2248	0.5344
2017	1.49	0.0016	0.0115	0.0012	0.0055	0.0909	0.2175	0.5170
2018	1.50	0.0016	0.0116	0.0012	0.0056	0.0915	0.2190	0.5205
2019	1.32	0.0015	0.0102	0.0011	0.0049	0.0805	0.1927	0.4580
2020	1.11	0.0013	0.0085	0.0009	0.0041	0.0677	0.1621	0.3852
2021	1.63	0.0017	0.0125	0.0013	0.0060	0.0992	0.2374	0.5642
2022	1.45	0.0016	0.0112	0.0012	0.0054	0.0885	0.2117	0.5032
2023	1.48	0.0016	0.0113	0.0012	0.0054	0.0898	0.2150	0.5111
1990/2023	**-37%**	**-24%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**
2022/2023	**2%**	**1%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**

YEAR	BC [kt]	CO [kt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]
1990	0.0699	1.0764	0.8892	0.0164	0.0281	0.0304	0.3978	0.1123	0.2808
1995	0.0554	1.5128	0.7045	0.0130	0.0222	0.0241	0.3152	0.0890	0.2225
2000	0.0477	1.8346	0.6068	0.0112	0.0192	0.0208	0.2715	0.0767	0.1916
2005	0.0520	11.3604	0.6612	0.0122	0.0209	0.0226	0.2958	0.0835	0.2088
2010	0.0463	1.3774	0.5890	0.0109	0.0186	0.0202	0.2635	0.0744	0.1860
2011	0.0454	1.6298	0.5776	0.0106	0.0182	0.0198	0.2584	0.0730	0.1824
2012	0.0439	1.6222	0.5586	0.0103	0.0176	0.0191	0.2499	0.0706	0.1764
2013	0.0430	1.5424	0.5472	0.0101	0.0173	0.0187	0.2448	0.0691	0.1728
2014	0.0439	1.6002	0.5586	0.0103	0.0176	0.0191	0.2499	0.0706	0.1764
2015	0.0457	1.5838	0.5814	0.0107	0.0184	0.0199	0.2601	0.0734	0.1836
2016	0.0460	1.0267	0.5852	0.0108	0.0185	0.0200	0.2618	0.0739	0.1848
2017	0.0445	1.5654	0.5662	0.0104	0.0179	0.0194	0.2533	0.0715	0.1788
2018	0.0448	1.5920	0.5700	0.0105	0.0180	0.0195	0.2550	0.0720	0.1800
2019	0.0395	1.4872	0.5016	0.0092	0.0158	0.0172	0.2244	0.0634	0.1584
2020	0.0332	1.3466	0.4218	0.0078	0.0133	0.0144	0.1887	0.0533	0.1332
2021	0.0486	1.6280	0.6179	0.0114	0.0195	0.0211	0.2764	0.0780	0.1951
2022	0.0433	1.5470	0.5510	0.0102	0.0174	0.0189	0.2465	0.0696	0.1740
2023	0.0440	1.5575	0.5597	0.0103	0.0177	0.0191	0.2504	0.0707	0.1767
1990/2023	**-37%**	**45%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**
2022/2023	**2%**	**1%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**

YEAR	Se [t]	Zn [t]	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
1990	0.0374	0.5148	7.0200	0.3744	0.4680	0.2340	0.1638	1.2402
1995	0.0297	0.4079	5.5620	0.2966	0.3708	0.1854	0.1298	0.9826
2000	0.0256	0.3513	4.7908	0.2555	0.3194	0.1597	0.1118	0.8464
2005	0.0278	0.3828	5.2200	0.2784	0.3480	0.1740	0.1218	0.9222
2010	0.0248	0.3410	4.6500	0.2480	0.3100	0.1550	0.1085	0.8215
2011	0.0243	0.3344	4.5600	0.2432	0.3040	0.1520	0.1064	0.8056
2012	0.0235	0.3234	4.4100	0.2352	0.2940	0.1470	0.1029	0.7791
2013	0.0230	0.3168	4.3200	0.2304	0.2880	0.1440	0.1008	0.7632
2014	0.0235	0.3234	4.4100	0.2352	0.2940	0.1470	0.1029	0.7791
2015	0.0245	0.3366	4.5900	0.2448	0.3060	0.1530	0.1071	0.8109
2016	0.0246	0.3388	4.6200	0.2464	0.3080	0.1540	0.1078	0.8162
2017	0.0238	0.3278	4.4700	0.2384	0.2980	0.1490	0.1043	0.7897

YEAR	Se [t]	Zn [t]	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
2018	0.0240	0.3300	4.5000	0.2400	0.3000	0.1500	0.1050	0.7950
2019	0.0211	0.2904	3.9600	0.2112	0.2640	0.1320	0.0924	0.6996
2020	0.0178	0.2442	3.3300	0.1776	0.2220	0.1110	0.0777	0.5883
2021	0.0260	0.3577	4.8780	0.2602	0.3252	0.1626	0.1138	0.8618
2022	0.0232	0.3190	4.3500	0.2320	0.2900	0.1450	0.1015	0.7685
2023	0.0236	0.3240	4.4187	0.2357	0.2946	0.1473	0.1031	0.7806
1990/2023	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**	**-37%**
2022/2023	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**

3.8.2.2 Methodological Issues

The category reports all emissions according to the method of EMEP/EEA GB_{2023}. Default emission factors were used for the calculation of the emissions (***Table 3.141***).

Table 3.141: *Default EF used in fugitive emission from solid fuels transformation*

T1 (coke)	UNIT	EF
NOx	g/Mg coke	0.9
NMVOC	g/Mg coke	7.7
SOx	g/Mg coke	0.8
NH_3	g/Mg coke	3.7
$PM_{2.5}$	g/Mg coke	61
PM_{10}	g/Mg coke	146
TSP	g/Mg coke	347
BC	% $PM_{2.5}$	0.49
CO	g/Mg coke	460
Pb	g/Mg coke	0.38
Cd	g/Mg coke	0.007
Hg	g/Mg coke	0.012
As	g/Mg coke	0.013
Cr	g/Mg coke	0.17
Cu	g/Mg coke	0.048
Ni	g/Mg coke	0.12
Se	g/Mg coke	0.016
Zn	g/Mg coke	0.22
PCDD/F	µg I-TEQ/Mg coke	3
B(a)P	g/Mg coke	0.16
B(b)F	g/Mg coke	0.2
B(k)F	g/Mg coke	0.1
I()P	g/Mg coke	0.07
PAHs	g/Mg coke	0.53

T1 (charcoal)	UNIT	EF
NOx	kg/t	0.07
CO	kg/t	220

3.8.2.3 Completeness

The emissions of HCB and PCB are reported with notation key NE.

3.8.2.4 Source-specific Recalculations

No recalculations in this submission.

3.8.3 Fugitive Emissions from Solid Fuels (NFR 1B1c)

There is no activity in the Slovak Republic, the notation key NO is used.

3.8.4 Fugitive Emissions Oil: Exploration, Production, Transport (NFR 1B2ai)

3.8.4.1 Overview

The category reports only NMVOC emissions. The definition of included activities is shown in ***Table 3.142***.

Table 3.142: *Activities according to national categorization included in 1B2ai*

CATEGORIZATION ACCORDING TO THE ANNEX NO. 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.2. Oil extraction and related transport and storage

The overview of emissions and activity data is shown in ***Table 3.143***. The production and transportation of crude oil have shown a decreasing trend since 1990. The production of oil from domestic sources is negligible in the Slovak Republic and the major share of these stocks comes from imports.

Table 3.143: *Overview of emissions and activity data in category 1B2ai*

YEAR	CRUDE OIL PRODUCTION [kt]	CRUDE OIL TRANSPORTED [kt]	NMVOC [kt]
1990	73.14	13 581.00	0.8248
1995	74.25	13 581.00	0.8262
2000	59.00	9 300.00	0.5760
2005	31.00	10 662.34	0.6145
2010	13.08	10 075.33	0.5604
2011	15.43	9 919.73	0.5550
2012	11.45	8 417.68	0.4689
2013	9.98	9 788.06	0.5410
2014	8.97	8 945.00	0.4942
2015	9.59	9 932.04	0.5483
2016	8.36	9 171.32	0.5057
2017	5.78	9 582.25	0.5247
2018	5.14	9 460.16	0.5173
2019	4.34	8 997.64	0.4913
2020	2.09	9 974.83	0.5413
2021	4.56	8 819.00	0.4819
2022	2.14	9 595.06	0.5208
2023	1.43	9 626.21	0.5216
1990/2023	**-98%**	**-29%**	**-37%**
2022/2023	**-33%**	**0.3%**	**0.2%**

3.8.4.2 Methodological Issues

For the calculation of NMVOC emissions, data from the Statistical Office of the Slovak Republic and directly from producers is used. Calculation of the fugitive NMVOC emissions is based on EFs provided in 2019 Refinements to the 2006 IPCC GL. These EFs are providing more detailed calculations on Tier 1 as there are provided separate EFs for exploration, production and transport. Also, this change harmonizes emission estimation with GHG emissions. These EFs are shown in ***Table 3.144***. EFs for land exploration and production of crude oil in developed countries are used. Conservative approach was used and the upper limit of EFs was used.

Table 3.144: *Overview of emission factors for exploration, production and transport of crude oil*

EMISSION	CRUDE OIL PRODUCED [Gg/10³ m³ oil]	CRUDE OIL PRODUCED [Gg/10³ m³ oil]
NMVOC (high)	0.00125	0.000054
Uncertainty	-100% to 800%	-50% to 200%

3.8.4.3 Completeness

The notation key of NA is used for the emissions of main pollutants except SOx and PCDD/F where the notation key NE is used in compliance with the EMEP/EEA GB_{2023}.

The verification process in category **1B2ai** is based on cross-checking the input data from the supplier companies Nafta, a. s. and Transpetrol, a. s. with the statistics from the Ministry of Economy of the Slovak Republic and the Statistical Office of the Slovak Republic.

For the inventory preparation and verification of the currently used methodology, the fugitive emissions were estimated also with the use of data provided directly by (bottom-up approach):

- Nafta, a.s.; is the exclusive company responsible for oil and NG production in Slovakia,
- Statistical Office of the Slovak Republic.

3.8.4.4 Source-specific Recalculations

No recalculations in this submission.

3.8.5 Fugitive Emissions Oil: Refining/Storage (NFR 1B2aiv)

3.8.5.1 Overview

An overall trend of activity data is shown in ***Table 3.145***. Emissions in this category show a decreasing trend which is connected with a decrease in activity.

Table 3.145: *Overview of emissions and activity data in category 1B2aiv*

YEAR	CRUDE OIL REFINED [Mt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]	Pb [t]
1990	6.22	0.2177	0.6843	1.5242	0.0124	0.0311	0.0373	0.2551	0.0187
1995	5.17	0.1809	0.5685	1.2663	0.0103	0.0258	0.0310	0.2119	0.0155
2000	5.44	0.1905	0.5986	1.3333	0.0109	0.0272	0.0327	0.2231	0.0163
2005	5.60	0.1959	0.6158	1.3715	0.0112	0.0280	0.0336	0.2295	0.0168
2010	5.45	0.1909	0.5998	1.3360	0.0109	0.0273	0.0327	0.2236	0.0164
2011	5.99	0.2097	0.6590	1.4678	0.0120	0.0300	0.0359	0.2456	0.0180
2012	5.40	0.1890	0.5939	1.3228	0.0108	0.0270	0.0324	0.2214	0.0162
2013	5.87	0.2055	0.6458	1.4384	0.0117	0.0294	0.0352	0.2407	0.0176
2014	5.22	0.1827	0.5742	1.2789	0.0104	0.0261	0.0313	0.2140	0.0157
2015	5.95	0.2084	0.6550	1.4589	0.0119	0.0298	0.0357	0.2441	0.0179
2016	5.74	0.2008	0.6312	1.4058	0.0115	0.0287	0.0344	0.2353	0.0172
2017	5.56	0.1945	0.6113	1.3615	0.0111	0.0278	0.0333	0.2278	0.0167
2018	5.46	0.1910	0.6003	1.3371	0.0109	0.0273	0.0327	0.2238	0.0164
2019	5.11	0.1788	0.5620	1.2517	0.0102	0.0255	0.0307	0.2095	0.0153
2020	6.44	0.2253	0.7082	1.5773	0.0129	0.0322	0.0386	0.2640	0.0193
2021	5.51	0.1927	0.6058	1.3492	0.0110	0.0275	0.0330	0.2258	0.0165
2022	5.40	0.1890	0.5940	1.3230	0.0108	0.0270	0.0324	0.2214	0.0162
2023	5.23	0.1829	0.5750	1.2806	0.0105	0.0261	0.0314	0.2143	0.0157
1990/2023	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**
2022/2023	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**

YEAR	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PCDD/F [g I-TEQ]
1990	0.0031	0.0037	0.0006	0.0006	0.0075	0.0330	0.0006	0.0062	0.0075
1995	0.0026	0.0031	0.0005	0.0005	0.0062	0.0274	0.0005	0.0052	0.0062
2000	0.0027	0.0033	0.0005	0.0005	0.0065	0.0288	0.0005	0.0054	0.0065
2005	0.0028	0.0034	0.0006	0.0006	0.0067	0.0297	0.0006	0.0056	0.0067
2010	0.0027	0.0033	0.0005	0.0005	0.0065	0.0289	0.0005	0.0055	0.0065
2011	0.0030	0.0036	0.0006	0.0006	0.0072	0.0318	0.0006	0.0060	0.0072
2012	0.0027	0.0032	0.0005	0.0005	0.0065	0.0286	0.0005	0.0054	0.0065

YEAR	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PCDD/F [g I-TEQ]
2013	0.0029	0.0035	0.0006	0.0006	0.0070	0.0311	0.0006	0.0059	0.0070
2014	0.0026	0.0031	0.0005	0.0005	0.0063	0.0277	0.0005	0.0052	0.0063
2015	0.0030	0.0036	0.0006	0.0006	0.0071	0.0316	0.0006	0.0060	0.0071
2016	0.0029	0.0034	0.0006	0.0006	0.0069	0.0304	0.0006	0.0057	0.0069
2017	0.0028	0.0033	0.0006	0.0006	0.0067	0.0295	0.0006	0.0056	0.0067
2018	0.0027	0.0033	0.0005	0.0005	0.0065	0.0289	0.0005	0.0055	0.0065
2019	0.0026	0.0031	0.0005	0.0005	0.0061	0.0271	0.0005	0.0051	0.0061
2020	0.0032	0.0039	0.0006	0.0006	0.0077	0.0341	0.0006	0.0064	0.0077
2021	0.0028	0.0033	0.0006	0.0006	0.0066	0.0292	0.0006	0.0055	0.0066
2022	0.0027	0.0032	0.0005	0.0005	0.0065	0.0286	0.0005	0.0054	0.0065
2023	0.0026	0.0031	0.0005	0.0005	0.0063	0.0277	0.0005	0.0052	0.0063
1990/2023	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**
2022/2023	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**	**-3%**

3.8.5.2 Methodological Issues

Emission factors used for the calculation of heavy metals and POPs are default EF from EMEP/EEA GB_{2023} (***Table 3.146***).

Table 3.146: *Emission factors in category 1B2aiv*

T1	UNIT	EF
NOx	kg/Mg crude oil input	0.035
NMVOC	kg/Mg crude oil input	0.11
SOx	kg/Mg crude oil input	0.245
$PM_{2.5}$	kg/Mg crude oil input	0.002
PM_{10}	kg/Mg crude oil input	0.005
TSP	kg/Mg crude oil input	0.006
CO	kg/Mg crude oil input	0.041
Pb	g/Mg crude oil input	0.003
Cd	g/Mg crude oil input	0.0005
Hg	g/Mg crude oil input	0.0006
As	g/Mg crude oil input	0.0001
Cr	g/Mg crude oil input	0.0001
Cu	g/Mg crude oil input	0.0012
Ni	g/Mg crude oil input	0.0053
Se	g/Mg crude oil input	0.0001
Zn	g/Mg crude oil input	0.001
PCDD/F	µg I-TEQ/Mg crude oil input	0.0012

3.8.5.3 Completeness

The data from the NEIS covering fugitive emissions are reported in the chapter on Petroleum refining (NFR **1A1b**), and notation key IE was used. Notation keys for PAHs, HCB and PCBs were used in compliance with EMEP/EEA GB_{2023}.

3.8.5.4 Source-specific Recalculations

No recalculations in this submission.

3.8.6 Distribution of Oil Products (NFR 1B2av)

3.8.6.1 Overview

The definition of stationary sources and emissions from their activities included in **1B2av** are presented in following ***Table 3.147***. All data is from the operator – facility data.

Table 3.147: *Activities according to national categorization included in the category 1B2av*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.40. Gas stations according to projected annual turnover or current annual turnover in m^3/year

The overall trend of activity data and NMVOC emissions is shown in ***Table 3.148***. The emissions in this category show an increasing trend which is connected with an increase in activity.

Table 3.148: *Overview of emissions and activity data in the category 1B2av*

YEAR	PETROL CONSUMED [kt]	DIESEL OIL CONSUMED [kt]	LPG CONSUMED [kt]	BIOFUEL CONSUMED [kt]	NMVOC [kt]
1990	440.58	1 151.45	NO	NO	1.1420
1995	558.63	828.28	NO	NO	1.3532
2000	600.03	729.85	14.47	NO	1.4317
2005	701.03	1 233.48	29.97	NO	1.7318
2010	599.63	1 443.09	27.03	113.67	1.5568
2011	547.72	1 360.71	17.73	118.20	1.4295
2012	548.73	1 473.83	30.07	121.33	1.4510
2013	514.14	1 431.97	32.96	129.36	1.3702
2014	485.38	1 496.71	29.97	145.95	1.3187
2015	493.79	1 691.73	33.71	159.30	1.3691
2016	516.88	1 710.33	38.25	157.53	1.4230
2017	507.45	1 744.56	42.26	172.58	1.4103
2018	511.22	1 795.78	41.95	167.08	1.4254
2019	522.29	1 828.07	39.28	173.33	1.4551
2020	478.67	1 636.00	32.76	187.20	1.3315
2021	488.76	1 811.40	38.92	196.73	1.3823
2022	524.57	1 871.85	37.61	204.25	1.4711
2023	567.07	1 786.11	37.73	200.37	1.5512
1990/2023	**29%**	**55%**	**-**	**-**	**36%**
2022/2023	**8%**	**-5%**	**0.3%**	**-2%**	**5%**

3.8.6.2 Methodological Issues

The main source of NMVOC emissions is gasoline distribution. Other sources of NMVOC emissions are in ***Table 3.148***. The emission factor for gasoline according to EMEP/EEA GB_{2023} is **EF = 2.2 kg/Mg** and the emission factor for other fuels according to the 2019 Refinements to the 2006 IPCC GL is **EF = 0.15 kg/Mg**. Tier 1 methodology was used.

3.8.6.3 Completeness

The notation key of NA is used for the emissions of main pollutants in compliance with the EMEP/EEA GB_{2023}.

3.8.6.4 Source-specific Recalculations

No recalculations in this submission.

3.8.7 Fugitive Emissions from Natural Gas (Exploration,Production, Processing, Transmission, Storage, Distribution and Other) (NFR 1B2b)

3.8.7.1 Overview

An overall trend of activity data is shown in ***Table 3.149***. Emissions in this category show an increasing trend which is connected with an increase in activity. This category is key for emissions of NMVOC.

Table 3.149: *Overview of emissions and activity data in category 1B2b*

YEAR	PRODUCTION [mil. m³]	PROCESSINg [mil. m³]	TRANSMISSION AND STORAGE [mil. m³]	DISTRIBUTION [mil. m³]	OTHER [mil. m³]	NMVOC [kt]
1990	444.00	444.00	73 600.00	6 666.00	1.00	2.1714
1995	344.00	344.00	73 600.00	6 485.00	159.40	2.0264
2000	173.00	173.00	68 600.00	7 136.00	524.30	1.6874
2005	147.00	147.00	73 900.00	7 399.00	50.00	1.7565
2010	94.03	94.03	65 302.00	6 098.00	3 435.21	1.5101
2011	89.68	89.68	68 093.00	5 630.00	2 414.64	1.5513
2012	90.70	90.70	45 470.00	5 289.00	2 917.23	1.0993
2013	93.59	93.59	52 780.00	5 820.00	3 757.48	1.2578
2014	86.06	86.06	46 500.00	4 535.00	3 807.59	1.1100
2015	84.57	84.57	55 800.00	4 639.00	4 017.26	1.2956
2016	87.89	87.89	60 600.00	4 716.00	3 969.67	1.3969
2017	87.29	87.29	64 200.00	4 901.25	4 246.87	1.4708
2018	84.15	84.15	59 700.00	4 777.99	3 724.15	1.3731
2019	73.60	73.60	69 060.00	4 841.46	3 129.80	1.5433
2020	65.26	65.26	56 980.00	5 003.88	2 783.82	1.2897
2021	65.33	65.33	40 361.57	5 471.00	4 368.00	0.9680
2022	55.61	55.61	25 772.86	4 463.69	3 997.00	0.6517
2023	50.21	50.21	10 940.17	4 179.08	2 815.00	0.3400
1990/2023	**-89%**	**-89%**	**-85%**	**-37%**	**281400%**	**-84%**
2022/2023	**-10%**	**-10%**	**-58%**	**-6%**	**-30%**	**-48%**

Data from the Statistical Office of the Slovak Republic and directly from producers are used to calculate NMVOC emissions. The calculation of fugitive NMVOC emissions is based on the EFs listed in the 2019 Refinements to the 2006 IPCC GL. These EFs providemore detailed calculations on Tier 1 as there are provided separate EFs for the exploration, production, processing, transmission, distribution and storage of natural gas. Also, this change harmonizes emission estimation with GHG emissions. These EFs are shown in ***Table 3.150***. EFs for land exploration and production of crude oil in developed countries are used. Conservative approach was used and the upper limit of EFs was used.

Table 3.150: *Overview of emission factors for exploration, production, processing, transmission, distribution and storage of natural gas*

T1	PRODUCTION [Gg/10^6 m³ NG]	GATHERING [Gg/10^6 m³ NG]	PROCESSING [Gg/10^6 m³ NG]	TRANSMISSION [Gg/10^6 m³ NG]	DISTRIBUTION [Gg/10^6 m³ NG]	OTHER (STORAGE) [Gg/10^6 m³ NG]
NMVOC	0.00061	0.00077	0.00006	0.00002	0.000009	0.000004

3.8.7.3 Completeness

Notation keys were used in compliance with EMEP/EEA GB_{2023}.

3.8.7.4 Source-specific Recalculations

No recalculations in this submission.

3.8.8 Venting and Flaring (Oil, Gas, Combined Oil and Gas) (NFR 1B2c)

3.8.8.1 Overview

Emissions from flaring in the refinery, technological losses and storage are included in different categories because they are part of already categorised sources in NEIS (**1A1b**, **1A1c**). Notation key IE is used for the main pollutants and emissions of HMs. For emissions of POPs used notation key NE complied with EMEP/EEA GB_{2023}. Flaring is observed to some extent only in NG production. It is not occurring in the distribution, transport and transmission of crude oil and natural gas in Slovakia. There are no EFs and methodology available for NG.

3.8.8.2 Methodological Issues

The methodology is described in the appropriate chapter for categories **1A1b** and **1A1c**.

3.8.8.3 Completeness

The notation key of NE is used for the emissions of NH_3 and POPs in compliance with the EMEP/EEA GB_{2023} and IE for the other emissions. Further data analysis is needed to establish a methodology for natural gas venting and flaring from each process.

3.8.8.4 Source-specific Recalculations

No recalculations in this submission.

3.8.9 Other Fugitive Emissions from Energy Production (NFR 1B2d)

3.8.9.1 Overview

In this category, post-meter NG fugitive emissions are reported. These emission sources are identified in the 2019 Refinements to the 2006 IPCC GL as fugitive emissions beyond gas meters and from natural gas-fuelled vehicles (***Table 3.151***). The emission factors for appliances and power plants include leakage emissions beyond gas meters, such as internal piping and the end-of-pipe appliances (e.g. home heating, water heating, stoves and barbecues).

Table 3.151: *Overview of emissions and activity data in category 1B2d*

YEAR	CNG CARS [vehicles]	APPLIANCES [pcs]	INDUSTRIAL PLANTS [mil. m^3]	NMVOC [kt]
1990	0	1 472 938	3 319.38	1.5061
1995	0	1 477 188	3 528.17	1.5125
2000	40	1 461 904	3 692.88	1.4988
2005	158	1 455 729	3 097.17	1.4867
2010	289	1 496 033	2 453.04	1.5206
2011	332	1 501 029	2 587.22	1.5269
2012	414	1 505 009	2 470.67	1.5297
2013	1 482	1 506 508	2 470.32	1.5312
2014	1 556	1 509 413	2 123.60	1.5307
2015	1 398	1 510 532	2 136.90	1.5319
2016	1 541	1 514 666	2 165.34	1.5363
2017	1 750	1 514 262	2 214.59	1.5364
2018	1 980	1 519 409	2 279.11	1.5422
2019	2 063	1 522 827	2 365.51	1.5465
2020	2 095	1 527 512	2 416.83	1.5517
2021	2 146	1 529 546	2 707.13	1.5566
2022	2 218	1 532 244	2 087.94	1.5531
2023	2 033	1 511 931	1 977.29	1.5317
1990/2023	**-**	**3%**	**-40%**	**2%**

YEAR	CNG CARS [vehicles]	APPLIANCES [pcs]	INDUSTRIAL PLANTS [mil. m^3]	NMVOC [kt]
2022/2023	-8%	-1%	-5%	-1%

3.8.9.2 Methodological Issues

Tier 1 methodology described in the 2019 Refinements to the 2006 IPCC GL and NMVOC emissions factor identified in the guidelines is used (***Table 3.152***). The missing data on appliances for the years 1990 – 1999 were extrapolated based on distributed NG for these years.

Table 3.152: *Emissions factors for calculating emissions od NMVOC according to different sources*

SEGMENT	VALUE	UNCERTAINTY	UNIT
Natural gas-fuelled vehicles	0.000008	70% to 140%	Tonnes/car
Appliances in commercial and residential sector	0.0001	±60%	Tonnes/appliance
Leakage at industrial plants and power stations	0.01	±60%	Tonnes/mil. m^3 Non-residential and commercial gas consumed

3.8.9.3 Completeness

Notation keys were used in compliance with EMEP/EEA GB_{2023}.

3.8.9.4 Source-specific Recalculations

Recalculations of NMVOC emissions were made based on changes in activity data (supplemented activity values for the years 1990-2022). The differences in emissions in category **1B2d** between the previous and current submissions caused by recalculations are shown in ***Table 3.153***.

Table 3.153: *Differences in emissions (%) in category 1B2d between the previous and current submission caused by recalculations*

YEAR	NMVOC
1990	4437%
1991	4624%
1992	4489%
1993	4352%
1994	4466%
1995	4187%
1996	4129%
1997	4050%
1998	3976%
1999	3962%
2000	3959%
2001	3781%
2002	4057%
2003	4157%
2004	4441%
2005	4700%
2006	749%
2007	760%
2008	757%
2009	779%
2010	773%
2011	768%
2012	773%
2013	773%
2014	789%
2015	788%
2016	787%

YEAR	NMVOC
2017	785%
2018	783%
2019	779%
2020	777%
2021	765%
2022	792%

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

Last update: 15.4.2025

4.1 OVERVIEW OF THE SECTOR INDUSTRY

The emissions covered by the industry sector originate from industrial processes but also from combined combustion and technology processes, which are united and reported for the basic unit (source). The emissions and facility data reported directly from an operator that is recorded in the NEIS database cannot be in some cases divided into separate combustion and technology emissions.

The reported data involve emissions and activity data from the technological processes in the mineral products industry (**2A**), chemical industry (**2B**), metal production (**2C**), solvent use (**2D**), other product manufacture (**2G**) and other industrial activities (**2H**, **2I**, **2K**). The list of categories according to the NFR structure and Tier level of inventory is presented in ***Table 4.1***. The national emission inventory of air pollutants is prepared from several sources to cover all potential sources of pollution.

The data sources:

a/ NEIS database of stationary large and medium sources of air pollution providing facility data for nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) sulphur oxides (SOx), ammonia (NH_3), total suspended particles (TSP, PM_{10} and $PM_{2.5}$ are consequently compiled) and carbon monoxide (CO). All data that comes from the database is considered as T3 methodology. The reporting duties are bonded to the national legislative obligations for air pollution sources to report their annual balances of fuels, emissions and all auxiliary data necessary for the compilation of final emissions.

b/ Estimations based on statistical data and emission factors for air pollutants, heavy metals (HMs) and persistent organic pollutants (POPs). Emissions reported using this type of calculation are considered T2 or T1.

Table 4.1: *Overview of reported categories, tier or notation key used in the industrial sector*

NFR	LONGNAME OF CATEGORY	METHODOLOGY/TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TZL	BC	HM	POPs
MINERAL INDUSTRY							
2A1	Cement production	NK	NK	T3	T1	NK	NK
2A2	Lime production	NK	NK	T3	T1	NK	NK
2A3	Glass production	NK	NK	T3	T1	T2	NK
2A5a	Quarrying and mining of minerals other than coal	T3	NK	T3	NK	NK	NK
2A5b	Construction and demolition	NK	NK	T1	NK	NK	NK
2A5c	Storage, handling and transport of mineral products	NK	NK	NK	NK	NK	NK
2A6	Other mineral products	T3	T3	T3	NK	NK	NK
CHEMICAL INDUSTRY							
2B1	Ammonia production	T3	T1	T3	NK	NK	NK
2B2	Nitric acid production	T3, NK	T3	NK	NK	NK	NK
2B3	Adipic acid production	NK	NK	NK	NK	NK	NK
2B5	Carbide production	T3, NK	NK	T3, NK	NK	NK	NK
2B6	Titanium dioxide production	NK	NK	NK	NK	NK	NK
2B7	Soda ash production	NK	NK	NK	NK	NK	NK
2B10a	Chemical industry: Other	T3	T3	T3	T1	NK	NK
2B10b	Storage, handling and transport of chemical products	T3	T3, NK	T3	NK	NK	NK
METAL INDUSTRY							
2C1	Iron and steel production	T3	T3	T3	T1	T1, T2	T2, NK
2C2	Ferroalloys production	T3	T3, NK	T3	T1	NK	NK

NFR	LONGNAME OF CATEGORY	METHODOLOGY/TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TZL	BC	HM	POPs
2C3	Aluminium production	T3	NK	T3	T1	NK	T2, NK
2C4	Magnesium production	NK	NK	NK	NK	NK	NK
2C5	Lead production	T3, NK	NK	T3, NK	NK	T2, NK	T2, NK
2C6	Zinc production	T1, NK	NK	T1, NK	NK	T1, NK	T1, NK
2C7a	Copper production	T3	NK	T3	T1	T2, NK	T2, NK
2C7b	Nickel production	NK	NK	NK	NK	NK	NK
2C7c	Other metal production	T3	T3	T3	NK	NK	NK
2C7d	Storage, handling and transport of metal products	NK	NK	NK	NK	NK	NK
SOLVENTS AND PRODUCT USE							
2D3a	Domestic solvent use including fungicides	T2, NK	NK	NK	NK	T1, NK	NK
2D3b	Road paving with asphalt	T3, NK	NK	T3	NK	NK	T1, NK
2D3c	Asphalt roofing	T3, NK	NK	T3	NK	NK	NK
2D3d	Coating applications	T2+T3, NK	NK	NK	NK	NK	NK
2D3e	Degreasing	T2+T3, NK	NK	NK	NK	NK	NK
2D3f	Dry cleaning	T3, NK	NK	NK	NK	NK	NK
2D3g	Chemical products	T3, NK	NK	NK	NK	T2, NK	T2, NK
2D3h	Printing	T2+T3, NK	NK	NK	NK	NK	NK
2D3i	Other solvent use	T2+T3, NK	NK	NK	NK	T2	NK
2G	Other product use	T2	T2	T2	T2	T2, NK	T2, NK
OTHER INDUSTRIAL ACTIVITIES							
2H1	Pulp and paper industry	NK	NK	T3	T1	NK	NK
2H2	Food and beverages industry	T2, NK	NK	T3	NK	NK	NK
2H3	Other industrial processes	T3, NK	T3	T3	NK	NK	NK
2I	Wood processing	T3	T3, NK	T3	NK	NK	NK
2J	Production of POPs	NK	NK	NK	NK	NK	NK
2K	Consumption of POPs and heavy metals	NK	NK	NK	NK	T1, NK	T1, NK
2L	Other production, consumption, storage, transportation or handling of bulk products	NK	NK	NK	NK	NK	NK

4.2 TRENDS IN THE SECTOR INDUSTRY

Table 4.2 below shows an overall decreasing trend of emissions of air pollutants since 1990 due to the strict air protection legislation. This, together with the advancements and progress of abatement systems led to the reduction of air pollutants as a result of the transposition of European legislation, continual improvement in the national legislation and the endeavour of the industry to implement BAT technologies (if the investments are available).

Table 4.2: *Overview of the emissions in the category 2 – Industry*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	7.1003	46.1594	11.3398	0.2605	2.3378	4.6750	15.4662	0.0372	84.8237
1995	6.7682	44.5311	10.1563	0.2695	2.2857	3.8186	11.8706	0.0818	75.4156
2000	7.9732	39.2656	13.9137	0.2066	2.9472	4.9475	15.1159	0.1084	93.4023
2005	6.7133	39.4370	11.4549	0.2667	1.4781	3.5462	10.3893	0.0906	104.3432
2010	5.9232	29.1419	7.3310	0.1221	0.9559	2.1660	6.7127	0.1161	94.2074
2011	6.6758	33.3473	9.2230	0.2206	0.9439	2.0670	6.4540	0.1138	107.1259

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2012	6.3180	27.6370	8.0566	0.2194	0.9191	1.6643	5.1780	0.1161	105.6835
2013	6.1896	28.3741	7.3859	0.1645	0.9606	2.0140	6.3800	0.1027	105.0621
2014	6.8971	30.1647	8.0180	0.1240	1.0435	2.0355	6.5122	0.1097	119.8514
2015	6.4984	33.3735	9.0904	0.1665	1.1808	3.6496	11.7870	0.1104	119.9171
2016	5.8978	31.7032	10.2867	0.2269	0.9090	1.9103	5.9485	0.1091	121.8027
2017	6.9338	29.8603	11.7145	0.2190	0.9744	2.4382	7.7015	0.1166	124.1939
2018	7.5900	32.1591	9.4058	0.2362	0.8714	1.7901	5.4600	0.1141	111.7930
2019	6.1286	28.1697	7.7214	0.2135	0.8244	1.9039	5.1503	0.1209	73.4620
2020	5.7511	28.3341	6.6529	0.2689	0.8325	2.6611	7.4536	0.1020	70.5006
2021	7.0832	28.2189	7.5907	0.2999	0.8543	2.4206	6.5801	0.1184	106.0956
2022	5.2685	25.9680	4.6974	0.2369	0.7018	2.0065	5.5231	0.1134	70.1133
2023	5.8378	26.4580	4.8931	0.2296	0.4948	1.0971	2.8294	0.0883	81.0338
1990/2023	**-18%**	**-43%**	**-57%**	**-12%**	**-79%**	**-77%**	**-82%**	**137%**	**-4%**
2022/2023	**11%**	**2%**	**4%**	**-3%**	**-29%**	**-45%**	**-49%**	**-22%**	**16%**

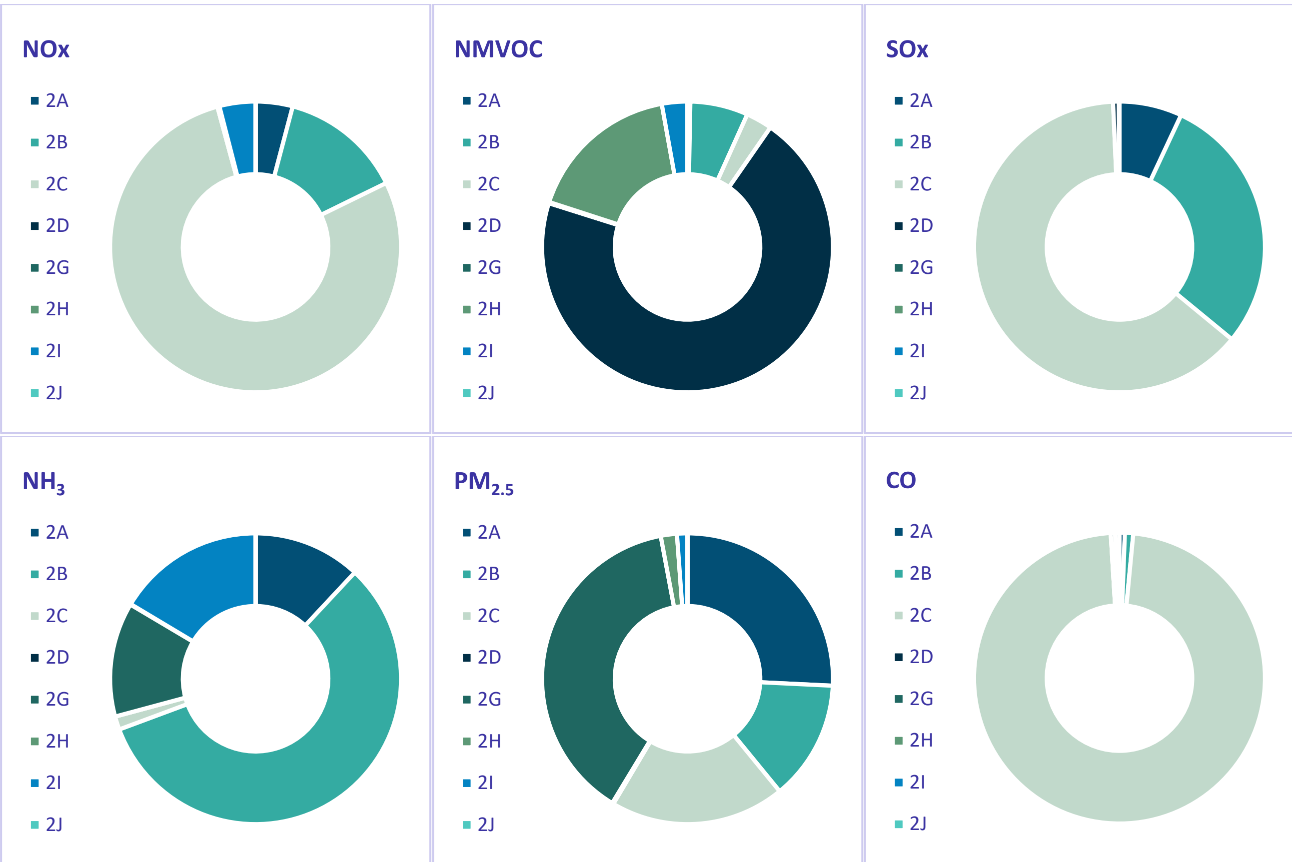
YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	20.7627	0.4293	0.2872	0.7115	1.5477	3.2077	1.3307	0.1629	12.9080
1995	17.7175	0.2975	0.2516	0.5943	1.3400	2.6638	1.0207	0.1643	11.8363
2000	19.0604	0.1256	0.2690	0.5350	0.8480	1.7655	0.9554	0.1696	13.0342
2005	6.3569	0.2069	0.1241	0.5362	0.9881	1.5732	0.2469	0.2569	13.0558
2010	4.9838	0.2538	0.1158	0.4886	1.5432	2.2447	0.2330	0.2901	13.9027
2011	5.0976	0.2895	0.1194	0.4628	1.9252	3.1880	0.2418	0.3014	13.2534
2012	5.2726	0.2599	0.1215	0.4709	1.6025	2.6734	0.2517	0.3166	13.9948
2013	5.7612	0.1514	0.1210	0.4787	1.0201	1.7001	0.2886	0.3180	14.9458
2014	5.5665	0.1502	0.1276	0.4750	1.2327	2.0577	0.2714	0.3271	12.5199
2015	5.4358	0.1456	0.1272	0.4623	1.4970	2.5823	0.2524	0.3211	15.3085
2016	5.6933	0.1499	0.1277	0.4862	1.7206	2.9671	0.2613	0.3226	16.3348
2017	6.1605	0.1582	0.1284	0.5062	1.6843	3.0118	0.2837	0.3299	16.4217
2018	5.5814	0.1470	0.1275	0.4665	1.6962	0.8573	0.2651	0.3296	16.5321
2019	4.4714	0.1300	0.1247	0.3647	1.8216	0.7937	0.2209	0.2721	12.8648
2020	3.2793	0.1124	0.1152	0.2929	1.6839	0.4743	0.1805	0.3429	11.1678
2021	5.4154	0.1540	0.1237	0.4837	1.8871	0.6670	0.2639	0.3728	14.1128
2022	4.4528	0.1349	0.1092	0.3666	1.1128	0.6740	0.2353	0.3882	12.5653
2023	5.1615	0.1305	0.1154	0.4284	1.0491	0.7579	0.2419	0.3586	11.1459
1990/2023	**-75%**	**-70%**	**-60%**	**-40%**	**-32%**	**-76%**	**-82%**	**120%**	**-14%**
2022/2023	**16%**	**-3%**	**6%**	**17%**	**-6%**	**12%**	**3%**	**-8%**	**-11%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [t]	PCB [t]
1990	36.2308	0.6067	0.6066	0.6066	0.0742	12.8284	0.1195	19.4713
1995	30.4406	0.2939	0.2936	0.2936	0.0361	10.5499	0.0975	17.6517
2000	32.1912	0.0083	0.0024	0.0024	0.0013	9.6324	0.1080	18.3708
2005	33.6390	0.0119	0.0035	0.0035	0.0019	10.9501	0.1048	21.5445
2010	27.3131	0.0124	0.0037	0.0037	0.0020	10.5515	0.0744	21.7213
2011	31.9122	0.0124	0.0037	0.0037	0.0020	9.9112	0.0876	20.0067
2012	32.8146	0.0122	0.0036	0.0036	0.0020	10.4361	0.0943	21.1447
2013	31.1698	0.0123	0.0036	0.0036	0.0020	10.8622	0.0918	22.4980
2014	37.1533	0.0127	0.0037	0.0037	0.0021	11.6648	0.1137	22.9581
2015	36.8139	0.0129	0.0038	0.0038	0.0021	11.1699	0.1122	21.7904
2016	37.2952	0.0131	0.0039	0.0039	0.0021	11.8736	0.1114	23.0773
2017	37.6749	0.0132	0.0039	0.0039	0.0021	12.1887	0.1124	23.8256

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [t]	PCB [t]
2018	37.1200	0.0131	0.0039	0.0039	0.0021	12.0346	0.1098	23.5218
2019	35.3413	0.0133	0.0039	0.0039	0.0022	9.7059	0.1040	18.6663
2020	27.0467	0.0115	0.0034	0.0034	0.0019	8.2704	0.0755	16.1544
2021	8.5398	0.0125	0.0037	0.0037	0.0021	11.8546	0.0963	23.1954
2022	5.8181	0.0060	0.0018	0.0018	0.0011	9.1435	0.0567	18.4065
2023	5.5444	0.0008	0.0003	0.0003	0.0003	10.4157	0.0766	20.5610
1990/2023	**-85%**	**-100%**	**-100%**	**-100%**	**-100%**	**-19%**	**-36%**	**6%**
2022/2023	**-5%**	**-87%**	**-83%**	**-83%**	**-72%**	**14%**	**35%**	**12%**

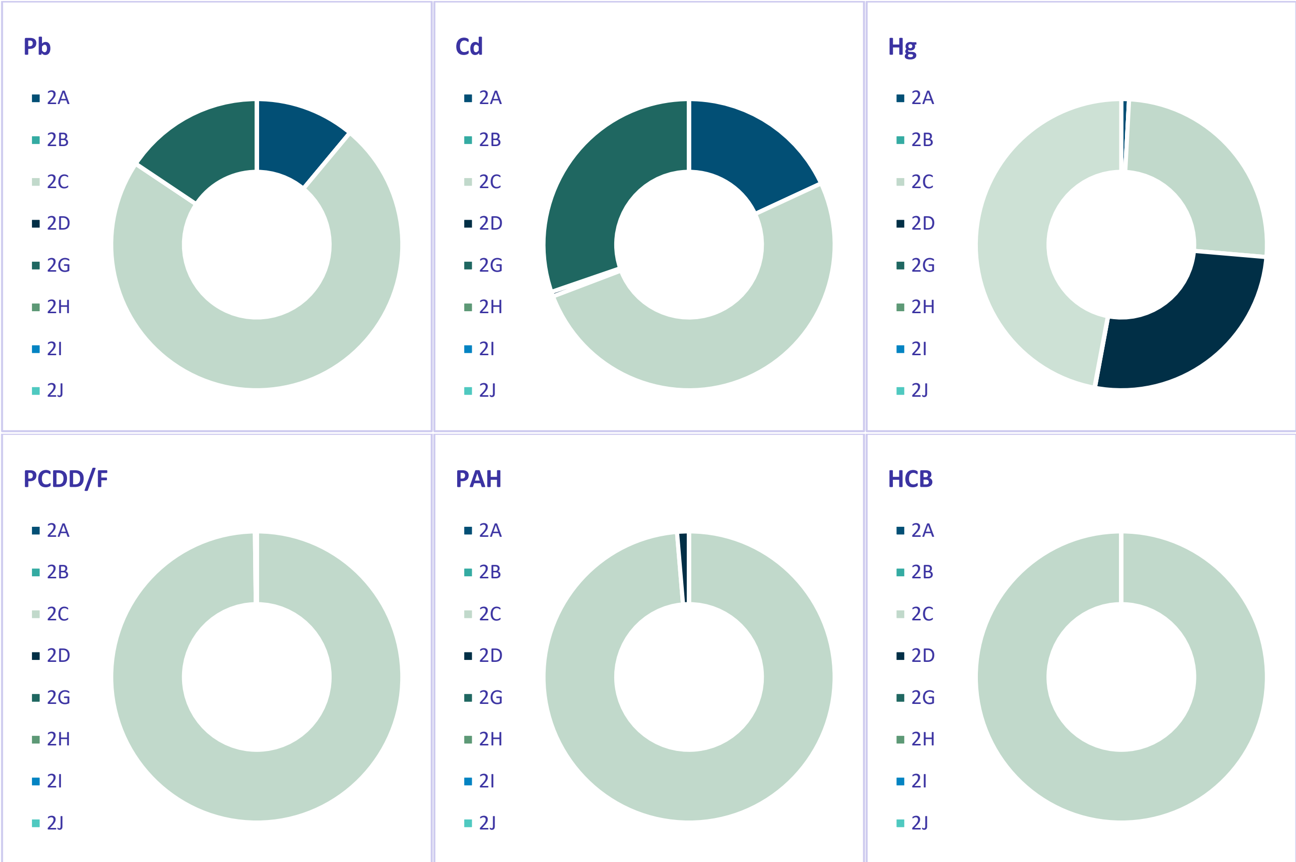
As shown in ***Figure 4.1***, the main contributor to NOx emissions in the industry sector is Iron and steel production (**2C1**). The most significant decrease was recorded in the period 2001-2009, since then, emissions have had a fluctuating trend. Solvents use contributes by an average of 78% to NMVOC emissions. The emission trend shows a decreasing trend due to stricter limits and technical requirements for solvent use. SOx emissions had a decreasing trend until 2009 in the sector industry, and since then emissions have fluctuated. The most important industrial category for these emissions is Metal production **2C**. Emissions of NH_3 have a long-term slightly decreasing trend. The fluctuations between 2004 and 2014 were caused by fluctuations in the Urine production industry. The main contributor to these emissions is subsector **2B** – Chemical production. Emissions of PMs have a continuously decreasing trend. These emissions are mostly emitted by the subsectors **2C** and **2G**. The fluctuation of CO emissions in the industry sector is connected with activity in the category of Iron and steel production (**2C1**).

Figure 4.1: *Share of emissions of main pollutants in category 2 – Industry in 2023*



Metal production categories emitted most of the emissions of heavy metals and persistent organic pollutants. Emissions of these pollutants have in general a decreasing trend (except Cr and Se, as abatement efficiency is not available). This trend is connected to the installation of abatement technologies in the Metal industry and the improvement of the technological processes (***Figure 4.2***).

Figure 4.2: *Share of emissions of heavy metals and POPs in category 2 – Industry in 2023*



4.3 RECALCULATIONS, IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

The industry sector undertakes continuing improvements. Several issues were corrected during this reporting cycle in categories **2A3**, **2A5b**, **2C3, 2C7a** (due to the correction of activity data to more accurate values or correction of error), **2C1** (due to slight correction in calculations of several heavy metals in historical years), **2H2** (completion and correction of activity data) and **2H3** (correction of emission data).

4.4 MINERAL INDUSTRY (NFR 2A)

4.4.1 Overview

The category covers these NFR activities: Cement production (**2A1**), Lime production (**2A2**), Glass production (**2A3**), Quarrying and mining of minerals other than coal (**2A5a**), Construction and demolition (**2A5b**), Other Mineral Products (**2A6**). Category **2A5c** is reported as IE.

Most of the producers, which are important concerning the release of emissions in the sector, belong to international concerns and operate in several states. The Slovak Republic produces a moderate range of mineral products and does not belong to a significant world producer of mineral commodities. The mining and quarrying sector is not a significant contributor to the country's economy.

Emissions of main pollutants decreased from the year 1990 significantly, with the exception of SOx and NH_3, which have an increasing trend, as well as heavy metals (***Table 4.3***).

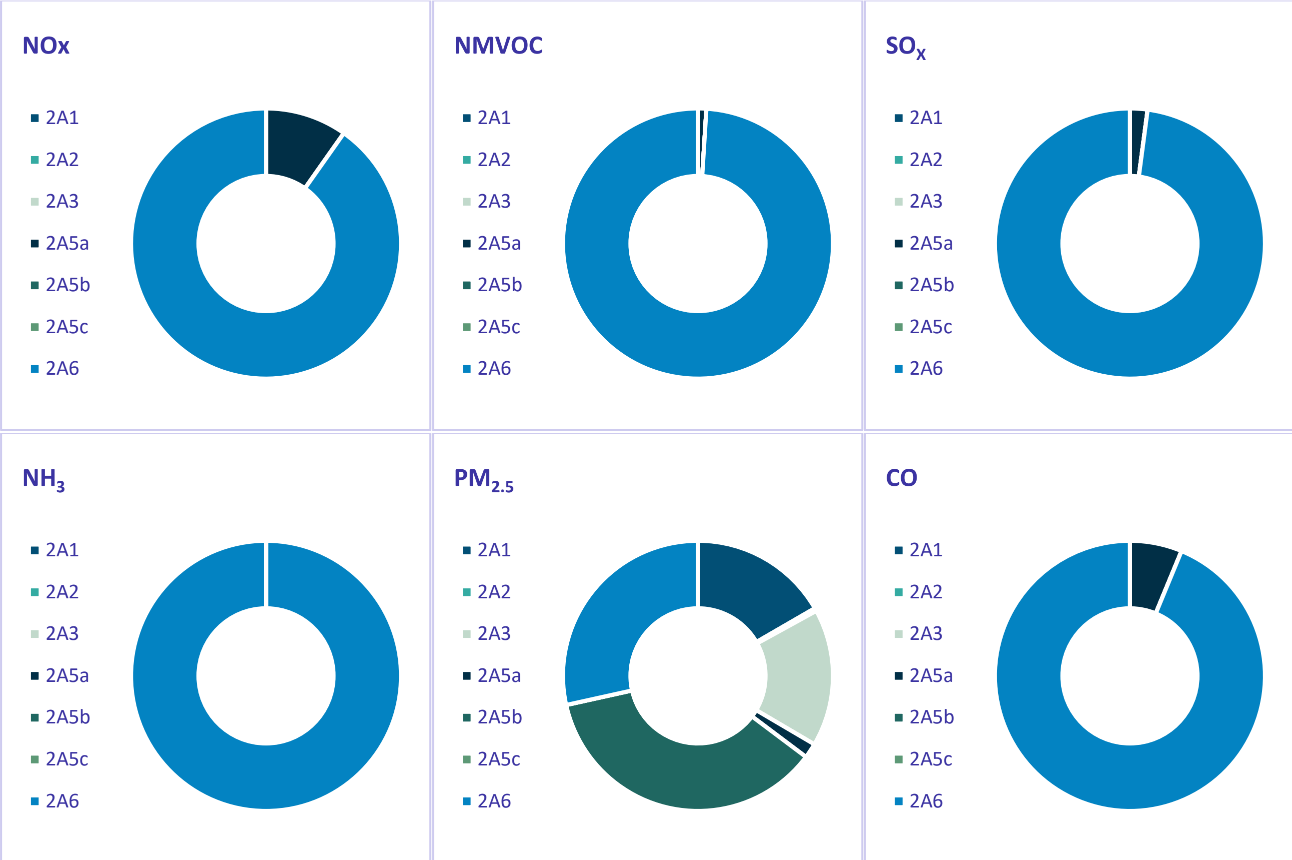
Table 4.3: *Overview of emissions in the category 2A*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.3486	0.1733	0.1915	0.0007	0.3913	1.5852	5.2822	0.0024	1.3184
1995	0.3515	0.1744	0.1932	0.0007	0.2895	0.6449	2.0453	0.0019	1.3286
2000	0.4595	0.0805	0.2510	0.0001	0.3894	1.0087	3.1525	0.0030	1.1154
2005	0.4547	0.1583	0.4992	0.0041	0.3773	1.7916	6.0106	0.0012	1.7897
2010	0.3263	0.0536	0.3319	0.0129	0.2069	1.1171	3.9141	0.0008	0.4707
2011	0.2935	0.0519	0.3009	0.0137	0.2082	0.9759	3.2877	0.0009	0.4372
2012	0.2678	0.0608	0.3299	0.0227	0.1289	0.4945	1.7221	0.0008	0.3037
2013	0.2160	0.0598	0.3123	0.0214	0.1673	0.8003	2.6533	0.0011	0.3252
2014	0.2078	0.0501	0.3121	0.0210	0.1833	0.7709	2.5717	0.0017	0.2742
2015	0.2328	0.0742	0.3639	0.0248	0.3393	2.4445	8.1369	0.0014	0.3337
2016	0.2585	0.1176	0.4312	0.0228	0.1620	0.8479	2.8139	0.0015	0.5467
2017	0.2946	0.1265	0.4350	0.0234	0.1801	1.3160	4.4599	0.0006	0.5958
2018	0.3183	0.1485	0.4528	0.0241	0.1398	0.7650	2.5761	0.0005	0.8134
2019	0.2938	0.1292	0.4271	0.0220	0.1584	1.0263	3.4639	0.0008	0.7771
2020	0.2906	0.0883	0.4510	0.0276	0.2451	1.8953	6.3667	0.0007	0.7034
2021	0.3245	0.1317	0.4080	0.0753	0.2160	1.5915	5.3558	0.0006	0.7855
2022	0.3123	0.1483	0.3454	0.0674	0.1890	1.3494	4.5621	0.0006	0.8216
2023	0.2404	0.0822	0.3405	0.0274	0.1275	0.6103	2.0461	0.0007	0.4784
1990/2023	**-31%**	**-53%**	**78%**	**3599%**	**-67%**	**-61%**	**-61%**	**-73%**	**-64%**
2022/2023	**-23%**	**-45%**	**-1%**	**-59%**	**-33%**	**-55%**	**-55%**	**7%**	**-42%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.2725	0.0058	0.0007	0.0140	0.0179	0.0016	0.0116	0.0724	0.0863
1995	0.3054	0.0072	0.0007	0.0173	0.0221	0.0017	0.0143	0.0895	0.0904
2000	0.3019	0.0070	0.0007	0.0168	0.0214	0.0017	0.0139	0.0869	0.0905
2005	0.4540	0.0139	0.0008	0.0337	0.0430	0.0020	0.0279	0.1742	0.1035
2010	0.5021	0.0182	0.0007	0.0439	0.0560	0.0017	0.0363	0.2272	0.0885
2011	0.5094	0.0185	0.0007	0.0446	0.0570	0.0017	0.0369	0.2309	0.0895
2012	0.4657	0.0193	0.0009	0.0466	0.0594	0.0021	0.0385	0.2409	0.1114
2013	0.4710	0.0195	0.0010	0.0471	0.0601	0.0023	0.0390	0.2436	0.1230
2014	0.4597	0.0190	0.0010	0.0460	0.0587	0.0022	0.0380	0.2378	0.1184
2015	0.4507	0.0187	0.0010	0.0451	0.0575	0.0024	0.0373	0.2331	0.1265
2016	0.4531	0.0188	0.0011	0.0453	0.0578	0.0025	0.0375	0.2344	0.1307
2017	0.4651	0.0192	0.0011	0.0465	0.0593	0.0025	0.0385	0.2406	0.1333
2018	0.4684	0.0194	0.0011	0.0468	0.0598	0.0025	0.0388	0.2423	0.1336
2019	0.3705	0.0153	0.0009	0.0370	0.0473	0.0022	0.0307	0.1916	0.1155
2020	0.5471	0.0226	0.0011	0.0547	0.0698	0.0025	0.0453	0.2830	0.1304
2021	0.5698	0.0236	0.0012	0.0570	0.0727	0.0027	0.0472	0.2947	0.1453
2022	0.6563	0.0272	0.0012	0.0656	0.0837	0.0027	0.0543	0.3395	0.1435
2023	0.5706	0.0236	0.0010	0.0571	0.0728	0.0023	0.0472	0.2951	0.1205
1990/2023	**109%**	**308%**	**40%**	**308%**	**308%**	**40%**	**308%**	**308%**	**40%**
2022/2023	**-13%**	**-13%**	**-16%**	**-13%**	**-13%**	**-16%**	**-13%**	**-13%**	**-16%**

Shares of NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, and CO emissions in the 2023 NFR categories included in the mineral industry are shown in ***Figure 4.3***.

Figure 4.3: *Shares of emissions of the main pollutants in 2A in 2023*



4.4.2 Cement Production (NFR 2A1)

4.4.2.1 Overview

Cement manufacturing is a highly energy-demanding process based on several stages (quarrying a mixture of limestone and clay; grinding the limestone and clay; burning the slurry or powder to a high temperature in a kiln, to produce clinker; blending and grinding the clinker with gypsum to make cement). The chemical base of the process is the thermal decomposition of calcium carbonate at about 900°C (calcination) on calcium oxide CaO and carbon dioxide CO_2. Then the CaO reacts at high temperatures (1 400 – 1 500˚C) with silica, alumina, and ferrous oxide to form the silicates, aluminates and ferrites of calcium. This partial fusion forms nodules of clinker. The burning process takes place typically in a rotary kiln.

The manufacture of cement is a strongly regulated process by legislative limits for pollution. The primary fuel used is usually finely ground coal dust, products based on coal dust (coal, stern pellets) petroleum coke, and pyrolysis. All four cement producers (large point sources) in the Slovak Republic have the approval to utilize alternative fuels (refuse-derived fuel – RDF and used tyres, sludge, fly ash, beef and bone meal or similarly categorized fuel waste) and raw materials for energy and resource recovery. The plant provides a yearly report on types and amounts of alternative fuel used.

Emission trends are shown in ***Table 4.4***.

Table 4.4: *Activity data and emissions in the category 2A1*

YEAR	CLINKER PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
1990	2 835.75	0.0773	0.1824	0.4489	0.0023
1995	2 235.75	0.0610	0.1438	0.3539	0.0018

YEAR	CLINKER PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
2000	2 313.71	0.0954	0.2251	0.5541	0.0029
2005	2 352.68	0.0370	0.0872	0.2149	0.0011
2010	1 653.59	0.0256	0.0598	0.1423	0.0008
2011	2 433.86	0.0307	0.0716	0.1704	0.0009
2012	2 126.12	0.0276	0.0644	0.1534	0.0008
2013	2 161.32	0.0365	0.0852	0.2027	0.0011
2014	2 415.34	0.0574	0.1340	0.3190	0.0017
2015	2 506.12	0.0458	0.1068	0.2542	0.0014
2016	2 599.39	0.0495	0.1154	0.2748	0.0015
2017	2 698.82	0.0207	0.0484	0.1151	0.0006
2018	2 695.74	0.0170	0.0396	0.0944	0.0005
2019	2 854.64	0.0275	0.0643	0.1531	0.0008
2020	2 945.23	0.0214	0.0500	0.1191	0.0006
2021	2 937.74	0.0189	0.0441	0.1051	0.0006
2022	3 041.27	0.0196	0.0456	0.1087	0.0006
2023	2 658.92	0.0212	0.0496	0.1180	0.0006
1990/2023	**-6%**	**-73%**	**-73%**	**-74%**	**-73%**
2022/2023	**-13%**	**9%**	**9%**	**9%**	**9%**

4.4.2.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.5.***

Table 4.5: *Activities according to national categorization included in 2A1*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
3.2. Manufacture of cement with a projected production capacity in t/d

Emission data is compiled in the NEIS, therefore, the individual-specific EF could be used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**.

Emission factors used for the reconstruction of historical years 1990-1999 were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 4.6***). The share of $PM_{2.5}$ and PM_{10} in TSP is calculated using average shares from 2005-2009.

Table 4.6: *Emission factors for calculation of historical years*

	TSP [g/t CLINKER PRODUCED]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]
EF	158.30	17%	41%	3.00%

*EMEP/EEA GB_{2023}

4.4.2.3 Completeness

Pollutants originating from combustion activities were reported under the category **1A2f**, as these pollutants cannot be separated in the NEIS database in the whole time series. Therefore, the notation key IE was used for these pollutants, and only particulate matter emissions were reported within this category.

4.4.2.4 Source-specific Recalculations

Recalculations were not performed for the current submission.

4.4.3 Lime Production (NFR 2A2)

4.4.3.1 Overview

The production of lime during the year 2023 in The Slovak Republic was operated by 5 companies in 7 stationary sources. All sources are covered by the NEIS database.

Production of lime, which is chemically calcium oxide (CaO), is performed by the thermal decomposition of limestone at the temperatures of 1 040 – 1 300°C. Production is therefore highly energy-demanding process. Hydrated lime ($Ca(OH)_2$) is also produced by Slovak operators.

Relevant rising emissions from this manufacturing, their trends and activity data (***Table 4.7***) are presented in the following figures.

Table 4.7: *Activity data and emissions in the category 2A2*

YEAR	LIME PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
1990	1076.00	0.0083	0.0993	0.8279	0.0000
1995	803.00	0.0062	0.0741	0.6179	0.0000
2000	753.59	0.0056	0.0666	0.5552	0.0000
2005	913.08	0.0054	0.0644	0.5365	0.0000
2010	822.36	0.0040	0.0480	0.3999	0.0000
2011	856.05	0.0024	0.0288	0.2398	0.0000
2012	797.33	0.0022	0.0265	0.2206	0.0000
2013	716.54	0.0008	0.0096	0.0798	0.0000
2014	727.63	0.0021	0.0247	0.2059	0.0000
2015	680.20	0.0009	0.0102	0.0854	0.0000
2016	663.02	0.0006	0.0075	0.0628	0.0000
2017	640.06	0.0006	0.0073	0.0612	0.0000
2018	668.99	0.0007	0.0080	0.0667	0.0000
2019	586.05	0.0006	0.0071	0.0594	0.0000
2020	515.35	0.0005	0.0061	0.0512	0.0000
2021	677.83	0.0006	0.0067	0.0560	0.0000
2022	688.95	0.0006	0.0070	0.0586	0.0000
2023	791.71	0.0004	0.0054	0.0449	0.0000
1990/2023	**-26%**	**-95%**	**-95%**	**-95%**	**-95%**
2022/2023	**15%**	**-23%**	**-23%**	**-23%**	**-23%**

4.4.3.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.8***.

Table 4.8: *Activities according to national categorization included in 2A2*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
3.3. Manufacture of lime with a projected production capacity of cement clinker in t/d

Emission data is compiled in the NEIS, therefore, the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**. Emission factors used for the reconstruction of historical years 1990-1999 were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 4.9***). Share of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009.

Table 4.9: *Emission factors for calculation of historical years*

	TSP [g/t LIME PRODUCED]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]
EF	769.44	1%	12%	0.46%

*EMEP/EEA GB$_{2023}$

4.4.3.3 Completeness

Pollutants originating from combustion activities were reported under the category **1A2f**, as these pollutants cannot be separated in the NEIS database in the entire time series. Therefore, the notation key IE was used for these pollutants, and only particulate matter emissions were reported within this category.

4.4.3.4 Source-specific Recalculations

Recalculations were not performed for the current submission.

4.4.4 Glass Production (NFR 2A3)

4.4.4.1 Overview

The emission from glass production is covered in the registry of the NEIS (4 companies: Johns Mansville Slovakia, Rona, Vetropack, R-Glass). Emission factors are given for process and combustion emissions together since they are recorded as united in annual data sets. It is not straightforward to separate these processes.
The basic raw material for glass production is silica (SiO_2). Limestone ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), soda ash (Na_2CO_3), potash (K_2CO_3), Pb_3O_4, Al_2O_3, and colouring agents are used in the glass production process. The main emissions that originated during the manufacturing are sulphur oxides (SOx), nitrogen oxides (NOx) and carbon dioxide (CO_2). However, other pollutants are also occurring: emissions of particulate matter (PMs) from handling raw materials, emissions of heavy metals produced by the melting process or presented in the PM; carbon monoxide (CO), or nitrous oxide (N_2O). DIOX emissions were balanced for the first time in submission 2021. Reported emissions, their trends and activity data from glass production are presented below in ***Table 4.10***.

Table 4.10: *Activity data and emissions in the category 2A3*

YEAR	CONTAINER GLASS [kt]	GLASS FIBRE [kt]	LEAD CRYSTAL GLASS [kt]	WATER GLASS [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
1990	48.26	93.08	13.26	78.69	0.0856	0.0894	0.0941	0.0001
1995	59.67	92.88	13.23	78.52	0.0897	0.0936	0.0985	0.0001
2000	57.96	93.94	13.38	79.41	0.1196	0.1248	0.1314	0.0001
2005	116.14	82.25	11.72	69.54	0.0512	0.0535	0.0563	0.0000
2010	151.45	44.19	6.29	37.36	0.0106	0.0110	0.0115	0.0000
2011	153.95	44.19	6.29	37.36	0.0113	0.0118	0.0124	0.0000
2012	160.58	103.83	NO	36.70	0.0079	0.0082	0.0087	0.0000
2013	162.43	134.63	NO	35.32	0.0117	0.0122	0.0128	0.0000
2014	158.51	125.45	NO	35.99	0.0165	0.0172	0.0181	0.0000
2015	155.42	151.18	NO	35.19	0.0187	0.0195	0.0205	0.0000
2016	156.25	156.08	NO	40.90	0.0292	0.0305	0.0321	0.0000
2017	160.38	157.46	NO	42.51	0.0216	0.0225	0.0237	0.0000
2018	161.53	155.98	NO	43.63	0.0445	0.0464	0.0488	0.0000
2019	127.75	148.16	NO	36.34	0.0301	0.0314	0.0331	0.0000
2020	188.66	128.42	NO	35.24	0.0320	0.0335	0.0352	0.0000
2021	196.48	155.62	NO	40.63	0.0270	0.0282	0.0297	0.0000
2022	226.30	121.87	NO	39.56	0.0290	0.0303	0.0319	0.0000
2023	196.75	97.73	NO	31.06	0.0210	0.0219	0.0230	0.0000
1990/2023	**308%**	**5%**	**-**	**-61%**	**-76%**	**-76%**	**-76%**	**-76%**
2022/2023	**-13%**	**-20%**	**-**	**-21%**	**-28%**	**-28%**	**-28%**	**-28%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.2725	0.0058	0.0007	0.0140	0.0179	0.0016	0.0116	0.0724	0.0863
1995	0.3054	0.0072	0.0007	0.0173	0.0221	0.0017	0.0143	0.0895	0.0904

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2000	0.3019	0.0070	0.0007	0.0168	0.0214	0.0017	0.0139	0.0869	0.0905
2005	0.4540	0.0139	0.0008	0.0337	0.0430	0.0020	0.0279	0.1742	0.1035
2010	0.5021	0.0182	0.0007	0.0439	0.0560	0.0017	0.0363	0.2272	0.0885
2011	0.5094	0.0185	0.0007	0.0446	0.0570	0.0017	0.0369	0.2309	0.0895
2012	0.4657	0.0193	0.0009	0.0466	0.0594	0.0021	0.0385	0.2409	0.1114
2013	0.4710	0.0195	0.0010	0.0471	0.0601	0.0023	0.0390	0.2436	0.1230
2014	0.4597	0.0190	0.0010	0.0460	0.0587	0.0022	0.0380	0.2378	0.1184
2015	0.4507	0.0187	0.0010	0.0451	0.0575	0.0024	0.0373	0.2331	0.1265
2016	0.4531	0.0188	0.0011	0.0453	0.0578	0.0025	0.0375	0.2344	0.1307
2017	0.4651	0.0192	0.0011	0.0465	0.0593	0.0025	0.0385	0.2406	0.1333
2018	0.4684	0.0194	0.0011	0.0468	0.0598	0.0025	0.0388	0.2423	0.1336
2019	0.3705	0.0153	0.0009	0.0370	0.0473	0.0022	0.0307	0.1916	0.1155
2020	0.5471	0.0226	0.0011	0.0547	0.0698	0.0025	0.0453	0.2830	0.1304
2021	0.5698	0.0236	0.0012	0.0570	0.0727	0.0027	0.0472	0.2947	0.1453
2022	0.6563	0.0272	0.0012	0.0656	0.0837	0.0027	0.0543	0.3395	0.1435
2023	0.5706	0.0236	0.0010	0.0571	0.0728	0.0023	0.0472	0.2951	0.1205
1990/2023	**109%**	**308%**	**40%**	**308%**	**308%**	**40%**	**308%**	**308%**	**40%**
2022/2023	**-13%**	**-13%**	**-16%**	**-13%**	**-13%**	**-16%**	**-13%**	**-13%**	**-16%**

4.4.4.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.11***.

Table 4.11: *Activities according to national categorization included in 2A3*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
3.7. Manufacture of glass, glass products, including glass fibre with projected melting capacity in t/d

Emission data is compiled in the NEIS database therefore, the individual-specific EFs were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**.

Emission factors used for the reconstruction of historical years 1990-1999 were calculated using a weighted average of IEF for each pollutant for the period 2000-2004 (***Table 4.12***). The share of $PM_{2.5}$ and PM_{10} in TSP is calculated using average shares from 2005-2009.

Table 4.12: *Emission factors for calculation of historical years*

	TSP [g/t GLASS PRODUCED]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]
EF	403.28	91%	95%	0.06%

*EMEP/EEA GB_{2023}

HMs

Heavy metals are reported by the Tier 2/Tier 1 method. The emissions of heavy metals are processed by the national emission factors presented in ***Table 4.13***. The methodology distinguishes several types of products.

Table 4.13: *Emission factors of heavy metals in 2A3*

EF [g/t [PRODUCT]/TYPE OF PRODUCT	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
T1 method			0.003			0.007			0.37
T2 Container glass	2.9	0.12	-	0.29	0.37	-	0.24	1.5	-
T2 Glass Fibre	-	-	-	-	-	-	-	-	-
T2 Lead crystal glass	10	-	-	-	-	-	-	-	-
T2 Water glass	-	-	-	-	-	-	-	-	-

4.4.4.3 Completeness

Pollutants originating from combustion activities were reported under the category **1A2f**, as these pollutants cannot be separated in the NEIS database in the entire time series. Therefore, the notation key IE was used for these pollutants, and only particulate matter emissions were reported within this category.

4.4.4.4 Source-specific Recalculations

In the current submission, the correction of activity data for years 2021 and 2022 was performed, and the following recalculation of several heavy metals was done (***Table 4.14***).

Table 4.14: *Previous and revised values of activity data in the category 2A3 and emission change*

YEARS	AD – GLASS PRODUCTION [kt]			Hg	Cu	Zn
	PREVIOUS	REVISED	CHANGE			
2021	386.13	392.73	2%	2%	2%	2%
2022	587.15	387.72	-34%	-34%	-34%	-34%

Firstly, the activity data of Water glass production was updated (in values: from 386.13 kt to 392.73 kt) for the year 2021. Recalculated emissions of Hg, Cu and Zn according to Tier 1 methodology reflect a 2% increase due to activity data. Secondly, the error in activity data of Water glass production (in values: from 587.15 kt to 387.72 kt) was removed and corrected for the year 2022. Recalculated emissions of Hg, Cu and Zn according to Tier 1 methodology reflect the change. The percentage decrease (-34%) is not significant in terms of tons. It represents -0.0006 t for emissions of Hg, values -0.0014 t for Cu and values -0.0738 t for Zn.

4.4.5 Quarrying and Mining of Minerals Other than Coal (NFR 2A5a)

4.4.5.1 Overview

In the territory of the Slovak Republic, surface and underground quarrying and mining locations for various materials were occurring during the year 2022 (lignite, oil and natural gas are not included in the category). Amongst them are metallic ores (Fe, Au, Ag, Pb, Zn – surface ore mining is not occurring), magnesite ore and building material (building stones, sandstones and sand, brick raw materials), limestone for cement and lime production, but also some other raw material (bentonite, perlite, talc and others). The emissions rising from the extractions of these minerals are mainly particulate matter. The other air pollutants are related to technological units and equipment necessary for quarrying, handling and processing of the material. Reported emissions from this category and their trends (***Table 4.15***) are presented in the following figures.

Table 4.15: *Overview of emissions in the category 2A5a*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	0.0080	0.0002	0.0068	0.0018	0.0213	0.1772	0.0218
1995	0.0086	0.0002	0.0073	0.0019	0.0230	0.1912	0.0235
2000	0.0139	0.0002	0.0055	0.0036	0.0430	0.3579	0.0374
2005	0.0214	0.0005	0.0144	0.0037	0.0446	0.3715	0.0431
2010	0.0254	0.0012	0.0200	0.0030	0.0359	0.3036	0.0350
2011	0.0202	0.0012	0.0065	0.0028	0.0330	0.2752	0.0272
2012	0.0221	0.0013	0.0071	0.0023	0.0277	0.2307	0.0236
2013	0.0295	0.0006	0.0085	0.0025	0.0304	0.2531	0.0340
2014	0.0270	0.0007	0.0075	0.0025	0.0296	0.2463	0.0449
2015	0.0292	0.0007	0.0106	0.0024	0.0293	0.2443	0.0320
2016	0.0302	0.0008	0.0092	0.0022	0.0270	0.2246	0.0391
2017	0.0367	0.0010	0.0079	0.0024	0.0262	0.2159	0.0423
2018	0.0289	0.0009	0.0055	0.0021	0.0250	0.2080	0.0359
2019	0.0303	0.0009	0.0062	0.0020	0.0242	0.2020	0.0382

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
2020	0.0323	0.0009	0.0065	0.0020	0.0241	0.2011	0.0270
2021	0.0328	0.0010	0.0079	0.0021	0.0253	0.2110	0.0277
2022	0.0276	0.0010	0.0074	0.0023	0.0276	0.2303	0.0300
2023	0.0235	0.0008	0.0071	0.0023	0.0273	0.2278	0.0299
1990/2023	**194%**	**403%**	**6%**	**29%**	**29%**	**29%**	**37%**
2022/2023	**-15%**	**-21%**	**-3%**	**-1%**	**-1%**	**-1%**	**0%**

4.4.5.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.16***.

Table 4.16: *Activities according to national categorization included in 2A5a*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
2.10. Surface mining of ores
3.10. Quarries and related stone processing
3.11. Mining and processing of silicate raw materials and other raw materials for the production of construction materials. Or mining and processing of other materials used in the industry except for sand and gravel in the wet state.

Emission data is compiled in the NEIS database therefore the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**.
For Quarries and related stone processing for emission calculation, it can be used the official bulletin of the Ministry of Environment (***Table 4.17***).

Table 4.17: *Emission factors for stone processing*

PROCESS – EQUIPMENT	EF FOR TSP IN G/T PROCESSED STONE							
	HUMIDITY IN %							
	0-0.5	0.5-1	1-1.5	1.5-2	2-3	3-4	4-5	5-7
Drilling of rock	9	6	4	3	2	1	0.5	0.2
Loading of cargo	0.2	0.2	0.1	0.1	0.1	0.1	0	0
Unloading of cargo	0.2	0.2	0.1	0.1	0.1	0.1	0	0
Primary crushing	15	10	6.5	4.3	2.4	1.1	0.5	0.2
Primary sorting	14	9	6.2	4.1	2.2	1	0.5	0.2
Transporting on conveyor belts	2	1.4	0.9	0.6	0.3	0.15	0.007	0.002
Secondary crushing	28	19	13	8.5	4.6	2.1	1	0.3
secondary sorting	27	18	12	8	4.4	2	1	0.3
Transporting on conveyor belts	4	2.7	1.8	1.2	0.7	0.2	0.14	0.04
Tertiary crushing	53	36	24	16	8.8	4	1.8	0.5
Tertiary sorting	51	35	23	15	8.5	3.8	1.7	0.5
Transporting on conveyor belts	8	5.5	3.7	2.5	1.4	0.6	0.3	0.1
Tertiary fine crushing (under 4 mm)	640	429	288	193	106	48	21	6.5
Tertiary fine sorting	604	405	271	182	100	45	20	6.1
Transporting on conveyor belts	33	22	15	10	5.5	2.5	1.1	0.3

Historical years 1990-1999 are calculated by using of weighted average of the years 2000-2004 for all rising pollutants. Previously used average IEF of the years 2000-2004 was replaced. Share of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009 (***Table 4.18***).

Table 4.18: *Emission factors for calculation of historical years in 2A5a*

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	TSP [g/GJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/GJ]
EF	136.34	2.77	115.13	3 020.65	1%	12%	371.80

4.4.5.3 Completeness

All rising pollutants were reported.

4.4.5.4 Source-specific Recalculations

Recalculations were not performed for the current submission.

4.4.6 Construction and Demolition (NFR 2A5b)

4.4.6.1 Overview

The chapter covers the emissions of particulate matter originating from the activities of building highway roads and housing construction and demolition. The overall trends of activity data for affected areas and emissions are shown in ***Table 4.19***.

Table 4.19: *Overview of activity data and emissions in 2A5b*

YEAR	AF. AREA OF HIGHWAYS AND EXPRESSWAYS [m^2]	AF. AREA OF NEW BUILDINGS FOR ADMINISTRATION [m^2]	AF. AREA OF COMPLETED FLATS [m^2]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	789 249	343 412	2 585 483	0.1074	1.0737	3.5836
1995	NO	283 365	637 201	0.0191	0.1905	0.6323
2000	36 000	223 318	1 805 397	0.0416	0.4165	1.3863
2005	1 618 920	130 400	2 155 845	0.1393	1.3926	4.6558
2010	1 504 692	64 800	1 586 802	0.0880	0.8799	2.9428
2011	416 628	84 000	1 363 224	0.0735	0.7348	2.4540
2012	NO	76 000	1 421 360	0.0302	0.3023	1.0068
2013	510 480	19 200	1 447 614	0.0601	0.6009	2.0080
2014	207 360	77 600	2 314 000	0.0504	0.5040	1.6812
2015	2 038 680	34 737	2 288 000	0.2222	2.2219	7.4311
2016	344 160	186 400	2 418 000	0.0645	0.6453	2.1526
2017	1 017 360	43 200	2 483 000	0.1189	1.1893	3.9747
2018	NO	52 800	2 782 000	0.0626	0.6259	2.0858
2019	518 400	97 600	2 873 000	0.0883	0.8832	2.9482
2020	1 857 600	36 000	3 055 000	0.1762	1.7621	5.8916
2021	1 107 900	63 200	2 873 000	0.1458	1.4582	4.8730
2022	468 000	52 000	3 016 000	0.1216	1.2160	4.0594
2023	72 000	53 600	2 912 000	0.0463	0.4627	1.5427
1990/2023	**-91%**	**-84%**	**13%**	**-57%**	**-57%**	**-57%**
2022/2023	**-85%**	**3%**	**-3%**	**-62%**	**-62%**	**-62%**

4.4.6.2 Methodological Issues

The emissions are reported in the category according to the methodology of EMEP/EEA GB_{2023} in a division of Non-residential construction, Construction of apartments and Road construction. The construction of family houses was not included yet due to missing activity data. Overview of used emission factors (***Table 4.20***).

Table 4.20: *EF used for the calculations in category 2A5b*

EF (GB_{2019} – division)	$PM_{2.5}$ [kg/m^2]	PM_{10} [kg/m^2]	TSP [kg/m^2]
Road construction	0.23	2.3	7.7
Non-residential construction	0.1	1	3.3
Construction of apartments	0.03	0.3	1

In the submission, parameters of the area affected (A), construction duration (d), control efficiency of applied emission reduction measures (CE), Thornthwaite precipitation-evaporation index (PE) and soil silt content (s) were taken into calculation following ***Equation 4.1***.

Equation 4.1: *Tier 1 approach to estimating total fugitive PM emissions*

$$E_{PM_s} = EF_{PM_s} \times A_{affected} \times d \times (1 - CE) \times \left(\frac{24}{PE}\right) \times \left(\frac{s}{9\%}\right)$$

Where:

E PMs = PMs emissions (kg PMs)

EF PMs = the emission factor for this pollutant emission (kg PMs/ [m² x year])

A affected = area affected by construction activity (m²)

d = duration of construction (year)

CE = efficiency of emission control measures (-)

PE = Thornthwaite precipitation-evaporation index (-)

s = soil silt content (%)

The parameters used for the calculation are listed in ***Table 4.21*** and ***Table 4.22***.

Table 4.21: *Parameters used for the calculations in category 2A5b*

PARAMETER	d	CE	s	$A_{affected}$
Road construction	0.83	0.5	20%	36000*
Non-residential construction	0.83	0.5	20%	0.8
Construction of apartments	0.75	0	20%	1.3

*m²/km

Thornthwaite precipitation-evaporation index was calculated using ***Equation 4.2***.

Equation 4.2: *Thornthwaite precipitation-evaporation index calculation*

$$PE\ index = 3.16 \sum_{i=0}^{12} \left(\frac{P_i}{1.8\,T_i + 22}\right)$$

Where:

P_i – monthly precipitation (in mm)

T_i – mean temperature (in °C)

The Thornthwaite precipitation-evaporation index was calculated using parameters and the index in ***Table 4.22***.

Table 4.22: *Parameters used for the calculations of Thornthwaite precipitation-evaporation index*

PARAMETER	P_i	T_i	PE
1990	72.47	10.00	73.39
1995	72.16	10.00	73.04
2000	67.92	10.00	68.29
2005	78.17	10.00	79.83
2010	104.58	10.00	110.32
2011	54.67	10.00	53.65
2012	62.25	10.00	61.99
2013	72.00	10.00	72.86
2014	77.83	10.00	79.45
2015	59.92	10.00	59.41
2016	77.00	10.00	78.51
2017	68.92	10.00	69.40
2018	56.08	10.00	55.20
2019	70.67	10.00	71.36
2020	73.83	10.00	74.92

PARAMETER	P_I	T_I	PE
2021	63.42	10.00	63.28
2022	51.58	10.00	50.30
2023	83.58	10.00	86.00

4.4.6.3 Completeness

All rising pollutants were reported.

4.4.6.4 Source-specific Recalculations

In the current submission, the recalculation was done for the year 2022 (***Table 4.23***).

Table 4.23: *Previous and revised activity data and emission change in the category 2A5b*

YEAR	AD - AFFECTED AREA OF HIGHWAYS AND EXPRESSWAYS [mil.m²]			$PM_{2.5}$	PM_{10}	TSP
	PREVIOUS	REVISED	CHANGE			
2022	3.21	3.54	10%	37%	37%	37%

The recalculation relates to the correction in activity data of constructed highways for the year 2022 (value difference: 0.3240 mil. m^2 of affected area). The update of input data was applied according to the EMEP/EEA GB_{2023} methodology for emissions calculation of TSP, $PM_{2.5}$ and PM_{10}, which were consequently revised. It resulted in a visible percentage change, although the values are not significant (for $PM_{2.5}$: 0.0888 kt to 0.1216 kt; for PM_{10}: 0.8881 kt to 1.2160 kt; for TSP: 2.9617 kt to 4.0594 kt).

4.4.7 Storage, Handling and Transport of Mineral Products (NFR 2A5c)

4.4.7.1 Overview

The category is reported by notation key NA and IE for TSP and PMs because the emissions from handling are already included in outputs from individual technologies, and it would be double-counting if reported in this category separately by T1.

4.4.8 Other Mineral Products (NFR 2A6)

4.4.8.1 Overview

The category covers other industrial activities of the mineral industry not covered in the described NFR categories. Reported emissions under the category and their trends are presented below (***Table 4.24***). The increase in emissions in 2021 was caused by the failure of the automatic burner for burning furnace gases on the Envirotec L2 filter device, which resulted in the opening of the emergency chimney and the release of emissions into the air.

Table 4.24: *Overview of emissions in the category 2A6*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	0.3406	0.1731	0.1847	0.0007	0.1110	0.1191	0.1505	1.2966
1995	0.3428	0.1742	0.1859	0.0007	0.1117	0.1199	0.1515	1.3050
2000	0.4456	0.0803	0.2455	0.0001	0.1236	0.1327	0.1677	1.0779
2005	0.4333	0.1578	0.4848	0.0041	0.1408	0.1494	0.1757	1.7465
2010	0.3009	0.0524	0.3119	0.0129	0.0757	0.0825	0.1141	0.4357
2011	0.2734	0.0507	0.2944	0.0137	0.0877	0.0959	0.1359	0.4100
2012	0.2457	0.0595	0.3228	0.0227	0.0587	0.0654	0.1020	0.2801
2013	0.1865	0.0591	0.3039	0.0214	0.0558	0.0622	0.0969	0.2912
2014	0.1807	0.0494	0.3046	0.0210	0.0545	0.0614	0.1012	0.2293
2015	0.2036	0.0735	0.3534	0.0248	0.0494	0.0568	0.1014	0.3016

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
2016	0.2283	0.1168	0.4220	0.0228	0.0159	0.0221	0.0670	0.5076
2017	0.2579	0.1254	0.4271	0.0234	0.0158	0.0223	0.0693	0.5535
2018	0.2895	0.1476	0.4473	0.0241	0.0130	0.0200	0.0724	0.7775
2019	0.2636	0.1283	0.4208	0.0220	0.0098	0.0162	0.0682	0.7389
2020	0.2583	0.0874	0.4445	0.0276	0.0128	0.0194	0.0685	0.6764
2021	0.2917	0.1308	0.4001	0.0753	0.0215	0.0288	0.0809	0.7578
2022	0.2846	0.1473	0.3380	0.0674	0.0160	0.0228	0.0732	0.7916
2023	0.2168	0.0814	0.3334	0.0274	0.0363	0.0434	0.0897	0.4486
1990/2023	**-36%**	**-53%**	**81%**	**3599%**	**-67%**	**-64%**	**-40%**	**-65%**
2022/2023	**-24%**	**-45%**	**-1%**	**-59%**	**127%**	**90%**	**23%**	**-43%**

4.4.8.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.25***.

Table 4.25: *Activities according to national categorization included in 2A6*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
3.4. Production of magnesium oxide from magnesite and production of alkaline refractory materials with a projected production capacity t/d
3.6. Installations for melting of mineral substances including the processing of melt materials and production of mineral fibres with a melting capacity projected in t/d
3.8. Manufacture of ceramic products by firing, roofing tiles, bricks, tiles, stoneware or porcelain:
-with a projected production capacity in t/d or
-with a kiln capacity in m^3 and with a setting density per kiln exceeding 300 kg/m 3
3.9. Production of lightweight non-metallic mineral products with a projected production capacity of m^3/d
3.12. Production of unfired masonry materials and precast units with a projected production capacity of m^3/h
3.13. Industrial production of concrete, mortar or other building materials with a projected production capacity in m^3/h
3.99. Other industrial production and processing of non-metallic mineral products - division by point 2.99
4.32. Production and processing of carbon materials:
a) production of charcoal with a projected production in kg/d
b) production of soot
c) burning carbonaceous materials, including impregnation
d) mechanical processing of carbonaceous materials

Emission data is compiled in the NEIS database, therefore, the individual-specific EF could be used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**.

Industrial production of concrete for emission calculation can be used in the official bulletin of the Ministry of Environment:

LFS – large fraction of stones

FFS – fine fraction of stones

Emission factors from the Bulletin of the Ministry of Environment are shown in ***Table 4.26*** (valid for 2000-2023). Emission factors for the historical years were calculated as a weighted average of the IEF of the period 2000-2004. The share of $PM_{2.5}$ and PM_{10} in TSP is calculated using average shares from 2005-2009 (***Table 4.27***).

Table 4.26: *Emission factors provided by Bulletin of MoE*

PROCESS	EF	
	TSP	PM_{10}
	g/m^3	
Transport and loading of LFS into boxes – fugitive emissions	3.8	1.8
Transport and loading of FFS into boxes – fugitive emissions	1	0.5
loading of LFS into underground storage or transport equipment – fugitive emissions	3.8	1.8

PROCESS	EF	
	TSP	PM_{10}
	g/m³	
loading of FFS into underground storage or transport equipment – fugitive emissions	1	0.5
Transport of LFS to mixing drum or convoy or above – ground storage	3.8	1.8
Transport of FFS to mixing drum or convoy or above – ground storage	1	0.5
transport of cement into the silo (abated)	0.1	0.1
transport of ash or cinder (abated)	0.2	0.1
filling the stock over mixing drum with FFS	3.8	1.8
filling the stock over mixing drum with LFS	1	0.5
filling the drum with solid material - abated	0.2	0.1
average humidity and batching of materials	19.7	9.5

Table 4.27: *Emission factors for calculation of historical years in 2A6*

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	TSP [g/GJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/GJ]
EF	159.01	80.81	86.22	0.35	70.26	74%	79%	605.28

4.4.8.3 Completeness

All rising pollutants were reported.

4.4.8.4 Source-specific Recalculations

No recalculation was made.

4.5 CHEMICAL PRODUCTS (NFR 2B)

4.5.1 Overview

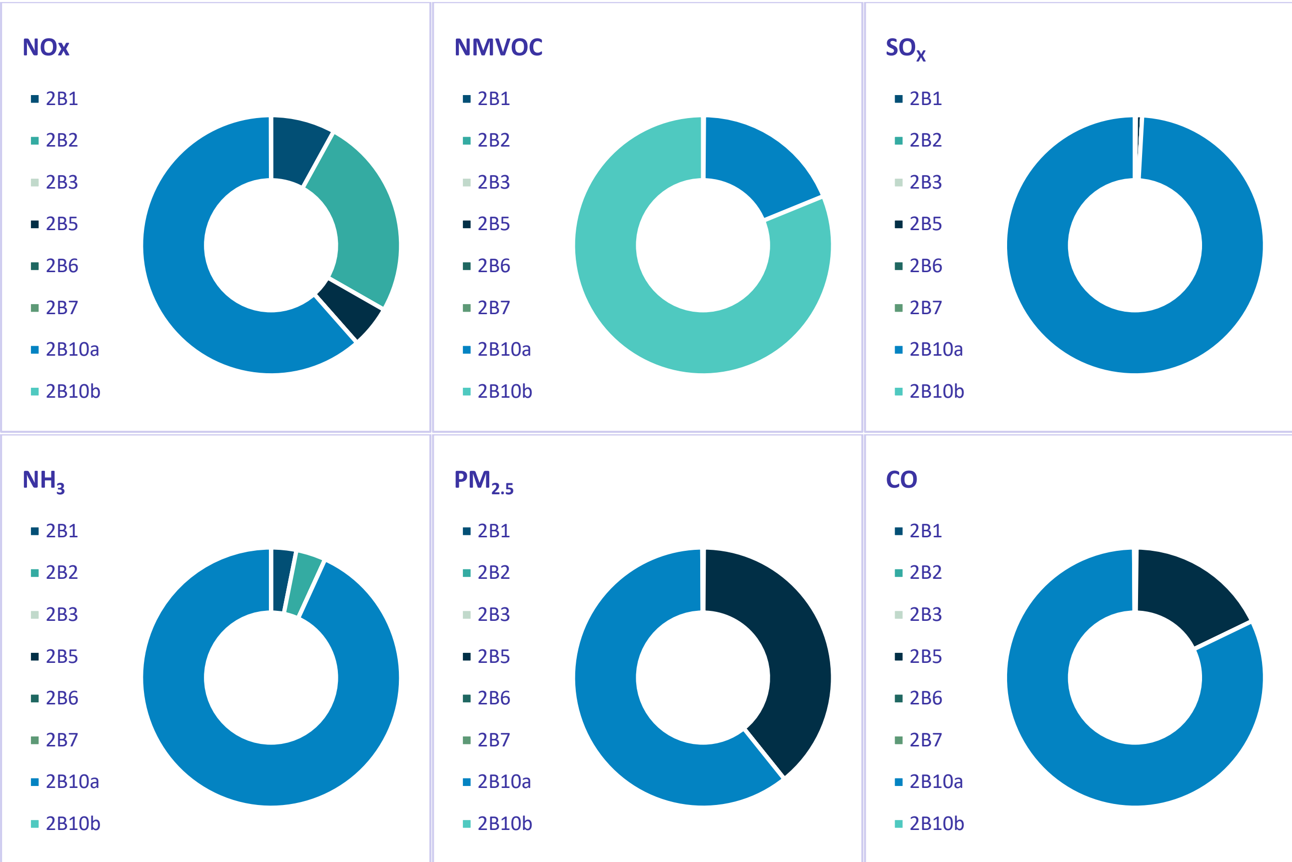
The category covers the NFR activities: Ammonia production (**2B1**), Nitric acid production (**2B2**), Adipic acid production (**2B3**), Carbide production (**2B5**), Titanium dioxide production (**2B6**), Soda ash production (**2B7**), Chemical industry: Other (**2B10a**), Storage, handling and transport of chemical products (**2B10b**).
Emissions from this category have a general decreasing trend, except for the emissions of SOx (***Table 4.28***). It was caused by stricter legislation and the adoption of emissions limits for the main pollutants. Emissions of NOx originate mostly from category **2B10a,** which includes the production of various organic and inorganic compounds, fertilizers, etc.
Not all are occurring in the territory of Slovakia. Shares of released emissions of main air pollutants in 2023. NFR categories included are provided in the figure below (***Figure 4.4***).

Table 4.28: *Overview of emissions in category 2B*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	1.0829	6.0322	1.6193	0.2449	0.2095	0.3308	0.5077	0.0034	4.1970
1995	1.2687	5.8719	1.5772	0.2368	0.3545	0.5731	0.9131	0.0033	4.1210
2000	1.2470	5.9168	0.9387	0.1699	0.3386	0.5499	0.8822	0.0027	5.0582
2005	1.0212	3.1771	1.0770	0.2241	0.2083	0.3384	0.5437	0.0017	1.5312
2010	0.6434	1.9941	1.2018	0.0684	0.0843	0.1411	0.2328	0.0009	1.0593
2011	1.1640	2.2196	1.3395	0.1668	0.1235	0.1982	0.3126	0.0016	0.9440
2012	0.9922	1.8870	1.2745	0.1548	0.1415	0.2314	0.3738	0.0014	1.6484
2013	1.0765	2.1398	1.4026	0.1061	0.1549	0.2543	0.4124	0.0014	1.2780
2014	0.9613	1.9304	1.2950	0.0639	0.1357	0.2248	0.3679	0.0011	1.3369
2015	1.0176	2.2004	1.3706	0.0945	0.1455	0.2375	0.3834	0.0014	1.2545
2016	1.0487	2.0332	1.5099	0.1574	0.1154	0.1920	0.3166	0.0012	1.1543

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2017	1.1728	2.0977	1.4116	0.1457	0.1224	0.2026	0.3331	0.0013	1.2053
2018	1.2158	2.1072	1.3936	0.1626	0.1188	0.1947	0.3163	0.0013	1.1725
2019	1.0795	1.9449	1.3327	0.1400	0.1342	0.2223	0.3674	0.0010	1.0253
2020	1.0160	2.0983	1.2662	0.2032	0.1229	0.2051	0.3403	0.0012	1.2007
2021	1.0212	2.2056	1.1903	0.1812	0.1272	0.2114	0.3493	0.0013	1.2051
2022	0.8252	2.0276	1.5051	0.1249	0.0846	0.1401	0.2306	0.0009	1.0211
2023	0.7962	1.7021	1.4189	0.1317	0.0659	0.1097	0.1811	0.0007	0.7513
1990/2023	**-26%**	**-72%**	**-12%**	**-46%**	**-69%**	**-67%**	**-64%**	**-79%**	**-82%**
2022/2023	**-4%**	**-16%**	**-6%**	**5%**	**-22%**	**-22%**	**-21%**	**-21%**	**-26%**

Figure 4.4: *Shares of emissions in 2B in 2023*



4.5.2 Ammonia Production (NFR 2B1)

4.5.2.1 Overview

Ammonia is made from nitrogen and hydrogen by fine-tuned versions of the process developed by Haber and Bosch $N_2 + 3H_2 = 2NH_3$. In principle, the reaction between hydrogen and nitrogen is easy. However, to get a respectable yield of ammonia in a chemical plant, a catalyst and extreme pressures of up to 600 atmospheres and a temperature of 400°C are needed. Emission trends and activity data from this category are shown in ***Table 4.29***. The emissions of particulate matter from this source decreased significantly in 2004 due to abatement technology installation.

Table 4.29: *Activity data and emissions in the category 2B1*

YEAR	AMMONIA PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	360.00	0.2136	0.0038	0.0011	0.0036	0.0212	0.0354	0.0590	0.0702

YEAR	AMMONIA PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1995	383.80	0.2277	0.0041	0.0012	0.0038	0.0226	0.0377	0.0629	0.0748
2000	403.00	0.2182	0.0049	0.0015	0.0040	0.0320	0.0533	0.0888	0.0161
2005	426.35	0.2711	0.0045	0.0013	0.0043	0.0039	0.0066	0.0109	0.1064
2010	233.56	0.1274	0.0017	0.0007	0.0023	0.0021	0.0035	0.0058	0.0427
2011	455.48	0.2496	0.0033	0.0014	0.0046	0.0041	0.0068	0.0113	0.0837
2012	377.30	0.2037	0.0027	0.0011	0.0038	0.0033	0.0056	0.0093	0.0683
2013	474.91	0.2436	0.0032	0.0013	0.0047	0.0040	0.0066	0.0111	0.0776
2014	346.27	0.1799	0.0024	0.0010	0.0035	0.0029	0.0049	0.0082	0.0573
2015	476.94	0.2279	0.0030	0.0012	0.0048	0.0037	0.0062	0.0104	0.0764
2016	403.96	0.2017	0.0026	0.0011	0.0040	0.0033	0.0055	0.0092	0.0676
2017	458.88	0.2253	0.0029	0.0012	0.0046	0.0037	0.0061	0.0102	0.0755
2018	516.74	0.2354	0.0030	0.0012	0.0052	0.0037	0.0061	0.0102	0.0787
2019	491.95	0.1449	0.0022	0.0008	0.0049	0.0024	0.0040	0.0066	0.0490
2020	545.23	0.1540	0.0023	0.0008	0.0055	0.0025	0.0042	0.0070	0.0519
2021	580.51	0.1647	0.0023	0.0009	0.0058	0.0027	0.0045	0.0075	0.0554
2022	462.12	0.0753	0.0020	0.0065	0.0046	0.0002	0.0003	0.0004	0.0018
2023	413.54	0.0638	0.0019	0.0016	0.0041	0.0001	0.0001	0.0002	0.0015
1990/2023	**15%**	**-70%**	**-50%**	**42%**	**15%**	**-100%**	**-100%**	**-100%**	**-98%**
2022/2023	**-11%**	**-15%**	**-6%**	**-76%**	**-11%**	**-56%**	**-56%**	**-56%**	**-16%**

4.5.2.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.30***.

Table 4.30: *Activities according to national categorization included in 2B1*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.27 Ammonia production

Emission data is compiled in the NEIS database, therefore, the individual-specific EFs were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology are presented in **ANNEX IV**.

Emissions of NH_3 were calculated using the Tier 1 emission factor from the EMEP/EEA GB_{2023}. Historical years were calculated using a weighted average of IEF for each pollutant from the period 2000-2004 (***Table 4.31***). Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009.

Table 4.31 *Emission factors for calculation of historical years and NH_3 and CO emissions in 2B1*

	NOx [g/t]	NMVOC [g/t]	SOx [g/t]	NH_3*[g/t]	TSP [g/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/t]
EF	593.41	10.67	3.10	10	163.77	36%	60%	194.97

*EMEP/EEA GB_{2023} – Tier 1

4.5.2.3 Completeness

All rising pollutants were reported.

4.5.2.4 Source-specific Recalculations

No recalculation was made.

4.5.3 Nitric Acid Production (NFR 2B2)

4.5.3.1 Overview

NOx emissions have had an overall increasing trend since 1990 due to the increase in the production of nitric acid (***Table 4.32***). Significant increases and subsequent decreases in NH_3 emissions between 2006/2007 were recorded due to a temporal malfunction at the source. A decrease in 2022 was caused by single source starting to use new technology to produce Nitric acid.

Table 4.32: *Overview of activity data and emissions in the category 2B2*

YEAR	NITRIC ACID PRODUCED [kt]	NOx [kt]	NH_3 [kt]
1990	400.54	0.1741	0.0039
1995	398.80	0.1733	0.0039
2000	407.22	0.1770	0.0040
2005	497.68	0.2163	0.0048
2010	510.97	0.3313	0.0026
2011	593.75	0.3711	0.0034
2012	550.51	0.3299	0.0035
2013	611.65	0.3609	0.0012
2014	580.09	0.3446	0.0011
2015	634.31	0.3251	0.0009
2016	568.55	0.3128	0.0039
2017	646.23	0.3407	0.0041
2018	575.32	0.3955	0.0038
2019	571.27	0.3673	0.0010
2020	580.24	0.2717	0.0010
2021	636.32	0.2906	0.0015
2022	523.76	0.2417	0.0049
2023	471.17	0.2009	0.0049
1990/2023	**18%**	**15%**	**24%**
2022/2023	**-10%**	**-17%**	**-2%**

4.5.3.2 Methodological Issues

The definition of activities covered by category **2B2** is provided in ***Table 4.33***. The characteristic of involved industrial activity is wider, but in fact, only nitric acid is reported under **2B2**. Nitric acid is currently produced in three industrial plants situated in the Slovak Republic (owned by a single operator).

Table 4.33: *Activities according to national categorization included in 2B2*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.22 Production of inorganic acids

Since 2005, N_2O, NH_3 and NOx emissions have been monitored by nitric acid producers with medium-pressure and high-pressure plants. Nitric acid is produced by using two technologies: two medium-pressure plants and one high-pressure plant. In September 2010, technology was changed to medium- and high-pressure technologies by a single producer. The secondary YARA catalyst was introduced. The second plant was using un-modified technology. At the end of 2012, the second medium-pressure plant was bought by the new owner (who already owned the second plant). The plant was modernized in the same way as the other.

Emission data is compiled in the NEIS, therefore, the individual specific EFs were used for sources recorded in the database.

For a reconstruction of historical years before 2000 (data in the NEIS are recorded since 2000), a rounded weighted average of IEF of available data was used (excluding the year of malfunction), therefore implied emission factor for this period for nitrogen oxides was used. Values are presented in ***Table 4.34***.

Table 4.34: *Emission factors for calculation of historical years NOx and NH_3 emissions in 2B2*

	NOx [g/t]	NH_3 [g/t]
EF	434.60	9.74

4.5.3.3 Completeness

All rising pollutants were reported.

4.5.3.4 Source-specific Recalculations

Recalculations were not performed for the current submission.

4.5.4 Adipic Acid Production (NFR 2B3)

4.5.4.1 Overview

Adipic acid is not produced in the Slovak Republic, therefore notation key NO was used.

4.5.5 Carbide Production (NFR 2B5)

4.5.5.1 Overview

The production of calcium carbide in the Slovak Republic started in 1992. The production of the other specified activities under national legislation (e.g. other inorganic compounds such as sodium, calcium, silicon, phosphorus or silicon carbide) is not occurring in the Slovak Republic.
Calcium carbide is manufactured by heating the mixture of lime and carbon (the reaction of CaO and coke) to 2000 to 2100°C in a submerged arc furnace. At those temperatures, the lime is reduced by carbon to calcium carbide and carbon monoxide (according to the reaction: $CaO + 3C \rightarrow CaC_2 + CO$). Since 2015, calcined anthracite has been used instead of other bituminous coal.
The main emissions from the production of calcium carbide (CaC_2) are dust. However, the reported emissions in the category cover all sub-processes of manufacturing as they are together in the data set under the category. Relevant rising emissions from this manufacturing, their trends and activity data (***Table 4.35***) are presented.
The emissions trend is slightly decreasing except for NMVOC, which increased significantly in 2019 and 2021 due to increased combustion of natural gas in the process of carbide production. The fluctuation continued in 2022 with a decrease and in 2023 with an increase, while other primary pollutants (NOx, TSP and PMs) had a decreasing trend in 2023. For emission of SOx and CO shows very slight increase.

Table 4.35: *Overview of activity data and emissions in the category 2B5*

YEAR	CARBIDE PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	NO	NO	NO	NO	NO	NO	NO	NO
1995	84.30	0.1968	0.0000	0.0144	0.1502	0.2503	0.4172	0.0638
2000	88.82	0.3865	0.0000	0.0250	0.1586	0.2644	0.4406	0.0679
2005	97.03	0.0688	0.0000	0.0089	0.1114	0.1856	0.3093	0.0660
2010	98.26	0.0561	0.0000	0.0027	0.0326	0.0543	0.0905	0.2789
2011	107.40	0.0565	0.0000	0.0027	0.0310	0.0516	0.0860	0.2791
2012	100.48	0.0522	0.0000	0.0043	0.0605	0.1008	0.1681	0.3169
2013	81.79	0.0433	0.0000	0.0058	0.0725	0.1208	0.2013	0.3324
2014	74.30	0.0505	0.0000	0.0053	0.0707	0.1179	0.1965	0.2972
2015	56.18	0.0502	0.0000	0.0067	0.0617	0.1028	0.1713	0.2817
2016	67.95	0.0590	0.0000	0.0083	0.0462	0.0770	0.1284	0.3341
2017	71.64	0.0580	0.0000	0.0083	0.0482	0.0803	0.1338	0.2139
2018	70.15	0.0535	0.0000	0.0079	0.0436	0.0726	0.1210	0.1890
2019	60.47	0.0600	0.0002	0.0083	0.0767	0.1279	0.2132	0.1688

YEAR	CARBIDE PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
2020	47.61	0.0716	0.0000	0.0067	0.0547	0.0912	0.1520	0.1464
2021	48.48	0.0607	0.0001	0.0073	0.0508	0.0847	0.1412	0.1597
2022	36.12	0.0516	0.0000	0.0102	0.0338	0.0563	0.0938	0.1276
2023	42.67	0.0418	0.0001	0.0110	0.0258	0.0430	0.0717	0.1326
1990/2023	-	-	-	-	-	-	-	-
2022/2023	**18%**	**-19%**	**78%**	**8%**	**-24%**	**-24%**	**-24%**	**4%**

4.5.5.2 Methodological Issues

The definition of activities covered by category **2B5** is provided in ***Table 4.36***. The characteristic of involved industrial activity is wider, but the only activity of calcium carbide production belongs to the occurring production activities.

Table 4.36: *Activities according to national categorization included in 2B5*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.25 Production of non-metals, metal oxides or other inorganic compounds such as sodium, calcium, silicon, phosphorus, calcium carbide, silicon carbide

Emission data is compiled in the NEIS, therefore, the individual-specific EFs were used for sources recorded in the database. Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009 (***Table 4.37***).

Table 4.37: *Emission factors for calculation of historical years in 2B5*

	NOx [g/t]	NMVOC [g/t]	SOx [g/t]	TSP [g/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/t]
EF	2 334.16	0.12	171.03	4 949.16	36%	60%	757.16

4.5.5.3 Completeness

All rising pollutants were reported. The notation key was used in compliance with EMEP/EEA GB_{2023}. In the years 1990 and 1991, the notation key NO was used, because production started in 1992.

4.5.5.4 Source-specific Recalculations

Recalculations were not performed for the current submission.

4.5.6 Titanium Dioxide Production (NFR 2B6)

4.5.6.1 Overview

Titanium dioxide is not produced in the Slovak Republic, and the NO notation key was used.

4.5.7 Soda Ash Production (NFR 2B7)

4.5.7.1 Overview

Soda ash is not produced in the Slovak Republic, and NO notation key was used.

4.5.8 Chemical Industry: Other (NFR 2B10a)

4.5.8.1 Overview

Emissions of air pollutants show a decreasing tendency in the long term. Their overview is provided below in ***Table 4.38.*** The category includes various activities of the chemical industry, which are detailed and specified in the methodology section (***Table 4.39***).

Table 4.38: *Overview of emissions in the category 2B10a*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.6952	2.9146	1.6182	0.2373	0.1882	0.2954	0.4488	0.0034	4.1268
1995	0.6708	2.8125	1.5615	0.2290	0.1817	0.2851	0.4331	0.0033	3.9823
2000	0.4653	3.2955	0.9122	0.1619	0.1480	0.2322	0.3528	0.0027	4.9742
2005	0.4649	1.3922	1.0667	0.2149	0.0930	0.1463	0.2234	0.0017	1.3587
2010	0.1286	0.6126	1.1984	0.0635	0.0497	0.0833	0.1365	0.0009	0.7377
2011	0.4867	0.8527	1.3355	0.1589	0.0884	0.1398	0.2152	0.0016	0.5813
2012	0.4064	0.6851	1.2691	0.1475	0.0777	0.1250	0.1965	0.0014	1.2631
2013	0.4287	0.7083	1.3955	0.1001	0.0785	0.1269	0.2000	0.0014	0.8680
2014	0.3862	0.5724	1.2887	0.0593	0.0621	0.1020	0.1632	0.0011	0.9824
2015	0.4142	0.5748	1.3627	0.0888	0.0801	0.1285	0.2017	0.0014	0.8963
2016	0.4751	0.5024	1.5005	0.1495	0.0659	0.1095	0.1790	0.0012	0.7526
2017	0.5485	0.5574	1.4021	0.1370	0.0705	0.1162	0.1890	0.0013	0.9156
2018	0.5312	0.5058	1.3845	0.1536	0.0715	0.1159	0.1850	0.0013	0.9041
2019	0.5072	0.4504	1.3236	0.1341	0.0550	0.0903	0.1475	0.0010	0.8067
2020	0.5186	0.4384	1.2586	0.1968	0.0656	0.1096	0.1812	0.0012	1.0015
2021	0.5050	0.4493	1.1821	0.1739	0.0736	0.1221	0.2005	0.0013	0.9892
2022	0.4565	0.3415	1.4884	0.1153	0.0506	0.0835	0.1363	0.0009	0.8909
2023	0.4896	0.3187	1.4063	0.1227	0.0400	0.0665	0.1092	0.0007	0.6163
1990/2023	**-30%**	**-89%**	**-13%**	**-48%**	**-79%**	**-77%**	**-76%**	**-79%**	**-85%**
2022/2023	**7%**	**-7%**	**-6%**	**6%**	**-21%**	**-20%**	**-20%**	**-21%**	**-31%**

4.5.8.2 Methodological Issues

The definition of activities covered by category **2B10a** is provided in ***Table 4.39***.

Table 4.39: *Activities according to national categorization included in 2B10a*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.6 Production of synthetic rubbers
4.7 Production of basic plastic materials based on synthetic and natural polymers excluding synthetic rubber
4.8 Production of simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic)
4.9 Production of halogenated organic compounds
4.10 Production of organic compounds containing oxygen
4.11 Production of organic compounds containing sulphur
4.12 Production of organic compounds containing nitrogen excluding carbamide
4.13 Production of organic compounds containing phosphorus
4.14 Production of organometallic compounds
4.15 Production of plant protection products or biocides
4.16 Production of auxiliary agents for the rubber industry
4.17 Production and processing of viscose
4.21 Production of inorganic gases and compounds except for ammonia
4.23 Production of inorganic hydroxides
4.26 Production of inorganic salts excluding fertilizers

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.28 Production of carbamide
4.29 Production of phosphorous-, nitrogen- or potassium-based fertilisers (simple or compound fertilisers excluding carbamide)
4.30 Production of inorganic pigments, refining bleaching preparations
4.31 Production of industrial explosives
4.32 Production and processing of carbon materials: a) production of charcoal with a projected production in kg/d b) production of soot c) burning carbonaceous materials, including impregnation d) mechanical processing of carbonaceous materials
4.34 Production of soaps, detergents and cosmetics with a production capacity in kg/h: a) detergents b) cosmetics
4.99 Other unspecified chemical production including the raw materials and intermediate products processing a) the part of technology is the fuel combustion with a rated thermal input in MW b) share of emission mass flow of air pollutant before abatement and emission mass flow of air pollutant, that is noted in Annex 3 for existing installations: AP with carcinogenic effects, organic vapour, other air pollutants

Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009 (***Table 4.40***).

Table 4.40: *Emission factors for calculation of historical years in 2B10a*

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	TSP [g/GJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]	CO [g/GJ]
EF	352.13	1476.34	819.68	120.20	227.33	42%	66%	1.8%	2090.38

*Tier 1 EMEP/EEA GB_{2023}

4.5.8.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2023}.

4.5.8.4 Source-specific Recalculations

No recalculation was made.

4.5.9 Storage, Handling and Transport of Chemical Products (NFR 2B10b)

4.5.9.1 Overview

The chapter covers the emissions rising from sources with the activity: distribution storages for pumping and individual pumping equipment for fuels, greases, petrochemicals and other organic liquids. Released air pollutants and their trends are presented in ***Table 4.41***.

Table 4.41: *Overview of emissions in the category 2B10b*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	0.0001	3.1138	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
1995	0.0001	3.0553	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2000	0.0001	2.6163	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2005	0.0001	1.7804	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2010	0.0001	1.3799	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2011	0.0001	1.3636	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2012	0.0001	1.1992	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2013	0.0001	1.4284	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2014	0.0001	1.3556	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2015	0.0001	1.6226	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2016	0.0000	1.5281	0.0000	NO	0.0000	0.0000	0.0000	0.0000
2017	0.0002	1.5373	0.0000	NO	0.0000	0.0000	0.0000	0.0002

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
2018	0.0001	1.5985	0.0000	NO	0.0000	0.0001	0.0001	0.0006
2019	0.0002	1.4921	0.0000	NO	0.0001	0.0001	0.0001	0.0008
2020	0.0002	1.6576	0.0000	NO	0.0001	0.0001	0.0001	0.0008
2021	0.0002	1.7539	0.0000	NO	0.0001	0.0001	0.0001	0.0008
2022	0.0002	1.6840	0.0000	NO	0.0001	0.0001	0.0001	0.0009
2023	0.0002	1.3814	0.0000	NO	0.0001	0.0001	0.0001	0.0009
1990/2023	**154%**	**-56%**	**107%**	**-**	**3646%**	**3646%**	**3647%**	**6692%**
2022/2023	**-3%**	**-18%**	**18%**	**-**	**-20%**	**-20%**	**-20%**	**0.2%**

4.5.9.2 Methodological Issues

Activities listed within this category are shown in ***Table 4.42***.

Table 4.42: *Activities according to national categorization included in 2B10b*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.5 Distribution storages for pumping and individual pumping equipment for fuels, greases, petrochemicals and other organic liquids having a vapour pressure according to the Annex. 3 second part of section 2.2, except for liquefied hydrocarbon gases and compressed natural gas diesel, according to installed aggregated storage capacity in m^3 or a projected or real annual turnover in m^3 according to which is higher.

Emissions in this category are from the NEIS database for the period 2000-2023. Historical years were linearly extrapolated.

4.5.9.3 Completeness

All rising pollutants were reported. The notation key was used in compliance with EMEP/EEA GB_{2023}.

4.5.9.4 Source-specific Recalculations

No recalculations were performed in this submission.

4.6 METAL PRODUCTION (NFR 2C)

4.6.1 Overview

Metal production is an important sector in the national economy. The category covers the NFR activities: Iron and steel production (**2C1**), Ferroalloys production (**2C2**), Aluminium production (**2C3**), Magnesium production (**2C4**), Lead production (**2C5**), Copper production (**2C7a**), Other metal production (**2C7c**) and Storage, handling and transport of metal products (**2C7d**). Emissions in this category have a decreasing trend (***Table 4.43***) due to stricter legislation and the adoption of emission limits as well as BAT technologies in this industry.

Table 4.43: *Overview of emissions in the category 2C*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	5.3556	0.3482	9.5119	0.0077	1.5525	2.3511	8.7088	0.0208	78.8745
1995	4.8373	0.3181	8.3694	0.0075	1.3862	2.1099	7.9009	0.0167	69.3173
2000	6.0021	0.2698	12.7058	0.0081	1.9146	2.8538	10.0320	0.0366	86.6576
2005	4.9041	0.7772	9.8522	0.0057	0.6272	0.8993	2.8102	0.0071	100.1900
2010	4.8614	0.6605	5.7673	0.0036	0.3977	0.5721	2.0893	0.0059	91.8471
2011	5.0363	0.7585	7.5523	0.0036	0.3393	0.5206	2.2781	0.0039	105.1633
2012	4.8798	0.6933	6.4198	0.0045	0.3725	0.5703	2.5268	0.0038	103.1368
2013	4.7659	0.6278	5.6372	0.0044	0.3879	0.5995	2.7311	0.0041	102.9434
2014	5.1730	0.7683	6.3798	0.0043	0.4737	0.7180	3.1047	0.0050	117.3026
2015	5.0144	0.7944	7.3183	0.0038	0.4520	0.6812	2.8878	0.0044	117.4430
2016	4.4131	0.8945	8.3043	0.0032	0.3889	0.5891	2.4564	0.0037	119.4836

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2017	5.2364	0.8599	9.8269	0.0030	0.4120	0.6187	2.5230	0.0043	121.6738
2018	5.6975	0.8715	7.5161	0.0031	0.3594	0.5388	2.1970	0.0046	108.9585
2019	4.3915	0.6607	5.9332	0.0040	0.2629	0.3494	0.9330	0.0041	70.7878
2020	4.1945	0.6909	4.9104	0.0051	0.2328	0.2800	0.3658	0.0037	67.8873
2021	5.4491	0.8601	5.9676	0.0048	0.2423	0.2962	0.4431	0.0038	103.1417
2022	3.8989	0.6722	2.8227	0.0045	0.1685	0.2077	0.3175	0.0029	67.4273
2023	4.5546	0.7701	3.0989	0.0034	0.0962	0.1305	0.2688	0.0014	79.0265
1990/2023	**-15%**	**121%**	**-67%**	**-56%**	**-94%**	**-94%**	**-97%**	**-93%**	**0%**
2022/2023	**17%**	**15%**	**10%**	**-24%**	**-43%**	**-37%**	**-15%**	**-52%**	**17%**

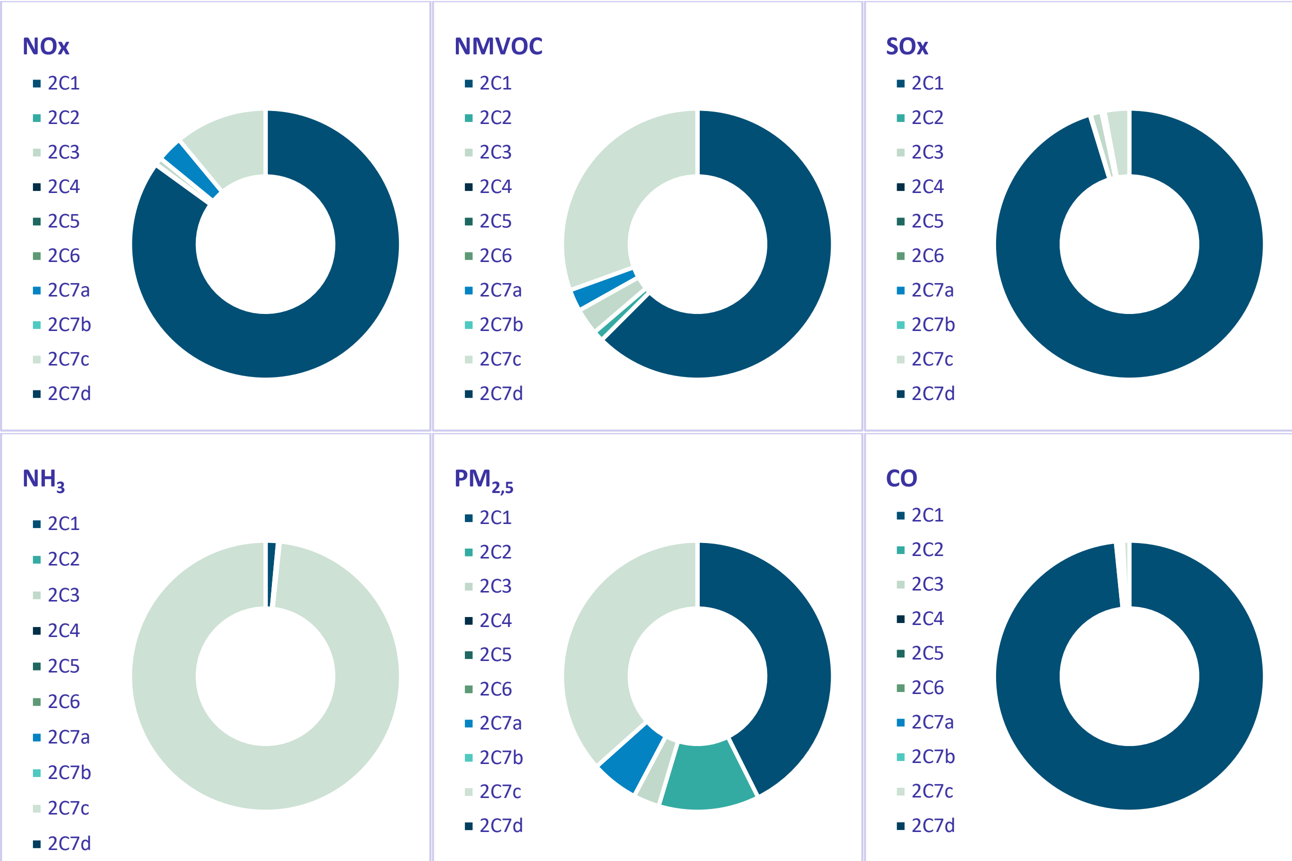
YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	20.4632	0.4196	0.2038	0.6972	1.5284	3.1871	1.3097	0.0903	9.1212
1995	17.3194	0.2641	0.1671	0.5766	1.3156	2.5838	0.9865	0.0746	8.2128
2000	18.3403	0.0890	0.1839	0.5172	0.8178	1.4983	0.9087	0.0825	9.0314
2005	5.2889	0.1563	0.0390	0.5011	0.9325	1.1883	0.1762	0.0826	7.1292
2010	4.3882	0.1870	0.0302	0.4442	1.4849	2.1420	0.1676	0.0628	6.9609
2011	4.0688	0.2223	0.0343	0.4168	1.8575	2.8447	0.1597	0.0703	6.4790
2012	4.1822	0.1904	0.0360	0.4228	1.5302	2.2688	0.1633	0.0755	6.6722
2013	4.4960	0.0877	0.0353	0.4298	0.9438	1.2057	0.1958	0.0742	7.1468
2014	4.4133	0.0845	0.0419	0.4274	1.1597	1.6176	0.1811	0.0891	7.0735
2015	4.2147	0.0793	0.0413	0.4154	1.4238	2.0979	0.1607	0.0877	6.7641
2016	4.4318	0.0835	0.0416	0.4390	1.6461	2.4611	0.1665	0.0880	7.1066
2017	4.6382	0.0876	0.0421	0.4574	1.6034	2.3616	0.1775	0.0891	7.4267
2018	4.3200	0.0779	0.0412	0.4177	1.6199	0.3579	0.1684	0.0871	6.9408
2019	3.3821	0.0616	0.0384	0.3256	1.7593	0.3333	0.1338	0.0802	5.4627
2020	2.4736	0.0458	0.0287	0.2370	1.6082	0.2826	0.1004	0.0597	4.0254
2021	4.3875	0.0790	0.0374	0.4252	1.8045	0.3548	0.1700	0.0779	7.0196
2022	3.1110	0.0575	0.0231	0.2990	1.0147	0.2346	0.1273	0.0485	4.9822
2023	3.7845	0.0667	0.0294	0.3691	0.9596	0.2608	0.1418	0.0633	6.0546
1990/2023	**-82%**	**-84%**	**-86%**	**-47%**	**-37%**	**-92%**	**-89%**	**-30%**	**-34%**
2022/2023	**22%**	**16%**	**28%**	**23%**	**-5%**	**11%**	**11%**	**30%**	**22%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [t]	PCB [t]
1990	36.2050	0.6066	0.6066	0.6066	0.0741	12.4963	0.1195	18.9415
1995	30.4281	0.2934	0.2934	0.2934	0.0359	10.3806	0.0975	17.1153
2000	32.1864	0.0077	0.0022	0.0022	0.0011	9.5126	0.1080	17.8307
2005	33.6304	0.0111	0.0032	0.0032	0.0016	10.8661	0.1048	21.0057
2010	27.3048	0.0114	0.0033	0.0033	0.0016	10.4849	0.0744	21.1782
2011	31.9026	0.0114	0.0033	0.0033	0.0016	9.8373	0.0876	19.4673
2012	32.8065	0.0112	0.0032	0.0032	0.0016	10.3636	0.0943	20.6039
2013	31.1630	0.0114	0.0033	0.0033	0.0016	10.7557	0.0918	21.9567
2014	37.1470	0.0117	0.0034	0.0034	0.0017	11.5113	0.1137	22.4163
2015	36.8028	0.0120	0.0034	0.0034	0.0017	11.0712	0.1122	21.2480
2016	37.2869	0.0122	0.0035	0.0035	0.0017	11.7023	0.1114	22.5342
2017	37.6663	0.0121	0.0035	0.0035	0.0017	12.0576	0.1124	23.2818
2018	37.1101	0.0122	0.0035	0.0035	0.0017	11.8577	0.1098	22.9772
2019	35.3311	0.0122	0.0035	0.0035	0.0017	9.5412	0.1040	18.1209
2020	27.0366	0.0106	0.0030	0.0030	0.0015	8.1028	0.0755	15.6085
2021	8.5280	0.0115	0.0033	0.0033	0.0016	11.6509	0.0963	22.6512
2022	5.8058	0.0050	0.0014	0.0014	0.0007	8.9899	0.0567	17.8634

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [t]	PCB [t]
2023	5.5330	0.0000	0.0000	0.0000	0.0000	10.2779	0.0766	20.0183
1990/2023	**-85%**	**-100%**	**-100%**	**-100%**	**-100%**	**-18%**	**-36%**	**6%**
2022/2023	**-5%**	**-100%**	**-100%**	**-100%**	**-100%**	**14%**	**35%**	**12%**

The major contributors of emissions of main pollutants, heavy metals and POPs are Iron and steel production. Shares of released emissions of air pollutants in 2023 included in NFR categories **2C** are presented in ***Figure 4.5***.

Figure 4.5: *Shares of emissions in 2C in 2023*



4.6.2 Iron and Steel Production (NFR 2C1)

4.6.2.1 Overview

Iron and steel processing from raw materials is the cornerstone for many other activities due to its widespread usage of these products as structural materials in various sectors (transport, industry, engineering, construction, etc.). However, it is an energy-intensive industry with a significant impact in terms of air pollution. Nowadays, production takes place in integrated metallurgical plants, which include a production unit for the preparation of iron ore (sintering production or pelletization), fuel production plant – coke oven, blast furnace for the production of pig iron, converters for steel production (the descaling of pig iron).

In the Slovak Republic, there is one major producer of sinter, pig iron and steel from primary raw materials, one producer of steel from secondary raw materials and several smaller processors of steel. An overview of the activity data and trends is shown in ***Table 4.44***. An overview of released emissions and trends is presented in ***Table 4.45***.

Table 4.44: *Trends in activity data in 2C1*

YEAR	SINTER PRODUCED [kt]	PIG IRON PRODUCED (DRY ESP) [kt]	STEEL PRODUCED – BASIC OXYGEN FURNACE (DRY ESP) [kt]	STEEL PRODUCED – BASIC OXYGEN FURNACE (WSV) [kt]	STEEL PRODUCED – ELECTRIC FURNACE [kt]
1990	3982.00	3561.00	1685.12	1876.38	310.73

YEAR	SINTER PRODUCED [kt]	PIG IRON PRODUCED (DRY ESP) [kt]	STEEL PRODUCED – BASIC OXYGEN FURNACE (DRY ESP) [kt]	STEEL PRODUCED – BASIC OXYGEN FURNACE (WSV) [kt]	STEEL PRODUCED – ELECTRIC FURNACE [kt]
1995	3251.00	3207.00	1516.93	1690.47	314.64
2000	3598.90	3166.38	1652.45	1867.54	316.36
2005	3494.50	3681.42	1850.11	2388.01	356.90
2010	2480.14	3648.84	2050.13	2351.65	331.25
2011	2920.13	3346.41	1794.40	2166.62	374.22
2012	3141.77	3519.76	2009.26	2226.93	372.40
2013	3060.35	3616.85	1998.74	2345.51	711.34
2014	3790.90	3862.62	2114.37	2325.11	527.85
2015	3740.27	3738.49	2059.96	2250.98	315.05
2016	3712.50	3986.68	2225.58	2373.86	293.80
2017	3747.75	4107.94	2235.21	2477.75	356.80
2018	3659.90	4036.85	2345.02	2296.82	380.30
2019	3468.10	3184.55	1821.11	1789.91	327.78
2020	2516.40	2753.36	1821.03	1298.34	279.95
2021	3208.70	4013.94	2221.20	2339.40	370.29
2022	1891.40	3153.00	1917.98	1640.70	365.53
2023	2552.30	3594.82	2045.36	2030.27	244.94
1990/2023	**-36%**	**1%**	**21%**	**8%**	**-21%**
2022/2023	**35%**	**14%**	**7%**	**24%**	**-33%**

The figures below present the emission trend of the pollutants for which **2C1** is a key category. Emissions show an overall decreasing trend due to the continual installation of abatement technologies throughout the production since 1990 (***Table 4.45***).

Most of air pollutant emissions in recent years shows a fluctuation in trends related to the activity data. In 2020, one of the blast furnaces was under reconstruction. After the reconstruction in 2021, it started to operate in full operation again, which caused an increase in related year 2021 compared to the previous 2020. In 2022, a decrease is visible in trends of released air pollutants. In 2023, the emissions again rose slightly alongside to the increase of production volume. The solely stable and more significant improvement is in emissions of PCDD/F. Since 2021, the ongoing decrease appear due to the new abatement technology to reduce these emissions from sinter production with an efficiency of 98.9%.

Table 4.45: *Overview of emissions of air pollutants in 2C1*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	3.2673	0.2250	7.7837	0.0011	1.1899	1.8822	8.0395	0.0043	64.0501
1995	2.9719	0.2047	7.0798	0.0010	1.0823	1.7120	7.3124	0.0039	58.2577
2000	4.0544	0.1578	11.0293	0.0007	1.3392	2.1182	9.0476	0.0048	72.0819
2005	2.6012	0.5416	7.4668	0.0000	0.3871	0.6021	2.3878	0.0014	78.0150
2010	2.2977	0.4037	3.8171	0.0000	0.1815	0.3135	1.7197	0.0007	71.3394
2011	2.2507	0.4809	4.6387	0.0000	0.1950	0.3448	2.0300	0.0007	84.3314
2012	2.5147	0.5077	4.4449	0.0000	0.2128	0.3790	2.2720	0.0008	83.4974
2013	2.7281	0.4807	3.5912	0.0000	0.2320	0.4129	2.4985	0.0008	85.3261
2014	3.2091	0.5369	3.6345	0.0000	0.2742	0.4820	2.8250	0.0010	98.9535
2015	3.0538	0.5460	4.8942	0.0000	0.2620	0.4560	2.6219	0.0009	97.6335
2016	2.7957	0.4971	4.4276	0.0000	0.2148	0.3825	2.2128	0.0008	96.7478
2017	3.2859	0.5143	6.2832	0.0000	0.2156	0.3857	2.2470	0.0008	100.8391
2018	3.5863	0.5405	4.4805	0.0000	0.1830	0.3283	1.9362	0.0007	89.0361
2019	2.3250	0.3580	2.9195	0.0000	0.0788	0.1337	0.6737	0.0003	52.2224
2020	2.5272	0.3661	2.4107	0.0000	0.0311	0.0436	0.0920	0.0001	51.6441

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2021	3.8258	0.5117	3.1983	0.0000	0.0494	0.0708	0.1803	0.0002	86.3580
2022	2.9289	0.3645	1.6522	0.0000	0.0350	0.0500	0.1321	0.0001	58.6566
2023	3.8703	0.4813	2.9521	0.0001	0.0410	0.0601	0.1810	0.0001	77.7556
1990/2023	**18%**	**114%**	**-62%**	**-95%**	**-97%**	**-97%**	**-98%**	**-97%**	**21%**
2022/2023	**32%**	**32%**	**79%**	**30%**	**17%**	**20%**	**37%**	**17%**	**33%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	19.7015	0.0902	0.2027	0.5258	0.8239	1.5686	0.9454	0.0903	9.1212
1995	16.5822	0.0806	0.1662	0.4677	0.7375	1.4026	0.8241	0.0746	8.2128
2000	18.3350	0.0884	0.1839	0.5168	0.8142	1.4922	0.9087	0.0825	9.0314
2005	4.4864	0.0794	0.0383	0.4343	0.3975	0.2520	0.1718	0.0826	7.1292
2010	4.3877	0.0777	0.0286	0.4270	0.3888	0.2238	0.1676	0.0628	6.9609
2011	4.0680	0.0730	0.0321	0.3934	0.3603	0.2245	0.1597	0.0703	6.4790
2012	4.1815	0.0748	0.0344	0.4046	0.3705	0.2392	0.1633	0.0755	6.6720
2013	4.4956	0.0851	0.0344	0.4264	0.3961	0.2472	0.1958	0.0742	7.1466
2014	4.4128	0.0809	0.0407	0.4227	0.3903	0.2710	0.1811	0.0891	7.0734
2015	4.2142	0.0744	0.0397	0.4089	0.3740	0.2608	0.1607	0.0877	6.7641
2016	4.4312	0.0777	0.0398	0.4313	0.3934	0.2690	0.1665	0.0880	7.1066
2017	4.6377	0.0821	0.0404	0.4501	0.4114	0.2754	0.1775	0.0891	7.4267
2018	4.3198	0.0771	0.0394	0.4177	0.3829	0.2708	0.1684	0.0871	6.9408
2019	3.3818	0.0607	0.0363	0.3256	0.2998	0.2306	0.1338	0.0802	5.4627
2020	2.4732	0.0450	0.0267	0.2370	0.2190	0.1848	0.1004	0.0597	4.0254
2021	4.3871	0.0782	0.0353	0.4251	0.3888	0.2551	0.1700	0.0779	7.0196
2022	3.1104	0.0570	0.0220	0.2988	0.2748	0.1825	0.1273	0.0485	4.9821
2023	3.7839	0.0663	0.0285	0.3690	0.3357	0.2169	0.1418	0.0633	6.0546
1990/2023	**-81%**	**-26%**	**-86%**	**-30%**	**-59%**	**-86%**	**-85%**	**-30%**	**-34%**
2022/2023	**22%**	**16%**	**30%**	**23%**	**22%**	**19%**	**11%**	**30%**	**22%**

YEAR	PCDD/F [g I-TEQ]	PAHs [t]	HCB [kg]	PCB [kg]
1990	35.2527	10.6024	0.1195	18.9415
1995	29.1714	9.4646	0.0975	17.1152
2000	32.1754	9.4995	0.1080	17.8307
2005	31.9584	10.8470	0.1048	21.0056
2010	23.8794	10.4653	0.0744	21.1779
2011	27.2235	9.8178	0.0876	19.4669
2012	29.1814	10.3443	0.0943	20.6036
2013	29.6216	10.7361	0.0918	21.9565
2014	34.9817	11.4911	0.1137	22.4161
2015	33.8493	11.0506	0.1122	21.2478
2016	33.7630	11.6814	0.1114	22.5339
2017	34.3126	12.0367	0.1124	23.2816
2018	33.6310	11.8368	0.1098	22.9769
2019	31.2261	9.5202	0.1040	18.1205
2020	23.1289	8.0846	0.0755	15.6082
2021	4.5459	11.6313	0.0963	22.6508
2022	3.7236	8.9812	0.0567	17.8632
2023	3.7771	10.2779	0.0766	20.0182
1990/2023	**-89%**	**-3%**	**-36%**	**6%**
2022/2023	**1%**	**14%**	**35%**	**12%**

4.6.2.2 Methodological Issues

Activities defined in national legislation involved in the category are presented in ***Table 4.46***.

Table 4.46: *Activities according to national categorization included in 2C1*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
2.1 Treatment, roasting and sintering of ferrous metal ores and manipulation with these materials in powder form
2.2 Production of pig iron in a blast furnace with a projected production capacity in t/h
2.3 Production of steel, for instance, converters, Siemens-Martin furnaces, double-heart tandem furnaces, electric furnaces, and März-Böhler furnaces with projected production capacity in t/h
2.5 Secondary metallurgical production and processing of ferrous metals (for instance rolling mills, press, smitheries, hardening furnaces and other facilities for thermal processing) a) rolling mills with projected production of crude steel in t/h b) operation of smitheries with projected thermal energy - 20 MW and projected power in kilojoules per hammer - ≤ 20 MW and projected power in kilojoules per hammer

The category covers sources of several companies operating in the Slovak Republic (for the year 2023).
Cat. 2.1: U.S. Steel Košice, a.s.
Cat. 2.2: U.S. Steel Košice, a.s.
Cat. 2.3: U.S. Steel Košice, a.s.; Železiarne Podbrezová a.s.
Cat. 2.5: U.S. Steel Košice, a.s., Železiarne Podbrezová a.s. and small others
Pig iron and steel are produced mainly in blast furnaces and by the EAF processes. The plant with blast furnaces is one complex with many energy-related installations (coke ovens, heating plant, manufacturing of steel products, etc.).
Emissions of main pollutants, PMs and CO are compiled within the NEIS database, therefore the individual specific EF were used for sources recorded in the database.
Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004 (***Table 4.47***). Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009. Emissions of BC were calculated using the EMEP/EEA GB_{2023} emission factor throughout the entire time series.

Table 4.47: *Emission factors for calculation of historical years in 2C1*

	NOx [g/t]	NMVOC [g/t]	SOx [g/t]	NH_3 [g/t]	TSP [g/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]	CO [g/t]
EF	843.79	58.12	2010.13	0.28	2076.19	15%	23%	0.36%	16540.89

*Tier 1 EMEP/EEA GB_{2023}

Heavy metals and POPs

The information on abatement technologies installed on the source was obtained from an integrated permit from 2006 granted based on Act no. 39/2013 Coll. on Integrated Prevention and Control of Environmental Pollution and Amendments to Certain Acts. The exact year of installation of the abatement technology was obtained from the environmental reports available online on the website of the operator.
U.S. Steel Košice operates Oceliareň 1 and Oceliareň 2. The sources do not have the same abatement technology installed. Emissions from Oceliareň 1 are abated by dry ESP and Oceliareň 2 by wSV. For both of the sources, abatement technology was already installed in the nineties, but the exact year is not known. Abatement technology in Oceliareň 1 was reconstructed in the year 2006, and Oceliareň 2 in 2002. The same company operates technology for sinter production. This source has installed Dry ESP technology since 2003, and in 2021, abatement for the reduction of PCDD/F was added (injection of active carbon).
Sources of information are environmental reports and annual reports of a single company. All three activities: sinter production, pig iron production, and steel production in BOF refer to a single company in the Slovak Republic. Other steel production operators use EAF to produce steel. Emissions factors used for calculation are shown in ***Table 4.48***.

Table 4.48: *Emission factor for heavy metals and POPs used in calculations for iron and steel production*

A	T	P	AT	Pb [g/t]	Hg [g/t]	Cd [g/t]	As [g/t]	Cr [g/t]	Cu [g/t]
Sinter production	-	1990-2002	None	3.5	0.004	0.049	0.018	0.016	0.033
Sinter production	-	2003-2020	Dry ESP	0.0099	0.000011	0.009	0.00005	0.0013	0.03
Sinter production		2021-2023	Dry ESP + active carbon inj.	0.0099	0.000011	0.009	0.00005	0.0013	0.03
Pig iron production	-	1990-2002	Dry ESP Upper EFs	0.000006	0.000000010	0.000056	0.0000003	0.000003	0.15
Pig iron production	-	2003-2023	Dry ESP default EFs	0.000009	0.000000015	0.000084	0.0000005	0.000006	0.015
Steel production	Basic oxygen furnace	1990-2005	Dry ESP Upper EFs	0.025	0.0003	0.0009	0.002	0.002	0.02
Steel production	Basic oxygen furnace	2006-2023	Dry ESP default EFs	0.015	0.00025	0.0006	0.0015	0.0013	0.02
Steel production	Basic oxygen furnace	1990-2001	wSV Upper EFs	3	0.036	0.0028	0.24	0.4	0.46
Steel production	Basic oxygen furnace	2002-2023	wSV Default EFs	1.8	0.03	0.0018	0.18	0.16	0.02
Steel production	Electric furnace	1990-2023	Fabric filter retrofitted-upper Efs	0.3	0.02	0.0018	0.0015	0.02	0.02

A	T	P	AT	Ni [g/t]	Se [g/t]	Zn [g/t]	PCDD/F [µg/t]	PAHs [g/t]	HCB [mg/t]	PCBs [mg/t]
Sinter production	-	1990-2002	None	0.09	0.02	0.06	8	0.3	0.03	0.09
Sinter production	-	2003-2020	Dry ESP	0.00025	0.02	0.06	8	0.3	0.03	0.09
Sinter production		2021-2023	Dry ESP + active carbon inj.	0.00025	0.02	0.06	0.0873	0.3	0.03	0.09
Pig iron production	-	1990-2002	Dry ESP Upper EFs	NE	NE	0.073	0.002	2.5	NE	2.5
Pig iron production	-	2003-2023	Dry ESP default EFs	NE	NE	0.073	0.002	2.5	NE	2.5
Steel production	Basic oxygen furnace	1990-2005	Dry ESP Upper EFs	0.0005	NE	0.023	0.69	0.1	NE	2.5
Steel production	Basic oxygen furnace	2006-2023	Dry ESP default EFs	0.0005	NE	0.023	0.69	0.1	NE	2.5
Steel production	Basic oxygen furnace	1990-2001	wSV Upper EFs	0.3	NE	4.5	0.69	0.1	NE	2.5
Steel production	Basic oxygen furnace	2002-2023	wSV Default EFs	0.06	NE	2.7	0.69	0.1	NE	2.5
Steel production	Electric furnace	1990-2023	Fabric filter retrofitted-upper Efs	0.075	NE	0.45	3	0.48	NE	2.5

A – Activity, T – Technology, P – Period, AT – Abatement technology

4.6.2.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with the EMEP/EEA GB_{2023}.

4.6.2.4 Source-specific Recalculations

The recalculation was done in the BOF Steel Production for historical years from 1990 to 2005. EFs – Upper Emission factors for abatement by Dry ESP are used in the calculations. But for Cu, Ni and Zn it was actually zero value, because NE is stated in the methodology. To avoid the underestimation, emission factors for standard Dry EPS were used to cover the historical years 1990-2005, and values were corrected. Overview of percentage change as well as emission values are provided in ***Table 4.49*** below.

Table 4.49: *Differences in emissions in the category 2C1 between previous and current submission caused by recalculation*

YEAR	Cu			Ni			Zn		
	PREVIOUS	REFINED	CHANGE	PREVIOUS	REFINED	CHANGE	PREVIOUS	REFINED	CHANGE
1990	1.5349	1.5686	2%	0.9446	0.9454	0%	9.0824	9.1212	0%
1991	1.4911	1.5210	2%	0.9082	0.9090	0%	8.1826	8.2170	0%
1992	1.4920	1.5199	2%	0.8995	0.9002	0%	7.7141	7.7462	0%
1993	1.3776	1.4080	2%	0.8403	0.8411	0%	8.1771	8.2120	0%
1994	1.4042	1.4358	2%	0.8514	0.8522	0%	8.4660	8.5022	0%
1995	1.3722	1.4026	2%	0.8233	0.8241	0%	8.1779	8.2128	0%
1996	1.2655	1.2931	2%	0.7891	0.7898	0%	7.4889	7.5206	0%
1997	1.3290	1.3580	2%	0.8278	0.8285	0%	7.8679	7.9013	0%
1998	1.2757	1.3051	2%	0.8023	0.8030	0%	7.8703	7.9041	0%
1999	1.3918	1.4243	2%	0.8698	0.8706	0%	8.6313	8.6688	0%
2000	1.4591	1.4922	2%	0.9079	0.9087	0%	8.9934	9.0314	0%
2001	1.5312	1.5664	2%	0.9507	0.9516	0%	9.5589	9.5994	0%
2002	0.6943	0.7332	6%	0.4662	0.4672	0%	6.4299	6.4747	1%
2003	0.2218	0.2641	19%	0.1612	0.1623	1%	6.7807	6.8293	1%
2004	0.2187	0.2616	20%	0.1636	0.1647	1%	6.7986	6.8479	1%
2005	0.2150	0.2520	17%	0.1709	0.1718	1%	7.0866	7.1292	1%

4.6.3 Ferroalloys Production (NFR 2C2)

4.6.3.1 Overview

Ferroalloys are produced by the reduction reaction of iron ore and added metal and/or metalloid oxides or other materials in arc furnaces and submerged arc furnaces. As shown, emissions of all rising pollutants showed a decreasing trend due to the installation of abatement technologies. Activity data, emissions and trends are presented in ***Table 4.50***.

Table 4.50: *Overview of activity data and emissions in the category 2C2*

YEAR	FERROALLOYS PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	169.00	0.4317	0.0376	0.2914	0.0000	0.1543	0.1956	0.2175	0.0154	2.8995
1995	134.80	0.3443	0.0300	0.2325	0.0000	0.1231	0.1560	0.1735	0.0123	2.3127
2000	94.73	0.5886	0.0241	0.1150	0.0000	0.2957	0.3749	0.4167	0.0296	2.7839
2005	108.72	0.0065	0.0121	0.0119	NO	0.0294	0.0373	0.0414	0.0029	0.5220
2010	96.83	0.0190	0.0152	0.0260	0.0000	0.0245	0.0311	0.0346	0.0025	0.0506
2011	75.05	0.0311	0.0089	0.0363	0.0000	0.0173	0.0220	0.0244	0.0017	0.0784
2012	102.87	0.0257	0.0091	0.0311	0.0000	0.0143	0.0181	0.0202	0.0014	0.0782
2013	65.68	0.0298	0.0100	0.0319	0.0000	0.0173	0.0219	0.0244	0.0017	0.1076
2014	47.20	0.0215	0.0159	0.0259	0.0000	0.0180	0.0228	0.0253	0.0018	0.1026
2015	95.62	0.0232	0.0176	0.0304	0.0000	0.0159	0.0201	0.0224	0.0016	0.0943
2016	106.27	0.0120	0.0165	0.0226	0.0000	0.0096	0.0121	0.0135	0.0010	0.1051
2017	129.48	0.0081	0.0195	0.0124	0.0000	0.0113	0.0144	0.0160	0.0011	0.1025

YEAR	FERROALLOYS PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2018	113.69	0.0107	0.0245	0.0173	0.0000	0.0142	0.0180	0.0200	0.0014	0.1273
2019	105.52	0.0081	0.0143	0.0195	0.0000	0.0115	0.0146	0.0162	0.0012	0.0907
2020	88.60	0.0047	0.0124	0.0134	0.0000	0.0086	0.0109	0.0121	0.0009	0.0752
2021	115.73	0.0046	0.0096	0.0079	0.0000	0.0084	0.0106	0.0118	0.0008	0.0823
2022	35.43	0.0039	0.0101	0.0033	0.0000	0.0088	0.0112	0.0125	0.0009	0.1144
2023	4.65	0.0039	0.0096	0.0032	0.0000	0.0116	0.0147	0.0163	0.0012	0.1101
1990/2023	**-97%**	**-99%**	**-75%**	**-99%**	**-66%**	**-93%**	**-93%**	**-93%**	**-93%**	**-96%**
2022/2023	**-87%**	**0%**	**-5%**	**-4%**	**-17%**	**31%**	**31%**	**31%**	**31%**	**-4%**

4.6.3.2 Methodological Issues

Activities of cast iron and cast iron products according to national legislation were separated into the individual category **2C2** (***Table 4.51***).

Table 4.51: *Activities according to national categorization included in 2C2*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
2.4 Ferrous metal foundries – production of cast iron and cast iron products with a projected production capacity in t/d

Emissions of main pollutants, PMs and CO are compiled within the NEIS database, therefore, the individual specific EFs were used for sources recorded in the database. Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.52***). Emissions of BC were calculated using the EMEP/EEA GB_{2023} emission factor throughout the entire time series.

Table 4.52: *Emission factors for calculation of historical years*

	NOx [g/t]	NMVOC [g/t]	SOx [g/t]	NH_3 [g/t]	TSP [g/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]	CO [g/t]
EF	2 554.18	222.64	1 724.52	0.13	1 286.72	71%	90%	10%	17 156.55

*Tier 1 EMEP/EEA GB_{2023}

4.6.3.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2023}.

4.6.3.4 Source-specific Recalculations

No recalculation was made in the current submission.

4.6.4 Aluminium Production (NFR 2C3)

4.6.4.1 Overview

Aluminium is produced by the electrolysis of alumina dissolved in the cryolite-based melt (t = 950°C). The main additives to cryolite (Na_3AlF_6) are aluminium fluoride (AlF_3) and CaF_2. In The Slovak Republic, the plants for aluminium production use a modern technology where the majority of HF and other fluorides escape from the electrolytic cells and are absorbed and adsorbed on alumina. Alumina is used subsequently in the electrolytic process. The anodes are made from graphite. So-called pre-baked anodes for aluminium products are made in separate plants. Due to this technology, emissions are much lower than in the Søderberg process.
There was only one source producing aluminium in the Slovak Republic. At the beginning of January 2023, the production of primary aluminium was completely stopped after 70 years of its production by shutting down the last of 226 furnaces. In the current state, only the technology of the anode production utilizes the capacity.

Emissions of the main pollutants have a decreasing trend due to the depression in production. PAHs have decreased due to the change of technology in the year 1996 for the production of aluminium from the Søderberg process (SP) to pre-baked anodes (PBA) (***Table 4.53***).

Table 4.53: *Overview of activity data and emissions in the category 2C3*

YEAR	Al – SP [kt]	Al – PBA [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]	PAHs [t]
1990	67.40	NO	0.2258	0.0016	0.7164	0.0484	0.0545	0.0591	0.0011	5.7010	1.8939
1995	32.60	NO	0.1092	0.0008	0.3465	0.0234	0.0263	0.0286	0.0005	2.7575	0.9161
2000	NO	109.81	0.2916	0.0029	1.1785	0.0944	0.1063	0.1152	0.0022	7.8868	0.0132
2005	NO	159.20	0.6886	0.1461	1.3099	0.1194	0.1343	0.1457	0.0027	12.9913	0.0191
2010	NO	163.00	0.5196	0.0355	1.3825	0.1206	0.1353	0.1471	0.0028	13.4722	0.0196
2011	NO	162.84	0.5497	0.0312	2.2302	0.0629	0.0706	0.0767	0.0014	13.5448	0.0195
2012	NO	160.66	0.5141	0.0283	1.3916	0.0701	0.0787	0.0855	0.0016	13.3409	0.0193
2013	NO	163.30	0.5130	0.0260	1.3879	0.0681	0.0764	0.0831	0.0016	13.3071	0.0196
2014	NO	167.67	0.4927	0.0538	2.0785	0.0975	0.1094	0.1189	0.0022	14.0622	0.0201
2015	NO	171.33	0.4430	0.0873	1.6566	0.0811	0.0910	0.0990	0.0019	14.2394	0.0206
2016	NO	173.64	0.4425	0.1152	2.8449	0.0835	0.0937	0.1018	0.0019	18.0049	0.0208
2017	NO	173.49	0.5510	0.0487	2.4411	0.1050	0.1178	0.1281	0.0024	16.5521	0.0208
2018	NO	173.72	0.5378	0.0361	2.0605	0.1082	0.1213	0.1319	0.0025	16.4582	0.0208
2019	NO	174.79	0.4974	0.0453	2.0394	0.1175	0.1318	0.1433	0.0027	15.5812	0.0210
2020	NO	151.70	0.4991	0.0473	1.8154	0.1168	0.1310	0.1424	0.0027	13.1902	0.0182
2021	NO	164.00	0.4941	0.0367	2.1134	0.1220	0.1368	0.1487	0.0028	14.1074	0.0197
2022	NO	71.93	0.3999	0.0223	0.9129	0.0816	0.0915	0.0995	0.0019	6.9537	0.0086
2023	NO	0.21	0.0387	0.0241	0.0407	0.0030	0.0034	0.0036	0.0001	0.2373	0.0000
1990/2023	**-**	**-**	**-83%**	**1449%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-96%**	**-100%**
2022/2023	**-**	**100%**	**-90%**	**8%**	**-96%**	**-96%**	**-96%**	**-96%**	**-96%**	**-97%**	**-100%**

4.6.4.2 Methodological Issues

Activities of aluminium production according to national legislation were separated into the individual category **2C3**. Emissions of main pollutants, PMs and CO are compiled within the NEIS database, therefore, the individual specific EFs were used for sources recorded in the database. In the submission 2020, emissions from aluminium production were allocated in category **2C7c**. These emissions were during the 2021 submission removed from the **2C7c** category and allocated to the **2C3** category.

Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.54***). Emissions of BC were calculated using the EMEP/EEA GB_{2023} emission factor throughout the time series.

Table 4.54: *Emission factors for calculation of historical years*

	NOx [g/t]	NMVOC [g/t]	SOx [g/t]	TSP [g/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	BC* [% of $PM_{2.5}$]	CO [g/t]
EF	3 350.77	23.11	10 629.29	876.41	82%	92%	2.3%	84 584.75

POPs

POPs were calculated using Tier 2 emission factors from EMEP/EEA GB_{2019} for primary aluminium production (***Table 4.55***).

Table 4.55: *Emission factors of PAHs calculation for primary aluminum production in 2C3*

TECHNOLOGY	PERIOD	B(a)P [g/t]	B(b)F [g/t]	B(k)F [g/t]	I()P [g/t]	PAHs [g/t]
Søderberg anodes	1990-1995	9	9	9	1.1	28.1
Pre-baked anodes	1996-2023	0.07	0.02	0.02	0.01	0.12

4.6.4.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2023}.

4.6.4.4 Source-specific Recalculations

In the current submission, the correction of activity data for year 2020 was performed and the following recalculation of PAHs emissions was done (***Table 4.56***).

Table 4.56: *Differences in emissions and activity data in the category (2C3) between previous and current submission caused by recalculations*

YEARS	AD – ALUMINIUM PRODUCTION [kt]			B(a)P	B(b)F	B(k)F	I()P	PAHs
	PREVIOUS	REVISED	CHANGE					
2020	151.87	151.70	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%

The value of aluminium production was slightly corrected for the year 2020 (decrease -0.12%). Therefore, the emissions of polycyclic aromatic hydrocarbons, B(a)P, B(b)F, B(k)F and I(cd)P have been recalculated.

4.6.5 Magnesium Production (NFR 2C4)

4.6.5.1 Overview

From submission 2023, notation key NO is used for all the emissions in this category. Emissions from magnesite clinker production were reallocated into category **2C7c** to comply with the emission inventory of GHG.

4.6.6 Lead Production (NFR 2C5)

4.6.6.1 Overview

The production, regeneration and disposal of electric accumulators and cells occurring in the Slovak Republic in the period 2011-2023. Therefore, this activity was included in category **2C5**. The trends of emissions from production and activity data are presented in ***Table 4.57***.

Table 4.57: *Activity data and emissions in the category 2C5*

YEAR	LEAD PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO[kt]
1990	NO	NO	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO	NO	NO
2011	0.05	0.0213	0.0002	0.0163	0.0001	0.0002	0.0005	0.0012
2012	0.20	0.0174	0.0002	0.0137	0.0000	0.0002	0.0005	0.0011
2013	0.26	0.0062	0.0004	0.0450	0.0001	0.0004	0.0010	0.0014
2014	0.29	0.0076	0.0005	0.0579	0.0001	0.0005	0.0012	0.0017
2015	0.32	0.0054	0.0004	0.0270	0.0001	0.0003	0.0007	0.0012
2016	0.29	0.0082	0.0007	0.0299	0.0001	0.0003	0.0008	0.0016
2017	0.30	0.0085	0.0008	0.0314	0.0001	0.0004	0.0009	0.0017
2018	0.05	0.0027	0.0001	0.0303	0.0001	0.0002	0.0005	0.0008
2019	0.07	0.0076	0.0005	0.0621	0.0001	0.0005	0.0012	0.0020
2020	0.13	0.0076	0.0005	0.0620	0.0001	0.0005	0.0012	0.0021
2021	0.16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2022	0.40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2023	0.42	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990/2023	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
2022/2023	**6%**	**14%**	**13%**	**12%**	**16%**	**16%**	**16%**	**14%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Zn [t]	PCDD/F [g I-TEQ]	PCB [kg]
1990	NO	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO	NO
2011	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000
2012	0.0002	0.0000	0.0000	0.0001	0.0000	0.0007	0.0000
2013	0.0003	0.0000	0.0000	0.0001	0.0000	0.0008	0.0000
2014	0.0003	0.0000	0.0000	0.0001	0.0000	0.0009	0.0000
2015	0.0004	0.0000	0.0000	0.0001	0.0000	0.0010	0.0000
2016	0.0003	0.0000	0.0000	0.0001	0.0000	0.0009	0.0000
2017	0.0003	0.0000	0.0000	0.0001	0.0000	0.0010	0.0000
2018	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000
2019	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000
2020	0.0001	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000
2021	0.0002	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000
2022	0.0004	0.0000	0.0000	0.0001	0.0000	0.0013	0.0000
2023	0.0005	0.0000	0.0000	0.0001	0.0000	0.0014	0.0000
1990/2023	-	-	-	-	-	-	-
2022/2023	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**

4.6.6.2 Methodological Issues

Activities defined in national legislation involved in the category are presented in ***Table 4.58***.

Table 4.58: *Activities according to national categorization included in 2C5*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.39 Production, regeneration and disposal of electric accumulators and cells

HMs and POPs

HMs and POPs were balanced using Tier 2/Tier 1 emission factors for Secondary lead production – current technology level from EMEP/EEA GB_{2023} (***Table 4.59***).

Table 4.59: *Emission factors of HMs and POPs for secondary lead production in 2C5*

TECHNOLOGY	Pb [g/t]	Cd [g/t]	Hg [g/t]*	As [g/t]	Zn [g/t]	PCDD/F [µg I-TEQ/t]	PCBs [µg/t]
Current technology	1.1	0.05	0.1	0.3	0.05	3.2	2.6

*Tier 1

4.6.6.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2023}.

4.6.6.4 Source-specific Recalculations

No recalculation was made in this submission.

4.6.7 Zinc Production (NFR 2C6)

4.6.7.1 Overview

The category is reported with notation key NO except for 2012-2014 when activity data were recorded. The overview of emissions is shown in ***Table 4.60***.

Table 4.60: Activity data and emissions in the category 2C6

YEAR	ZINC PRODUCTION [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	Pb [t]	Cd [t]	Hg [t]
1990	NO	NO	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO	NO	NO
2011	NO	NO	NO	NO	NO	NO	NO	NO
2012	0.04	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.03	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	NO	NO	NO	NO	NO	NO	NO	NO
2016	NO	NO	NO	NO	NO	NO	NO	NO
2017	NO	NO	NO	NO	NO	NO	NO	NO
2018	NO	NO	NO	NO	NO	NO	NO	NO
2019	NO	NO	NO	NO	NO	NO	NO	NO
2020	NO	NO	NO	NO	NO	NO	NO	NO
2021	NO	NO	NO	NO	NO	NO	NO	NO
2022	NO	NO	NO	NO	NO	NO	NO	NO
2023	NO	NO	NO	NO	NO	NO	NO	NO
1990/2023	-	-	-	-	-	-	-	-
2022/2023	-	-	-	-	-	-	-	-

YEAR	As [t]	Zn [t]	PCDD/F [g I-TEQ]	PCBs [kg]
1990	NO	NO	NO	NO
1995	NO	NO	NO	NO
2000	NO	NO	NO	NO
2005	NO	NO	NO	NO
2010	NO	NO	NO	NO
2011	NO	NO	NO	NO
2012	0.0000	0.0002	0.0002	0.0000
2013	0.0000	0.0002	0.0002	0.0000
2014	0.0000	0.0001	0.0001	0.0000
2015	NO	NO	NO	NO
2016	NO	NO	NO	NO
2017	NO	NO	NO	NO
2018	NO	NO	NO	NO
2019	NO	NO	NO	NO
2020	NO	NO	NO	NO
2021	NO	NO	NO	NO
2022	NO	NO	NO	NO
2023	NO	NO	NO	NO
1990/2023	-	-	-	-
2022/2023	-	-	-	-

4.6.7.2 Methodological Issues

Tie 1 methodology from the EMEP/EEA GB_{2023} was used to calculate emissions from this source. Emission factors are displayed in ***Table 4.61***.

Table 4.61: *Emission factors in the category 2C6*

	SOx [g/t]	$PM_{2.5}$ [g/t]	PM_{10} [g/t]	TSP [g/t]	Pb [g/t]	Cd [g/t]	Hg [g/t]	As [g/t]	Zn [g/t]	PCDD/F [µg I-TEQ/t]	PCBs [g/t]
EF	1350	12	13	15	0.2	0.04	0.04	0.03	5	5	2

4.6.7.3 Completeness

All rising pollutants were reported. Notation keys were used following the EMEP/EEA GB_{2023}. For the period 1990-2013 and 2015-2023, notation key NO was used.

4.6.7.3 Source-specific Recalculations

No recalculation was made.

4.6.8 Copper Production (NFR 2C7a)

4.6.8.1 Overview

Pollutants released during copper production are particulate matter (PM), sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (non-methane VOC and methane (CH_4)), carbon monoxide (CO), carbon dioxide (CO_2), nitrous oxide (N_2O), trace elements, and selected persistent organic pollutants (POPs). The POPs are mostly dioxins and furans, which are emitted from shaft furnaces, converters, and flame furnaces.

Emissions of air pollutants were excluded from the category **2C7c** – Other Metal Production although the definition of activity according to the categorization of Annex No 6 of decree no 410/2012 coll. as amended does not divide for the specific type of metal production only general: Treatment of non-ferrous metals ores and manipulation with these materials in powder form.

Activity data, emissions and trends are shown in ***Table 4.62***. The emission trend of these pollutants is decreasing due to the activity within the category which shows. However, the emissions in 2023 have an increasing trend.

Table 4.62: *Activity data and emissions in the category 2C7a*

YEAR	PRIMARY COPPER [kt]	SECONDARY COPPER [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	19.04	19.04	0.0161	0.0036	0.0098	0.0048	0.0061	0.0145	0.0000	1.4800
1995	8.38	25.13	0.0141	0.0031	0.0087	0.0042	0.0053	0.0128	0.0000	1.3023
2000	NO	0.22	0.0000	0.0000	0.0004	0.0000	0.0001	0.0001	0.0000	0.0001
2005	NO	33.44	0.0047	0.0036	0.0112	0.0075	0.0095	0.0106	0.0000	1.7321
2010	NO	68.51	0.0416	0.0843	0.0944	0.0116	0.0146	0.0682	0.0000	3.0990
2011	NO	93.58	0.0383	0.0733	0.0842	0.0093	0.0118	0.0360	0.0000	2.6989
2012	NO	72.49	0.0386	0.0467	0.0701	0.0071	0.0089	0.0280	0.0000	1.7787
2013	NO	34.23	0.0393	0.0066	0.0236	0.0027	0.0034	0.0051	0.0000	0.2434
2014	NO	48.09	0.0169	0.0048	0.0252	0.0019	0.0025	0.0027	0.0000	0.1995
2015	NO	65.61	0.0246	0.0165	0.0827	0.0086	0.0109	0.0121	0.0000	1.4275
2016	NO	78.29	0.0373	0.0171	0.0938	0.0078	0.0099	0.0110	0.0000	1.5884
2017	NO	74.50	0.0212	0.0137	0.0767	0.0067	0.0085	0.0094	0.0000	1.2507
2018	NO	77.31	0.0508	0.0088	0.0209	0.0010	0.0013	0.0015	0.0000	0.9727
2019	NO	91.22	0.0449	0.0094	0.0231	0.0012	0.0015	0.0017	0.0000	1.0432
2020	NO	86.83	0.0942	0.0143	0.0307	0.0029	0.0037	0.0041	0.0000	1.4668
2021	NO	88.48	0.0621	0.0176	0.0478	0.0020	0.0026	0.0029	0.0000	0.8360
2022	NO	46.24	0.0436	0.0083	0.0464	0.0011	0.0014	0.0015	0.0000	0.7837
2023	NO	38.99	0.1400	0.0201	0.0115	0.0054	0.0069	0.0076	0.0000	0.3338
1990/2023	**-**	**2%**	**771%**	**463%**	**17%**	**13%**	**13%**	**-47%**	**13%**	**-77%**
2022/2023	**-**	**-16%**	**221%**	**141%**	**-75%**	**403%**	**403%**	**423%**	**403%**	**-57%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	PCDD/F [g I-TEQ]	PCBs [kg]
1990	0.7617	0.3294	0.0010	0.1714	0.7045	1.6185	0.3643	0.9523	0.0001
1995	0.7372	0.1835	0.0008	0.1089	0.5780	1.1812	0.1624	1.2567	0.0001
2000	0.0053	0.0005	0.0000	0.0004	0.0035	0.0062	0.0000	0.0110	0.0000
2005	0.8026	0.0769	0.0008	0.0669	0.5351	0.9363	0.0043	1.6721	0.0001
2010	0.0005	0.1093	0.0016	0.0172	1.0961	1.9182	0.0000	3.4254	0.0003
2011	0.0007	0.1493	0.0022	0.0234	1.4973	2.6202	0.0000	4.6789	0.0003
2012	0.0005	0.1156	0.0017	0.0182	1.1598	2.0296	0.0000	3.6243	0.0003
2013	0.0001	0.0025	0.0008	0.0033	0.5477	0.9585	0.0000	1.5404	0.0001
2014	0.0001	0.0036	0.0011	0.0047	0.7695	1.3466	0.0000	2.1642	0.0002
2015	0.0002	0.0049	0.0015	0.0064	1.0497	1.8371	0.0000	2.9524	0.0002
2016	0.0002	0.0058	0.0018	0.0076	1.2526	2.1921	0.0000	3.5230	0.0003
2017	0.0002	0.0055	0.0017	0.0072	1.1921	2.0861	0.0000	3.3527	0.0003
2018	0.0002	0.0007	0.0018	NO	1.2369	0.0871	0.0000	3.4789	0.0003
2019	0.0002	0.0008	0.0021	NO	1.4595	0.1028	0.0000	4.1047	0.0003
2020	0.0002	0.0008	0.0020	NO	1.3893	0.0978	0.0000	3.9073	0.0003
2021	0.0002	0.0008	0.0020	NO	1.4157	0.0997	0.0000	3.9816	0.0003
2022	0.0001	0.0004	0.0011	NO	0.7399	0.0521	0.0000	2.0809	0.0002
2023	0.0001	0.0004	0.0009	NO	0.6238	0.0439	0.0000	1.7546	0.0001
1990/2023	**-100%**	**-100%**	**-13%**	**-**	**-11%**	**-97%**	**-100%**	**84%**	**65%**
2022/2023	**-16%**	**-16%**	**-16%**	**-**	**-16%**	**-16%**	**-16%**	**-16%**	**-16%**

4.6.8.2 Methodological Issues

Emissions from copper production were excluded from category **2C7c** and reallocated into this category. Emissions data for the period 2000-2023 originate from the NEIS database. Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.63***).

Table 4.63: *Emission factors for calculation of historical years in 2C7a*

	NOx [g/t]	NMVOC [g/t]	SOx [g/t]	TSP [g/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/t]
EF	422.07	93.54	258.25	381.14	33%	42%	38 862.82

Heavy metals and POPs

Far calculation of heavy metals and POPs, Tier 2/Tier 1 EF from EMEP/EEA GB_{2023} were used (***Table 4.64***). To use a higher-Tier method, it was necessary to contact only the Slovak copper production plant. The operator has provided the information needed for the change of the methodology.

From the provided information it is clear that the source started to use technology for secondary copper production in the year 1990, but the data before 2000 are very unclear due to a lack of documentation. It was assumed that both technologies were used. Copper mining was active in Slovakia until the year 1999. The exact amount of primary or secondary copper is not known, therefore, in the year 1990, it was assumed that 50% of copper was produced using primary sources and 50% using secondary. The ratio is decreasing for primary copper production by 5% per year until 1999. On the contrary, the ratio of secondary copper production is increasing by the same percentage until 1999. In 1999, the former operator sold the company and the new operator started to produce copper only from secondary sources. This information comes from an integrated permit for the operation of the source from 2005.

The efficiency of the abatement technology is partly country-specific (***Table 4.65***).

Table 4.64: *Emission factor for heavy metals and POPs in the category 2C7a*

TECHNOLOGY	PERIOD	Pb [g/t]	Cd [g/t]	Hg [g/t]	As [g/t]	Cr [g/t]	Cu [g/t]	Ni [g/t]	PCDD/F [μg I-TEQ/t]	PCBs [μg/t]
T1 Copper production	1990-2023	-	-	0.023	-	16	-	-	-	0.9

T2 Primary production	1990-1999	16	15	0.031	7	21	57	19	0.01	-
T2 Secondary production	1990-2023	24	2.3	-	2	-	28	0.13	50	-

Table 4.65: *Efficiency of the abatement technology*

ABATEMENT	PERIOD	Pb [g/t]*	Cd [g/t]	As [g/t]	Cu [g/t]	Ni [g/t]*	PCDD/F [µg I-TEQ/t]
State of art fabric filter	2006-2012	99.97%	30.64%	87.47%	0%	99.97%	0%
State of art fabric filter	2013-2017	99.99%	96.79%	95.14%	0%	99.99%	10%
State of art fabric filter	2018-2023	99.99%	99.60%	100.00%	96%	99.99%	10%

*Default values from EMEP/EEA GB_{2023}

4.6.8.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2023}.

4.6.8.4 Source-specific Recalculations

In the current submission, the activity data for the historical year 2011 was corrected (***Table 4.66***).

Table 4.66: *Previous and revised activity data and percentage difference in emissions in the category 2C7a*

YEAR	AD – COPPER PRODUCED [kt]			Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PCB
	PREVIOUS	REVISED	CHANGE											
2011	72.49	93.58	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%	29%

Copper production for the year 2011 was updated because its value was incorrectly stated as the same number as for the year 2012. Consequently, the emissions of heavy metals, PCDD/F and PCB were recalculated.

4.6.9 Nickel Production (NFR 2C7b)

4.6.9.1 Overview

The category is reported with the notation key NO. This production is not occurring in the Slovak Republic. The notation key for fuel was changed from NA to NO, likewise in **2B1,** where the use of the NO key for fuels was advised by the TERT.

4.6.10 Other Metal Production (NFR 2C7c)

4.6.10.1 Overview

The trends of emissions from other metal production are presented in ***Table 4.67***. An increasing trend of emissions is connected to the increase in activity data. The decrease in emissions of PMs is connected to the installation of abatement technologies.

Table 4.67: *Overview of emissions in the category 2C7c*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	1.4147	0.0804	0.7105	0.0065	0.1551	0.2127	0.3782	4.7439
1995	1.3978	0.0795	0.7020	0.0065	0.1532	0.2102	0.3737	4.6872
2000	1.0674	0.0850	0.3825	0.0074	0.1854	0.2544	0.4523	3.9049
2005	1.6031	0.0738	1.0524	0.0056	0.0838	0.1161	0.2247	6.9296
2010	1.9835	0.1218	0.4472	0.0036	0.0595	0.0775	0.1198	3.8859
2011	2.1452	0.1638	0.5467	0.0036	0.0547	0.0712	0.1103	4.5086
2012	1.7692	0.1012	0.4682	0.0045	0.0682	0.0854	0.1207	4.4407
2013	1.4495	0.1041	0.5576	0.0044	0.0677	0.0845	0.1191	3.9577
2014	1.4252	0.1562	0.5577	0.0043	0.0819	0.1009	0.1315	3.9832
2015	1.4644	0.1266	0.6274	0.0037	0.0843	0.1028	0.1318	4.0471

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
2016	1.1174	0.2479	0.8855	0.0032	0.0731	0.0905	0.1164	3.0357
2017	1.3616	0.2628	0.9821	0.0030	0.0733	0.0920	0.1217	2.9278
2018	1.5092	0.2614	0.9065	0.0031	0.0530	0.0695	0.1069	2.3633
2019	1.5085	0.2332	0.8696	0.0040	0.0537	0.0672	0.0969	1.8481
2020	1.0616	0.2504	0.5782	0.0050	0.0733	0.0903	0.1141	1.5089
2021	1.0625	0.2845	0.6001	0.0048	0.0605	0.0753	0.0994	1.7581
2022	0.5226	0.2671	0.2078	0.0044	0.0420	0.0536	0.0719	0.9190
2023	0.5016	0.2350	0.0914	0.0033	0.0352	0.0455	0.0602	0.5897
1990/2023	**-65%**	**192%**	**-87%**	**-49%**	**-77%**	**-79%**	**-84%**	**-88%**
2022/2023	**-4%**	**-12%**	**-56%**	**-25%**	**-16%**	**-15%**	**-16%**	**-36%**

4.6.10.2 Methodological Issues

Activities defined in national legislation involved in the category are presented in ***Table 4.68***. In this submission, emissions from the source magnesite clinker production were reallocated in this category.

Table 4.68: *Activities according to national categorization included in 2C7c*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
2.6 Treatment of non-ferrous metals ores and manipulation with these materials in powder form.
2.7 Production of non-ferrous metals and their mutual alloys and production of ferroalloys from crude ores, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes.
2.8 Melting of non-ferrous metals including the alloyage, remelting and refining of metal scrap with a projected melting capacity in t/d: a) for lead and cadmium b) for other non-ferrous metal
2.9 Surface treatment of metals, coating application and related activities except for organic solvents use and powder coating a) Surface treatment - by using electrolytic processes with a projected volume of baths in m^3 b) Surface treatment - by using chemical processes with a projected volume of baths in m^3 c) Surface treatment - application of metal or alloy layers and metal coatings and their alloys except for crude steel in the melt with a projected capacity in kg/h d) Surface treatment - application of metal or alloy layers, using flame, electric arc, plasma or another method with projected capacity in kg/h e) Surface treatment - application of protective coating from molten metals with the input of crude steel with a projected application capacity in t/h f) Surface treatment - anodic oxidation of aluminium materials g) Surface treatment - application of non-metallic coatings like enamels and other similar surface treatments, with a projected capacity of application in m^2/h h) Related activities - abrasive cleaning (blasting), excluding cassette equipment, with a projected capacity of processed material in m^2/h i) Related activities - thermal cleaning: - with the volume of the combustion chamber in m^3 or - with operation hours per year j) Related activities - electrolytic-plasma cleaning, degreasing and polishing with a projected capacity in dm^2/h

Emissions data for the period 2000-2023 originate from the NEIS database. Historical years for this source category were calculated using a weighted average of IEF for each pollutant from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.69***).

Table 4.69: *Emission factors for calculation of historical years in 2C7c*

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	TSP [g/GJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/GJ]
EF	288 777.33	16 416.56	145 029.48	1 335.22	77 206.78	41%	56%	968 333.68

4.6.10.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with the EMEP/EEA GB_{2023}.

4.6.10.4 Source-specific Recalculations

No recalculations in this submission.

4.6.11 Storage, Handling and Transport of Metal Products (NFR 2C7d)

4.6.11.1 Overview

Activities of storage, handling and transport of metal products are usually involved in individual sources. Emissions of air pollutants are from this reason reported with notation key IE.

4.7 SOLVENTS (NFR 2D) AND OTHER PRODUCT USE (NFR 2G)

The chapter provides information on the emission inventory of NMVOC for the sector solvents, which covers NFR categories **2D3a**, **2D3b**, **2D3c**, **2D3d**, **2D3e**, **2D3f**, **2D3g**, **2D3h**, **2D3i** and **2G**. Categories **2D3b** and **2D3c** are relevant emissions of PMs, TSP, BC and PCDD/F and sources of **2D3c** are emitted besides CO emissions. In the category **2D3i**, emissions of lubricant consumption in transport were added. The categories included in the emission balance are listed in ***Table 4.70***.

Table 4.70: *Categories included in Solvents*

NFR CODE	LONGNAME
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3c	Asphalt roofing
2D3d	Coating applications
2D3e	Degreasing
2D3f	Dry cleaning
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use
2G	Other product use

4.7.1 Overview

Concerning air protection, the most important emissions rising from the categories of so-called solvents are non-methane volatile organic compounds (NMVOC). They are part of many different substances, which are used in industry and human activities. The wide scale of substances contains NMVOC: pure solvents (individual organic compounds) or many different mixtures used in industry, dry-cleaning agents, cleaning detergents, paints, paint thinners, glues, cosmetics and toiletries, a variety of household products or car care products, fuels, hydraulic fluids and others. However, fuels are not the primary objective of this chapter. Their versatility leads to more difficulty tracking the fluxes and some categories are estimated, especially for domestic use.

Emissions released from this subsector are listed in ***Table 4.71***. Shares of released emissions of NMVOC in 2023 included in NFR categories **2D** are presented in ***Figure 4.6***

Figure 4.6: The share in NMVOC emissions of individual categories in 2D and 2G in 2023

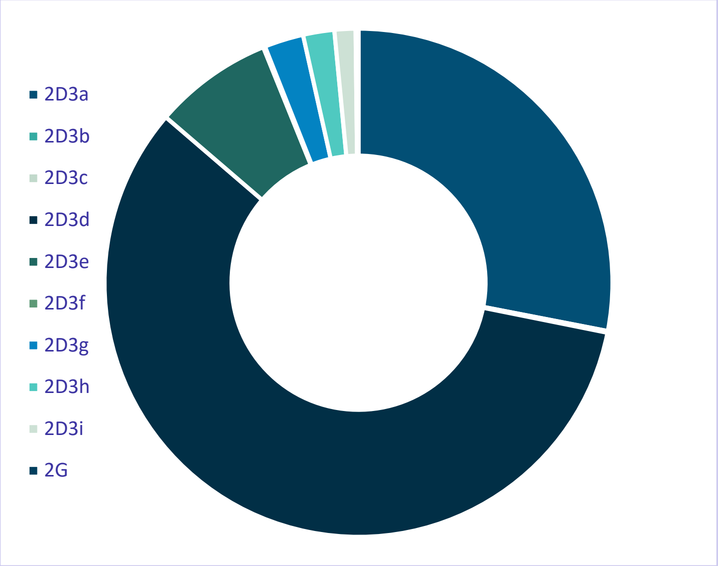


Table 4.71: Overview of emissions in the category 2D

YEAR	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	Pb [t]	Cd [t]	Hg [t]
1990	38.5027	0.0147	0.0990	0.1254	0.2920	0.0020	0.0002	0.0002	0.0298
1995	35.8277	0.0139	0.0495	0.0626	0.1403	0.0010	0.0001	0.0002	0.0301
2000	29.6027	0.0150	0.0477	0.0600	0.0834	0.0007	0.0002	0.0002	0.0303
2005	30.7325	0.0223	0.0039	0.0062	0.0165	0.0001	0.0002	0.0003	0.0303
2010	22.4157	0.0271	0.0014	0.0026	0.0087	0.0000	0.0003	0.0004	0.0306
2011	26.1459	0.0259	0.0016	0.0030	0.0108	0.0000	0.0003	0.0003	0.0304
2012	21.1965	0.0278	0.0015	0.0026	0.0088	0.0000	0.0003	0.0004	0.0305
2013	21.0883	0.0297	0.0015	0.0028	0.0104	0.0000	0.0003	0.0004	0.0305
2014	22.5021	0.0271	0.0011	0.0023	0.0095	0.0000	0.0003	0.0004	0.0305
2015	25.6429	0.0325	0.0005	0.0020	0.0129	0.0000	0.0004	0.0004	0.0306
2016	23.9248	0.0351	0.0007	0.0015	0.0066	0.0000	0.0004	0.0005	0.0307
2017	21.7249	0.0339	0.0005	0.0012	0.0059	0.0000	0.0004	0.0005	0.0307
2018	24.1538	0.0371	0.0005	0.0011	0.0052	0.0000	0.0004	0.0005	0.0308
2019	20.5470	0.0226	0.0004	0.0010	0.0051	0.0000	0.0004	0.0007	0.0308
2020	20.8513	0.0222	0.0005	0.0011	0.0051	0.0000	0.0004	0.0007	0.0308
2021	19.8864	0.0218	0.0005	0.0016	0.0090	0.0000	0.0004	0.0006	0.0307
2022	17.8903	0.0231	0.0005	0.0015	0.0087	0.0000	0.0004	0.0007	0.0307
2023	18.5773	0.0313	0.0007	0.0017	0.0082	0.0000	0.0004	0.0007	0.0306
1990/2023	**-52%**	**112%**	**-99%**	**-99%**	**-97%**	**-99%**	**135%**	**221%**	**3%**
2022/2023	**4%**	**35%**	**47%**	**14%**	**-5%**	**27%**	**-1%**	**-1%**	**0%**

YEAR	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PCDD/F [g I-TEQ]	PAHs [t]
1990	0.0003	0.0009	0.0001	0.0066	0.0001	3.6898	0.0257	0.3319
1995	0.0002	0.0005	0.0001	0.0034	0.0001	3.4896	0.0120	0.1681
2000	0.0002	0.0004	0.0001	0.0024	0.0001	3.7594	0.0043	0.1185
2005	0.0003	0.0004	0.0001	0.0018	0.0001	5.6020	0.0079	0.0823
2010	0.0004	0.0004	0.0002	0.0014	0.0002	6.7983	0.0074	0.0644
2011	0.0004	0.0004	0.0002	0.0016	0.0002	6.4890	0.0088	0.0717
2012	0.0004	0.0004	0.0002	0.0016	0.0002	6.9798	0.0072	0.0703
2013	0.0004	0.0004	0.0002	0.0022	0.0002	7.3916	0.0060	0.1045
2014	0.0005	0.0005	0.0002	0.0032	0.0002	5.0755	0.0055	0.1515
2015	0.0005	0.0004	0.0002	0.0021	0.0002	8.1397	0.0103	0.0967
2016	0.0006	0.0006	0.0002	0.0036	0.0002	8.8067	0.0074	0.1692
2017	0.0005	0.0005	0.0002	0.0028	0.0002	8.4867	0.0077	0.1289
2018	0.0006	0.0008	0.0002	0.0037	0.0002	9.1710	0.0090	0.1748
2019	0.0008	0.0007	0.0003	0.0035	0.0002	7.0228	0.0093	0.1624
2020	0.0008	0.0007	0.0003	0.0035	0.0002	6.9051	0.0093	0.1656
2021	0.0008	0.0008	0.0003	0.0042	0.0002	6.7711	0.0108	0.2014
2022	0.0008	0.0007	0.0003	0.0033	0.0002	7.1883	0.0114	0.1514
2023	0.0008	0.0007	0.0003	0.0030	0.0002	4.6846	0.0107	0.1360
1990/2023	**189%**	**183%**	**-26%**	**213%**	**-55%**	**61%**	**-58%**	**-59%**
2022/2023	**5%**	**-1%**	**-5%**	**-1%**	**-9%**	**-2%**	**-7%**	**-10%**

4.7.1 Domestic Solvent Use Including Fungicides (NFR 2D3a)

4.7.1.1 Overview

Emissions of NMVOCs have increasing character in this category due to the trend in activity data. Emissions, their trend and activity data are shown in ***Table 4.72***. As expected, the use of soaps and disinfectants has increased during the Covid crisis. A comparison of 2019 and 2020 shows an increase of almost 50%. However, this increase was not reflected in the total emissions, as this area of use represents only a negligible part of emissions in category **2D3a** (*ca* 3.5%).

Table 4.72: *Activity data and emissions in the category 2D3a*

YEAR	INHABITANTS	NMVOC [kt]	Hg [t]
1990	5297774	4.6887	0.0297
1995	5363676	4.7589	0.0300
2000	5400679	4.4477	0.0302
2005	5387285	4.6860	0.0302
2010	5431024	3.6796	0.0304
2011	5394251	4.7223	0.0302
2012	5407579	5.8156	0.0303
2013	5413393	4.0732	0.0303
2014	5418649	3.8580	0.0303
2015	5423800	4.4401	0.0304
2016	5430798	5.3332	0.0304
2017	5437754	6.4964	0.0305
2018	5446771	6.3239	0.0305
2019	5457873	6.1607	0.0306
2020	5459781	6.4473	0.0306
2021	5434712	5.6022	0.0304
2022	5428792	5.3771	0.0304
2023	5424687	5.2198	0.0304
1990/2023	**2%**	**11%**	**2%**
2022/2023	**0%**	**-3%**	**0%**

4.7.1.2 Methodological Issues

This category is performed by the combination of Tier 2a and Tier 2b methods. Activity data were taken from the Statistical Office of the Slovak Republic. Activity data deal with the import, export and production of the following sources:

- Perfumes and toilet waters.
- Hair lacquers.
- Pre-shave, shaving or aftershave preparations.
- Personal deodorants and antiperspirants.
- Polishes, creams and similar preparations, for footwear or leather.
- Polishes, creams and similar preparations, for the maintenance of wooden furniture, floors or other woodwork.
- Soap in forms excluding bars, cakes or moulded shapes, paper, wadding, felt and non-wovens impregnated or coated with soap/detergent, flakes, granules or powders.
- Windscreen wipers, defrosters and demisters for motorcycles or motor vehicles.
- Insecticides.
- Fungicides.

- Herbicides, anti-sprouting products and plant-growth regulators.

NMVOC emissions from most sources were calculated using the Tier 2a method. Solvent contents and emission factors were taken from EMEP/EEA GB_{2023} (***Table 4.73***). Emissions from the insecticides, fungicides and herbicides were calculated using the Tier 2b method, emission factors were taken from EMEP/EEA GB_{2023} (***Table 4.74***). In 2023, a decrease is reported in NMVOC emissions (-0.16 kt), mainly from the use of perfumes and toilet waters (-21%).

Table 4.73: *Used solvent contents and emissions factors (per t of solvent) for Tier 2a method according to the EMEP/EEA GB_{2023}*

SOURCE	SOLVENT CONTENT [%]	EF NMVOC [kg/t]
Perfumes and toilet waters	80	950
Hair lacquers	90	950
Pre-shave, shaving or aftershave preparations	80	950
Personal deodorants and antiperspirants	50	950
Polishes, creams and similar preparations, for footwear or leather	45	950
Polishes, creams and similar preparations, for the maintenance of wooden furniture, floors or other woodwork	80	950
Soap in forms excluding bars, cakes or moulded shapes, paper, wadding, felt and non-wovens impregnated or coated with soap/detergent, flakes, granules or powders	5	950
Windscreen wipers, defrosters and demisters for motorcycles or motor vehicles	50	500

Table 4.74: *Used solvent contents and emissions factors (per t of product) for Tier 2b method according to the EMEP/EEA GB_{2023}*

SOURCE	EF NMVOC [kg/t]
Insecticides	150
Fungicides	150
Herbicides, anti-sprouting products and plant-growth regulators	150

Historical data: The emissions are taken from the Statistical Office of the Slovak Republic for the years 1999 to 2023. The historical data (1990-1998) were extrapolated using the surrogate method. The number of inhabitants served as a driver of the extrapolation. Activity data used for the calculation are displayed in ***Table 4.75***.

Table 4.75: *Activity data ($\boldsymbol{consumption = production + import - export}$) in the category 2D3a*

YEAR	PERFUMES AND TOILET WATERS [kt]	HAIR LACQUERS [kt]	PRE-SHAVE, SHAVING OR AFTERSHAVE PREPARATIONS [kt]	PERSONAL DEODORANTS AND ANTIPERSPIRANTS [kt]
1999	0.89	0.41	1.16	2.16
2000	0.89	0.41	1.16	2.17
2001	0.89	0.41	1.16	2.16
2002	0.89	0.41	1.16	2.16
2003	0.89	0.41	1.16	2.16
2004	0.89	0.41	1.16	2.16
2005	0.89	0.41	1.16	2.17
2006	0.89	0.41	1.16	2.17
2007	0.89	0.41	1.17	2.17
2008	0.89	0.41	1.17	2.18
2009	0.90	0.41	1.17	2.18
2010	0.87	0.26	0.86	1.86
2011	1.58	0.16	1.07	1.60
2012	0.66	0.51	2.74	1.80
2013	0.65	0.10	0.67	1.82
2014	0.53	0.12	0.74	1.85
2015	0.95	0.25	0.84	1.77

YEAR	PERFUMES AND TOILET WATERS [kt]	HAIR LACQUERS [kt]	PRE-SHAVE, SHAVING OR AFTERSHAVE PREPARATIONS [kt]	PERSONAL DEODORANTS AND ANTIPERSPIRANTS [kt]
2016	0.88	0.22	1.00	2.44
2017	1.28	0.78	1.42	3.27
2018	1.16	0.95	1.31	2.94
2019	1.11	0.81	1.14	2.59
2020	1.27	0.72	1.28	2.39
2021	2.05	0.56	0.83	1.36
2022	1.52	0.58	0.46	1.25
2023	1.19	0.70	0.50	1.26

YEAR	POLISHES, CREAMS AND SIMILAR PREPARATIONS, FOR FOOTWEAR OR LEATHER [kt]	POLISHES, CREAMS AND SIMILAR PREPARATIONS, FOR THE MAINTENANCE OF WOODEN FURNITURE, FLOORS OR OTHER WOODWORK [kt]	SOAP IN FORMS EXCLUDING BARS, CAKES OR MOULDED SHAPES, PAPER, WADDING, FELT AND NON-WOVENS IMPREGNATED OR COATED WITH SOAP/DETERGENT, FLAKES, GRANULES OR POWDERS [kt]
1999	0.13	0.20	1.66
2000	0.06	0.20	2.35
2001	0.15	0.19	2.59
2002	0.16	0.14	3.37
2003	0.13	0.14	3.58
2004	0.10	0.27	2.88
2005	0.09	0.41	3.27
2006	0.09	0.46	2.68
2007	0.15	0.43	2.68
2008	0.18	0.50	1.67
2009	0.14	0.34	1.67
2010	0.20	0.15	1.25
2011	0.24	0.61	1.34
2012	0.26	0.55	5.07
2013	0.29	0.65	3.90
2014	0.29	0.72	3.29
2015	0.24	0.66	3.28
2016	0.17	1.15	3.51
2017	0.26	0.72	3.16
2018	0.17	0.72	3.31
2019	0.14	0.77	3.32
2020	0.12	0.76	4.77
2021	0.15	0.71	4.21
2022	0.87	0.82	4.05
2023	0.16	0.61	4.68

YEAR	WINDSCREEN WIPERS, DEFROSTERS AND DEMISTERS FOR MOTORCYCLES OR MOTOR VEHICLES [kt]	INSECTICIDES [kt]	FUNGICIDES [kt]	HERBICIDES, ANTI-SPROUTING PRODUCTS AND PLANT-GROWTH REGULATORS [kt]
1999	0.03	1.55	1.93	4.57
2000	0.03	1.55	1.93	4.57
2001	0.05	1.55	1.93	4.56
2002	0.06	1.55	1.93	4.56
2003	0.07	1.55	1.93	4.56
2004	0.09	1.55	1.93	4.57
2005	0.12	1.55	1.93	4.57
2006	0.37	1.56	1.93	4.58
2007	0.13	1.56	1.94	4.59

YEAR	WINDSCREEN WIPERS, DEFROSTERS AND DEMISTERS FOR MOTORCYCLES OR MOTOR VEHICLES [kt]	INSECTICIDES [kt]	FUNGICIDES [kt]	HERBICIDES, ANTI-SPROUTING PRODUCTS AND PLANT-GROWTH REGULATORS [kt]
2008	0.68	1.56	1.94	4.60
2009	0.35	1.57	1.95	4.61
2010	0.50	1.19	1.38	3.32
2011	0.14	1.19	1.90	4.56
2012	0.14	1.26	2.19	4.11
2013	0.28	1.29	1.60	5.45
2014	0.17	1.49	1.32	4.17
2015	0.08	2.08	2.04	4.23
2016	0.47	1.96	2.31	4.57
2017	0.43	1.59	2.48	4.68
2018	0.59	1.71	1.99	5.10
2019	0.71	1.97	2.34	6.11
2020	0.53	1.72	2.37	7.74
2021	0.72	1.84	2.14	4.72
2022	0.98	1.83	1.76	5.42
2023	0.88	1.06	6.47	4.23

4.7.1.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.1.4 Source-specific Recalculations

No recalculation was made.

4.7.2 Road Paving with Asphalt (NFR 2D3b)

4.7.2.1 Overview

The numbers of operators vary around 50 installations, yearly. The operators ensure the obligation of regular emission monitoring and yearly emission balance in line with national legislation by way of continuous or discontinuous monitoring or by the approved way of determining the yearly emissions. The yearly emission balances are reported under the fee decisions (Act No 401/1998 on air pollution charges as amended). Discontinuous monitoring can be performed solely by the authorized and accredited person in line with national requirements. The category reports NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC and PCDD/PCDF emissions. The emissions show a decreasing overall trend (***Table 4.76***).

Table 4.76: *Activity data and emissions in the category 2D3b*

YEAR	ASPHALT USED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	PCDD/F [g I-TEQ]
1990	366.80	0.0705	0.0163	0.0218	0.1874	0.0009	0.0257
1995	170.99	0.0328	0.0076	0.0102	0.0873	0.0004	0.0120
2000	60.96	0.0117	0.0022	0.0030	0.0258	0.0001	0.0043
2005	112.99	0.0191	0.0001	0.0014	0.0117	0.0000	0.0079
2010	105.65	0.0144	0.0001	0.0008	0.0069	0.0000	0.0074
2011	125.30	0.0182	0.0001	0.0011	0.0088	0.0000	0.0088
2012	102.25	0.0149	0.0001	0.0008	0.0070	0.0000	0.0072
2013	85.95	0.0152	0.0001	0.0010	0.0086	0.0000	0.0060
2014	79.20	0.0137	0.0001	0.0010	0.0082	0.0000	0.0055
2015	147.30	0.0201	0.0001	0.0015	0.0124	0.0000	0.0103
2016	105.80	0.0189	0.0001	0.0007	0.0058	0.0000	0.0074
2017	109.99	0.0187	0.0001	0.0006	0.0054	0.0000	0.0077

YEAR	ASPHALT USED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	PCDD/F [g I-TEQ]
2018	128.39	0.0199	0.0000	0.0006	0.0047	0.0000	0.0090
2019	132.50	0.0165	0.0000	0.0005	0.0046	0.0000	0.0093
2020	132.95	0.0151	0.0000	0.0005	0.0046	0.0000	0.0093
2021	154.80	0.0208	0.0001	0.0010	0.0084	0.0000	0.0108
2022	163.13	0.0210	0.0001	0.0010	0.0081	0.0000	0.0114
2023	152.474	0.0180	0.0001	0.0009	0.0074	0.00000	0.0107
1990/2023	**-58%**	**-74%**	**-100%**	**-96%**	**-96%**	**-100%**	**-58%**
2022/2023	**-7%**	**-14%**	**-9%**	**-9%**	**-9%**	**-9%**	**-7%**

4.7.2.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators. No small sources are on the territory of the SR, thus data from the NEIS covers all activity. The category uses the Tier 3 method.

Table 4.77: *Industrial activities included in 2D3b according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
3.5 Manufacturing of bituminous mixtures with the projected production capacity of the mixture in tons/hour.

The sources are considered mixed and have inseparable combustion and technological emissions at release because the NFR code assignment is associated with the entire source coding (3.5). However, most of the sources use natural gas (NG) as a fuel, therefore NOx, SOx and CO are assumed to have the combustion origin. It is also assumed that VOC, TSP and PMs do not create a significant part of released emissions from NG. The allocation of NOx, SOx and CO emissions into the template was done manually (not in the environment of the database).

Calculations: Most of the operators in the category (approx. 70 %) report their emissions by way of mass flow multiplied by the number of operational hours per related year. Mass balance is determined by authorized measurement according to ISO standard procedures.

Equation 4.3: *Calculation No 1*

$$E\ [t] = q[kg/h] \times t[h] \times 10^{-3}$$

Where

q = Mass flow

t = Number of operational hours for the related year

The rest of the operators (approx. 30 %) report the emissions by the calculation:

Equation 4.4: *Calculation No 2*

$$E\ [t] = (1 - \eta/100) \times EF\ [kg/M\ of\ AD] \times AD\ [M\ of\ AD] \times 10^{-3}$$

Where

EF = Emission Factor

AD = Activity Data (M of AD = Quantity of related Activity Data).

In the case of activity data is fuel, because of mixed sources (combined combustion and technological process), the emissions are performed by the calculation:

Equation 4.5: *Other calculations*

$$E\ [t] = (1 - \eta/100) \times EF\ [kg/t] \times AD\ [t] \times 10^{-3}$$
$$E_{Total} = (1 - 1 - \eta/100) \times EF[kg/mil.m^3] \times AD\ [th.m^3]$$

Where

EF = Emission Factor

AD = Quantity of fuel

For EF please see **ANNEX IV: Chapter A4.6**.

Abatement: The abatement techniques with individual effectiveness are also in the registry of the NEIS and final emissions are calculated concerning abatements at individual technologies. The overview of different types of separators is presented in **ANNEX IV: Chapter A4.7**.

Calculation of PMs: The compilation of PMs is performed in the environment of the NEIS database. The algorithm for calculation of PM_{10} and $PM_{2.5}$ is applicable only for data 2005 and newer due to the database structure. Emissions are calculated from the values of TSP as their fraction according to Interim Study 2008[1] prepared for SHMÚ with the base of GAINS methodology published by IIASA.[2]

Activity data: Some information can be found in the NEIS. The production is independently obtained from the Research Institute of Engineering Constructions which is authorized by the Slovak Association for Asphalt Roads (SAAV) for collecting and verification of data. The activity data is in the form of annual reports of produced and used asphalt and asphalt mixtures in the road construction sector.

POPs: Emissions of PCDD/F were calculated using the UNEP Toolkit for Asphalt mixing:

EF (PCDD/F) = 0.00007 [mg/Mg Asphalt]

Historical data: The emissions are taken from the NEIS for the years 2005 to 2023.
The national emission factors are used for the calculation of historical data. The EFs were calculated as a weighted average from the values of implied emission factors, which were calculated for every available year in the period 2000-2004 and related yearly consumption of asphalt. PMs were calculated as an average of the share from TSP in the previous years 2005-2009.

EF (NMVOC) = 0.19 [g/Mg Asphalt]
EF (TSP) = 0.51 [g/Mg Asphalt]
EF ($PM_{2.5}$) = 8.71% of EF (TSP)
EF (PM_{10}) = 11.65% of EF (TSP)

4.7.2.3. Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.2.4 Source-specific Recalculations

No recalculation was made.

4.7.3 Asphalt Roofing (NFR 2D3c)

4.7.3.1 Overview

The category reports NMVOC, $PM_{2.5}$, PM_{10}, TSP and BC emissions. Emissions have an overall decreasing trend (***Table 4.78***). Two operators producing asphalt shingles were identified. One operator operated in the period 1990-2014 and the second in 2013-2023.

Table 4.78: *Activity data and emissions in the category 2D3c*

YEAR	ASPHALT USED FOR ROOFING [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
1990	130.17	0.0467	0.0827	0.1036	0.1046	0.0011
1995	65.92	0.0237	0.0419	0.0525	0.0530	0.0005
2000	46.47	0.0163	0.0454	0.0570	0.0575	0.0006
2005	32.28	0.0058	0.0038	0.0047	0.0048	0.0000

[1] SHMU, ECOSYS: *Návrh výpočtu tuhých znečisťujúcich látok s aerodynamickým priemerom menších ako 10 a 2.5 μm (PM_{10} a $PM_{2.5}$),* Bratislava, August 2008, Interim report.
[2] Z. KLIMONT, J. COFALA, I. BERTOK, M. AMANN, C. HEYES, F. GYARFAS: *Modelling Particulate Emissions in Europe (A Framework to Estimate Reduction Potential and Control Costs)*, 2002, IIASA Interim Report. IIASA, Laxenburg, Austria: IR-02-076Z., available at: http://pure.iiasa.ac.at/6712

YEAR	ASPHALT USED FOR ROOFING [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
2010	25.26	0.0024	0.0014	0.0017	0.0017	0.0000
2011	28.10	0.0024	0.0015	0.0019	0.0019	0.0000
2012	27.59	0.0023	0.0014	0.0018	0.0018	0.0000
2013	40.99	0.0029	0.0014	0.0018	0.0018	0.0000
2014	59.42	0.0026	0.0011	0.0013	0.0013	0.0000
2015	37.91	0.0010	0.0004	0.0005	0.0005	0.0000
2016	66.37	0.0020	0.0006	0.0008	0.0008	0.0000
2017	50.56	0.0013	0.0004	0.0006	0.0006	0.0000
2018	68.53	0.0021	0.0004	0.0005	0.0005	0.0000
2019	63.68	0.0019	0.0004	0.0005	0.0005	0.0000
2020	64.96	0.0022	0.0004	0.0006	0.0006	0.0000
2021	78.96	0.0022	0.0004	0.0005	0.0006	0.0000
2022	59.39	0.0021	0.0004	0.0005	0.0005	0.00001
2023	53.34	0.0024	0.0006	0.0008	0.0008	0.00001
1990/2023	**-59%**	**-95%**	**-99%**	**-99%**	**-99%**	**-99%**
2022/2023	**-10%**	**13%**	**58%**	**58%**	**58%**	**58%**

4.7.3.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators.

Table 4.79: *Industrial activities included in 2D3c according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.37 Production of waterproofing materials and floor coverings with a projected amount of raw materials processed in kg/h.

No small sources are on the territory of SR thus the Tier 3 method is used.

$$E_{TOTAL} = E_{NEIS}$$

The category code is associated with the sources, therefore some emissions from technological processes are inseparable from the combustion processes. Mix source of combustion and non-combustion emissions. NFR code is assigned to the source. The source in the NEIS database is a technological facility (installation) or a particular part of the facility (installation). Source uses fuel directly in the technological process. Therefore, the source's output/discharge emissions compiled by the NEIS or based on measurements contain the fractions of non- and combustion emissions that are inseparable.

Activity data: Provided activity data (used asphalt) is obtained from statistics and is harmonized with the GHG emission inventory.

Historical data: The emissions are taken from the NEIS for the years 2005 to 2023.

The national emission factors are used for the calculation of historical data. The EFs were calculated as a weighted average from the values of implied emission factors, which were calculated for every available year of the period 2000-2004 and the related consumption of asphalt used for roofing from statistics. PMs were calculated as an average share of TSP in the period 2005-2009. BC is calculated according to EF from EMEP/EEA GB_{2023}.

EF (NMVOC) = 358.89 [g/Mg Asphalt Use for Roofing]

EF (TSP) = 1 088.76 [g/Mg Asphalt Use for Roofing]

EF ($PM_{2.5}$) = 79% of EF (TSP)

EF (PM_{10}) = 99% of EF (TSP)

EF (BC) = 0.013% of EF ($PM_{2.5}$)

4.7.3.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.3.4 Source-specific Recalculation

No recalculation was made.

4.7.4 Coating Applications (NFR 2D3d)

4.7.4.1 Overview

The category reports NMVOC emissions. Emissions have an overall decreasing trend (***Table 4.80***). Looking at the trend in more detail, most activities in this category show a constant or slightly increasing trend. On the other hand, activity data from small sources has a decreasing trend since 2015. This is also in line with the decreasing trend in the use of water-based paints and varnishes, which are mostly used in small sources. The decrease is due to the application of Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products, and amending Directive 1999/13/EC.

Table 4.80: *Activity data and emissions in the category 2D3d*

YEAR	COATINGS APPLIED [kt]	NMVOC [kt]
1990	NE	16.2918
1995	NE	16.0548
2000	47.26	12.6172
2005	65.75	14.6252
2010	129.30	13.5736
2011	93.24	11.0852
2012	89.07	10.7094
2013	99.00	11.4733
2014	110.69	13.3619
2015	152.01	15.1841
2016	117.59	13.1636
2017	117.42	11.1261
2018	143.87	12.0145
2019	91.67	9.3340
2020	98.32	10.7841
2021	88.65	10.7074
2022	83.66	9.5709
2023	86.79	10.8199
1990/2023	**-**	**-34%**
2022/2023	**4%**	**13%**

4.7.4.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators. Small sources on the territory of SR not covered by the NEIS are calculated from statistical data. A combination of T2+T3 is used.

Table 4.81: *Industrial activities included in 2D3d according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
6.1 Paint shops in the automotive industry with a projected consumption of organic solvents in tonnes/year
6.2 Surface coating of road vehicles with a total projected consumption of organic solvents in tonnes/year: a) in automotive manufacturing of small series b) surface coating of road vehicles in cases where the activity is performed by unautomated technological units c) car repair – vehicle spraying in car paint shops)
6.3 Surface coating with a projected consumption of organic solvents in tonnes/year: a) of metal and plastics, including the ships covering, aircraft and railway trackage vehicle; textile, fabric, film and paper coating b) on winding wire

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
c) on reel strips of metallic materials
6.9 Industrial wood processing: a) mechanical processing of wooden lumps with projected processing capacity in v m^3/day b) mechanical processing of disintegrated wooden mass such as sawdust, shavings, and chips with a projected processing capacity in v m^3/day c) production of agglomerated materials with projected consumption of polycondensed adhesives in tonnes of dry matter/year Processing and surface treatment using organic solvents including associated activities, such as deburring, according to a projected consumption of organic solvents in tonnes/year: a) adhesive application b) wood and plastic lamination c) coating application d) impregnation

Emissions: Decree No 410/2012 Coll. as amended defined limit >= 0.6 t/yr. for the obligation of solvents evidence and registering into the NEIS as a medium source of air pollution. The cat. 6.9 in Slovak legislation covers more activities concerning wood processing as defined in the NFR. Therefore, the mechanical processing of wood is included. Yearly numbers of operators vary around 450 and cover large and medium sources. Emissions taken from the NEIS database are processed by the system and abatement of environmental technology, recovery fluxes or separators are already taken into account in final emissions. Emission calculations:

$$E_{TOTAL} = E_{SMALL\ SOURCES} + E_{NEIS}$$

Calculations in the NEIS: Reporting of solvents in the NEIS evidence is performed in Balance sheets of organic solvents for individual releases. The quantity of VOC is calculated by the equations:

Equation 4.6: *Equation a)*

$$E\ [t] = c[mg/m^3] \times V[th.m^3] \times 10^{-6}$$

Where

c = concentration of air pollutant

V = quantity/volume of released waste gas

Equation 4.7: *Equation b)*

$$E\ [t] = q[kg/h] \times t[h] \times 10^{-3}$$

Where

q = mass flow

t = number of operational hours for the related year

Equation 4.8: *Equation c) Direct and indirect balance in case of unambiguous emission dependence*

$$E = O1 + F$$

Where

O1 = Emissions released by outputs

F = Fugitive emissions are differently calculated for direct and indirect emissions

Calculations of Small Sources: Small sources were balanced. The balance is performed by a top-down approach. The statistical data is processed and total solvents consumption is calculated according to the scheme of the interim studies on the specific solvent content of solvent-based substances (**ANNEX IV: Chapter A4.8**). For the small sources, the assumption of no separator technology is used, thus the conversion of solvents to the air is considered 100%.

Small sources calculation:

$$Production + Import - Export = Total\ Product\ Consumption$$
$$Total\ Product\ Consumption \rightarrow Calculation\ of\ Total\ Solvents\ Consumption$$
$$Total\ Solvents\ Consumption - Industrial\ Solvents\ Consumption = Small\ Sources$$

Adjustment for VOC content: The calculation of VOC emission reduction is based on the implementation of the VOC reduction regarding Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC. Our specific VOC content used in the calculation is related to the period before (the scheme is presented in ***ANNEX IV*: Chapter A4.8**).

Historical data: The emissions are taken from the NEIS for the years 2005 to 2023. Due to the absence of statistical data before 2001 as well as data in the NEIS before 2005, the historical data are extrapolated with a linear trend.

Table 4.82: *Statistical activity data of total product consumption in t*

YEAR	SB	WB
2001	32 009	21 231
2002	36 099	23 569
2003	33 595	26 342
2004	40 746	26 516
2005	35 395	30 356
2006	47 038	31 443
2007	37 268	37 450
2008	37 402	76 942
2009	38 083	62 771
2010	51 429	77 875
2011	45 838	47 400
2012	45 410	43 655
2013	46 748	52 248
2014	52 626	58 059
2015	54 251	97 764
2016	51 658	65 932
2017	43 334	74 089
2018	45 025	98 840
2019	40 382	51 293
2020	43 890	54 429
2021	46 557	42 088
2022	45 348	38 313
2023	49 054	37 738

Table 4.83: *2D3d – Emission of NMVOC (t) in the division of Small sources and Industrial sources*

YEAR	EM SS	EM NEIS
2005	12 410	2 215
2006	14 927	2 720
2007	10 436	2 858
2008	13 157	2 745
2009	13 201	2 368
2010	10 908	2 666
2011	8 071	3 014
2012	7 338	3 371
2013	8 438	3 036
2014	10 158	3 204
2015	11 843	3 342
2016	9 674	3 490
2017	7 468	3 658
2018	8 157	3 857

YEAR	EM SS	EM NEIS
2019	5 184	4 150
2020	7 549	3 235
2021	7 466	3 241
2022	6 315	3 256
2023	7 414	3 406

4.7.4.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.4.4 Source-specific Recalculations

No recalculation was made.

4.7.5 Degreasing (NFR 2D3e)

4.7.5.1 Overview

The category reports NMVOC emissions. The emissions show a decreasing overall trend (***Table 4.84***). The peak of recorded emissions in 2011 relates to the activity data from statistics, namely the decrease in exported acetone and the increased amount of imported acetone. When comparing data on acetone import, export and production around 2011, it can be stated that the peak is due to a shift from the predominant production and export of acetone to its predominant import (the import increased from 645 tons in 2010 to 6,325 tons in 2011). Since that, the import has been almost stable in the range of 2-3 kt (the export decreased from 14,037 tons in 2010 to 4,913 tons in 2011). Since that, the export of acetone has been negligible, below 300 tons. The production of acetone decreased from 15,980 tons in 2010 to 5,884 tons in 2011. Since that, the production has been negligible, below 200 tons.

Table 4.84: *Activity data and emissions in the category 2D3e*

YEAR	SOLVENTS USED [kt]	NMVOC [kt]
1990	10.73	10.5242
1995	9.42	9.2301
2000	8.10	7.9361
2005	7.00	6.8824
2010	3.85	3.7372
2011	8.92	8.8211
2012	3.14	3.0365
2013	4.25	4.1564
2014	3.91	3.8076
2015	4.71	4.6319
2016	4.09	4.0113
2017	2.73	2.6479
2018	4.49	4.4097
2019	3.94	3.8703
2020	2.31	2.2590
2021	2.21	2.1246
2022	1.51	1.4332
2023	1.50	1.4118
1990/2023	**-86%**	**-87%**
2022/2023	**-1%**	**-1%**

4.7.5.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators. Small sources on the territory of SR not covered by the NEIS are calculated from statistical data. A combination of T2 + T3 is used.

Table 4.85: *Industrial activities included in 2D3e according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
6.4. Degreasing and cleaning of metal surfaces, electro components, plastics and other materials including the removal of old coatings by organic solvents with a projected consumption in tonnes/year: a) organic solvents according to § 26 paragraph. 1 b) other organic solvents

Decree No 410/2012 Coll. as amended defined the limit >= 0.6 t/yr. for the obligation of solvent evidence and registering into the NEIS as a medium source of air pollution. Emissions taken from the NEIS database are processed by the system and abatement of environmental technology, recovery fluxes or separators are already taken into account in final emissions.

$$E_{TOTAL} = E_{SMALL\ SOURCES} + E_{NEIS}$$

Calculations in the NEIS: Please, see methods of Calculations in the NEIS in **ANNEX IV**

: Chapter A4.1-A4.5.

Calculations of Small Sources: The calculation of small sources is balanced likewise in **2D3d**. The balance is performed by a top-down approach. The statistical data are processed and total solvents consumption is calculated but without the step of calculating the VOC-specific content because the specific pure solvents that are used for these purposes in SR (for VOC used for degreasing activities are Trichlorethylene, Tetrachlorethylene (perchloroethylene), 1-propanol (propanol) and 2-propanol (i-propanol) and Acetone are balanced). For the small sources, the assumption of no separator technology is used and the conversion of solvents used to the air is 100%.

Small sources calculation:

$$Production + Import - Export = Total\ Product\ Consumption$$
$$Total\ Product\ Consumption \rightarrow Calculation\ of\ Total\ Solvents\ Consumption$$
$$Total\ Solvents\ Consumption - Industrial\ Solvents\ Consumption = Small\ Sources$$

Table 4.86: *2D3e – Emission of NMVOC (t) in the division of small sources and industrial sources*

YEAR	EM SS	EM NEIS
2005	6 680	202
2006	6 866	178
2007	5 742	193
2008	5 418	162
2009	4 864	121
2010	3 627	110
2011	8 700	121
2012	2 934	102
2013	4 060	96
2014	3 719	89
2015	4 542	90
2016	3 918	94
2017	2 536	112
2018	4 312	97
2019	3 785	85
2020	2 193	66
2021	2 051	74

YEAR	EM SS	EM NEIS
2022	1 363	70
2023	1 344	68

4.7.5.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.5.4 Source-specific Recalculations

No recalculation was made.

4.7.6 Dry Cleaning (NFR 2D3f)

4.7.6.1 Overview

The category reports NMVOC emissions. The emissions show a decreasing overall trend (***Table 4.87***).

Table 4.87: *Activity data and emissions in the category 2D3f*

YEAR	SOLVENTS USED [kt]	NMVOC [kt]
1990	0.09	0.0642
1995	0.08	0.0595
2000	0.07	0.0548
2005	0.07	0.0500
2010	0.06	0.0455
2011	0.06	0.0468
2012	0.05	0.0401
2013	0.04	0.0395
2014	0.05	0.0439
2015	0.05	0.0429
2016	0.04	0.0409
2017	0.04	0.0364
2018	0.04	0.0361
2019	0.04	0.0334
2020	0.03	0.0224
2021	0.02	0.0199
2022	0.03	0.0232
2023	0.03	0.0222
1990/2023	**-71%**	**-65%**
2022/2023	**2%**	**-4%**

4.7.6.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators.

Table 4.88: *Industrial activities included in 2D3f according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
6.5. Dry cleaning of textiles, bleaching and dyeing of fabrics and other fibrous materials such as linen, cotton, and jute, by: a) a projected consumption of organic solvents in tons/year b) a projected amount of bleached or dyed textiles or fibres in tons/day

The number of operators has declined from 127 to approximately 100 in the recent 10 years which is the driver of the decline. No small sources are on the territory of SR, because Decree defined limit = 0 for the obligation of solvents evidence and registering into the NEIS as a medium source of air pollution.

$$E_{TOTAL} = E_{NEIS}$$

Calculations in the NEIS: Reporting of solvents in the NEIS evidence is performed in Balance sheets of organic solvents for individual releases. The quantity of VOC is calculated by the equations:

Equation 4.9: *Equation a)*

$$E\ [t] = c[mg/m^3] \times V[th.m^3] \times 10^{-6}$$

Where
c = concentration of air pollutant
V = quantity/volume of released waste gas

Equation 4.10: *Equation b)*

$$E\ [t] = q[kg/h] \times t[h] \times 10^{-3}$$

Where
q = mass flow
t = number of operational hours for the related year

Equation 4.11: *Equation c) Direct and indirect balance in case of unambiguous emission dependence*

$$E = O1 + F$$

Where
O1 = Emissions released by outputs
F = Fugitive emissions are calculated differently for direct and indirect emissions

Historical data: The emissions are taken from the NEIS for the years 2005 to 2023. Due to the absence of statistical data before 2001 as well as data in the NEIS before 2005, the historical data are extrapolated with a linear trend.

4.7.6.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.6.4 Source-specific Recalculations

No recalculation was made.

4.7.7 Chemical Products (NFR 2D3g)

4.7.7.1 Overview

The category reports NMVOC emissions. The emissions show a decreasing overall trend (***Table 4.89***). The most remarkable decline was in 2006. The decline is caused by the modernization of the operation facilities of pharmaceutical producers (4.20 categorization according to Annex No. 6 of 410/2012 Coll. DECREE). The application of the EU directive (Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC) also contributed to the decrease in emissions, as it caused changes in the manufacture of footwear (6.11 categorization according to the Annex No. 6 of 410/2012 Coll. DECREE). The economic crisis in 2019 caused the closure of several companies, making the impact of the modernized manufacturers on emissions dominant.

Table 4.89: *Activity data and emissions in the category 2D3g*

YEAR	SOLVENTS USED [kt]	ASPHALT USED [kt]	NMVOC [kt]	Cd [t]	As [t]	Cr [t]	Ni [t]	Se [t]	PAHs [t]
1990	7.27	130.17	4.2144	0.0000	0.0001	0.0008	0.0065	0.0001	0.3319
1995	8.21	65.92	3.4669	0.0000	0.0000	0.0004	0.0033	0.0000	0.1681

YEAR	SOLVENTS USED [kt]	ASPHALT USED [kt]	NMVOC [kt]	Cd [t]	As [t]	Cr [t]	Ni [t]	Se [t]	PAHs [t]
2000	9.14	46.47	2.7194	0.0000	0.0000	0.0003	0.0023	0.0000	0.1185
2005	10.21	32.28	2.7519	0.0000	0.0000	0.0002	0.0016	0.0000	0.0823
2010	10.51	25.26	0.6295	0.0000	0.0000	0.0002	0.0013	0.0000	0.0644
2011	9.02	28.10	0.7138	0.0000	0.0000	0.0002	0.0014	0.0000	0.0717
2012	9.41	27.59	0.7165	0.0000	0.0000	0.0002	0.0014	0.0000	0.0703
2013	8.77	40.99	0.6870	0.0000	0.0000	0.0002	0.0020	0.0000	0.1045
2014	9.03	59.42	0.7091	0.0000	0.0000	0.0004	0.0030	0.0000	0.1515
2015	9.33	37.91	0.5895	0.0000	0.0000	0.0002	0.0019	0.0000	0.0967
2016	9.97	66.37	0.5772	0.0000	0.0000	0.0004	0.0033	0.0000	0.1692
2017	10.08	50.56	0.5635	0.0000	0.0000	0.0003	0.0025	0.0000	0.1289
2018	9.76	68.53	0.5674	0.0000	0.0000	0.0004	0.0034	0.0000	0.1748
2019	9.38	63.68	0.5044	0.0000	0.0000	0.0004	0.0032	0.0000	0.1624
2020	8.39	64.96	0.4253	0.0000	0.0000	0.0004	0.0032	0.0000	0.1656
2021	7.85	78.96	0.5070	0.0000	0.0000	0.0005	0.0039	0.0000	0.2014
2022	8.26	59.39	0.5329	0.0000	0.0000	0.0004	0.0030	0.0000	0.1514
2023	6.99	53.34	0.4639	0.0000	0.0000	0.0003	0.0027	0.0000	0.1360
1990/2023	**-4%**	**-59%**	**-89%**	**-59%**	**-59%**	**-59%**	**-59%**	**-59%**	**-59%**
2022/2023	**-15%**	**-10%**	**-13%**	**-10%**	**-10%**	**-10%**	**-10%**	**-10%**	**-10%**

4.7.7.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators.

Table 4.90: *Industrial activities included in 2D3g according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.19 Manufacture of paints, varnishes, inks, glues and adhesives with projected consumption of organic solvents in tonnes/year
4.20 Manufacture of pharmaceutical products with a projected consumption of organic solvents in tonnes/year
4.33 Manufacturing and processing of rubber: a) with a projected consumption of organic solvents in tonnes/year b) production of raw rubber compounds c) processing of the rubber compounds with a projected capacity in kg/hour
4.38 Industrial Plastics Processing: a) fibre production with a projected capacity in tonnes/year b) production of films and other products with a projected amount of processed polymer in kg/hour c) the processing of polyester resins with the addition of styrene or epoxy resins with amines, such as the production of boats, trucks, and car parts, with a projected consumption of raw materials in kg/day d) the processing of amino and phenolic resins with a projected consumption of raw materials in kg/day e) production of polyurethane products with a projected consumption of organic solvents in tonnes/year f) manufacturing expanded plastic, such as polystyrene foam, with a projected consumption of organic blowing agents in tonnes/year
6.10 Manufacturing and processing of leather: a) manufacture of leather with projected quantities for tonne/day b) treatment of the leather, except footwear and shoe production, coating and other applications on the leather, with a projected consumption of organic solvents in tonnes/year
6.11 Manufacturing of footwear with a projected consumption of organic solvents in tonnes/year

No small sources occur on the territory of the SR. However, the limit threshold for reporting into the NEIS is not 0, but there is an assumption of no existence of SS for these kinds of products and activities. Thus facility data from the NEIS is used.

$$E_{TOTAL} = E_{NEIS}$$

Emissions of HMs and PAHs were calculated using the Tier 2 method for Asphalt blowing from the EMEP/EEA GB_{2023}. The emission factors used for the calculation are listed in ***Table 4.91***.

Table 4.91: Emission factors for HMs and PAHs

	Cd [g/t]	As [g/t]	Cr [g/t]	Ni [g/t]	Se [g/t]	PAHs [g/t]
EF	0.0001	0.0005	0.006	0.05	0.0005	2.55

Calculations in the NEIS: Reporting of solvents in the NEIS evidence is performed in Balance sheets of organic solvents for individual releases. The quantity of VOC is calculated by the equations:

Equation 4.12: Equation a)

$$E\ [t] = c[mg/m^3] \times V[th.m^3] \times 10^{-6}$$

Where
c = concentration of air pollutant
V = quantity/volume of released waste gas

Equation 4.13: Equation b)

$$E\ [t] = q[kg/h] \times t[h] \times 10^{-3}$$

Where
q = mass flow
t = number of operational hours for the related year

Equation 4.14: Equation c) Direct and indirect balance in case of unambiguous emission dependence

$$E = O1 + F$$

Where
O1 = Emissions released by outputs
F = Fugitive emissions are differently calculated for direct and indirect emissions

The activities of 6.10 were included here according to guidebook **2D3g** Table 3-13 manufacturing of shoes and similarly 6.11 according to the EMEP/EEA GB_{2023} Table 3-14 Leather tanning instead of 2D3i, where the activities were before.
The other emissions are recorded from sources in the NEIS categorization, but emissions are assumed to not relate to technology (NOx, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO) were allocated to the **1A2gviii** to be in line with EMEP/EEA GB_{2023}.

Historical data: The emissions are taken from the NEIS for the years 2005 to 2023. Due to the absence of any statistical data before 2001 as well as data in the NEIS before 2005, the historical data are extrapolated with a linear trend.

4.7.7.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.7.4 Source-specific Recalculations

No recalculation was made.

4.7.8 Printing (NFR 2D3h)

4.7.8.1 Overview

The category reports NMVOC emissions. The emissions show a decreasing overall trend (***Table 4.92***). The most significant decrease was recorded between 2006 and 2008, which can be attributed to the gradual application of the Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC.

Table 4.92: *Activity data and emissions in the category 2D3h*

YEAR	SOLVENTS USED [kt]	NMVOC [kt]
1990	4.48	2.1784
1995	4.60	1.8269
2000	4.72	1.4754
2005	4.47	1.4178
2010	4.87	0.5250
2011	5.28	0.5129
2012	5.17	0.6804
2013	4.35	0.4905
2014	5.01	0.5291
2015	5.08	0.5604
2016	5.46	0.5581
2017	6.07	0.6018
2018	5.74	0.5220
2019	5.16	0.3623
2020	3.99	0.6416
2021	4.67	0.6694
2022	4.74	0.6840
2023	4.26	0.3701
1990/2023	**-5%**	**-83%**
2022/2023	**-10%**	**-46%**

4.7.8.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators. Small sources on the territory of SR not covered by the NEIS are calculated from the statistical data. A combination of T2 + T3 is used.

Table 4.93: *Industrial activities included in 2D3h according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
6.7 Polygraphy according to a projected consumption of organic solvents in tonnes /year: a) publication rotogravure b) other rotogravure c) headset web offset printing d) flexography e) varnishing and laminating technology f) rotary screen printing on textiles, paperboard g) other printing techniques, such as cold offset, sheet-fed equipment and other

Emission calculations:

$$E_{TOTAL} = E_{SMALL\ SOURCES} + E_{NEIS}$$

The methods of Calculations in NEIS can be found in **ANNEX IV: Chapter A4.1-A4.5**.

Calculations of Small Sources: Small sources were balanced. The balance is performed by a top-down approach. The statistical data are processed and total solvents consumption is calculated. From the total balance of **2D3d**, the printing inks have been separated and allocated into **2D3h** as small sources.

Small sources calculation:

$$Production + Import - Export = Total\ Product\ Consumption$$
$$Total\ Product\ Consumption \rightarrow Calculation\ of\ Total\ Solvents\ Consumption$$
$$Total\ Solvents\ Consumption - Industrial\ Solvents\ Consumption = Small\ Sources$$

Historical data: The emissions are taken from the NEIS for the years 2005 to 2023. Due to the absence of any statistical data before 2001 as well as data in the NEIS before 2005, the historical data are extrapolated with a linear trend.

4.7.8.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.8.4 Source-specific Recalculations

No recalculation was made.

4.7.9 Other Solvent Use (NFR 2D3i)

4.7.9.1 Overview

The category reports NMVOC emissions. Emissions of NMVOC from the NEIS database are shown in ***Table 4.94***. Emissions in this category calculated from lubricant consumption in transport are presented in ***Table 4.95***.

Table 4.94: *Overview of emissions of NMVOC in the category 2D3i*

YEAR	SOLVENT USED [kt]	NMVOC [kt]
1990	0.56	0.4239
1995	0.54	0.3741
2000	0.51	0.3243
2005	0.39	0.2942
2010	0.42	0.2085
2011	0.47	0.2232
2012	0.39	0.1809
2013	0.39	0.1504
2014	0.35	0.1761
2015	0.42	0.1729
2016	0.48	0.2195
2017	0.78	0.2328
2018	0.88	0.2581
2019	0.96	0.2635
2020	0.82	0.2545
2021	0.74	0.2329
2022	0.75	0.2460
2023	0.85	0.2491
1990/2023	**50%**	**-41%**
2022/2023	**12%**	**1%**

Table 4.95: *Emissions from lubricant consumption in transport*

YEAR	SOx [kt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0147	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	3.6898
1995	0.0139	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	3.4896
2000	0.0150	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	3.7594
2005	0.0223	0.0002	0.0003	0.0001	0.0003	0.0002	0.0001	0.0001	0.0001	5.6020
2010	0.0271	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.7983
2011	0.0259	0.0003	0.0003	0.0002	0.0004	0.0002	0.0002	0.0002	0.0001	6.4890
2012	0.0278	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.9798
2013	0.030	0.0003	0.0004	0.0002	0.0004	0.0002	0.0002	0.0002	0.0001	7.3916
2014	0.027	0.0003	0.0004	0.0002	0.0004	0.0002	0.0002	0.0002	0.0001	5.0755
2015	0.032	0.0004	0.0004	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002	8.1397
2016	0.035	0.0004	0.0005	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002	8.8067
2017	0.034	0.0004	0.0005	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002	8.4867
2018	0.037	0.0004	0.0005	0.0003	0.0006	0.0004	0.0002	0.0003	0.0002	9.1710
2019	0.023	0.0004	0.0007	0.0003	0.0008	0.0004	0.0003	0.0003	0.0002	7.0228

YEAR	SOx [kt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2020	0.022	0.0004	0.0006	0.0002	0.0007	0.0003	0.0003	0.0003	0.0002	6.9051
2021	0.022	0.0004	0.00064	0.00024	0.00074	0.00034	0.0003	0.0003	0.0002	6.7711
2022	0.023	0.0004	0.0007	0.0003	0.0008	0.0004	0.0003	0.0003	0.0002	7.1883
2023	0.031	0.0004	0.0007	0.0003	0.0008	0.0004	0.0003	0.0003	0.0002	4.6846
1990/2023	**112%**	**135%**	**239%**	**161%**	**256%**	**161%**	**213%**	**213%**	**161%**	**27%**
2022/2023	**35%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-1%**	**-35%**

4.7.9.2 Methodological Issues

The source of emissions is the NEIS database – recorded facility data from operators. Small sources on the territory of SR not covered by the NEIS are calculated from the statistical data. A combination of T2 + T3 is used. Activities included in this category are listed in ***Table 4.96***.

Table 4.96: *Industrial activities included in 2D3i according to national categorization*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.35 Industrial extraction of vegetable oil and animal fat and vegetable oil refining with a projected consumption of organic solvents in tons/year
6.6 Adhesive coating - bonding of materials other than wood, wood products and agglomerated materials, leather and footwear production with a projected consumption of organic solvents in tons/year

Emission calculations in the industry:

$$E_{TOTAL} = E_{SMALL\ SOURCES} + E_{NEIS}$$

The methods of Calculations in the NEIS can be found in **ANNEX IV: Chapter A4.1-A4.5**.

Historical data: The emissions are taken from the NEIS for the years 2000 to 2023. Due to the absence of statistical data before 2001 as well as data in the NEIS before 2000, the historical data are extrapolated with a linear trend.

Emission calculations in transport are based on the model COPERT.

4.7.9.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2023}.

4.7.9.4 Source-specific Recalculation

Recalculation was made due to the lubricant use recalculation in the COPERT model. It was caused by the software update of the COPERT model, where corrections of several emission factors, and the addition of new vehicle categories were made.

Table 4.97: *Previous and revised emissions in the category 2D3i*

YEAR	SOx [kt]			Pb [t]			Cd [t]		
	P	R	C	P	R	C	P	R	C
2013	0.0273	0.0297	9%	0.0003	0.0003	15%	0.0004	0.0004	5%
2014	0.0279	0.0271	-3%	0.0003	0.0003	4%	0.0004	0.0004	3%
2015	0.0301	0.0325	8%	0.0003	0.0004	8%	0.0004	0.0004	8%
2016	0.0316	0.0351	11%	0.0004	0.0004	11%	0.0004	0.0005	11%
2017	0.0326	0.0339	4%	0.0004	0.0004	4%	0.0004	0.0005	4%
2018	0.0338	0.0371	10%	0.0004	0.0004	8%	0.0005	0.0005	8%
2019	0.0224	0.0226	1%	0.0004	0.0004	1%	0.0005	0.0007	28%
2020	0.0211	0.0222	6%	0.0003	0.0004	6%	0.0005	0.0006	34%
2021	0.0220	0.0218	-1%	0.0004	0.0004	-1%	0.0006	0.0006	-1%
2022	0.0234	0.0231	-1%	0.0004	0.0004	-1%	0.0007	0.0007	-1%

YEAR	Hg [t]			As [t]			Cr [t]			Cu [t]		
	P	R	C	P	R	C	P	R	C	P	R	C
2013	0.0002	0.0002	8%	0.0004	0.0004	7%	0.0003	0.0002	-29%	0.0002	0.0002	0%
2014	0.0002	0.0002	3%	0.0004	0.0004	3%	0.0003	0.0002	-31%	0.0002	0.0002	3%
2015	0.0002	0.0002	8%	0.0005	0.0005	8%	0.0003	0.0002	-28%	0.0002	0.0002	8%
2016	0.0002	0.0002	11%	0.0005	0.0005	11%	0.0003	0.0002	-26%	0.0002	0.0002	11%
2017	0.0002	0.0002	4%	0.0005	0.0005	4%	0.0003	0.0002	-30%	0.0002	0.0002	4%
2018	0.0002	0.0003	8%	0.0005	0.0006	8%	0.0003	0.0004	8%	0.0002	0.0002	8%
2019	0.0003	0.0003	-4%	0.0006	0.0008	32%	0.0004	0.0004	-3%	0.0002	0.0003	25%
2020	0.0002	0.0002	0%	0.0005	0.0007	38%	0.0003	0.0003	2%	0.0002	0.0003	31%
2021	0.0002	0.0002	-1%	0.0007	0.0007	-1%	0.0003	0.0003	-1%	0.0003	0.0003	-1%
2022	0.0003	0.0003	-1%	0.0008	0.0008	-1%	0.0004	0.0004	-1%	0.0003	0.0003	-1%

YEAR	Ni [t]			Se [t]			Zn [t]		
	P	R	C	P	R	C	P	R	C
2013	0.0002	0.0002	9%	0.0001	0.0001	-5%	6.8365	7.3916	8%
2014	0.0002	0.0002	3%	0.0001	0.0001	3%	6.9937	5.0755	-27%
2015	0.0002	0.0002	8%	0.0001	0.0002	8%	7.5426	8.1397	8%
2016	0.0002	0.0002	11%	0.0002	0.0002	11%	7.9169	8.8067	11%
2017	0.0002	0.0002	4%	0.0002	0.0002	4%	8.1600	8.4867	4%
2018	0.0002	0.0003	8%	0.0002	0.0002	8%	8.4633	9.1710	8%
2019	0.0003	0.0003	14%	0.0002	0.0002	9%	6.9608	7.0228	1%
2020	0.0002	0.0003	19%	0.0002	0.0002	14%	6.5433	6.9051	6%
2021	0.0003	0.0003	-1%	0.0002	0.0002	-1%	6.8394	6.7711	-1%
2022	0.0003	0.0003	-1%	0.0002	0.0002	-1%	7.2661	7.1883	-1%

P – Previous, R – Revised, C – Change in %

4.7.10 Other Product Use (NFR 2G)

4.7.10.1 Overview

In this category, emissions arising from tobacco combustion and the use of fireworks are reported. Tobacco smoke contains many toxicologically significant chemicals and groups of chemicals, including polycyclic aromatic hydrocarbons (benzopyrene), tobacco-specific nitrosamines, aldehydes, carbon monoxide, hydrogen cyanide, nitrogen oxides, benzene, toluene, phenols, aromatic amines (nicotine, ABP (4-Aminobiphenyl)). The chemical composition of smoke depends on puff frequency, intensity, volume, and duration at different stages of cigarette consumption.[3]

Fireworks produce smoke and dust that may contain residues of heavy metals, sulfur-coal compounds and some low-concentration toxic chemicals. These by-products of fireworks combustion will vary depending on the mix of ingredients of a particular firework. This activity is no significant contributor to national totals.

Table 4.98 below shows a significant increase in emissions in this category from 1990 due to an increase in tobacco and fireworks use. In ***Table 4.98*** emission trend of NMVOC is also shown.

Table 4.98: *Overview of emissions in the category Other Product Use 2G*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.0012	0.0032	0.0001	0.0028	0.0181	0.0181	0.0181	0.0081	0.0371
1995	0.0087	0.0232	0.0004	0.0199	0.1293	0.1293	0.1293	0.0582	0.2647
2000	0.0097	0.0257	0.0016	0.0220	0.1433	0.1433	0.1433	0.0645	0.2961
2005	0.0119	0.0316	0.0024	0.0271	0.1761	0.1762	0.1762	0.0792	0.3649

[3] U.S. Dept. of Health and Human Services, 1981: The Health Consequences of Smoking: The Changing Cigarette

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2010	0.0161	0.0431	0.0004	0.0370	0.2404	0.2404	0.2404	0.1082	0.4915
2011	0.0160	0.0425	0.0020	0.0365	0.2372	0.2372	0.2373	0.1067	0.4888
2012	0.0164	0.0436	0.0024	0.0374	0.2433	0.2433	0.2433	0.1095	0.5021
2013	0.0144	0.0380	0.0031	0.0325	0.2118	0.2119	0.2119	0.0953	0.4394
2014	0.0153	0.0404	0.0027	0.0346	0.2254	0.2254	0.2254	0.1014	0.4662
2015	0.0155	0.0410	0.0030	0.0352	0.2289	0.2289	0.2289	0.1030	0.4740
2016	0.0155	0.0409	0.0031	0.0350	0.2281	0.2281	0.2281	0.1026	0.4727
2017	0.0167	0.0439	0.0041	0.0376	0.2448	0.2448	0.2449	0.1101	0.5090
2018	0.0162	0.0428	0.0031	0.0367	0.2390	0.2390	0.2390	0.1075	0.4948
2019	0.0172	0.0457	0.0028	0.0392	0.2551	0.2551	0.2552	0.1148	0.5271
2020	0.0143	0.0383	0.0010	0.0329	0.2139	0.2139	0.2139	0.0962	0.4387
2021	0.0168	0.0448	0.0018	0.0384	0.2497	0.2497	0.2497	0.1123	0.5136
2022	0.0163	0.0433	0.0026	0.0371	0.2417	0.2417	0.2418	0.1087	0.4994
2023	0.0129	0.0340	0.0031	0.0292	0.1899	0.1900	0.1900	0.0854	0.3948
1990/2023	**966%**	**951%**	**2907%**	**951%**	**952%**	**952%**	**952%**	**951%**	**964%**
2022/2023	**-21%**	**-21%**	**18%**	**-21%**	**-21%**	**-21%**	**-21%**	**-21%**	**-21%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Zn [t]
1990	0.0268	0.0037	0.0000	0.0000	0.0005	0.0188	0.0028	0.0107
1995	0.0925	0.0260	0.0000	0.0002	0.0018	0.0782	0.0165	0.0436
2000	0.4180	0.0294	0.0000	0.0007	0.0083	0.2654	0.0303	0.1530
2005	0.6138	0.0364	0.0000	0.0010	0.0122	0.3828	0.0411	0.2212
2010	0.0932	0.0483	0.0000	0.0002	0.0019	0.1009	0.0276	0.0549
2011	0.5192	0.0484	0.0000	0.0009	0.0103	0.3415	0.0436	0.1959
2012	0.6244	0.0498	0.0000	0.0011	0.0124	0.4023	0.0482	0.2314
2013	0.7939	0.0439	0.0001	0.0013	0.0158	0.4919	0.0516	0.2845
2014	0.6932	0.0464	0.0001	0.0012	0.0138	0.4377	0.0491	0.2524
2015	0.7700	0.0472	0.0001	0.0013	0.0153	0.4818	0.0523	0.2782
2016	0.8080	0.0471	0.0001	0.0014	0.0161	0.5032	0.0537	0.2908
2017	1.0569	0.0509	0.0001	0.0018	0.0210	0.6475	0.0649	0.3750
2018	0.7925	0.0493	0.0001	0.0013	0.0158	0.4966	0.0542	0.2867
2019	0.7184	0.0524	0.0001	0.0012	0.0143	0.4579	0.0530	0.2638
2020	0.2582	0.0433	0.0000	0.0004	0.0051	0.1890	0.0313	0.1070
2021	0.4578	0.0508	0.0000	0.0008	0.0091	0.3092	0.0425	0.1768
2022	0.6851	0.0496	0.0000	0.0012	0.0136	0.4363	0.0504	0.2514
2023	0.8061	0.0395	0.0001	0.0014	0.0160	0.4945	0.0498	0.2863
1990/2023	**2907%**	**978%**	**2907%**	**2907%**	**2907%**	**2531%**	**1660%**	**2577%**
2022/2023	**18%**	**-20%**	**18%**	**18%**	**18%**	**13%**	**-1%**	**14%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
1990	0.0001	0.0001	0.0000	0.0000	0.0000	0.0002
1995	0.0005	0.0005	0.0002	0.0002	0.0002	0.0012
2000	0.0005	0.0006	0.0002	0.0002	0.0002	0.0013
2005	0.0007	0.0007	0.0003	0.0003	0.0003	0.0016
2010	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2011	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2012	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2013	0.0008	0.0009	0.0004	0.0004	0.0004	0.0019
2014	0.0008	0.0009	0.0004	0.0004	0.0004	0.0021
2015	0.0008	0.0009	0.0004	0.0004	0.0004	0.0021

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
2016	0.0008	0.0009	0.0004	0.0004	0.0004	0.0021
2017	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2018	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2019	0.0009	0.0010	0.0004	0.0004	0.0004	0.0023
2020	0.0008	0.0009	0.0004	0.0004	0.0004	0.0019
2021	0.0009	0.0010	0.0004	0.0004	0.0004	0.0023
2022	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2023	0.0007	0.0008	0.0003	0.0003	0.0003	0.0017
1990/2023	**951%**	**951%**	**951%**	**951%**	**951%**	**951%**
2022/2023	**-21%**	**-21%**	**-21%**	**-21%**	**-21%**	**-21%**

4.7.10.2 Methodological Issues

Activity data about amounts of fireworks and tobacco and import/export data from the Statistical Office of the Slovak Republic were used. There was no production of fireworks in the Slovak Republic in the whole time series. Following ***Recommendation No SK-2G-2022-0001***, the activity data was checked, and the data for tobacco combustion for the years 2005 and 2007 were reconsidered and replaced by the value calculated as a trend. For calculations of fireworks ***Equation 4.15*** for the period 1991-2022 was used:

Equation 4.15: *Amount of product used in the Slovak Republic in a particular year*

$$Product\ total\ = Product\ import\ total - Product\ export\ total$$

There was a single producer of tobacco products, which operated until 2008; therefore, production data are confidential. The operator produced cigarettes until the year 2004 and cigars and cigarillos until the year 2008, hence ***Equation 4.15*** was used for cigarettes for the period 2005-2023 and cigars and cigarillos for the period 2009-2023. For the previous periods, it was assumed that the production was equal to export and only import data entered into calculations. For the next submission, obtaining confidential data about the production of tobacco products was planned. ***Table 4.99*** shows the results of these calculations.

Table 4.99: *Activity data used in the category Other Product Use*

YEAR	TOBACCO COMBUSTED [kt]	FIREWORKS USED [kt]
1990	0.67	0.03
1995	4.79	0.12
2000	5.30	0.53
2005	6.52	0.78
2010	8.90	0.12
2011	8.78	0.66
2012	9.01	0.80
2013	7.84	1.01
2014	8.35	0.88
2015	8.47	0.98
2016	8.45	1.03
2017	9.06	1.35
2018	8.85	1.01
2019	9.45	0.92
2020	7.92	0.33
2021	9.25	0.58
2022	8.95	0.87
2023	7.03	1.03

Emission factors for the calculations originate from the Tier 2 methodology in EMEP/EEA GB_{2023} (***Table 4.100, 4.101***). **Condensable component of PMs** is included in emission factors for tobacco combustion, for the use of fireworks is this information unknown.

Table 4.100: *Emission factors in the category Other Product Use – Use of fireworks*

POLLUTANT	NOx	SOx	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
Unit	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
Value	260	3020	51.94	99.92	109.83	7150	784	1.48	0.057	1.33	15.6	444	30	260

Table 4.101: *Emission factors in the category Other Product Use – Tobacco combustion*

POLLUTANT	NOx	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Cd	Cu	Ni
Unit	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[% of $PM_{2.5}$]	[kg/t]	[g/t]	[g/t]	[g/t]
Value	1.8	4.84	4.15	27	27	27	0.45	55.1	5.4	5.4	2.7

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	I()P	PAHs
Unit	[µg I-TEQ/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
Value	0.1	0.111	0.045	0.045	0.045	0.246

4.7.10.3 Completeness

All rising pollutants were reported.

4.7.10.4 Source-specific Recalculations

No recalculation was made.

4.8 OTHER PROCESSES (NFR 2H)

The chapter is divided into 3 industrial activities: Pulp and paper industry (**2H1**), Food and beverages industry (**2H2**) and other industrial processes (**2H3**). An overview of emissions and their trends is listed in ***Table 4.102***. Emissions of PMs and NH_3 have a decreasing trend due to the installation of abatement technologies on the plants during the time series. Emissions of NOx, NMVOC, SOx and CO have a substantially increasing trend, but this category does not belong among the key categories for the Slovak Republic.

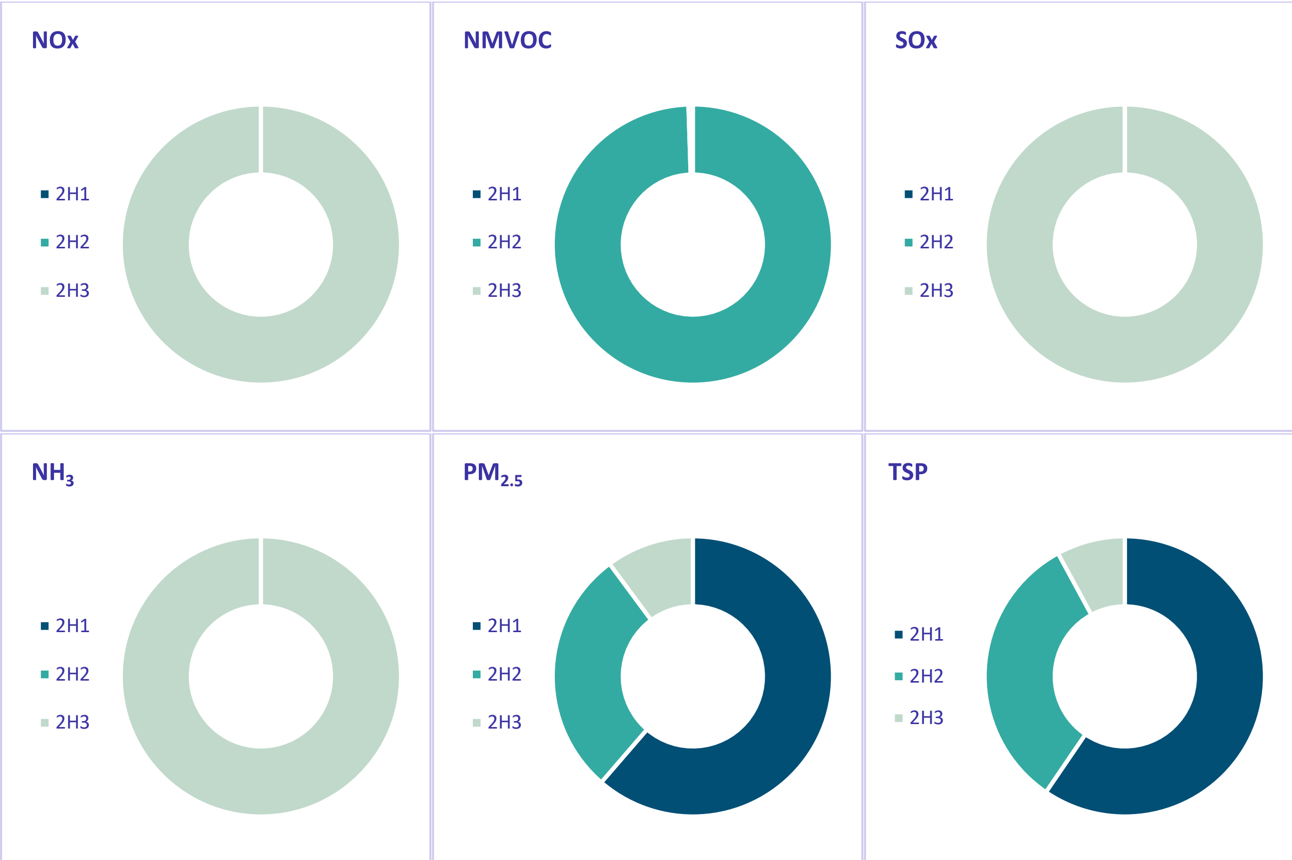
Table 4.102: *Overview of emissions in the category 2H*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.0002	0.8000	0.0000	0.0018	0.0183	0.0682	0.1674	0.0005	0.0000
1995	0.0003	2.0257	0.0000	0.0021	0.0291	0.1089	0.2671	0.0007	0.0000
2000	0.0001	3.2407	0.0000	0.0059	0.0389	0.1454	0.3565	0.0010	0.0000
2005	0.0007	4.1588	0.0000	0.0000	0.0547	0.2133	0.5295	0.0013	0.0001
2010	0.0001	3.7559	0.0000	0.0000	0.0146	0.0545	0.1336	0.0003	0.0001
2011	0.0002	3.9198	0.0000	0.0000	0.0265	0.1020	0.2525	0.0006	0.0001
2012	0.0003	3.5611	0.0000	0.0000	0.0232	0.0897	0.2223	0.0005	0.0001
2013	0.0001	4.2448	0.0000	0.0000	0.0305	0.1189	0.2953	0.0007	0.0001
2014	0.0009	4.4789	0.0012	0.0000	0.0171	0.0655	0.1617	0.0004	0.0000
2015	0.0014	4.1181	0.0020	0.0000	0.0102	0.0377	0.0923	0.0002	0.0001
2016	0.0021	4.4331	0.0030	0.0000	0.0095	0.0342	0.0832	0.0002	0.0014
2017	0.0021	4.4627	0.0030	0.0000	0.0106	0.0384	0.0935	0.0002	NO
2018	0.0021	4.1313	0.0031	0.0000	0.0101	0.0363	0.0883	0.0002	NO
2019	0.0021	4.2741	0.0030	0.0000	0.0095	0.0337	0.0859	0.0002	NO
2020	0.0014	4.0504	0.0020	0.0000	0.0129	0.0477	0.1167	0.0003	NO
2021	0.0007	4.3422	0.0011	0.0000	0.0134	0.0496	0.1215	0.0003	NO
2022	0.0006	4.5571	0.0009	0.0000	0.0120	0.0440	0.1075	0.0002	NO

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2023	0.0000	4.5409	0.0001	0.0001	0.0089	0.0319	0.0776	0.0001	NO
1990/2023	**-94%**	**468%**	**3703%**	**-93%**	**-52%**	**-53%**	**-54%**	**-69%**	**-**
2022/2023	**-98%**	**0%**	**-86%**	**328%**	**-26%**	**-27%**	**-28%**	**-36%**	**-**

Shares of NOx, NMVOC, SOx, NH_3 and $PM_{2.5}$ emissions in 2023 included in NFR categories are shown in ***Figure 4.7***.

Figure 4.7: *Shares of emissions in 2H in 2023*



4.8.1 Pulp and Paper Industry (NFR 2H1)

4.8.1.1 Overview

Pulp and paper production consists of three major processing steps: pulping, bleaching and paper production. The type of pulping and the amount of bleaching used depend on the feedstock's nature and the end product's desired qualities.

Several companies were operating during the year 2023 in the pulp and paper industry in the Slovak Republic. Among them, only one is categorized as a medium source, the rest are large sources. In ***Table 4.103*** can be seen that emissions of all pollutants decreased in general since the year 1990.

Table 4.103: *Activity data and emissions in the category 2H1*

YEAR	PULP PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
1990	179.23	0.0175	0.0654	0.1604	0.0005
1995	283.87	0.0277	0.1036	0.2541	0.0007
2000	388.64	0.0383	0.1431	0.3508	0.0010
2005	492.58	0.0518	0.2019	0.5012	0.0013
2010	592.09	0.0120	0.0447	0.1094	0.0003

YEAR	PULP PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
2011	622.76	0.0234	0.0901	0.2231	0.0006
2012	635.18	0.0204	0.0790	0.1959	0.0005
2013	637.44	0.0276	0.1077	0.2675	0.0007
2014	649.37	0.0137	0.0524	0.1294	0.0004
2015	691.78	0.0069	0.0250	0.0609	0.0002
2016	680.46	0.0064	0.0230	0.0557	0.0002
2017	692.87	0.0076	0.0274	0.0666	0.0002
2018	666.82	0.0071	0.0255	0.0618	0.0002
2019	636.44	0.0067	0.0241	0.0583	0.0002
2020	713.39	0.0102	0.0377	0.0921	0.0003
2021	765.02	0.0109	0.0409	0.1004	0.0003
2022	721.28	0.0085	0.0313	0.0764	0.0002
2023	630.23	0.0054	0.0192	0.0462	0.0001
1990/2023	**252%**	**-69%**	**-71%**	**-71%**	**-69%**
2022/2023	**-13%**	**-36%**	**-39%**	**-40%**	**-36%**

4.8.1.2 Methodological Issues

Activities assigned in this category are listed in ***Table 4.104***.

Table 4.104: *Activities according to national categorization included in 2H1*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.18 Manufacture of pulp and derivatives thereof, including the treatment of waste to products of this manufacture
4.36 Production and refinement of paper, and cardboard with projected output in t/d

Emission data is compiled in the NEIS database, therefore, the individual-specific EFs were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and the detailed methodology of the NEIS are presented in **ANNEX IV**. The following table presents the share of use of different types of calculation of emissions reported from plants and sources in the NEIS.
Historical years from 1990-1999 were calculated using a weighted average of implied emission factors from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009. The emission of BC was calculated using the Tier 1 emission factor from EMEP/EEA GB_{2023} (***Table 4.105***).

Table 4.105: *Emission factors for calculation of historical years and BC in 2H1*

	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	TSP [g/t]	BC [% of $PM_{2.5}$]
EF	11%	41%	895.06	2.60%

4.8.1.3 Completeness

Heavy metals, PCDD/F and HCB are reported with the notation key NA, other POPs are reported using the notation key NE in complying with the EMEP/EEA GB_{2023}. Combustion emissions (NOx, NMVOC, SOx, NH_3, CO) were allocated to the category **1A2d**, therefore, the notation key IE was used.

4.8.1.4 Source-specific Recalculations

No recalculation was made.

4.8.2 Food and Beverages Industry (NFR 2H2)

4.8.2.1 Overview

Food manufacturing may involve the heating of fats and oils and foodstuffs containing them, the baking of cereals, flour and beans, fermentation in the making of bread, the cooking of vegetables and meats, and the drying of residues. These processes may occur in sources varying in size from domestic households to manufacturing plants.

An alcoholic beverage is produced by the fermentation of sugar, which comes from fruit, cereals or other vegetables. Sugar is converted by yeast into ethanol. Before fermentation, materials are specifically processed, for example, in the manufacture of beer, cereals are allowed to germinate, then roasted and boiled before fermentation. To make spirits, the fermented liquid is then distilled. Alcoholic beverages, particularly spirits and wine, may be stored for many years before consumption.

Emissions from this combustion were reported in category **1A2e**. In this category, only process emissions were reported (***Table 4.106***).

Table 4.106: *Activity data and emissions in the category 2H2*

YEAR	BREAD TYPICAL EUROPE [kt]	WHITE BREAD [kt]	CAKES, BISCUITS AND BREAKFAST CEREALS [kt]	MEAT, FISH AND POULTRY [kt]	SUGAR [kt]	MARGARINE ADN SOLID COOKING FATS [kt]	ANIMAL FEED [kt]	COFEE ROASTING [kt]
1990	20.78	0.69	23.26	27.70	27.31	3.23	89.05	0.70
1995	53.57	1.77	55.40	71.42	70.41	8.34	229.57	1.81
2000	86.40	2.85	89.35	115.18	113.55	13.45	370.24	2.92
2005	110.04	3.63	113.81	146.71	144.63	17.13	471.57	3.72
2010	99.62	2.60	104.58	147.54	148.34	8.86	136.37	1.90
2011	95.83	2.81	111.24	137.07	177.92	8.20	110.75	2.10
2012	93.42	2.74	108.67	120.52	138.43	7.17	170.19	2.20
2013	89.11	2.60	113.03	105.81	176.89	15.06	252.29	2.01
2014	91.30	2.60	109.42	105.81	199.58	13.89	214.47	2.03
2015	89.74	2.62	109.74	111.79	171.19	13.55	234.04	2.23
2016	87.18	2.88	125.61	125.36	197.12	13.92	213.44	2.35
2017	87.61	2.63	129.23	152.41	187.72	14.02	272.23	2.50
2018	83.71	2.56	112.52	171.34	150.28	13.59	257.50	2.22
2019	84.98	2.50	109.26	167.77	155.77	14.01	282.46	2.43
2020	86.05	1.77	106.51	150.43	148.80	13.88	281.11	2.29
2021	83.50	1.36	184.00	162.62	158.67	13.71	220.44	2.45
2022	85.57	9.05	124.83	167.19	172.01	12.04	260.17	2.53
2023	93.51	12.42	132.10	200.03	131.46	11.41	322.70	2.69
1990/2023	**350%**	**1711%**	**468%**	**622%**	**381%**	**253%**	**262%**	**284%**
2022/2023	**9%**	**37%**	**6%**	**20%**	**-24%**	**-5%**	**24%**	**7%**

YEAR	WINE UNSPECIFIED COLOUR [10³hl]	BEER INCLUDING DE-ALCOHOLIZIED [10³hl]	SPIRITS UNSPECIFIED SORT [10³hl]	OTHER SPIRITS [10³hl]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	57.94	732.38	14.65	11.12	0.7775	0.0004	0.0014	0.0035
1995	149.37	1 888.14	37.77	28.67	1.9999	0.0009	0.0036	0.0091
2000	240.90	3 045.16	60.92	46.23	3.2254	0.0005	0.0018	0.0045
2005	275.86	3 878.63	77.59	58.88	4.1057	0.0021	0.0083	0.0209
2010	278.16	3 001.63	79.58	57.95	3.6624	0.0014	0.0057	0.0142
2011	314.22	2 973.17	78.00	61.24	3.8930	0.0015	0.0060	0.0149
2012	372.24	2 998.38	77.76	51.89	3.5270	0.0012	0.0049	0.0121
2013	416.45	2 961.11	88.83	46.12	4.2182	0.0016	0.0065	0.0162
2014	384.73	2 727.39	92.62	45.63	4.4477	0.0018	0.0073	0.0181
2015	358.94	2 491.48	87.08	52.08	4.0845	0.0020	0.0079	0.0198
2016	364.97	2 283.41	91.54	51.67	4.3965	0.0017	0.0069	0.0173
2017	415.07	2 399.34	94.51	78.75	4.4384	0.0020	0.0079	0.0197
2018	370.19	2 092.58	101.59	79.68	4.1083	0.0020	0.0080	0.0200

YEAR	WINE UNSPECIFIED COLOUR [10³hl]	BEER INCLUDING DE-ALCOHOLIZIED [10³hl]	SPIRITS UNSPECIFIED SORT [10³hl]	OTHER SPIRITS [10³hl]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
2019	395.24	2 017.91	105.17	79.97	4.2466	0.0016	0.0064	0.0199
2020	424.26	2 501.31	94.58	66.76	4.0228	0.0018	0.0073	0.0182
2021	361.49	2 270.48	107.15	83.41	4.3093	0.0015	0.0059	0.0147
2022	354.95	2 361.28	111.99	83.80	4.5273	0.0025	0.0100	0.0249
2023	341.94	2 224.85	130.26	93.00	4.5179	0.0025	0.0101	0.0253
1990/2023	**490%**	**204%**	**789%**	**736%**	**481%**	**612%**	**612%**	**612%**
2022/2023	**-4%**	**-6%**	**16%**	**11%**	**0%**	**2%**	**2%**	**2%**

4.8.2.2 Methodological Issues

Emissions were calculated using Tier 2 emission factors from the EMEP/EEA GB_{2023}. Activity data were obtained from the national PRODCOM database and Import/export statistics for the period 2005-2023. Historical data were extrapolated using GDP as surrogate data.

Emission data of PMS was compiled in the NEIS database, therefore, the individual-specific EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and the detailed methodology of the NEIS are presented in **ANNEX IV**. The following table presents the share of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Historical years from 1990-1999 were calculated using a weighted average of implied emission factors from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009. The emission of BC was calculated using the Tier 1 emission factor from the EMEP/EEA GB_{2023} (***Table 4.107***).

Table 4.107: *Emission factors for calculation of NMVOC in the category 2H2*

	NMVOC [kg/t] or [kg/hl]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	TSP [g/t]
Bread typical Europe	4.5	10.00%	40.00%	9.13
White bread	4.5			
Cakes, biscuits and breakfast cereals	1			
Meat, fish and poultry	0.3			
Sugar	10			
Margarine and solid cooking fats	10			
Animal feed	1			
Coffee roasting	0.55			
Wine unspecified colour	0.08			
Beer including de-alcoholized	0.035			
Spirits unspecified sort	15			
Other spirits	0.4			

4.8.2.3 Completeness

All rising pollutants were reported. Notation keys were used following EMEP/EEA GB_{2023}.

4.8.2.4 Source-specific Recalculations

A few recalculations were made due to the completion of activity data and correction of statistical data. The summary value of activity data was slightly corrected. The data of wine, spirits, cakes and biscuits and breakfast cereals production were completed or corrected according to statistical data, therefore historical data from 1990 to2005, which are extrapolated by using GDP as surrogate data has been recalculated. The double counting in coffee roasting in 2005 and 2007 also slightly affected the extrapolation of historical data. The change in NMVOC emissions varies around -4% for the historical years 1990-2007. The change is in the range of 1-3% for the years 2008-2021. For the year 2022, the activity data of sugar and cakes and biscuits were corrected and the resulting change in emissions is 9%. The update of activity data negligibly influenced the emissions of PMs and TSP (less than 0.5%) in the years 1990-1993.

Table 4.108: *Previous and revised activity data and emissions in the category 2H2*

YEARS	AD – FOOD PRODUCED [kt]			NMVOC [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	403.52	388.45	-4%	0.8118	0.7775	-4%
1991	487.66	468.78	-4%	0.9811	0.9390	-4%
1992	589.36	566.06	-4%	1.1857	1.1343	-4%
1993	712.26	683.43	-4%	1.4330	1.3702	-4%
1994	860.79	825.34	-4%	1.7318	1.6553	-4%
1995	1040.30	996.91	-4%	2.0930	1.9999	-4%
1996	1257.23	1204.79	-4%	2.5294	2.4169	-4%
1997	1110.44	1064.12	-4%	2.2341	2.1348	-4%
1998	1464.91	1403.81	-4%	2.9472	2.8162	-4%
1999	1778.36	1704.18	-4%	3.5778	3.4188	-4%
2000	1677.77	1607.79	-4%	3.3755	3.2254	-4%
2001	2296.67	2200.87	-4%	4.6206	4.4152	-4%
2002	1724.68	1652.74	-4%	3.4698	3.3156	-4%
2003	1660.70	1591.43	-4%	3.3411	3.1926	-4%
2004	1892.14	1813.22	-4%	3.8068	3.6375	-4%
2005	2140.70	2044.75	-4%	4.3014	4.1057	-5%
2006	2179.91	2073.66	-5%	4.5159	4.2938	-5%
2007	2064.43	1986.60	-4%	4.3545	4.1886	-4%
2008	1978.73	2019.40	2%	4.2576	4.3263	2%
2009	1745.10	1759.02	1%	3.9277	3.9457	0%
2010	1592.92	1611.46	1%	3.6406	3.6624	1%
2011	1574.86	1596.18	1%	3.8681	3.8930	1%
2012	1557.39	1599.16	3%	3.4852	3.5270	1%
2013	1754.52	1800.00	3%	4.1727	4.2182	1%
2014	1741.39	1785.62	3%	4.4035	4.4477	1%
2015	1674.69	1712.19	2%	4.0470	4.0845	1%
2016	1673.57	1760.12	5%	4.3099	4.3965	2%
2017	1794.72	1883.38	5%	4.3497	4.4384	2%
2018	1775.45	1849.55	4%	4.0342	4.1083	2%
2019	1823.86	1898.25	4%	4.1722	4.2466	2%
2020	1762.85	1836.28	4%	3.9481	4.0228	2%
2021	1811.77	1943.74	7%	4.1774	4.3093	3%
2022	1908.31	1997.02	5%	4.1641	4.5273	9%

4.8.3 Other Industrial Processes (NFR 2H3)

4.8.3.1 Overview

This category includes various sources such as body shops, grain silos, galvanic lines etc. ***Table 4.109*** shows the emission trend in this category. Most of the emissions show an increasing trend, but this category is not significant for emission totals in the Slovak Republic. The visible increase in emissions of NH_3 in 2021 was caused by a new source – the fermentation hall for biodegradable waste, which started operation in 2021. In 2023, the increment of NH_3 emissions is linked to the emission growth of one particular source (which had an interannual increase of 328.44%).

Table 4.109: Overview of emissions in the category 2H3

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	0.0002	0.0225	0.0000	0.0018	0.0004	0.0014	0.0034	0.0000
1995	0.0003	0.0258	0.0000	0.0021	0.0005	0.0016	0.0039	0.0000
2000	0.0001	0.0153	0.0000	0.0059	0.0001	0.0005	0.0012	0.0000
2005	0.0007	0.0530	0.0000	0.0000	0.0008	0.0030	0.0074	0.0001
2010	0.0001	0.0935	0.0000	0.0000	0.0012	0.0041	0.0100	0.0001
2011	0.0002	0.0268	0.0000	0.0000	0.0017	0.0059	0.0145	0.0001
2012	0.0003	0.0341	0.0000	0.0000	0.0016	0.0059	0.0143	0.0001
2013	0.0001	0.0267	0.0000	0.0000	0.0013	0.0048	0.0116	0.0001
2014	0.0009	0.0312	0.0012	0.0000	0.0016	0.0058	0.0142	0.0000
2015	0.0014	0.0336	0.0020	0.0000	0.0014	0.0048	0.0116	0.0001
2016	0.0021	0.0367	0.0030	0.0000	0.0014	0.0043	0.0102	0.0014
2017	0.0021	0.0243	0.0030	0.0000	0.0010	0.0031	0.0073	NO
2018	0.0021	0.0231	0.0031	0.0000	0.0010	0.0028	0.0065	NO
2019	0.0021	0.0275	0.0030	0.0000	0.0011	0.0033	0.0076	NO
2020	0.0014	0.0275	0.0020	0.0000	0.0009	0.0027	0.0064	NO
2021	0.0007	0.0328	0.0011	0.0000	0.0010	0.0028	0.0064	NO
2022	0.0006	0.0298	0.0009	0.0000	0.0010	0.0027	0.0062	NO
2023	0.0000	0.0230	0.0001	0.0001	0.0009	0.0026	0.0061	NO
1990/2023	**-94%**	**2%**	**3703%**	**-93%**	**126%**	**90%**	**82%**	**-**
2022/2023	**-98%**	**-23%**	**-86%**	**328%**	**-8%**	**-3%**	**-1%**	**-**

4.8.3.2 Methodological Issues

Activities listed in ***Table 4.110*** were reported in this category.

Table 4.110: Activities according to national categorization included in 2H3

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
5.99 Other plants and technologies of waste treatment
6.99 Other industrial technologies, manufacturing, and processing equipment not specified in points 1 to 5

Total category emissions represent a negligible part of national totals of emissions (less than 0.05% for every emission). Method and activity data won't be further investigated. Historical data from 1990-1999 were calculated using a weighted average of implied emission factors for the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.111***). Activity data for the calculation of implied emission factors are the total energy used in this category.

Table 4.111: Emission factors for calculation of historical years 2H3

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	TSP [g/GJ]	CO [g/GJ]
EF	441.18	40 599.77	6.23	3 314.83	12%	41%	6 090.68	73.27

4.8.3.3 Completeness

Notation keys are reported in compliance with the EMEP/EEA GB_{2023}. The notation key for the CO in the period 2017-2023 is NO.

4.8.3.4 Source-specific Recalculations

Recalculation was done for NOx and SOx emissions in the year 2022. Previous values were estimated by trend due to the lack of data in NEIS. Estimation was improved with the new dataset for the current year.

Table 4.112: Previous and revised activity data and emissions in the category 2H3

YEARS	NOx [kt]			SOx [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2022	0.0024	0.0006	-73%	0.0035	0.0009	-73%

4.9 WOOD PROCESSING (NFR 2I)

4.9.1 Overview

The present chapter addresses emissions of dust from the processing of wood. This includes the manufacture of plywood, reconstituted wood products and engineered wood products. This source category is only important for particulate emissions.

An overview of emissions and their trends are presented in ***Table 4.113***. Emission trends in this category decrease in general. Although, the interannual change shows an increase. In the last reported year, the increase is evident, mainly for NH_3 emissions. It originates from one producer of agglomerated materials and its rise in production.

Table 4.113: Overview of emissions in the category 2I

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	0.3117	0.2996	0.0023	0.0026	0.0492	0.1962	0.4900	0.3966
1995	0.3017	0.2901	0.0022	0.0025	0.0477	0.1899	0.4744	0.3840
2000	0.2549	0.1294	0.0016	0.0006	0.0747	0.1865	0.4660	0.2749
2005	0.3207	0.4017	0.0018	0.0058	0.0306	0.1213	0.3026	0.4673
2010	0.0759	0.2189	0.0025	0.0002	0.0104	0.0382	0.0939	0.3387
2011	0.1658	0.2091	0.0023	NO	0.0075	0.0300	0.0751	0.0925
2012	0.1614	0.1947	0.0022	NO	0.0081	0.0323	0.0808	0.0924
2013	0.1167	0.1756	0.0011	NO	0.0066	0.0262	0.0656	0.0761
2014	0.5389	0.3945	0.0000	0.0001	0.0071	0.0285	0.0713	0.4715
2015	0.2167	0.5026	0.0000	0.0083	0.0045	0.0178	0.0446	0.4119
2016	0.1600	0.2590	0.0000	0.0083	0.0044	0.0175	0.0437	0.1440
2017	0.2112	0.5449	0.0000	0.0093	0.0041	0.0165	0.0412	0.2100
2018	0.3401	0.7039	0.0000	0.0096	0.0038	0.0152	0.0379	0.3539
2019	0.3445	0.5681	0.0001	0.0082	0.0040	0.0160	0.0399	0.3448
2020	0.2344	0.5166	0.0001	0.0002	0.0045	0.0180	0.0450	0.2705
2021	0.2709	0.7482	0.0001	0.0002	0.0052	0.0207	0.0518	0.4497
2022	0.2151	0.6291	0.0002	0.0030	0.0055	0.0220	0.0549	0.3439
2023	0.2338	0.7514	0.0002	0.0377	0.0058	0.0230	0.0576	0.3827
1990/2023	**-25%**	**151%**	**-91%**	**1370%**	**-88%**	**-88%**	**-88%**	**-4%**
2022/2023	**9%**	**19%**	**18%**	**1151%**	**5%**	**5%**	**5%**	**11%**

4.9.2 Methodological Issues

The definition of activities covered by category **2I** is provided in ***Table 4.114***. The activity is involved in **2D3d**, where only VOC is balanced. Other rising emissions (NOx, SOx, NMVOC, NH_3, TSP, $PM_{2.5}$, PM_{10}, CO) are reported here.

Table 4.114: Activities according to national categorization included in 2I

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
6.9 Industrial wood processing: a) mechanical processing of wooden lumps with projected processing capacity in v m^3/day b) mechanical processing of disintegrated wooden mass such as sawdust, shavings, and chips with a projected processing capacity in v m^3/day

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
c) production of agglomerated materials with projected consumption of polycondensed adhesives in t of dry matter/year
Processing and surface treatment using organic solvents including associated activities, such as deburring, according to a projected consumption of organic solvents in tonnes/year:
a) adhesive application
b) wood and plastic lamination
c) coating application
d) impregnation

Historical years from 1990-1999 were calculated using a weighted average of implied emission factors from the period 2000-2004. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.115***). Activity data for the calculation of implied emission factors is the total energy used in this category.

Table 4.115: *Emission factors for calculation of historical years in 2I*

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	TSP [g/GJ]	CO [g/GJ]
EF	533 488.04	512 899.12	3 938.45	4 388.26	10%	40%	838 858.63	678 981.14

4.9.3 Completeness

Notation keys are reported in compliance with the EMEP/EEA GB_{2023}.

4.9.4 Source-specific Recalculations

No recalculation was made.

4.10 PRODUCTION OF POPS (NFR 2J)

4.10.1 Overview

This activity is not occurring in the Slovak Republic, therefore, notation key NO was used.

4.11 CONSUMTION OF POPS AND HEAVY METALS (NFR 2K)

4.11.1 Overview

The present chapter deals with emissions from the consumption of POPs and heavy metals. These are used in e.g. refrigerators, air conditioning equipment and electrical equipment. Category reports the emissions of Hg and PCBs. The trend of emissions and activity data are presented in ***Table 4.116***.

Table 4.116: *Activity data and emissions in the category 2K*

YEAR	INHABITANTS	Hg [t]	PCBs [kg]
1990	5 297 774	0.0530	0.5298
1995	5 363 676	0.0536	0.5364
2000	5 400 679	0.0540	0.5401
2005	5 387 285	0.0539	0.5387
2010	5 431 024	0.0543	0.5431
2011	5 394 251	0.0539	0.5394
2012	5 407 579	0.0541	0.5408
2013	5 413 393	0.0541	0.5413
2014	5 418 649	0.0542	0.5419
2015	5 423 800	0.0542	0.5424
2016	5 430 798	0.0543	0.5431

YEAR	INHABITANTS	Hg [t]	PCBs [kg]
2017	5 437 754	0.0544	0.5438
2018	5 446 771	0.0545	0.5447
2019	5 454 147	0.0545	0.5454
2020	5 458 827	0.0546	0.5459
2021	5 441 991	0.0544	0.5442
2022	5 431 026	0.0543	0.5431
2023	5 426 853	0.0543	0.5427
1990/2023	**2%**	**2%**	**2%**
2022/2023	**0%**	**0%**	**0%**

4.11.2 Methodological Issues

Emission of Hg and PCB are calculated by the Tier 1 method according to EMEP/EEA GB_{2019}. Activity data were obtained from the ŠÚ SR – number national population - Mid-year population.

$$E = Inhabitants * EF_{Default}$$

Other pollutants (NOx, NMVOC, SOx, NH_3, PMs, TSP, BC, CO, POPs) are reported in compliance with EMEP/EEA Guidebook with notation key NA, as well as fuels, and with notation key NE for heavy metals and HCB.

A simple equation was needed to balance the emissions of Hg and PCBs from this source category:

$$E = EF\ GB_{2023} \times AD(ŠÚ\ SR)$$

The emission factors used for the calculation are shown in ***Table 4.117***.

Table 4.117: *Emission factors in the category 2K*

	Hg [g/capita]	PCBs [g/capita]
EF	0.01	0.1

4.11.3 Completeness

Notation keys were used in compliance with the EMEP/EEA GB_{2023}.

4.11.4 Source-specific Recalculations

No recalculations in this submission.

4.12 OTHER PRODUCTION, CONSUMPTION, STORAGE, TRANSPORTATION OR HANDLING OF BULK PRODUCTS (NFR 2L)

4.12.1 Overview

The category is reported with notation key NO. This production is not occurring in the Slovak Republic.

CHAPTER 5: AGRICULTURE (NFR 3)

Last update: 15.4.2025

This chapter was prepared by the sectoral expert involved in the National Inventory System of the Slovak Republic:

INSTITUTE	CHAPTER	SECTORAL EXPERT
SLOVAK HYDROMETEOROLOGICAL INSTITUTE	ALL CHAPTERS	KRISTÍNA TONHAUZER

The anthropogenic activities in the agriculture sector significantly contribute to the concentration changes of some gases in the atmosphere. Ammonia emitted from agriculture is considered the most relevant gas from planning abatements to reduce their influence on the environment. Sources of ammonia (NH_3), particulate matter (PM), total suspended particulate (TSP), the non-methane volatile organic compound (NMVOC) and nitrogen oxides (NOx) emissions are analysed according to the EMEP/EEA GB_{2023} when principles of good practice in agriculture are taken into account. The emissions of NH_3, NOx, PM, TSP and NMVOC can be reduced if effective measures are implemented in agricultural practice. The abatements were implemented for the conditions of the Slovak Republic. The absence of sufficient data about the storage and application of manure resulted in the fact that the emissions were evaluated in the same way as usual. Slovak agricultural inventory takes advantage of parallel inventory preparation and reporting of greenhouse gases (GHG) and air pollutants ensuring efficiency and consistency in the compilation of emission inventories because of a wide range of substances using common datasets and inputs. Therefore, a link is established between the NH_3, NOx and N_2O emission estimates following the N-flow concepts in the agricultural emission inventories. Consequently, consistency between the two inventories is a principle of the emission estimate.
The emissions balance is compiled annually based on sectoral statistics and in recent years based on the regionalisation of agricultural areas in the Slovak Republic. The Ministry of Agriculture and Rural Development of the Slovak Republic publishes annual statistics in the Green Report 2024, part agriculture and food. Activity data are also available in the Statistical Yearbooks. Sector Agriculture is prepared in cooperation with the National Agricultural and Food Centre – the Research Institute for Animal Production in Nitra (NPPC – VÚŽV). The NPPC – VÚŽV provided activity data and parameters, improved the methodology and ensured QA/QC activities in animal inventory in categories **3B** and **3D**. Activity data on the number of livestock and animal productions are provided annually by the Statistical Office of the Slovak Republic (ŠU SR). The Central Control and Testing Institute in Agriculture (UKSÚP) provided the soil data to the SHMÚ annually, based on the cooperation agreement between both institutions.

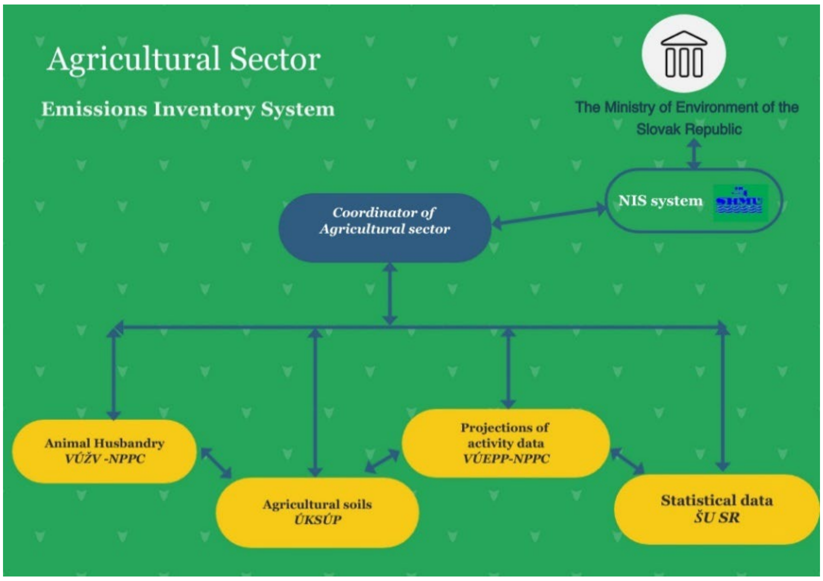
5.1 OVERVIEW OF THE SECTOR AGRICULTURE

The share of the agriculture and food industry in the national economy has continued in mixed trend in the macroeconomic indicators in the 2023. Gross value added (1.88%) and intermediate consumption (2.06%) as well as average salary (77.97%) slightly increased in constant prices. Investments in fixed assets (such as buildings, machinery, equipment, and infrastructure) and employment has decreased (4.25% and 2.84%, respectively) compared to last year. As it comes to share of the foreign agri-food trade on the national export, it remains stable 4.74 - 4.77% last three reporting years. Imports has confirmed increased share from 2022 representing 7.12%.
Agriculture sector has achieved positive economic balance before tax deduction in 2023, however, it decreased compared to 2022 with exceptional profits according to analysis of statistical data from Ministry of Agriculture and Rural Development. In comparison with 5 years moving average, this reporting year was the economic result of the sector 40 %, mainly due to the increase in revenues from own products of animal origin (+28.0%) and plant origin (+20.1%). Subsidies played a crucial role in the economy of agricultural enterprises, as most of them would have operated at a loss without financial support. The total amount of financial aid for Slovak agriculture increased by 9.6% year-over-year, reaching €807.8 million, with 63% coming from EU funds. The

share of total subsidies in agricultural revenues rose to 18.5%, with direct payments accounting for 7.4%. Crop production had the continuing dominant share in the economy compared to animal production (60% to 40%). Decrease in the production of most commodities of crop production mainly due to the decrease in harvesting areas and the decrease or stagnation of harvests per hectare, except for sunflower, soybean, sugar beet, fruit and vegetables. The number of livestock decreased in all species with an impact decrease of animal products except slaughter poultry (1.8%), cattle (9.8%) and pigs (3.9%) (Green Report 2024).

The emissions inventory in agriculture is prepared in cooperation with the National Agricultural and Food Centre – the Research Institute for Animal Production in Nitra (the NPPC – VÚŽV). The NPPC – VÚŽV provided activity data and parameters, improved the methodology and ensured QA/QC activities in animal inventory in the NFR categories ***3B*** and ***3D***. Activity data on the number of livestock and animal productions are provided annually by the Statistical Office of the Slovak Republic (ŠU SR). The Central Control and Testing Institute in Agriculture (UKSÚP) provided the soil data to the SHMÚ annually, based on the cooperation agreement between both institutions. Emission Inventory System in the Slovak ***Agriculture sector*** is described in ***Figure 5.1***. In the 2022 Submission, the mitigation measures were included repeatedly in the emission inventory. The information on mitigation measures was available from 2006. More information is available in **Chapter 5.9.4** and **ANNEX VI**.

Figure 5.1: *Emission Inventory System in the Slovak Agriculture sector*



Slovak farmers adapted to changes in Agriculture after 1990. They invested in the development of their farms to stay in the business and to be competitive in this sector. The EU policy supported the used tools as the base of transformation. The EU policy and measures transformed into the Slovak legal system. Farmers had to follow new strict criteria like more balanced feeding rations changing of housing systems, and new storage capacity for organic waste, which was supported by Decree No 410/2012 Coll. and Nitrates Directive and subsidies from the Common Agriculture Policy.[1]

Table 5.1: *Overview of the GHG gases and Tiers reported in the Agriculture sector according to the CRF categories in 2023*

CATEGORY (CODE AND NAME)	TIER/POLLUTANTS
3B1a Dairy cattle	NH_3-T3, NOx-T2, PM-T1, NMVOC-T2, TSP-T1
3B1b Non-dairy cattle	NH_3-T3, NOx-T2, PM-T1, NMVOC-T2, TSP-T1
3B2 Sheep	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B3 Swine	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1

[1] http://www.mpsr.sk/index.php?start&navID=78&id=1325%20 (in Slovak)

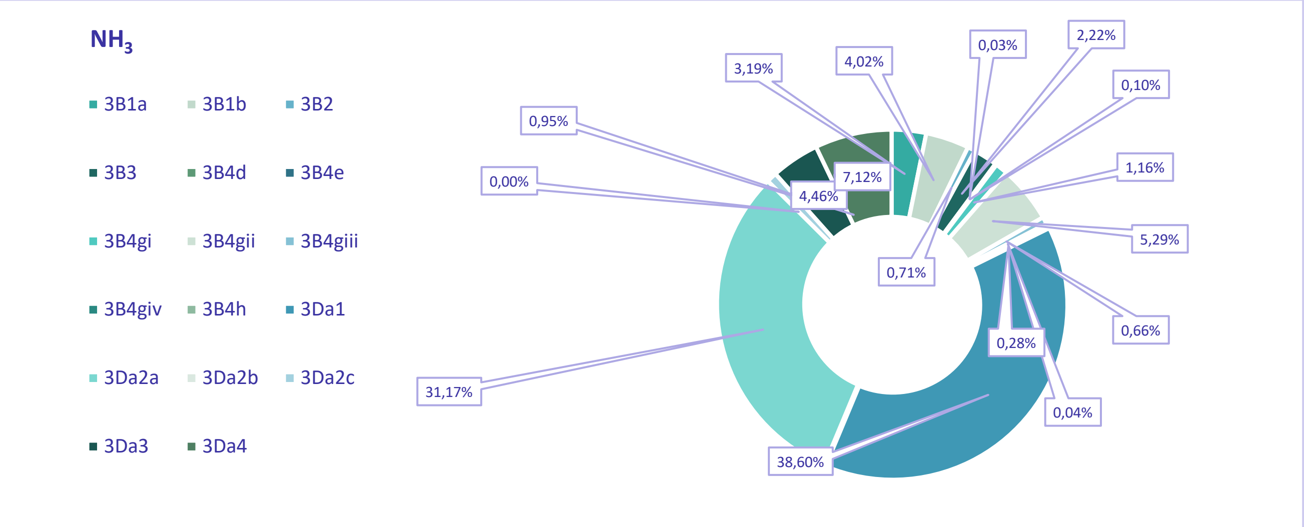
CATEGORY (CODE AND NAME)	TIER/POLLUTANTS
3B4d Goats	NH_3-T2, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B4e Horses	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B4gi Laying hens	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B4gii Broilers	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B4giii Turkeys	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B4giv Other poultry	NH_3-T3, NOx-T2, PM-T1, NMVOC-T1, TSP-T1
3B4h Other animals – Rabbits	NH_3-T1, NOx-T1, PM-T1, NMVOC-T1, TSP-T1
3Da1 Inorganic N-fertilizers	NH_3-T2, NOx-T1
3Da2 Animal manure applied to the soil	NH_3-T3, NMVOC-T2, NOx-T2
3Da3 Urine and dung deposited by grazing animals	NH_3-T2, NMVOC-T2, NOx-T2
3Da4 Crop residues applied to soils	NH_3-T1
3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products	PMs-T2, TSP-T1
3De Cultivated Crops	NMVOC-T1

5.2 EMISSION TRENDS

5.2.1 Ammonia (NH_3)

Sector agriculture is a dominant contributor to NH_3 emissions with a share of 87% of the national total in 2023. The largest share of ammonia emissions was generated by **3D** Agricultural soils, which produced 18.18 kt (72%) of NH_3 within the sector in 2023. The significant source of NH_3 emissions is the Inorganic N-fertilizers with a share of 38.6% followed by the Animal manure applied to soils category representing 31.2% of the total NH_3 emissions in 2023. Emissions from **3B1** Cattle, **3B3** Swine and **3B2** Sheep produced 2.24 kt of NH_3 (10%) in the sector in 2023. ***Figure 5.2*** shows the distribution of significant categories of ammonia from agriculture for 2023.

Figure 5.2: *NH_3 emissions per subsectors in %*



Agricultural NH_3 emissions have decreased by 57% since 1990 and increased by 8.3% compared to the previous year (***Table 5.2*** and ***Figure 5.3***). The main driver for this drop was the significant decrease in the emissions in manure management due to the dramatic reduction in livestock population. More information on the reduction of the number of livestock is available in **Chapter 5.8.3**. In addition, ammonia abatement measures implemented since 2006 made complementary emission reductions. More information is available in **ANNEX VI**. The emission from agricultural soils has continued in the dominant contribution compared to emissions from animal production (82 % to 18 %), which correlated with the overall economic and production situation in the agricultural sector.

Figure 5.3: *NH_3 emission trend by sectors*

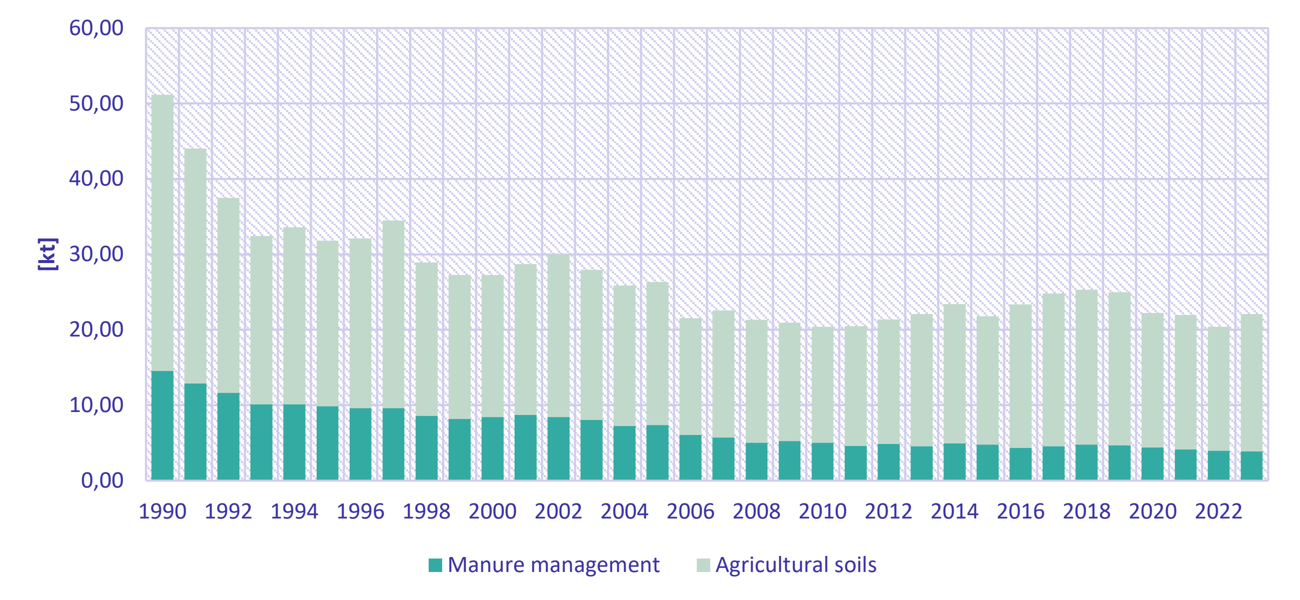


Table 5.2: *NH_3 emission time-series by sub-sectors in kt*

YEARS	3B MANURE MANAGEMENT	3D AGRICULTURAL SOILS	3 AGRICULTURE TOTAL
	[kt]		
1990	14.56	36.61	51.17
1995	9.86	21.95	31.81
2000	8.42	18.88	27.29
2005	7.38	18.97	26.36
2010	5.03	15.35	20.38
2011	4.62	15.85	20.47
2012	4.85	16.51	21.36
2013	4.55	17.52	22.08
2014	4.93	18.47	23.40
2015	4.79	16.99	21.78
2016	4.36	19.03	23.38
2017	4.59	20.21	24.79
2018	4.80	20.52	25.32
2019	4.69	20.29	24.98
2020	4.40	17.82	22.21
2021	4.15	17.81	21.96
2022	3.98	16.42	20.40
2023	3.91	18.18	22.09
1990/2023	**-73%**	**-50%**	**-57%**
2005/2023	**-47%**	**-4%**	**-16%**

5.2.2 Particulate Matters

In 2023, agriculture accounted for 2.5% (0.33 kt) of $PM_{2.5}$, 21% (4.02 kt) of PM_{10} and 20.01% (4.57 kt) of the national total, TSP emissions. The Agriculture sector is not key source of particulate matter. The contribution of the **3Dc** was 88% (3.53 kt) to the total PM_{10} emissions from the sector.

$PM_{2.5}$, PM_{10} and TSP emissions from agriculture have decreased in the 2005-2023 period (***Table 5.4*** and ***Figure 5.5****)* as a result of the decreasing emissions from **3B** Manure management and decreasing partial emissions from **3D** Agricultural Soils. In **3D** Agricultural Soils is a visible increase in emissions due to the increase sowing areas of oil plants and wheat. The overall trend of PM_{10} emissions from Agriculture is shown in ***Figure 5.4***.

Figure 5.4: *PM_{10} emission trends by sectors*

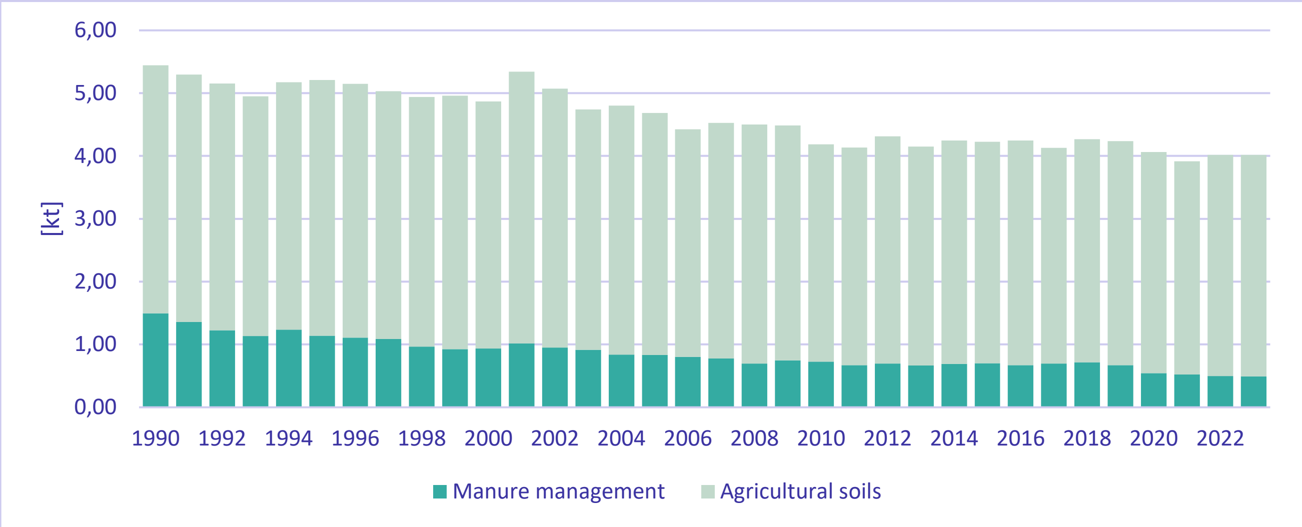


Figure 5.5: *$PM_{2.5}$ emission trends by sectors*

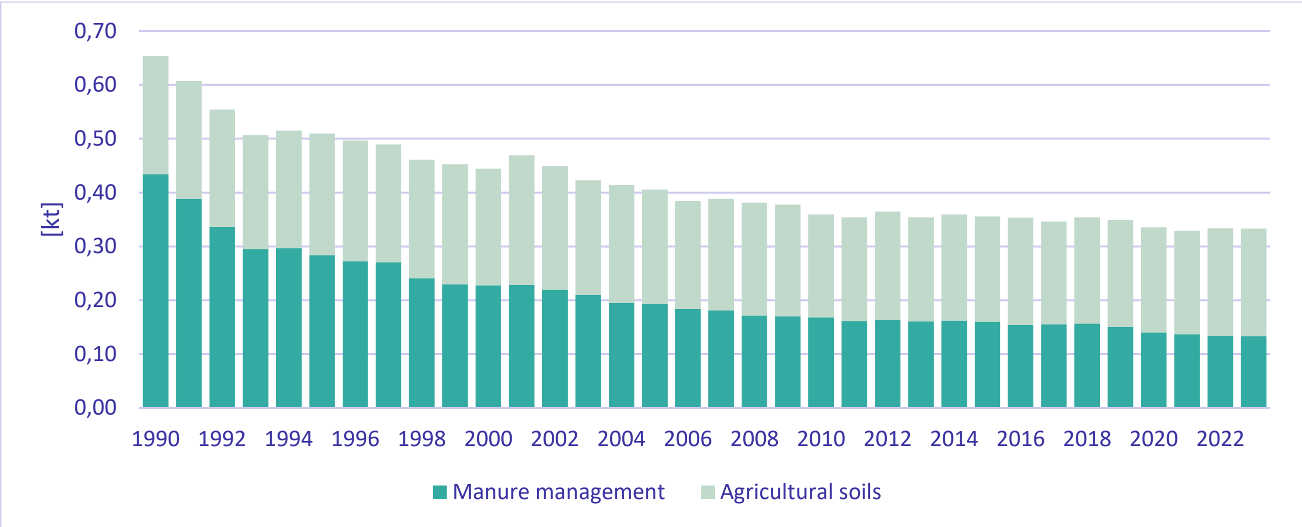


Table 5.3: *TSP emission time-series by sub-sectors in kt*

YEARS	3B MANURE MANAGEMENT	3D AGRICULTURAL SOILS	3 AGRICULTURE TOTAL
	[kt]		
1990	5.741	3.100	8.841
1995	4.621	3.002	7.623
2000	3.609	2.903	6.512
2005	3.144	3.029	6.173
2010	2.724	2.998	5.723
2011	2.525	3.010	5.536
2012	2.617	3.007	5.624
2013	2.500	3.008	5.508
2014	2.542	2.997	5.539
2015	2.608	2.998	5.606
2016	2.514	2.993	5.507

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
		[kt]	
2017	2.561	2.981	5.542
2018	2.647	2.994	5.642
2019	2.464	2.989	5.453
2020	1.924	2.980	4.904
2021	1.814	2.896	4.710
2022	1.722	2.885	4.606
2023	1.686	2.885	4.570
1990/2023	**-71%**	**-7%**	**-48%**
2005/2023	**-46%**	**-5%**	**-26%**

5.2.3 Non-methane Volatile Organic Compounds (NMVOC)

In 2023, Agricultural NMVOC emissions consisted of 7.3 kt and 9.6% share of the national total (***Table 5.4***). The primary agricultural source of NMVOC emissions is the **3B** Manure management accounting for 8.4% of national total NMVOC emission (6.38 kt). NMVOC emissions from animal husbandry mainly originate from silage feeding and partly digested fat, carbohydrate and protein decomposition in the rumen and the manure. Consequently, cattle farming is the most important source of agricultural NMVOC emissions (63%). NMVOC emissions have decreased by 66% over the period 1990-2023, as the result of the decline of livestock and effect of implemented mitigation measures in ammonia emissions after 2006.

5.4 Table: *NMVOC emission time-series by sub-sectors in kt*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
		[kt]	
1990	20.754	0.435	21.189
1995	13.072	0.368	13.440
2000	10.950	0.318	11.268
2005	9.594	0.517	10.112
2010	7.859	0.499	8.358
2011	7.712	0.569	8.281
2012	7.665	0.479	8.145
2013	7.509	0.624	8.132
2014	7.380	0.728	8.108
2015	7.576	0.613	8.189
2016	7.243	0.744	7.987
2017	7.363	0.683	8.046
2018	6.966	0.694	7.660
2019	6.751	0.661	7.412
2020	6.285	0.699	6.983
2021	6.104	0.846	6.950
2022	5.899	0.758	6.657
2023	6.380	0.919	7.299
1990/2023	**-69%**	**111%**	**-66%**
2005/2023	**-33%**	**78%**	**-28%**

5.2.4 Nitrogen Oxides (NOx)

In 2023, Agricultural NOx emissions consisted of 6.04 kt and a share of 11.8% of the national total. Agricultural NOx emissions have decreased by 54% since 1990 (***Table 5.5***). The primary drivers of this drop are the significant decrease in the emissions from cattle and swine, due to the dramatic decline in livestock population. Focusing on the period between 2016-2023, NOx emissions from the agricultural sector decreased due to a decrease in inorganic fertilizer use.

Table 5.5: *NOx emission time-series by sub-sectors in kt*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
		[kt]	
1990	0.301	12.780	13.081
1995	0.181	5.415	5.596
2000	0.164	5.595	5.759
2005	0.153	5.944	6.097
2010	0.117	6.044	6.161
2011	0.112	6.547	6.659
2012	0.115	5.831	5.946
2013	0.113	6.371	6.484
2014	0.123	6.700	6.823
2015	0.118	6.404	6.521
2016	0.113	6.886	6.999
2017	0.115	6.725	6.840
2018	0.122	7.060	7.182
2019	0.120	7.012	7.132
2020	0.117	6.820	6.937
2021	0.112	6.781	6.893
2022	0.107	6.261	6.368
2023	0.109	5.930	6.038
1990/2023	**-64%**	**-54%**	**-54%**
2005/2023	**-29%**	**0%**	**-1%**

5.3 CATEGORY-SPECIFIC IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

According to the Final Review Report 2024 of national air pollution emission inventories, recommendations in the Agriculture sector were received:

3De Cultivated Crops category, the TERT observed that Slovakia applied a Tier 2 methodology along with the default NMVOC emission factor developed for several crop categories (Table 3-4 of the 2019 EMEP/EEA Emission Inventory Guidebook) to estimate NMVOC emissions for the entire reporting period. The TERT noted that these default emission factors, which were evaluated using global crop yield data, do not reflect Slovakia's national circumstances and therefore result in an overestimation of NMVOC emissions for the **3De** category. The TERT recommends that Slovakia include a revised estimate in the next submission.

3Da2a Animal Manure applied to Soils the TERT noted a lack of transparency in the 2024 IIR regarding the extent and penetration factors of NH_3 reduction techniques over 2020-2023. This resulted in a significant decrease in the emissions from 2020 to 2021. In response to a question raised during the 2023 review, Slovakia provided a file that shows which reduction techniques were applied on which farms (by region and livestock category).

The TERT reiterates the recommendation made in the previous review that Slovakia includes a summary of information on mitigation measures used in Slovakia and detailed explanations for the decrease in emissions in the IIR of their next submission.

5.4 SOURCE SPECIFIC QA/QC AND VERIFICATION

QA/QC procedures in the Agriculture sector are linked to the QA/QC Plans for the NIS SR (at the sectoral level) and follow basic QA/QC rules and activities as defined in the EMEP/EEA GB_{2023}.

The QC checks (e.g. consistency check between NFR data and national statistics) were done during the NFR and IIR compilation, the General QC questionnaire was filled in and archived by the QA/QC manager.

An opportunity to cross-check the activity data and emissions with the air pollution inventory to ensure consistency between the two inventories provided. In the last two years, the QA/QC procedures have significantly improved. QA/QC provides an additional opportunity to crosscheck the activity data and emissions with the GHGs inventory to ensure consistency between the two inventories. In the last two years, the QA/QC procedures have significantly improved.

The QA/QC extended by check of activity data for rounding errors, compared to the original data sources.

- Check the correct use of the units in the calculation sheets.
- Check the reasons for data gaps and provide explanations.
- Cross-check the data sources of the activity data if possible (e.g. total annual milk yield per cow, amount of wool, harvested area).
- Check the recalculation differences.
- Check for errors between the calculation sheets and the templates.

5.5 CATEGORY-SPECIFIC RECALCULATIONS

Recalculations made in the agriculture sector were provided and implemented in line with the Improvement Plan reflecting recommendations made during previous reviews.

Table 5.6: *Overview of these recalculations and corrections implemented in the 2025 submission*

	CATEGORY	YEAR	POLLUTION	DESCRIPTION	REFERENCES
			15. FEBRUARY 2025		
1	3B3 Swine	1990-2022	NMVOC, TSP	Correction of calculation error in distribution of swine population to the categories. Total number of animals in the category remains unchanged.	5.5
2	3B1 Manure management-Cattle.3B2 Manure management-Sheep. 3B3 Manure management – Swine. 3B4	2007-2022	NH_3, NOx	Revision of abatement measures to be properly linked with the type of manure (solid or liquid).	5.8.4
3	3B1 Manure management-Cattle.3B2 Manure management-Sheep. 3B3 Manure management – Swine. 3B4	1990-2022	PM_{10}, $PM_{2.5}$	Correction of calculation error in aggregation of emissions of animal subcategories to the NFR categories.	5.8.5
4	3B4	1990-2005, 2007-2022	NH_3, NOx	Correction of wrong transcript to input file for calculation dealing with values of N-rate for poultry types.	5.8.4
5	3Da2a Animal Manure Applied to Soils	1990-2022	NH3, NOx	a) Correction in adding emission from rabbits was included to properly represent the total in the category (1990-2005). From 2007 onwards b) and c).	5.9.4

	CATEGORY	YEAR	POLLUTION	DESCRIPTION	REFERENCES
			15. FEBRUARY 2025		
				b) Revision of abatement measures to be properly linked with the type of manure (solid or liquid). c) Correction of wrong transcript to input file for calculation dealing with values of N-rate for poultry types.	
6	3Da2c Other organic fertilisers applied to soils (including compost)	1990-2022	NH_3, NOx	Implementation of revised N content coefficients for other organic fertilizers.	5.9.4
7	3Da4 Crop residues applied to soils	1990-2022	NH_3	Frac Remove was revised due to an update in the nitrogen content of the above-ground biomass of grain crops used as bedding material in the poultry category.	5.9.4
8	3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products	1990-2022	PM_{10}, $PM_{2.5}$, TSP	Inclusion of information about the cropped area covered by "Other crops" compared to previous submissions where only wheat, rye, oilplants (rapeseed), grass, barley and oat were considered.	5.9.4
9	3De Cultivated crops	1990-2022	NMVOC	Implementation of revised approach to estimate NMVOC emissions based on TERT recommendation number SK-3De-2023-0001.	5.9.4

5.6 NATIONAL CIRCUMSTANCES AND TIME-SERIES CONSISTENCY

Slovak farmers have adapted to changes in agriculture after 1990. They invested in the development of their farms to avoid bankruptcy and to be self-competitive in this sector. The EU policy supported the used tools as the base of transformation. The EU policy and measures were transformed into the Slovak legal system. Farmers had to follow new strict criteria like changing of housing systems, a decrease in pasture time and new storage capacity for organic waste, which was supported by Decree No 389/2005 Coll. and Nitrates Directive. These measures are well advanced and copy the practices used in Western European countries. Therefore, default parameters for Western Europe are used in inventory. The most significant animals in regard to emissions in Slovakia are cattle and swine.

Cattle breeding in the Slovak Republic is comparable with the Western European countries, which is documented by a high milk yield of dairy cattle and high daily weight gains of non-dairy cattle. To maintain a high milk yield and high daily gains, food rich in proteins and cereals is important. Dairy cows in three Slovak regions (Bratislava, Trnava and Nitra) produce 26.3-29.5 litres/day. In other regions, milk productivity is 19-24.6 litres/day. Lower milk production relates to feeding. In this case, pasture is included in the feeding ratio. It is typical for semi-intensive farming in regions Košice, Prešov, Banská Bystrica or Žilina. These circumstances are documented in ***Figures 5.6*** and ***5.7***. Highly productive dairy cows (milked 25-30 litres/day) need to be fed by approximately 8 kg of cereals with excellent digestibility and high nutrition. An annual increase in milk productivity is evidence of increasing productivity of animal production. Balanced and sustainable farming in Slovakia has an impact on the high value of AGEI (306.8 MJ/head/day) (***Figure 5.6***).

Figure 5.6: *Trend in average gross energy intake (MJ/day) in different Slovak regions*

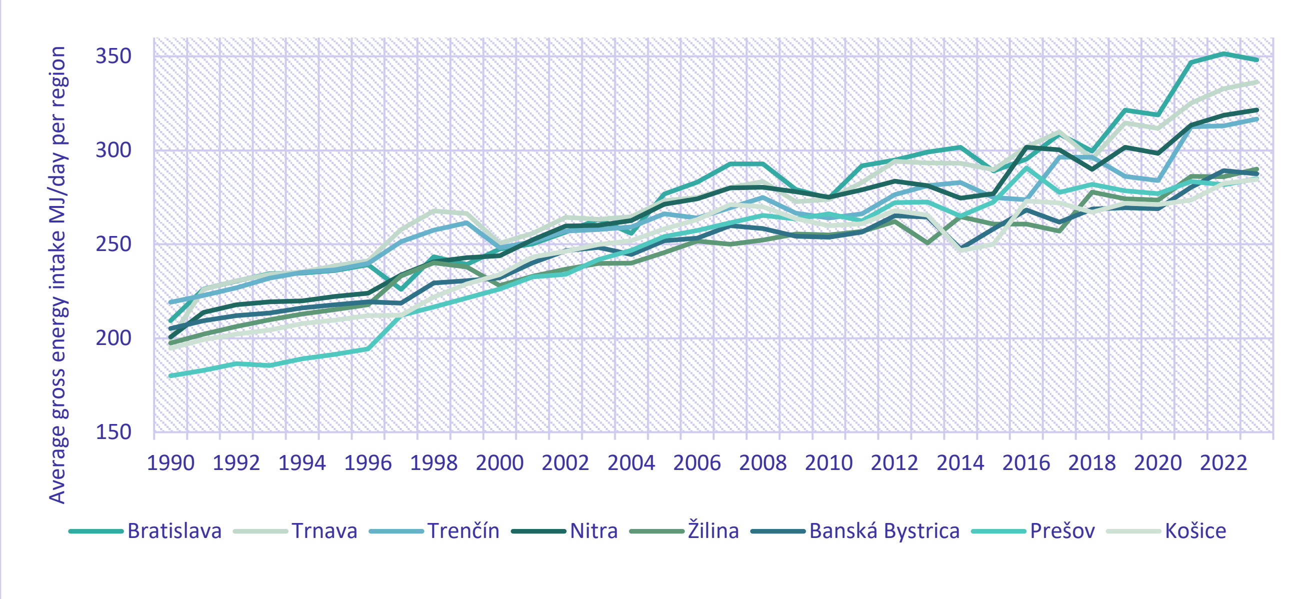
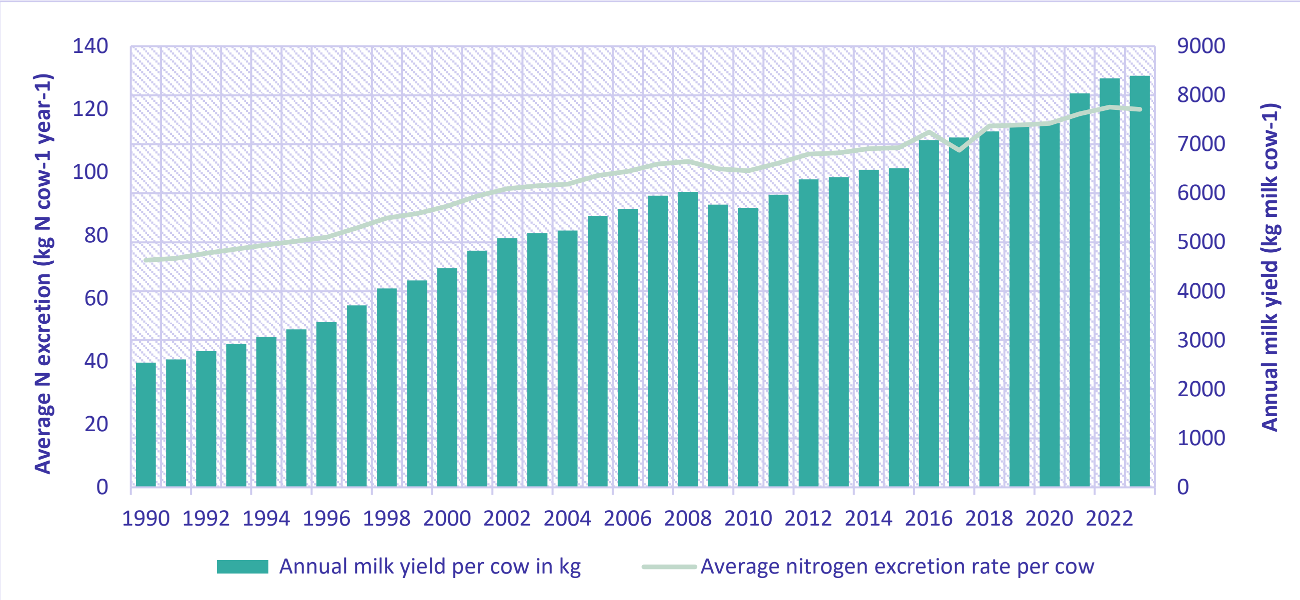
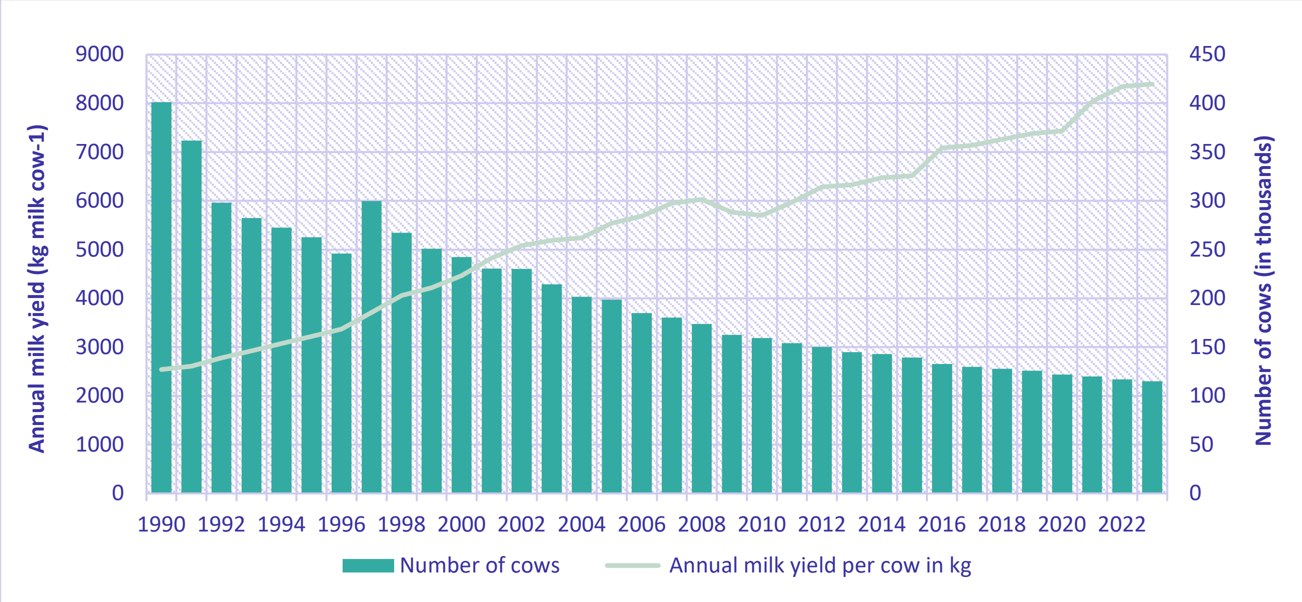


Figure 5.7: *Correlation of milk production (kg/day/head) and nitrogen excretion rate (kg N/y/head)*



The number of dairy cows decreased according to data from the ŠÚ SR by 71% in 2023 compared to 1990 (***Figure 5.8)***. Milk production increased up to 230% in 2023 compared to 1990 and by 0.6 % compared to previous year despite the continuously decreasing number of dairy cows. The main reason for this trend is the increase in average performance. The high-performance average is the result of good animal husbandry, breeding conditions, new synergy with technologies and animal genetics. All factors contribute together to achieving milk yields of up to 10 000 kg of milk per head per year.

Figure 5.8: *Trend in dairy cattle population and dairy milk production (kg/head/day)*

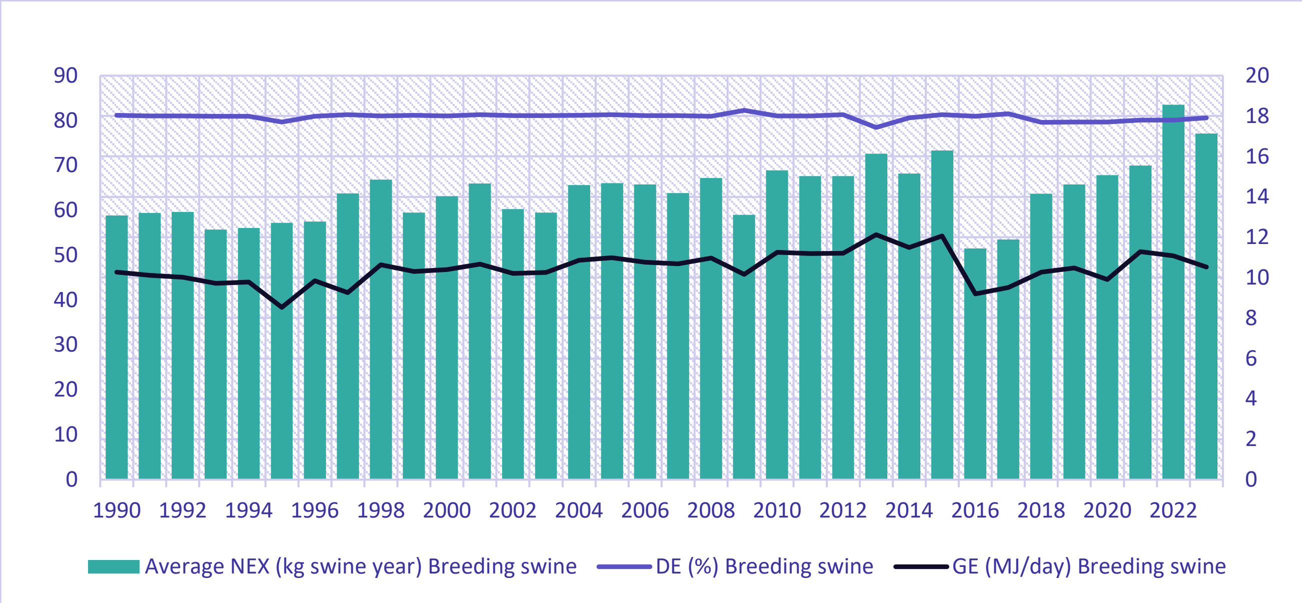


The pig farming system in the Slovak Republic is divided into two types - breeding and market pigs. Breeding pigs are bred for reproduction purposes. Fattening pigs are bred mainly for the production of pork meat and fat. Pigs are housed in the Slovak conditions for the whole year. Housing technology and diet can significantly affect the production of greenhouse gases. Stall conditions can be very variable. Pigs are bred in intensive farming on rosette floors, which is one of the low emission techniques. Another part of pigs, mainly in semi-intensive farming are reared on straw. Deep bedding is used mostly at micro and small farms. Diet has a significant impact on emissions production. The main component of the feeding is cereals (barley, triticale, wheat about 80-90 %). Complementary feed ingredients are soybean scrap, rapeseed scrap, and beer brewing waste. The resultant feeding rations have a high nutritional value and are easily digestible (***Figures 5.9*** and ***5.10***).

Trends in breeding swine

A very dynamic trend is visible in breeding swine. The decrease and increase in crude proteins have an impact on the nitrogen excretion rate and gross energy intake. Pig breeding in Slovakia has problems mainly due to the risk of persistent morbidity – African swine fever and other economic reasons, which led to decreasing numbers of breeding pigs after 2016. Low purchase prices create pressure to decrease of number of pigs, but the overall effectivity of breeding systems increased continually after 2016 and 2018 decreases.

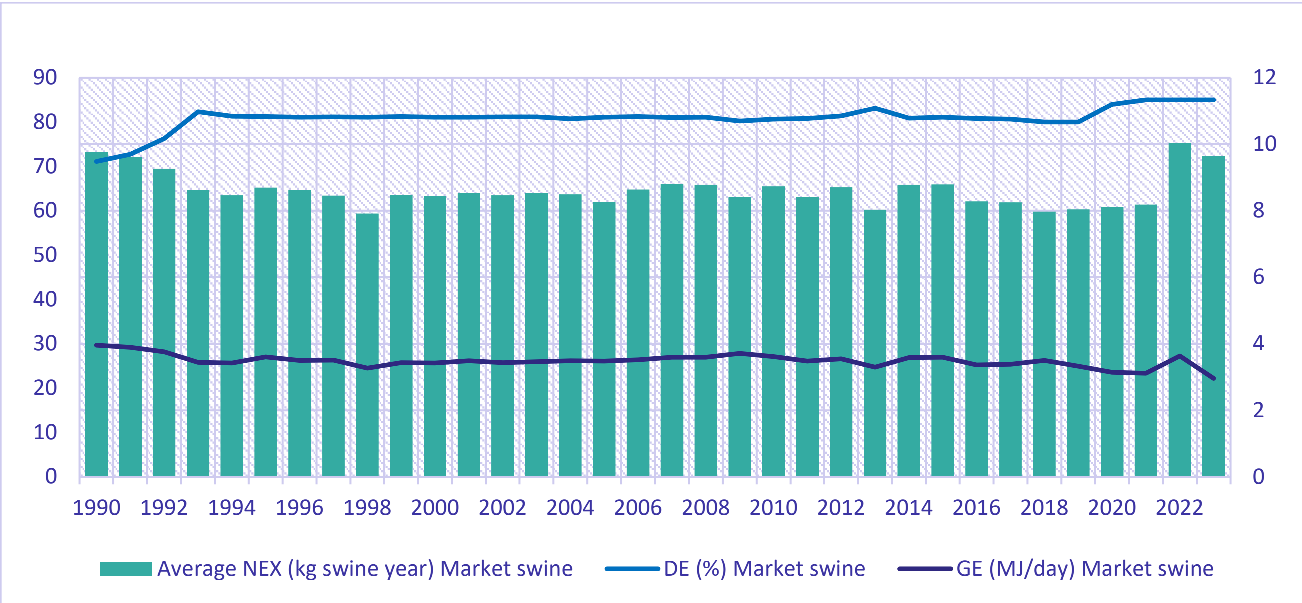
Figure 5.9: *Trend of feed digestibility, nitrogen excretion rate and gross energy intake of breeding swine in the Slovak Republic in 1990-2023*



Trends in market swine

After 1990, the digestibility of feeding doses increased significantly due to the increase of cereals, vitamins, dietary fibre, crude proteins and amino acids. These changes affect the increase in pig performance. After 1994 to 2021 is visible almost stable level of digestibility except in 2013 where there is a visible smoot increase in digestibility which influences the increase in a number of market pigs by almost 10 % compared to the previous year. In 2019, visible increase in digestibility of feeding gross energy intake and nitrogen excretion rate. Base of data published in Green Report 2023. The sector has been recovered. Presented values were estimated by VÚŽV and correlated with an increase in pig performance in that year.

Figure 5.10: *Trend of feed digestibility, nitrogen excretion rate and gross energy intake of market swine in the Slovak Republic in 1990-2023*



5.7 UNCERTAINTIES

Uncertainty analysis was provided for the first time in the 2020 Submission. Tier 1 and default uncertainties (EMEP/EEA Guideline) were used in the total assessment evaluated by Approach 1.

5.8 MANURE MANAGEMENT (NFR 3B)

Emitted gas: *NH_3, NMVOC, NOx, TSP, PM_{10}, $PM_{2.5}$*

Methods: *T1 and T2*

Emissions factors: *D, CS*

Key sources: *Yes*

Significant subcategories: *Cattle, Swine, Poultry*

The emissions of NH_3, NOx, TSP, NMVOC and PM were estimated from category **3B** Manure management. NOx and NH_3 emissions from Sector **3** Agriculture were estimated according to the EMEP/EEA GB_{2023} as a Tier 2 approach for dairy cattle, non-dairy cattle, sheep, swine, goats, horses and poultry. The nitrogen excretion rate for the swine category is calculated based on the nitrogen content of the feed according to the IPCC 2019 RF methodology.
The detailed Tier 2 method was used to calculate NMVOC emissions for dairy cows and non-dairy cattle (key sources of emission). The other animal categories were calculated by the Tier 1 approach and the EMEP/EEA GB_{2023} was considered. The TSP, PM_{10} and $PM_{2.5}$ were calculated by the EMEP/EEA GB_{2023}. The Tier 1 approach was used for all animal species because the Tier 2 methodology is unavailable.

5.8.1 Animal Waste management Systems

Allocation of manure into AWMS is based on a survey on manure management practices used. A questionnaire survey in farms was performed in cooperation with the NPPC-VÚŽV and other research institutions during the year 2014. Farmers reported the total produced amount of solid and liquid manure and the amount of manure, which was processed in anaerobic digesters by regions. This survey defined more accurately the numbers of days on pasture for cattle, sheep, goats and horses. Manure left on pasture was estimated based on this data. Time-series was completed by extrapolation. In 2024 submission, new data was implemented in poultry and swine categories, this survey was provided by Research Institute of Animal Production in Nitra.
Allocation according to the climatic conditions is 100% for cool temperate dry climate for all animals based on the IPCC 2019 RF and climate data for the Slovak Republic.
Western Europe´s default value for nitrogen excretion was used. More information is in the **Chapter 5.6**.

5.8.2 Nitrogen Excretion Rate

Nitrogen Excretion Rate – cattle – a country-specific nitrogen excretion rate was used for the cattle category, based on the Tier 2 approach. The approach was implemented to estimate faecal, urinary and total manure N excretions. The approach was implemented for each subcategory of cattle based on statistical inputs – milk yield, the weight of the animal and daily gain. The method estimates the average annual requirements of crude protein for maintenance, lactation, pregnancy and daily gain. Milk yield, daily gain and share of proteins in milk on the regional level were taken from the Statistical Office of the Slovak Republic. The calculation model is in line with the enteric fermentation model same activity data was implemented. The methodology was developed in the National Agricultural and Food Centre – The Research Institute for Animal Production in Nitra. Additional information on the usability of maintenance and pregnancy was taken into account. Parameters are documented in ***Table 5.7.***

Table 5.7: *Additional parameters for estimation of nitrogen excretion rate*

PARAMETER	UNITS*	SOURCES
Crude protein per litre of milk	85 g per liter	P.Petrikovič – A Sommer Nutrition for cattle
Share of protein in calf meat	21.5 %	Keresteš. J. at all. Biotechnology nutrition and health
Usability for maintenance	2 %	P.Petrikovič – A Sommer Nutrition for cattle
Usability for pregnancy	20 %	P.Petrikovič – A Sommer Nutrition for cattle
Nitrogen overage -dairy cattle	25 %	Expert judgement
Nitrogen overage - other cattle	20 %	Expert judgement
Share of protein in beef meat	21 %	Keresteš. J. at all. Biotechnology nutrition and health
The conversion factor from CP to N	6.25	2006 IPCC GL p.10.58
Time without milking	60 days	https://www.plis.sk/
Crude protein for pregnancy begin part of pregnancy	680 g/day	P.Petrikovič – A Sommer Nutrition for cattle
Crude protein for pregnancy begin part of pregnancy	765 g/day	P.Petrikovič – A Sommer Nutrition for cattle

*consistent in all time-series

The nitrogen excretion rate was determined for the whole time-series with methods according to the publication *P. Petrikovič – A. Sommer: Nutrition for Cattle.*[2] The complex of crude protein contains the amount of protein nitrogen and non-protein nitrogen estimated with the Kjeldahl method. Crude protein is multiplied by a conversion factor of **6.25** to dietary nitrogen.

The calculation method is based on a reverse estimation of nitrogen excretion from the average parameters of animal production (milk yield and daily gain, body weight) of the cattle. Parameters multiplied with tabular values of crude protein from individual physiological activities. Subsequently, the partial crude protein from activities is summed to the total crude protein. Total crude protein was recalculated to nitrogen.

Dairy cattle:

$$CP_{m-Total} = \left[(4.93 * H^{0.75} * U_m) - \left(\frac{CP_m}{100} * U_m\right)\right]$$

$$CP_{l-Total} = \left[(MY * CP_l) - \left(\frac{MY * 1000}{100 * SP_l}\right)\right]$$

$$CP_{p-Total} = \frac{C_{p1+}C_{p2}}{100} * U_p$$

$$Total_{CP} \frac{\frac{(CP_{m-Total}+CP_{l-Total})*lactation\ period}{1000} + \frac{(CP_{m-Total}+CP_{p-Total})*time\ without\ milking}{1000}}{intervening\ period} * 365$$

$$N_{intake\ (T)} = \left(\frac{\frac{Total_{Cp}}{100}}{6.25}\right)$$

$$NEX_{(T)} = N_{intake\ (T)} + \left(N_{intake\ (T)} * O_N\right)$$

Non-dairy cattle:

$$CP_{m-Total} = \left[(4.93 * H^{0.75} * U_m) - \left(\frac{CP_m}{100} * U_m\right)\right]$$

$$CP_{dg-Total} = \left[\left(200 + (4.43 * H^{0.75})\right) * dg\right] * SP_m$$

$$Total_{CP} = \frac{\left(CP_{m-Total} + CP_{dg-Total}\right)}{1000} * 365$$

$$N_{intake\ (T)} = \left(\frac{\frac{Total_{Cp}}{100}}{6.25}\right)$$

$$NEX_{(T)} = N_{intake\ (T)} + \left(N_{intake\ (T)} * O_N\right)$$

Where: **$CP_{m-Total}$** = crude protein for maintenance in g per day, **$H^{0.75}$** = metabolic body size, **H =** average body weight in kg, **U_m** = Usability for maintenance in %, **MY** = milk yield in kg/day **$CP_{l-Total}$** = crude protein for lactation g per day, **$CP_{p-Total}$** = crude protein for pregnancy in g per day, **$CP_{dg-Total}$** = crude protein for daily gain in g per day, **dg** = daily gain of animal in kg, **4.93** factor for maintenance, **4.43** factor crude protein per daily gain, **SP_l** = share of proteins in milk in %, **SP_m** = share of proteins in meat in %, **lactation period** = period of milk production in days, **intervening period** = is a figure indicating the time elapsed between two calves in days, **$Total_{CP}$** = total calculated

[2] Perikovič, P., Sommer, A., 2002, Nitrition for Cattle, The Research Insitute for Animal Production, ISBN: 80-88872-21-9 in Slovak, online: http://old.agroporadenstvo.sk/zv/hd/ziviny_hd/ziviny21.htm http://old.agroporadenstvo.sk/zv/hd/ziviny_hd/ziviny23.htm

crude protein in kg, **NEX$_{(T)}$** = annual N excretion rates kg N animal^{-1} year^{-1}, **6.25** = conversion from kg of dietary protein to kg dietary N kg feed protein (kg N)$^{-1}$, **O$_N$** = share of overage of nitrogen in N, **N$_{INTAKE (T)}$** = daily N consumed per animal of category T, **C$_{p1}$** = crude protein for pregnancy begin part of pregnancy, **C$_{p2}$**= crude protein for pregnancy final part of pregnancy.

Nitrogen Excretion Rate for swine and poultry – a country-specific nitrogen excretion rate was used for the swine and poultry categories, based on the Tier 2 method from the IPCC 2019 RF. The nitrogen excretion rates were developed based on the nitrogen content of the feed. The amounts of the nitrogen-containing feed ingredients in the diet were determined for the whole time-series. Feeding rations for different subcategories of pigs were estimated with the model "Software for Feeding Ration Optimization" developed by the NPPC-VÚŽV.

The nitrogen intakes were determined from the crude protein content of each feed ingredient in the feeding ration for all subcategories of swine. The value of gross energy intake is consistent with the value used in category **3B13**. Data on dry matter intake were taken according to the publication *P. Petrikovič at al.: Nutrition for Pigs* and *J. Zelenka at al.: Nutrition for Poultry*. Experimental feeding rations were compiled with "The Animal Optimization Software" from Agrokonzulta Žamberk, Ltd. (CZ). This software uses the feed database and Nutrition Standards developed at the NPPC-VÚŽV. The nitrogen intakes were determined from the crude protein content of each feed ingredient in the diet for all subcategories of swine and the gross energy intake of the swine.

$$\mathrm{N_{intake\ (T)}} = DMI_i * \left(\frac{\frac{\mathrm{CP\ \%}}{100}}{6.25} \right)$$

Where: **N$_{INTAKE (T)}$** = daily N consumed per animal of category T. kg N/head/day, **DMI$_i$**=dry matter intake per day during a specific growth stage, (kg DMI animal day^{-1}), **18.45** = conversion factor for dietary GE/kg of dry matter MJ/kg, **CP** = percent crude protein in diet %, **6.25** = conversion from kg of dietary protein to kg of dietary N. kg feed protein (kg/N).

The values of the annual nitrogen excretions that are retained by animals and their sources are summarized in **Tables 5.8 - 5.12**. The results for swine for 2019 were presented in **Tables 5.10-5.11**. Sheep are also significant contributors to emissions, but data about crude protein were unavailable. The N-excretion rates were calculated according to Equation 10.32 of the IPCC 2019 RF:

$$NEX_{(T)} = N_{intake\ (T)} * (1 - N_{retention})$$

Where: **NEX$_{(T)}$** = annual N excretion rates in kg N/head/yr, **N$_{INTAKE (T)}$** = the annual N intake per head of animal of species/category T. kg N /head/yr, **N$_{RETENTION (T)}$** = fraction of annual N intake that is retained by the animal of species (according to the Table 10.20 of the IPCC 2019 RF).

***Table 5.8:** Country-specific regional parameters for swine for the period of 1990*

1990		A	B	C	D	E	F	G	H
SOWS	CP (%)	15.70	15.70	15.80	15.70	15.70	15.60	15.70	15.50
	N-intake (kg N animal/day)	0.083	0.082	0.083	0.082	0.085	0.084	0.083	0.082
	N$_{EX}$ (kgN/animal/year)	21.10	21.00	21.10	21.10	21.60	21.50	21.20	21.00
GILTS PREGNANT	CP (%)	12.86	13.33	13.63	13.54	13.54	14.00	13.38	13.44
	N-intake (kg N animal/day)	0.049	0.053	0.055	0.054	0.054	0.057	0.053	0.054
	N$_{EX}$ kg N/animal/year)	12.40	13.60	14.00	13.90	13.90	14.50	13.60	13.70
GILTS UNPREGNANT	CP (%)	12.86	13.33	13.63	13.54	13.54	14.00	13.38	13.44
	N-intake (kg N animal/day)	0.039	0.043	0.044	0.044	0.044	0.046	0.043	0.043
	N$_{EX}$ (kg N/animal/year)	10.00	10.90	11.30	11.20	11.20	11.70	11.00	11.00
HOGS	CP (%)	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	N-intake (kg N animal/day)	0.052	0.051	0.053	0.054	0.052	0.054	0.053	0.052
	N$_{EX}$ (kg N/animal/year)	13.20	18.70	19.50	19.50	19.10	19.50	19.20	19.10
PIGLETS	CP (%)	12.90	13.30	13.60	13.50	13.50	14.00	13.40	13.40
	N-intake (kg N animal/day)	0.012	0.013	0.014	0.014	0.014	0.014	0.013	0.013
	N$_{EX}$ (kg N/animal/year)	3.10	3.40	3.50	3.50	3.50	3.60	3.40	3.40

1990		A	B	C	D	E	F	G	H
PIGS (21-50 kg)	**CP (%)**	12.90	13.30	13.60	13.50	13.50	14.00	13.40	13.40
	N-intake (kg N animal/day)	0.023	0.025	0.026	0.025	0.025	0.027	0.025	0.025
	N_{EX} (kg N/animal/year)	5.80	6.40	6.60	6.50	6.50	6.80	6.40	6.40
FATTENING PIGS (UP TO 20 kg)	**CP (%)**	14.70	14.30	15.20	14.80	14.40	14.30	14.70	14.10
	N-intake (kg N animal/day)	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
	N_{EX} (kg N/animal/year)	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
FATTENING PIGS (21-50 kg)	**CP (%)**	14.30	15.00	14.10	14.50	12.60	14.30	12.70	13.70
	N-intake (kg N animal/day)	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	N_{EX} (kg N/animal/year)	8.20	8.20	8.10	8.20	8.20	8.20	8.20	8.20
FATTENING PIGS (50-80 kg)	**CP (%)**	14.70	14.30	15.20	14.80	14.40	14.30	14.70	14.10
	N-intake (kg N animal/day)	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
	N_{EX} (kg N/animal/year)	12.00	12.00	11.90	12.00	12.00	12.00	12.00	12.10
FATTENING PIGS (80-110 kg)	**CP (%)**	14.70	14.30	15.20	14.80	14.40	14.30	14.70	14.100
	N-intake (kg N animal/day)	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
	N_{EX} (kg N/animal/year)	15.00	15.10	15.00	15.00	15.10	15.10	15.00	15.10
FATTENING PIGS (FROM 110 kg)	**CP (%)**	14.70	14.30	15.20	14.80	14.40	14.30	14.70	14.10
	N-intake (kg N animal/day)	0.066	0.066	0.065	0.066	0.066	0.066	0.066	0.066
	N_{EX} (kg N/animal/year)	16.80	16.90	16.70	16.80	16.80	16.90	16.80	16.90

Regions: A: Bratislava, B: Trnava, C: Trenčín, D: Nitra, E: Žilina, F: Banská Bystrica, G: Prešov, H: Košice

Table 5.9: *Country-specific regional parameters for swine for the period of 2023*

2023		A	B	C	D	E	F	G	H
SOWS	**CP (%)**	17.3%	16.9%	16.6%	16.5%	16.1%	16.5%	16.8%	15.9%
	N-intake (kg N animal/day)	0.091	0.089	0.087	0.086	0.083	0.085	0.089	0.081
	NEX (kg N/animal/year)	19.65	21.86	21.12	21.2	20.68	22.77	21.53	21.05
GILTS PREGNANT	**CP (%)**	13.6%	14.0%	12.4%	13.0%	13.6%	13.3%	13.8%	12.8%
	N-intake (kg N animal/day)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	NEX (kg N/animal/year)	12.45	12.45	12.45	12.45	12.45	12.45	12.45	12.45
GILTS UNPREGNANT	**CP (%)**	13.6%	14.0%	12.4%	13.0%	13.6%	13.3%	13.8%	12.8%
	N-intake (kg N animal/day)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	NEX (kg N/animal/year)	15.11	15.11	15.11	15.11	15.11	15.11	15.11	15.11
HOGS	**CP (%)**	15.9%	15.9%	15.9%	15.9%	15.9%	15.9%	15.9%	15.9%
	N-intake (kg N animal/day)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
	NEX (kg N/animal/year)	27.08	27.08	27.08	27.08	27.08	27.08	27.08	27.08
PIGS (21-50 kg)	**CP (%)**	13.6%	14.0%	12.4%	13.0%	13.6%	13.3%	13.8%	12.8%
	N-intake (kg N animal/day)	0.024	0.025	0.022	0.023	0.024	0.024	0.025	0.023
	NEX (kg N/animal/year)	8.07	8.07	8.07	8.07	8.07	8.07	8.07	8.07
FATTENING PIGS UP (TO 20 kg)	**CP (%)**	14.3%	15.0%	14.1%	14.5%	12.6%	14.3%	12.7%	13.7%
	N-intake (kg N animal/day)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	NEX (kg N/animal/year)	4.84	4.84	4.84	4.84	4.84	4.84	4.84	4.84
FATTENING PIGS (21-50 kg)	**CP (%)**	14.3%	15.0%	14.1%	14.5%	12.6%	14.3%	12.7%	13.7%
	N-intake (kg N animal/day)	0.0448	0.0448	0.0448	0.0448	0.0448	0.0448	0.0448	0.0612
	NEX (kg N/animal/year)	9.43	9.43	9.43	9.43	9.43	9.43	9.43	9.43
FATTENING PIGS (50-80 kg)	**CP (%)**	14.3%	15.0%	14.1%	14.5%	12.6%	14.3%	12.7%	13.7%
	N-intake (kg N animal/day)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	NEX (kg N/animal/year)	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80
FATTENING PIGS (80-110 kg)	**CP (%)**	14.3%	15.0%	14.1%	14.5%	12.6%	14.3%	12.7%	13.7%
	N-intake (kg N animal/day)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	NEX (kg N/animal/year)	17.72	17.72	17.72	17.72	17.72	17.72	17.72	17.72
	CP (%)	14.3%	15.0%	14.1%	14.5%	12.6%	14.3%	12.7%	13.7%
	N-intake (kg N animal/day)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

2023		A	B	C	D	E	F	G	H
FATTENING PIGS (FROM 110 kg)	NEX (kg N/animal/year)	18.67	18.67	18.67	18.67	18.67	18.67	18.67	18.67

***Table 5.10:** Country specific regional parameters for poultry*

2023		A	B	C	D	E	F	G	H
Breeding broilers	N retention (%)	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
	N-intake (kg N animal/day)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	NEX (kg N/animal/year)	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898
Ducks	N retention (%)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	N-intake (kg N animal/day)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
	NEX (kg N/animal/year)	1.295	1.295	1.295	1.295	1.295	1.295	1.295	1.295
Fattening broilers	N retention (%)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	N-intake (kg N animal/day)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	NEX (kg N/animal/year)	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739
Geese	N retention (%)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	N-intake (kg N animal/day)	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	NEX (kg N/animal/year)	1.739	1.739	1.739	1.739	1.739	1.739	1.739	1.739
Laying hens including cocks	N retention (%)	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
	N-intake (kg N animal/day)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	NEX (kg N/animal/year)	0.794	0.794	0.794	0.794	0.794	0.794	0.794	0.794
Turkeys	N retention (%)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	N-intake (kg N animal/day)	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
	NEX (kg N/animal/year)	3.529	3.529	3.529	3.529	3.529	3.529	3.529	3.529

REGIONS: A: Bratislava, B: Trnava, C: Trenčín, D: Nitra, E: Žilina, F: Banská Bystrica, G: Prešov, H: Košice

Nitrogen Excretion Rate – Other animals – the calculation is based on the determination of body weight. All animals have their specific body weight. This parameter was estimated and is country-specific. The body weight parameter is consistent across the time-series and specific for animal species. The NPPC-VÚŽV provided a specific body mass for animals. Annual nitrogen excretion rates were calculated for sheep, goats, horses and poultry. N-excretion rates were calculated based on the IPCC 2019 RF, Equation 10.30:

$$NEX_T = N_{rate(T)} * \frac{TAM}{1000} * 365$$

Where: **N_{EX}** = annual N-excretion for each livestock spices respectively category in kg N per animal, **$N_{RATE(T)}$** = default N-excretion rate in kg N (100 kg/animal mass)/day (IPCC 2019 RF), **TAM** = country-specific animal mass for each livestock species/category in kg per animal.

Direct emissions from manure management systems were estimated according to the following equation:

$$N_2O_{EM} = \left[\sum\left[\sum(N * N_{EX} * AWMS)\right] * EF\right] * \frac{44}{28}$$

Where: **N_2O_{EM}** = direct N_2O emissions from manure management in kg N_2O; **N** = number of livestock species respectively category, **N_{EX}** = annual average N-excretion/head of species respectively category in kg N/animal, **AMWS** = percentage of total annual nitrogen excretion for each livestock category, that is managed in manure management systems in the country, **EF** = default emission factor for direct N_2O emissions from manure management system in kg N_2O-N/kg N in manure management system, **44/28** = conversion of N_2O-N emissions to N_2O emissions.

***Table 5.11:** Country-specific regional parameters for dairy cattle in 1990*

CATEGORIES	N_{EX}	BODY MASS	LIQUID	SOLID	PASTURE	ANAEROBIC DIGESTER
	[kg N head/year]	[kg]	[%]			
Dairy cows Bratislava region	82.63	589	42.85	56.86	0.29	NO
Dairy cows Trnava region	78.69	589	18.57	79.79	1.64	NO
Dairy cows Trenčín region	74.60	589	7.12	86.92	5.97	NO
Dairy cows Nitra region	75.84	589	16.56	82.62	0.82	NO

CATEGORIES	N_{EX}	BODY MASS	LIQUID	SOLID	PASTURE	ANAEROBIC DIGESTER
	[kg N head/year]	[kg]	[%]			
Dairy cows Žilina region	66.07	589	5.93	75.34	18.73	NO
Dairy cows Banská Bystrica region	71.66	589	10.67	77.88	11.44	NO
Dairy cows Prešov region	62.65	589	4.06	80.43	15.51	NO
Dairy cows Košice region	69.36	589	2.41	86.29	11.30	NO

Table 5.12: *Country-specific regional parameters for dairy cattle in 2023*

CATEGORIES	N_{EX}	BODY MASS	LIQUID	SOLID	PASTURE	ANAEROBIC DIGESTER
	[kg N head/year]	[kg]	[%]			
Dairy cows Bratislava region	132.14	600	0.00	99.52	0.48	0.00
Dairy cows Trnava region	131.65	600	8.11	77.00	1.34	13.55
Dairy cows Trenčín region	126.63	600	7.58	77.29	6.18	8.95
Dairy cows Nitra region	128.43	600	16.49	80.47	0.64	2.40
Dairy cows Žilina region	111.66	600	5.89	57.31	30.11	6.70
Dairy cows Banská Bystrica region	113.17	600	13.95	69.60	11.74	5.70
Dairy cows Prešov region	109.43	600	6.35	70.74	20.25	2.67
Dairy cows Košice region	108.72	600	3.04	77.64	10.78	8.55

Table 5.13: *Country specific regional parameters for poultry in 1990-2023*

CATEGORIES	N_{EX}	BODY MASS	PASTURE	MANURE POULTRY WITHOUT LITTER	POULTRY MANURE WITH LITTER
	[kg N head/year]	[kg]	[%]		
Laying hens including cocks	0.79	2	-	75%	25%
Fattening broilers	0.74	1.02	-	-	100%
Breeding broilers	0.90	1.02	-	-	100%
Turkeys	2.41	3.28	-	-	100%
Geese	1.74	1.53	50%	50%	50%
Ducks	1.30	2.05	50%	50%	50%

Table 5.14: *N_{EX} and share (%) for different domestic livestock and share in AWMS in 2023*

CATEGORIES		N_{EX}	LIQUID	SOLID	PASTURE	OTHER (LITTER)
		[N kg/head]	[%]			
NON-DAIRY CATTLE	Suckler cows	40.35	-	45.21	54.79	-
	Calves in 6 month (milk type)	19.96	-	-	100.00	-
	Heifer (milk type)	38.42	-	97.56	2.44	-
	Heifer (pregnant) (milk type)	57.56	-	97.55	2.45	-
	Fattening (milk type)	46.48	10.00	90.00	-	-
	Oxen (milk type)	93.79	-	100.00	-	-
	Breeding bull (milk type)	66.21	-	100.00	-	-
	Calves in 6 month (beef type)	12.18	-	40.00	60.00	-
	Heifer (beef type)	38.29	-	45.21	54.79	-
	Heifer (pregnant) (beef type)	54.73	-	45.21	54.79	-
	Fattening (beef type)	51.75	20.00	80.00	-	-
	Oxen (beef type)	69.51	-	100.00		-
	Breeding bull (beef type)	43.35	-	75.34	24.66	-
	2023*	40.47	2.46	71.17	26.37	-
SHEEP	Mature ewes (milk type)	7.88	-	49.59	50.41	-
	Mature ewes (beef type)	9.20	-	45.20	54.80	-
	2023*	8.35	-	48.03	51.97	-
	Growing lambs (milk type)	4.27	-	49.59	50.41	-

CATEGORIES		N_{EX}	LIQUID	SOLID	PASTURE	OTHER (LITTER)
		[N kg/head]	[%]			
	Growing lambs pregnant (milk type)	7.23	-	49.59	50.41	-
	Growing lambs (beef type)	6.24	-	45.21	54.79	-
	Growing lambs pregnant (beef type)	8.54	-	45.21	54.79	-
	2023*	5.88	-	48.08	51.92	-
	Rams (milk type)	10.51	-	100.00	-	-
	Rams (beef type)	11.83	-	100.00	-	-
	2023*	10.98	-	81.63	18.37	-
GOATS	Mature female goats	9.23	-	49.60	50.40	-
	Pregnant goats	7.98	-	49.60	50.40	-
	Other mature goats	3.61	-	49.60	50.40	-
	2023*	7.82	-	49.60	50.40	-
HORSES	Young horses up to 1 year	17.32	70.00	-	30.00	-
	Young horses from 1 to 3 year	39.86	70.00	-	30.00	-
	Castrated horses	66.43	70.00	-	30.00	-
	Stallions	52.20	70.00	-	30.00	-
	Mares	47.45	70.00	-	30.00	-
	2023*	49.78	70.00	-	30.00	-
Others	Rabbits	4.6	-	68%	32%	-

* weighted average

5.8.2.1 Methodological Issues –Method NH_3 and NOx

Emissions of NOx and NH_3 from **3B1** Cattle, **3B2** Sheep and **3B3** Swine and other animals **3B4** were calculated using the Tier 3 method of the EMEP/EEA GB_{2023} and country-specific values whenever possible.

5.8.2.2 Emissions Factors NH_3 and NO_x

All animals

The values of the N excretion, housed-period and the proportion of solid, liquid and yard manure were replaced by the country-specific values year by year for all animal species. The input data on regional N-excretion and percentage of liquid, solid and yard manure are presented in ***Tables 5.12 - 5.13***. Solid storage of manure was found as the most frequent AMWS for cattle. The regional differences for horses, goats and poultry categories were not considered.

NH_3 emissions are estimated according to the EMEP/EEA GB_{2023} as the Tier 3 approach for cattle, sheep, goats, swine, horses and poultry in the system Python. For the calculation of the Tier 3 approach was accepted philosophy for ammonia reduction. Ammonia reduction at the various stages of livestock manure production and handling are interdependent and combinations of measures are not simply additive in terms of their combined emission reduction. In the 2022 submission, the Fixed hatch or roof. Covering the surface of the tank with straw and foil and slurry/liquid with natural crust cover were implemented into inventory. Implementation of abatements was done according to Approach 2 presented in the 2021 Task Force on Emission Inventories and Projections as called Approach 2. Abated emission factors were calculated separately and implemented into the N flow tool in the system Python.

Table 5.15: *Country-specific liquid NH_3 emission factors for the period 2006-2023*

SPECIFIC EFs	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS, LAYING HENS, GEESE, TURKEYS, DUCKS, HORSES, SHEEP	BREEDING PIGS	FATTENING PIGS
YEARS	LIQUID [kg NH_3/kg N]				
2006	0.2205	0.2198	NO	0.0987	0.1026
2007	0.2128	0.2145	NO	0.1002	0.0999
2008	0.2092	0.2108	NO	0.0933	0.0957
2009	0.2077	0.2105	NO	0.0848	0.0880
2010	0.2063	0.2081	NO	0.0823	0.0885
2011	0.2026	0.2065	NO	0.0801	0.0885
2012	0.2027	0.2064	NO	0.0786	0.0858
2013	0.2036	0.2041	NO	0.0757	0.0849
2014	0.2034	0.2045	NO	0.0736	0.0812
2015	0.2044	0.2060	NO	0.0731	0.0812
2016	0.2041	0.2059	NO	0.0719	0.0712
2017	0.2030	0.2061	NO	0.0720	0.0725
2018	0.2038	0.2052	NO	0.0720	0.0736
2019	0.2024	0.2040	NO	0.0717	0.0722
2020	0.2026	0.2040	NO	0.0747	0.0719
2021	0.2079	0.2036	NO	0.0929	0.0956
2022	0.2011	0.2041	NO	0.0682	0.0665
2023	0.2035	0.2047	NO	0.0700	0.0670

Table 5.16: *Country-specific solid NH_3 emission factors for the period 2006-2023*

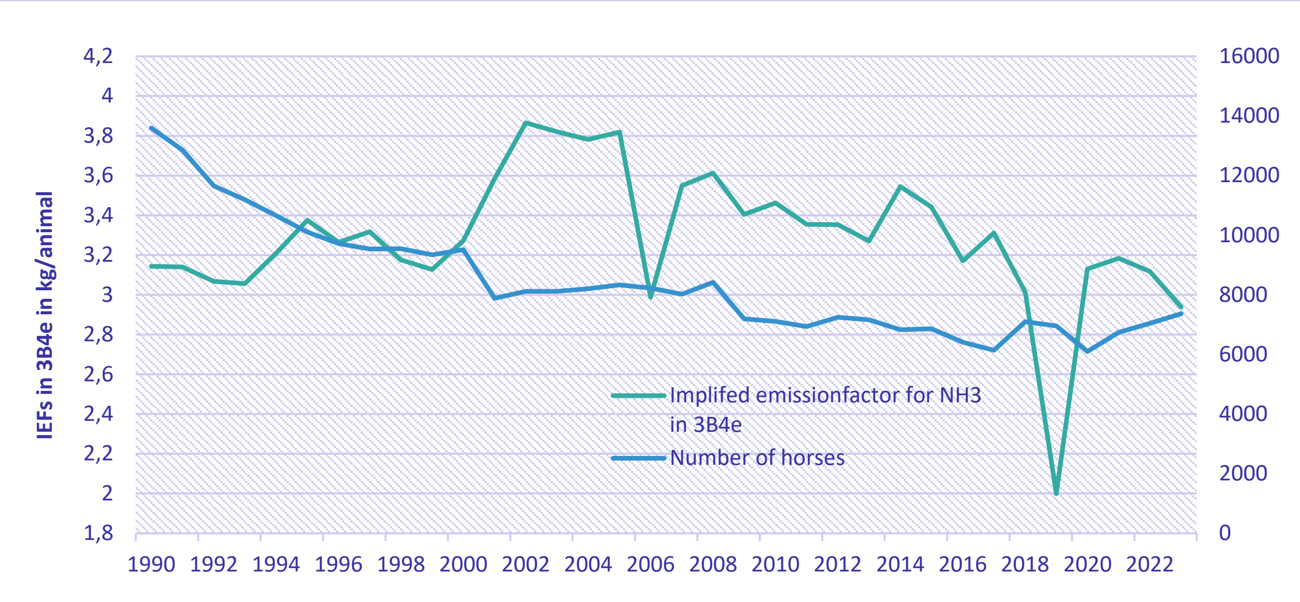
SPECIFIC EFs	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS
YEARS	SOLID [kg NH_3/kg N]					
2006	0.2684	0.2683	0.2949	0.0800	0.1417	0.213
2007	0.2743	0.2692	0.2888	0.0646	0.160	0.240
2008	0.2736	0.2702	0.2900	0.0660	0.160	0.240
2009	0.2731	0.2706	0.2947	0.0658	0.160	0.240
2010	0.2768	0.2773	0.2984	0.0636	0.160	0.240
2011	0.2794	0.2775	0.2967	0.0654	0.160	0.240
2012	0.2774	0.2784	0.2915	0.0667	0.160	0.240
2013	0.2788	0.2816	0.2897	0.0630	0.160	0.240
2014	0.2799	0.2835	0.2872	0.0628	0.160	0.240
2015	0.2788	0.2814	0.2904	0.0644	0.160	0.240
2016	0.2798	0.2813	0.2943	0.0649	0.160	0.240
2017	0.2805	0.2815	0.2945	0.0667	0.160	0.240
2018	0.2822	0.2813	0.2953	0.0651	0.160	0.240
2019	0.2811	0.2798	0.2950	0.0660	0.160	0.240
2020	0.2797	0.2817	0.2953	0.0646	0.160	0.240
2021	0.2778	0.2810	0.2976	0.0774	0.160	0.240
2022	0.2791	0.2834	0.2957	0.0651	0.160	0.240
2023	0.2759	0.2839	0.2937	0.0642	0.160	0.240

SPECIFIC EFs	DUCKS	HORSES	BREEDING PIGS	FATTENING PIGS	SHEEP
YEARS	SOLID [kg NH_3/kg N]				
2006	0.213	0.350	0.2008	0.1840	0.2800
2007	0.240	0.350	0.2093	0.1934	0.2383
2008	0.240	0.350	0.2059	0.1914	0.2410
2009	0.240	0.350	0.2407	0.2123	0.1826
2010	0.240	0.350	0.2481	0.2103	0.1717

SPECIFIC EFs	DUCKS	HORSES	BREEDING PIGS	FATTENING PIGS	SHEEP
YEARS	SOLID [kg NH_3/kg N]				
2011	0.240	0.350	0.2572	0.2088	0.2800
2012	0.240	0.350	0.2580	0.2118	0.2800
2013	0.240	0.350	0.2679	0.2197	0.2800
2014	0.240	0.350	0.2670	0.2297	0.2800
2015	0.240	0.350	0.2692	0.2446	0.2800
2016	0.240	0.350	0.2719	0.2482	0.2800
2017	0.240	0.350	0.2683	0.2598	0.2800
2018	0.240	0.314	0.2682	0.2598	0.2800
2019	0.240	0.301	0.2714	0.2538	0.2592
2020	0.240	0.300	0.2512	0.2585	0.2677
2021	0.240	0.294	0.2173	0.2028	0.2558
2022	0.240	0.344	0.2514	0.2670	0.2678
2023	0.240	0.344	0.2489	0.2673	0.2700

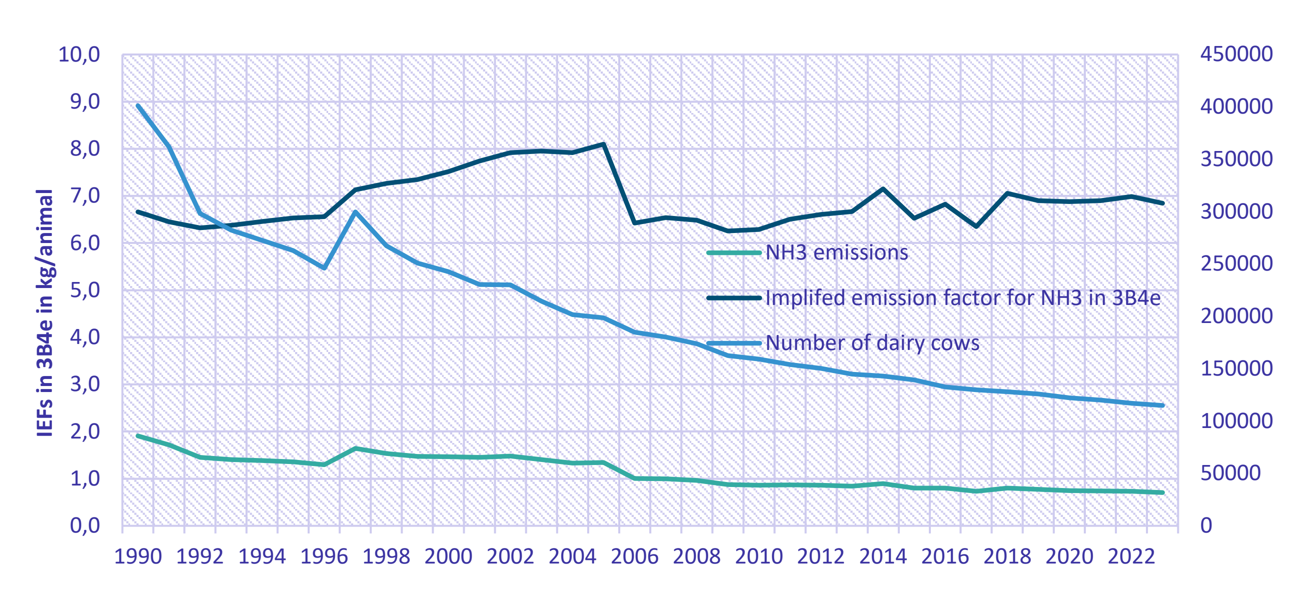
For the remaining input data as well as for the emission factors, standards and default values provided in the EMEP/EEA GB_{2023} were applied.

Figure 5.11: *Trends of implied emission factors and number of horses in the Slovak Republic in 1990-2023*



In Slovak horse farms, extensive breeding systems are prevalent. The repeating increase and decrease is due to exports after 1990 and caused an irregular trend in NH_3 emissions. It is noted that most of the parameters in our calculations are static, such as N_{EX}, AWMS, housing period and straw content. The only dynamic changes are observed in the number of livestock, which correlates with emissions. Additionally, after 2018 there have been changes in emission factors as a result of implemented mitigation measures as indicated in **Annex VI** (according to the NECD **Recommendation No A6/SK-3B4e-2023-0001** of the SVK NECD Final Review Report 2023).

__Figure 5.12:__ Trends of implied emission factors, ammonia emissions and number of dairy cows in the Slovak Republic in 1990 - 2023



In reflection of the NECD **Recommendations No A3/SK-3B1a-2023-0001** of the SVK NECD 2023 Final Review Report and **No A4/SK-3B1a-2023-0002** of the SVK NECD Final Review Report 2023, the trend of NH_3 emissions is correlated with the number of livestock, which has been decreasing due to economic reasons stemming from the transition from a controlled system to a market-oriented one. Since 2004, this decline has continued due to accession to the EU. In recent years, there has been a further decrease in numbers due to low purchase prices of milk. Emissions are primarily correlated with the number of livestock. As a result of the decrease in livestock numbers, there was an estimated decrease in the weighted average of nitrogen excretion rate in 2017. Implied emission factors have been continually increasing, mainly due to productivity growth and an increase in cow milk yield.

__Table 5.17:__ Country-specific NH_3 emission factors for 3B1a Dairy cattle and background data for the period 1990-2023

3B1a DAIRY CATTLE CATEGORY				
YEAR	BODY MASS AVERAGE*	MILK YIELD	N-EXCRETION*	IMPLIED EMISSION FACTOR FOR 3B1a
	[kg/head]	[kg/head/year]	[kg N head/year]	[kg NH_3/head/year]
1990	589.41	6.96	72.09	4.75
1995	590.21	8.83	78.18	5.17
2000	591.02	12.24	89.22	6.05
2005	594.76	15.18	98.93	6.76
2010	597.81	15.62	100.52	5.43
2011	597.86	16.35	102.87	5.64
2012	598.08	17.22	105.70	5.74
2013	598.37	17.34	106.11	5.82
2014	598.50	17.74	107.51	6.25
2015	598.57	17.85	107.74	5.73
2016	598.65	19.41	112.79	6.02
2017	598.70	19.56	106.94	5.62
2018	598.75	19.89	114.64	6.25
2019	598.89	20.22	115.01	6.13
2020	598.89	20.36	115.48	6.13
2021	598.98	22.02	118.57	6.16

3B1a DAIRY CATTLE CATEGORY				
YEAR	BODY MASS AVERAGE*	MILK YIELD	N-EXCRETION*	IMPLIED EMISSION FACTOR FOR 3B1a
	[kg/head]	[kg/head/year]	[kg N head/year]	[kg NH_3/head/year]
2022	597.75	22.86	120.67	6.26
2023	597.76	23.00	119.91	6.14

*Weighted average from 8 Slovak regions

5.8.3 Activity Data

Primary data sources used for the emissions evaluations were published in the Census of Sowing Areas of Field Crops in the Slovak Republic, the Annual Census of Domestic Livestock in the Slovak Republic, the Statistical Yearbooks 1990 – 2023 and the research results from projects and studies provided by several organizations inside the NPPC-VÚŽV.
Activity data for dairy, non-dairy cattle, sheep and swine are based on bottom-up statistical information at the regional level. The used input parameters were calculated as weighted averages. The ŠÚ SR provides annual livestock numbers at a detailed regional level in the Livestock Census annually on 31st December.
Due to a different regionalisation of Slovakia in the years 1990 – 1996 (only three regions: Západoslovenský, Stredoslovenský and Východoslovenský), it was not possible to use time series immediately. The reallocation of older data into new regions (8 districts after 1997) was necessary. Reallocation was based on the following assumptions:
Západoslovenský region (1990 – 1996) is equal to Bratislavský, Nitriansky, Trnavský, Trenčiansky regions (1997 – present);

- Stredoslovenský region (1990 – 1996) is similar to Banskobystrický and Žilinský regions (1997 – present);
- Východoslovenský region (1990 – 1996) is similar to Prešovský and Košický regions (1997 – present).

A reallocation was prepared by using the linear extrapolation tools to reach statistical totals as reported by the ŠÚ SR and time series was extrapolated back to the base year. The ŠÚ SR and the SHMÚ use a standard statistical approach for data extrapolations. Good statistical practice is described in the EUROSTAT Guidance. After the 2017 submission, the extrapolated number of swine was reported. The SHMÚ filled the data gap by using a standard statistical approach for extrapolation (linear extrapolation in spreadsheets). In addition, time series 1997 – 2020 of the milk production, wool production and daily gain for cattle and sheep at the regional level was provided by the ŠÚ SR in 2016. Activity data used for methane emissions estimation is summarized in ***Table 5.41***.
Detailed statistical information is available at the regional level and emissions are estimated by bottom-up method (Tier 2). The NPPC-VÚŽV implemented the results of a questionnaire farm survey where a better classification and disaggregation of cattle categories were used. Based on survey data, cattle were divided into dairy and non-dairy. Dairy cattle are estimated separately from non-dairy cattle. Dairy cattle are defined as cows that produce milk only for human consumption (highly productive cows). Suckler cows are defined as cows that are farmed for the nutrition of calves (low productive cows). Suckler cows are included in non-dairy cattle category. In addition, non-dairy cattle include breeding bulls, oxen, calves, heifer pregnant, un-pregnant heifers and fattening bulls. This categorization is consistent in whole time series. The number of livestock decreased compared to the previous year in all species. The highest declines were recorded in the swine category (-84 %) compared to 1990. The main reason for this decrease is the data gap on self-sufficiency - small household farmers and morbidity of animals. The same reason was the cause of the decline of poultry (-41 %) and horses (-46 %).

Between 2005 and 2023, the production of most agricultural crops showed a declining trend. The decrease was recorded for tobacco by -100 % and for beans by -100 %, for beans -83 %, for potato by -70 % and rye by 63 %.

The production of potatoes increased by +59 %, soya +49 %, oil plants +47 %, wheat +42 %, meadows +35 %, rye +19 %, clover +16 % and leguminous plant +4 % during the given period.

Since 2005, livestock numbers have decreased for all farmed species. Between 2005 and 2023, the number of dairy cattle decreased by -64 %, pigs by -42 %, poultry by -31 % and sheep by -10 %.

Table 5.18: *Animal population according to the districts for the year 2023*

REGION		A	B	C	D	E	F	G	H
DAIRY CATTLE		4 790	19 065	13 729	17 993	20 163	14 419	17 300	7 437
NON-DAIRY CATTLE	Suckling cows	1 658	2 024	4 558	1 807	9 466	18 602	23 351	11 980
	Calves in 6 month (milk sort)	1 787	9 491	5 526	8 489	6 634	4 984	5 640	2 406
	Heifer (milk sort)	971	5 077	4 502	5 875	8 575	5 091	6 281	2 765
	Heifer (pregnant) (milk sort)	1 434	4 906	3 508	6 743	4 804	3 037	3 742	1 427
	Fattening (milk sort)	481	9 981	4 164	7 243	3 815	3 829	3 886	1 864
	Oxen (milk sort)	4	4	7	9	213	42	35	8
	Breeding bull (milk sort)	21	134	68	109	291	387	455	316
	Calves in 6 month (beef sort)	619	1 008	1 835	852	3 114	6 431	7 612	3 877
	Heifer (beef sort)	336	539	1 494	590	4 026	6 569	8 478	4 454
	Heifer (pregnant) (beef sort)	496	521	1 165	677	2 256	3 919	5 052	2 299
	Fattening (beef sort)	167	1 060	1 383	727	1 791	4 940	5 246	3 003
	Oxen (beef sort)	1	0	2	1	100	55	48	13
	Breeding bull (beef sort)	41	267	135	218	583	775	911	632
SHEEP	Mature ewes	1 923	1 437	20 039	5 038	49 401	59 887	38 614	15 622
	Growing lambs	664	776	6 867	1 754	16 443	17 717	11 137	4 180
	Growing lambs (pregnant)	411	96	3 962	1 021	8 307	8 404	5 871	2 144
	Other mature sheep	58	38	601	152	1 443	1 743	1 112	444
SWINE	Breeding swine	5 559	17 822	4 976	8 118	132	6 498	248	695
	Fattening swine	13 323	163 666	29 884	105 216	1 644	26 519	5 155	13 582
HORSES	Horses (0-1year)	10	24	89	47	32	19	37	69
	Horses (1-3year)	33	74	206	267	82	87	106	172
	Stallions	50	61	107	61	81	86	110	32
	Mares	323	210	470	457	440	583	425	420
	Castrated stallions	297	100	266	244	347	369	225	226

REGION		A	B	C	D	E	F	G	H
GOATS	Mature goats	245	250	739	360	1 721	1 623	1 144	898
	Growing goats (pregnant)	98	9	41	67	598	46	169	158
	Other mature goats	120	96	328	108	245	469	533	654
POULTRY	Laying hens and roosters	547 615	113 768	228 502	905 606	406 618	440 161	14 808	207 962
	Breeding broilers	188 490	77 275	89 879	320 840	77 412	133 222	326	324 263
	Fattening broilers	25 856	1 002 652	1 162 082	1 183 866	300 933	1 304 888	89 499	343 605
	Turkeys	6	5 987	207	109 129	31 465	19	0	4
	Ducks	5	31 442	9	262	35	83	1	27
	Geese	0	56	5	387	2	20	4	93
	Rabbits	4 549 966							

REGIONS: A: Bratislava, B: Trnava, C: Trenčín, D: Nitra, E: Žilina, F: Banská Bystrica, G: Prešov, H: Košice

In the breeding of cattle in Slovakia, a slight decline in the number of individual animal categories was recorded in the year 2023. By the end of 2023, there were 429.72 thousand head of cattle in Slovakia, which was 3.5 thousand head less compared to the previous year (-0.8 %). The number of cows reached 188.3 thousand head, showing an interannual decrease of 1.8 thousand head (-0.95 %). The declining trend in the number of milking cows continued in 2023, with their count reaching only 114.9 thousand head by the end of the year, which is 2.0 thousand head less than in 2022 (-1.7 %).
The population of suckling cows increased during the year, reaching 73.45 thousand head by the end of 2023, showing a year-on-year increase of 2.5 hundred head (+0.34 %). The share of suckling cows in the total number of cows increased by 25.3 percentage points year-on-year to 63.9 %. In the cattle fattening sector, there were 53.6 thousand head of cattle, an increase of 2.9 thousand head (+5.7 %) compared to the previous year. The increase in the number of animals occurred in all weight categories.
Selected reproductive indicators of cattle (excluding households) slightly improved interannual. The number of calves born per 100 cows decreased by 1.29 head and the number of reared calves per 100 cows decreased by 1.41 head. Average daily weight gains in cattle fattening decreased by 0.014 kg/live weight, reaching 0.757 kg per head per day in 2023. Milk utility increased to 8 408 kg of milk per dairy cow per year, an increase of 46.1 kg (+0.55 %).
Despite the interannual reduction in the number of dairy cows, production remains at the level from 2022, having decreased only slightly by 1.02 thousand tons (-0.11 %), reaching a production of 901.2 thousand tons in 2023. Milk producers sold a total of 866 thousand tons (+0.135 %) of cow's milk. The volume of milk deliveries amounted to 816.4 thousand tons (-0.642 %), and direct sales were 49.62 thousand tons (+14.9 %).
In the year 2023, there was a slight increase in the number of pigs in Slovakia. The total number of pigs reached 403.04 thousand head, showing an interannual increase of 22.14 thousand head (+5.8 %). The number of breeding sows increased by 2.7 thousand head (+6.7 %) to reach 44.05 thousand head. The number of pigs in fattening and pre-fattening was lower by 19.4 thousand head (-5.4 %) compared to the previous year.
There have been some positive changes in the early stages of the production cycle compared to previous year. Number of litters per sow (+0.03 litter), the number of piglets born per sow slightly increased (+0.89 piglets), the number of piglets born per litter increased (+0.19 piglets) compared to the previous year. Piglet mortality slightly decreased (-0.03 %). Productivity in the fattening and pre-fattening of pigs decreased, with average daily weight gains reaching 0.622 kg per live weight, which was 0.011 kg (-2.2 %) less than in 2022.
The total number of poultry reached 9 669.4 thousand head, representing an increase of 3.5% compared to the status on December 31, 2022. Among them, the number of hens reached 2 779.5 thousand head, showing an interannual decrease of 14.7 %. The proportion of hens in the total poultry population decreased to 28.7 % (-

6.2 percentage points). The number of roosters reached 85 538 head (+13%) and showing an interannual increase of 20.6 thousand head (+31.6 %). The number of chicks was also higher by 786 hundred head compared to previous year. The number of geese decreased by 270 head (-32.3%), whereas the number of ducks increased by 16 329 head (+105.1 %) compared to the previous year.

Sheep farming in Slovakia has shown a fluctuating trend year-on-year. By the end of the year 2023, there were 288.7 thousand head of sheep, which was a decrease of 12.4 thousand head (-4.1 %) compared to the previous year. The number of ewes decreased by 10.7 thousand head (-5.3 %) to reach 191.96 thousand head.

Fertility indicators for ewes improved interannual. The number of lambs born (76.7 per 100 ewes) increased and the parameter of lambs raised per 100 ewes decreased (66.2 vs 71.5) compared to previous year. The average wool shearing per sheep per year reached 1.67 kg (-9.1 %).

5.8.4 Category-specific Recalculations

Recalculations were made due to revision of abatement measures to be properly linked with the type of manure (solid or liquid). During the national expert review of the calculations to account for abatement measures revealed calculation of abated emission factors aggregated measures that could not be linked with the type of the manure. In the storage stage, in the calculation for the last submission all measures contributed to the reduction of the default factor by the proportion their penetration across the population of the animal category. The recalculation in this submission linked „Fixed hatch or roof“ to EF for solid manure and measures „Covering the surface of the tank with straw“, „Covering the surface of the tanks with foil“ and „Slurry/liquid with natural crust cover“ linked with EF for liquid manure. In the aplication stage, four measures were contributing with the reduction to both default EF, solid or liquid. The recalculation introduced the calculation in which the measures that include „injection“ being applicable only for liquid EF (2 measures) and measures using „incorporation within 12/24 hours“ being applicable only for solid EF (2 measures).

Additionally in **3B4** subcategories emissions of NH_3 and NOx changed due to correction of wrong transcript to input file for calculation dealing with values of N-rate for poultry types. The impact of the recalculations in **3B** categories is shown in ***Table 5.19***.

Table 5.19: *Previous and revised NH3 and NO_X emissions from manure management*

YEAR	NH3 [kt]		CHANGE	NOx [kt]		CHANGE
	PREVIOUS	REVISED		PREVIOUS	REVISED	
1990	16.76	14.56	-13.2%	0.33	0.30	-7.5%
1991	14.97	12.90	-13.8%	0.28	0.26	-7.6%
1992	13.52	11.66	-13.8%	0.25	0.23	-8.2%
1993	12.00	10.11	-15.8%	0.21	0.19	-9.0%
1994	12.33	10.12	-17.9%	0.21	0.19	-10.5%
1995	11.88	9.86	-17.0%	0.20	0.18	-10.5%
1996	11.67	9.64	-17.4%	0.20	0.18	-11.0%
1997	11.62	9.61	-17.3%	0.20	0.18	-11.2%
1998	10.38	8.59	-17.3%	0.18	0.16	-11.4%
1999	9.83	8.17	-16.8%	0.18	0.16	-11.2%
2000	10.16	8.42	-17.2%	0.19	0.16	-11.5%
2001	10.88	8.73	-19.7%	0.19	0.16	-13.2%
2002	10.26	8.43	-17.8%	0.18	0.16	-12.2%
2003	9.90	8.05	-18.8%	0.18	0.15	-12.9%
2004	9.00	7.25	-19.5%	0.17	0.14	-13.2%
2005	9.14	7.38	-19.2%	0.18	0.15	-12.7%
2006	8.71	6.04	-30.7%	0.16	0.16	0.0%
2007	8.41	5.72	-32.0%	0.16	0.13	-18.5%

YEAR	NH3 [kt]		CHANGE	NOx [kt]		CHANGE
	PREVIOUS	REVISED		PREVIOUS	REVISED	
2008	7.53	5.05	-33.0%	0.14	0.12	-18.2%
2009	8.00	5.25	-34.4%	0.15	0.12	-19.8%
2010	7.71	5.03	-34.8%	0.14	0.12	-18.8%
2011	7.14	4.62	-35.3%	0.14	0.11	-17.9%
2012	7.40	4.85	-34.5%	0.14	0.12	-17.8%
2013	7.09	4.55	-35.8%	0.14	0.11	-17.7%
2014	7.42	4.93	-33.5%	0.14	0.12	-14.9%
2015	7.48	4.79	-36.0%	0.14	0.12	-17.6%
2016	7.05	4.36	-38.2%	0.14	0.11	-18.0%
2017	7.26	4.59	-36.8%	0.14	0.12	-17.6%
2018	7.63	4.80	-37.1%	0.15	0.12	-17.6%
2019	7.22	4.69	-35.0%	0.14	0.12	-17.3%
2020	6.26	4.40	-29.7%	0.14	0.12	-14.4%
2021	5.77	4.15	-28.0%	0.12	0.11	-9.8%
2022	5.72	3.98	-30.5%	0.12	0.11	-11.6%

5.8.5 Particular Matters (PM_{10}, $PM_{2.5}$ and TSP)

The significant sources of particular matters are dust from straw, silage and residue of feed. The activity of animals contributes production of emission feathers from poultry residues skin and others. The particular matters have a filterable character.
In 2023, manure management contributed 1.0 % and 2.6 % to the national total PM emissions given as 3.6 % TSP of the sectorial emissions relates to poultry production. Total $PM_{2.5}$ from manure management decreased from 0.43 kt in 1990 to 0.13 kt in 2023, which is a decrease of -69.8% compared to a basic year and a decrease of nearly -0.6% compared to the previous year. Total PM_{10} from manure management decreased from 1.4 kt in 1990 to 0.49 kt in 2023, which is a decrease of 64.7 % compared to 1990 and a decrease of -0.3 % compared to the previous year. Total TSP from manure management decreased from 4.78 kt in 1990 to 1.69 kt in 2023, which is a decrease of 64.7 % and a decrease of -2.1 % compared to the previous year. The decreasing trend in the number of animals influenced the emissions trend.

5.8.5.1 Methodological Issues

Emission estimation is based on the Tier 1 methodology of the EMEP/EEA GB_{2023}:

$$E_{Particular\ matters} = AAP_{animal} \text{ x } \mathrm{EF}_{pollutant\_animal}$$

Where: AAP*:* annual average population. Number of animals of a particular category that are present, on average, within the year, $\mathrm{EF}_{pollutant\_animal}$ = default emissions factors for pollutants.

5.8.5.2 Emission Factors (PM_{10}. $PM_{2.5}$ and TSP)

PM_{10}, $PM_{2.5}$ and TSP emissions from manure management were calculated using the default Tier 1 emissions factors for each category of farm animals (***Table 5.20***). The same emissions factors were used for all years.

Table 5.20: *Default emissions PM and TSP factors*

CATEGORIES	EMISSION FACTOR FOR TSP	EMISSION FACTOR FOR PM_{10}	EMISSION FACTOR FOR $PM_{2.5}$
	[kg/head/year^{-1}]	[kg/head/year^{-1}]	[kg/head/year^{-1}]
Dairy cattle	1.38	0.63	0.41
Calves	0.34	0.16	0.10
Heifers unpregnant	0.59	0.27	0.18
Heifers pregnant	0.59	0.27	0.18

CATEGORIES	EMISSION FACTOR FOR TSP	EMISSION FACTOR FOR PM_{10}	EMISSION FACTOR FOR $PM_{2.5}$
	[kg/head/year⁻¹]	[kg/head/year⁻¹]	[kg/head/year⁻¹]
Fattening	0.59	0.27	0.18
Oxen	0.59	0.27	0.18
Suckled cows	0.59	0.27	0.18
Calves	0.34	0.16	0.10
Heifers unpregnant	0.59	0.27	0.18
Heifers pregnant	0.59	0.27	0.18
Fattening	0.59	0.27	0.18
Oxen	0.59	0.27	0.18
Breeding bulls	0.59	0.27	0.18
Sows 180 kg	0.62	0.17	0.01
Piglets	0.27	0.05	0.002
Fattening pigs	1.05	0.14	0.006
Laying hens including cocks	0.19	0.04	0.003
Broilers	0.04	0.02	0.002
Turkeys	0.11	0.11	0.02
Ducks	0.14	0.14	0.02
Geese	0.24	0.24	0.03
Horses	0.48	0.22	0.14
Goats	0.14	0.06	0.02
Mature ewes	0.14	0.06	0.02
Growing lambs pregnant	0.14	0.06	0.02
Growing lambs unpregnant	0.14	0.06	0.02
Rams	0.14	0.06	0.02
Mature ewes	0.14	0.06	0.02
Growing lambs pregnant	0.14	0.06	0.02
Growing lambs unpregnant	0.14	0.06	0.02
Rams	0.14	0.06	0.02
Rabbits	0.02	0.01	0.004

5.8.5.3 Activity Data

The number of livestock is described in **Chapter 5.8.3**.

5.8.5.4 Category-specific Recalculations

Recalculations were made due to correction of calculation error in aggregation of emissions of animal subcategories to the NFR categories. The recalculation in TSP and PMs emissions from manure management are summarized in ***Table 5.21***.

Table 5.21: *Previous and revised TSP, $PM_{2.5}$ and PM_{10} emissions from manure management*

YEAR	PM_{10} [kt]		CHANGE	$PM_{2.5}$ [kt]		CHANGE	TSP [kt]		CHANGE
	P	R		P	R		P	R	
1990	1.383	1.494	8.0%	0.429	0.434	1%	4.784	5.741	20.0%
1991	1.250	1.356	8.5%	0.383	0.388	1%	4.486	5.404	20.5%
1992	1.128	1.224	8.5%	0.331	0.336	1%	4.022	4.856	20.7%
1993	1.039	1.135	9.3%	0.290	0.295	2%	3.836	4.674	21.8%
1994	1.143	1.236	8.2%	0.292	0.297	2%	3.907	4.718	20.7%
1995	1.048	1.138	8.6%	0.279	0.284	2%	3.839	4.621	20.4%
1996	1.021	1.109	8.6%	0.268	0.273	2%	3.730	4.489	20.3%
1997	1.009	1.088	7.7%	0.267	0.271	2%	3.600	4.278	18.8%

YEAR	PM_{10} [kt]		CHANGE	$PM_{2.5}$ [kt]		CHANGE	TSP [kt]		CHANGE
	P	R		P	R		P	R	
1998	0.894	0.967	8.2%	0.237	0.241	2%	3.152	3.787	20.2%
1999	0.855	0.923	8.0%	0.225	0.230	2%	3.031	3.624	19.6%
2000	0.870	0.935	7.5%	0.223	0.227	2%	3.040	3.609	18.7%
2001	0.954	1.020	6.8%	0.225	0.228	2%	3.452	4.016	16.3%
2002	0.882	0.949	7.6%	0.216	0.219	2%	3.142	3.722	18.5%
2003	0.854	0.916	7.3%	0.207	0.210	2%	3.058	3.595	17.6%
2004	0.788	0.838	6.4%	0.192	0.195	2%	2.751	3.186	15.8%
2005	0.788	0.836	6.1%	0.190	0.193	2%	2.728	3.144	15.2%
2006	0.757	0.803	6.2%	0.181	0.184	2%	2.687	3.091	15.0%
2007	0.738	0.778	5.4%	0.179	0.181	1%	2.602	2.945	13.2%
2008	0.666	0.697	4.7%	0.169	0.171	1%	2.359	2.629	11.4%
2009	0.720	0.746	3.5%	0.171	0.170	0%	2.550	2.803	9.9%
2010	0.697	0.726	4.2%	0.166	0.168	1%	2.469	2.724	10.3%
2011	0.647	0.672	4.0%	0.160	0.162	1%	2.303	2.525	9.7%
2012	0.666	0.694	4.1%	0.162	0.164	1%	2.378	2.617	10.0%
2013	0.637	0.667	4.6%	0.159	0.161	1%	2.243	2.500	11.4%
2014	0.661	0.689	4.2%	0.160	0.162	1%	2.302	2.542	10.4%
2015	0.672	0.699	4.1%	0.158	0.160	1%	2.370	2.608	10.1%
2016	0.644	0.672	4.3%	0.152	0.154	1%	2.276	2.514	10.4%
2017	0.666	0.694	4.3%	0.153	0.155	1%	2.312	2.561	10.8%
2018	0.685	0.715	4.3%	0.155	0.157	1%	2.394	2.647	10.6%
2019	0.640	0.669	4.5%	0.149	0.151	1%	2.213	2.464	11.3%
2020	0.518	0.543	5.0%	0.138	0.140	1%	1.701	1.924	13.1%
2021	0.500	0.522	4.4%	0.136	0.137	1%	1.623	1.814	11.8%
2022	0.477	0.495	3.9%	0.133	0.134	1%	1.561	1.722	10.3%

5.8.6 NMVOC Emissions

5.8.6.1 Methodological Issues

In terms of increased transparency of methodology and activity data of cattle. Estimation of NMVOC was completed by the available parameters time of housing feeding situation – the amount of silage in the ration and gross feed intake. Dairy cattle and non-dairy cattle have been calculated using Tier 2 methodology by EMEP/EEA GB_{2023}.

5.8.6.2 Emissions Factors

Dairy cattle

Dairy cattle and non-dairy cattle were calculated using the Tier 2 methodology according to the EMEP/EEA GB_{2023}.

This methodology distinguishes emission factors ‘with silage feeding’ from cattle categories and the emission estimate is reliable. **$Frac_{silage}$** used in the Slovak inventory was calculated from the feeding ration as a share of silage from the other ration supplements. **$Frac_{silage}$** were estimated for all cattle subcategories. This parameter was measured and is country-specific. The regional differences were considered. **$Frac_{silage}$** is divided for each region and is across the time-series. Energy from feeding ration was calculated from feeding ration and is country-specific. The regional differences were also considered.

Total NMVOC emissions from manure management and enteric fermentation from cattle were estimated based on the detailed classification of animals into the following categories: dairy cattle (high producing dairy cows and non-dairy cattle (suckled cows, calves 6 months, heifers, pregnancy heifers, breeding bull, oxen, fattening) and followed parameters (***Tables 5.22-Table 5.24***).

NMVOC for cattle is based on the following equations [1]:

$$E_{NMVOC\,i} = AAP_{animal} \times (E_{NMVOC.silage\,store} + E_{NMVOC.silage\,feeding\,+} + E_{NMVOC.\,house} + E_{MVOC.appl} + E_{NMVOC.graz})$$

$$E_{NMVOC.silage\,store\,i} = MJ \times x_{house} \times (EF_{NMVOC.silage\,feeding}\, xFrac\_of\_max_{silage}) \times Frac_{silage\_store})$$

$$E_{NMVOC.\,silage\,feeding} = MJ \times x_{hous} \times (EF_{NMVOC\,feed\,silage\,i} \times Frac\_of\_max_{silage})$$

$$E_{NMVOC\,house} = MJ \times x_{house} \times (EF_{NMVOC\,silage})$$

$$E_{NMVOC\,manure\,store} = E_{NMVOC\,house} \times x_{house} \times \left(\frac{E_{NH_3\,storage}}{E_{NH_3\,house}}\right)$$

$$E_{NMVOC\,appl} = E_{NMVOC\,house} \cdot x_{house} \cdot \left(\frac{E_{NH_3\,appli}}{E_{NH_3\,house}}\right)$$

$$E_{NMVOC\,graz} = MJ \times (1 - x_{house}).\, EF_{NMVOC.graz}$$

Where:

MJ_i: Gross feed intake in MJ year, x_i : Share of time the animals spend in the animal house (%), $Frac_{silage}$: If silage feeding is dominant $Frac_{silage}$ should be equal to 1.0.$Frac_{silage\,store}$: The share of the emission from the silage store compared to the emission from the feeding table in the barn, $E_{NH_3\,applic\,i}$ $E_{NH_3\,house\,i}$ $E_{NH_3\,storage\,i}$: Emissions from ***3B*** Manure Management.

Table 5.22: Overview of parameters in dairy cattle categories

DAIRY CATTLE	BE [MJ/year]	FRACTION OF SILAGE	$E_{Housing\_slurry}$ [kt]	$E_{Housing\_solid}$ [kt]	$E_{storage\_slurry}$ [kt]	$E_{storage\,FYM}$ [kt]	$E_{slurry\,application}$ [kt]	$E_{soild\_application}$ [kt]	$E_{pasture}$ [kt]
1990	95 606	0.51	0.38	0.87	0.08	1.02	0.63	5.36	1.21
1991	90 071	0.50	0.31	0.80	0.07	0.94	0.51	4.96	1.10
1992	90 184	0.51	0.26	0.67	0.06	0.79	0.43	4.17	0.93
1993	90 728	0.51	0.25	0.65	0.05	0.76	0.41	4.02	0.89
1994	91 556	0.51	0.24	0.64	0.05	0.75	0.41	3.95	0.88
1995	92 447	0.51	0.24	0.63	0.05	0.74	0.39	3.87	0.86
1996	92 731	0.51	0.23	0.59	0.05	0.70	0.37	3.68	0.82
1997	94 338	0.50	0.28	0.75	0.06	0.89	0.46	4.67	1.03
1998	95 625	0.50	0.25	0.70	0.05	0.82	0.42	4.33	0.96
1999	96 477	0.51	0.25	0.66	0.05	0.78	0.42	4.12	0.91
2000	98 771	0.51	0.25	0.66	0.05	0.78	0.41	4.09	0.91
2001	100 412	0.51	0.24	0.65	0.05	0.76	0.40	4.03	0.89
2002	101 109	0.51	0.23	0.67	0.05	0.79	0.38	4.16	0.91
2003	101 531	0.51	0.23	0.63	0.05	0.73	0.38	3.88	0.86
2004	101 827	0.51	0.22	0.59	0.05	0.69	0.36	3.67	0.81
2005	102 927	0.52	0.21	0.61	0.04	0.71	0.34	3.74	0.82
2006	104 118	0.52	0.23	0.56	0.05	0.58	0.34	3.14	0.78
2007	104 676	0.52	0.21	0.57	0.04	0.59	0.30	3.17	0.78
2008	105 371	0.52	0.20	0.55	0.04	0.57	0.29	3.08	0.75
2009	103 978	0.52	0.19	0.50	0.04	0.52	0.28	2.78	0.69
2010	103 901	0.52	0.20	0.48	0.04	0.51	0.28	2.69	0.67
2011	105 628	0.52	0.20	0.48	0.04	0.51	0.29	2.65	0.66
2012	106 895	0.52	0.19	0.48	0.04	0.51	0.28	2.67	0.67
2013	107 906	0.52	0.20	0.46	0.04	0.48	0.29	2.56	0.64
2014	104 803	0.52	0.18	0.47	0.03	0.48	0.26	2.60	0.64
2015	109 602	0.52	0.16	0.46	0.03	0.47	0.23	2.56	0.63
2016	111 167	0.51	0.16	0.46	0.03	0.47	0.24	2.55	0.63
2017	112 583	0.51	0.14	0.43	0.03	0.44	0.20	2.38	0.58
2018	104 551	0.51	0.17	0.45	0.03	0.46	0.25	2.49	0.61
2019	104 535	0.51	0.15	0.45	0.03	0.46	0.22	2.49	0.61
2020	104 898	0.51	0.15	0.43	0.03	0.44	0.22	2.42	0.59

DAIRY CATTLE	BE [MJ/year]	FRACTION OF SILAGE	$E_{Housing\_slurry}$ [kt]	$E_{Housing\_solid}$ [kt]	$E_{storage\_slurry}$ [kt]	$E_{storage\ FYM}$ [kt]	$E_{slurry\ application}$ [kt]	$E_{soild\_application}$ [kt]	$E_{pasture}$ [kt]
2021	116 507	0.52	0.13	0.44	0.01	0.37	0.15	2.01	0.60
2022	117 893	0.51	0.13	0.44	0.01	0.40	0.14	1.90	0.59
2023	126 105	0.51	0.13	0.30	0.02	0.28	0.20	1.59	0.59

*all parameters are weighted averages representing aggregation in level SR

***Table 5.23:** Overview of parameters for non-dairy cattle categories*

NON-DAIRY CATTLE	BE [MJ/year]	FRACTION OF SILAGE	$E_{Housing\_slurry}$ [kt]	$E_{Housing\_solid}$ [kt]	$E_{storage\_slurry}$ [kt]	$E_{storage\ FYM}$ [kt]	$E_{slurry\_application}$ [kt]	$E_{soild\_application}$ [kt]	$E_{pasture}$ [kt]
1990	45 558	0.25	0.6173	2.1166	0.1329	2.0473	1.0217	10.7673	1.8868
1991	44 203	0.25	0.5178	1.9257	0.1115	1.8680	0.8572	9.8247	1.7783
1992	46 541	0.25	0.4388	1.6435	0.0945	1.5928	0.7264	8.3773	1.5742
1993	46 395	0.25	0.3792	1.3933	0.0816	1.3764	0.6276	7.2392	1.3847
1994	45 463	0.24	0.3431	1.2694	0.0739	1.2682	0.5680	6.6700	1.2919
1995	46 019	0.24	0.3593	1.2711	0.0773	1.2458	0.5947	6.5522	1.2969
1996	45 711	0.25	0.3425	1.2328	0.0737	1.2087	0.5669	6.3568	1.2507
1997	40 483	0.29	0.3612	1.1410	0.0778	1.1753	0.5978	6.1811	1.1284
1998	41 767	0.30	0.3291	1.0400	0.0708	1.0787	0.5447	5.6734	1.0552
1999	42 762	0.28	0.3360	1.0068	0.0723	1.0446	0.5562	5.4937	1.0233
2000	43 489	0.28	0.3164	0.9887	0.0681	1.0336	0.5237	5.4359	1.0321
2001	43 695	0.28	0.3020	0.9496	0.0648	0.9925	0.4995	5.2384	1.0069
2002	44 186	0.27	0.2835	0.9456	0.0608	0.9970	0.4689	5.2618	1.0367
2003	44 306	0.27	0.2856	0.9242	0.0612	0.9637	0.4723	5.0886	1.0121
2004	44 813	0.27	0.2656	0.8549	0.0569	0.8959	0.4391	4.7349	0.9480
2005	45 349	0.27	0.2543	0.8875	0.0544	0.9372	0.4204	4.9600	0.9618
2006	46 333	0.26	0.2798	0.8567	0.0590	0.7931	0.4208	4.3315	0.9562
2007	46 527	0.26	0.2549	0.8657	0.0538	0.8320	0.3838	4.4469	0.9527
2008	47 247	0.25	0.2734	0.9389	0.0575	0.8645	0.4023	4.6333	0.9276
2009	47 214	0.26	0.2310	0.7745	0.0482	0.7223	0.3372	3.8524	0.8774
2010	48 384	0.23	0.2327	0.7724	0.0484	0.7251	0.3396	3.8283	0.8914
2011	48 585	0.23	0.2346	0.7659	0.0486	0.7257	0.3423	3.9037	0.8835
2012	48 599	0.22	0.2335	0.8041	0.0484	0.7548	0.3404	3.9549	0.9292
2013	49 187	0.23	0.2442	0.7968	0.0462	0.7630	0.3580	3.8838	0.9280
2014	47 343	0.24	0.2191	0.8290	0.0407	0.7708	0.3209	4.0728	0.9678
2015	50 233	0.22	0.1943	0.8249	0.0359	0.7580	0.2847	4.0495	0.9664
2016	50 099	0.22	0.1984	0.8180	0.0366	0.7546	0.2905	4.0098	0.9606
2017	51 499	0.22	0.1887	0.8192	0.0342	0.7449	0.2758	3.9726	0.9523
2018	45 000	0.22	0.2222	0.8591	0.0407	0.7912	0.3267	4.2110	1.0059
2019	44 998	0.22	0.2003	0.8540	0.0367	0.7852	0.2950	4.2016	0.9933
2020	45 200	0.22	0.2038	0.8702	0.0375	0.7945	0.3002	4.2592	1.0056
2021	48 187	0.22	0.1884	0.8561	0.0182	0.6455	0.2228	3.4154	1.0022
2022	48 290	0.22	0.1848	0.8564	0.0197	0.7027	0.2099	3.2783	1.0020
2023	51 933	0.22	0.1842	0.6108	0.0249	0.5836	0.2946	3.0838	1.0020

*all parameters are weighted averages representing aggregation in level SR

***Table 5.24:** Overview of emissions factors for non-dairy cattle categories*

NMVOC EMISSION FACTORS							
EF_{NMVOC}.silage feeding*	[kg NMVOC] [kg/MJ feed intake]	0.000200	0.000200	0.000200	0.000200	0.000200	0.000200
EF_{NMVOC} house*	[kg NMVOC] [kg/MJ feed intake]	0.000035	0.000035	0.000035	0.000035	0.000035	0.000035

EF_{NMVOC} graz*	[kg NMVOC]	0.000007	0.000007	0.000007	0.000007	0.000007	0.000007
	[kg/MJ feed intake]						

Other animals

NMVOC emissions from other animal categories were calculated using the Tier 1 methodology and emission factors outlined in the EMEP/EEA GB_{2023}. Used emission factors are summarized in ***Table 5.25***. There is no evidence about adding silage into the feeding ratio for other animal categories.

Table 5.25: *Emission factor for another animal without silage feeding*

CATEGORIES	EF WITHOUT SILAGE FEEDING [kg NMVOC/head/year^{-1}]
Sheep	0.169
Sows	1.704
Fattening pigs	0.551
Goats	0.542
Horses	4.275
Laying hens	0.165
Broilers	0.489
Turkeys	0.489
Ducks	0.489
Geese	0.489
Rabbits	0.059

5.8.6.3 Activity Data

See **Chapter 5.8.3**.

5.8.6.4 Category-specific Recalculations

Recalculations were made due to correction of calculation error in distribution of swine population to the categories. Total number of animals in the category remains unchanged. Emissions of NMVOC and TSP from manure management were recalculated. Animal subcategory of Weaners had aggregated „Breeding pigs 21 – 50 kg“ and „Fattening pigs up to 50 kg“. This was modified in this submission for Weaners to account only for the first group, remainder of animals were aggregated in the animal subcategory Fattening pigs in which this group has assigned lower NMVOC and TSP emission factor. In addition, incorrect cell reference caused EF to be multiplied by zero for the two of three subcategories under Breeding swine from 1991 to 2022 causing main share of the underestimation in the 2024 submission.

Table 5.26: *The impact of recalculations of NMVOC emissions from manure management*

YEAR	NMVOC [kt]		CHANGE
	2024	2025	
1990	22.17	20.75	-6.4%
1991	16.73	17.38	3.9%
1992	14.74	15.33	4.0%
1993	13.04	13.63	4.5%
1994	12.79	13.36	4.5%
1995	12.52	13.07	4.4%
1996	12.16	12.69	4.4%
1997	12.43	12.91	3.9%
1998	11.19	11.63	4.0%
1999	10.57	10.99	4.0%
2000	10.55	10.95	3.8%
2001	10.81	11.21	3.7%
2002	10.40	10.81	3.9%

YEAR	NMVOC [kt]		CHANGE
	2024	2025	
2003	9.99	10.37	3.8%
2004	9.29	9.60	3.3%
2005	9.30	9.59	3.2%
2006	8.53	8.81	3.3%
2007	8.49	8.74	2.8%
2008	7.99	8.18	2.4%
2009	8.13	8.31	2.2%
2010	7.68	7.86	2.3%
2011	7.56	7.71	2.1%
2012	7.50	7.67	2.2%
2013	7.33	7.51	2.5%
2014	7.21	7.38	2.4%
2015	7.41	7.58	2.3%
2016	7.08	7.24	2.4%
2017	7.19	7.36	2.5%
2018	6.79	6.97	2.6%
2019	6.57	6.75	2.7%
2020	6.13	6.28	2.6%
2021	5.97	6.10	2.3%
2022	5.79	5.90	2.0%

5.9 AGRICULTURAL SOILS (NFR 3D)

Emitted gas: *NH_3, NMVOC, NOx, TSP, PM_{10}, $PM_{2.5}$*
Methods: *Tier 1, Tier 2*
Emission factors: *D*
Key sources: *Yes*
Particular significant subcategories: *Inorganic N-fertilizers, Animal manure applied to the soils*

The NFR sector **3D** contains NH_3 and NOx emissions from Inorganic N-fertilizer (**3Da1**), Animal manure applied to soils (**3Da2a**), Sewage sludge applied to soils (**3Da2b**), Other organic fertilizers applied to soils (**3Da2c**), Urine and dung deposited during grazing (**3Da3**) as well as PM and NMVOC emissions from crop production (**3De**). The emission sources are calculated according to the revised EMEP/EEA GB_{2023} accept **3Da1** Inorganic N-fertilizers. The major reason for the overall decreasing trend is a sharp decrease in the use of synthetic fertilizers in the early 90-ties and the continual decrease in the use of animal manure with the decrease in the number of animals. Since 1999, the trend has been stable with small fluctuations caused by changes in animal population and inter-annual changes in categories **3D1** – Inorganic Nitrogen Fertilizers.

Table 5.27: *NH_3 emissions (kt) in agricultural soils according to the subcategories in particular years*

YEAR	3D NH_3 EMISSIONS FROM MANAGED SOILS [kt]					
	3Da1 INORGANIC-N FERTILIZERS	3Da2a ANIMAL MANURE APPLIED TO SOILS	3Da2b SEWAGE SLUDGE APPLIED TO SOILS	3Da2c OTHER ORGANIC FERTILIZERS APPLIED TO SOILS	3Da3 URINE AND DUNG DEPOSITED BY GRAZING ANIMAL	3Da4 CROP RESIDUES APPLIED TO SOILS
1990	7.71	25.20	0.043	0.04	1.99	1.62
1995	2.91	16.18	0.027	0.04	1.37	1.42
2000	3.22	13.50	0.011	0.07	1.15	0.91
2005	4.64	11.93	0.035	0.01	1.06	1.28
2010	4.81	8.50	0.009	0.05	0.98	1.00
2011	5.39	8.06	0.004	0.11	0.97	1.31

YEAR	3D NH_3 EMISSIONS FROM MANAGED SOILS [kt]					
	3Da1 INORGANIC-N FERTILIZERS	3Da2a ANIMAL MANURE APPLIED TO SOILS	3Da2b SEWAGE SLUDGE APPLIED TO SOILS	3Da2c OTHER ORGANIC FERTILIZERS APPLIED TO SOILS	3Da3 URINE AND DUNG DEPOSITED BY GRAZING ANIMAL	3Da4 CROP RESIDUES APPLIED TO SOILS
2012	5.95	8.35	0.007	0.11	1.01	1.09
2013	6.94	8.02	0.005	0.28	1.00	1.27
2014	7.14	8.28	0.003	0.39	1.02	1.63
2015	6.17	8.28	0.003	0.16	1.01	1.36
2016	8.04	7.94	0.005	0.33	1.00	1.70
2017	9.59	7.99	0.002	0.31	0.98	1.32
2018	9.20	8.51	0.001	0.31	1.02	1.46
2019	9.19	8.24	0.000211	0.35	1.00	1.48
2020	7.50	7.48	0.000004	0.25	0.99	1.58
2021	7.85	7.13	0.000004	0.30	0.99	1.52
2022	6.96	6.94	0.000004	0.25	1.00	1.52
2023	8.53	6.89	$1.3*10^{-18}$	0.21	0.99	1.52

Table 5.28: *NO_x emissions (kt) in agricultural soils according to the subcategories in particular years*

YEAR	3D NOx EMISSIONS FROM MANAGED SOILS [kt]					
	3Da1 INORGANIC-N FERTILIZERS	3Da2a ANIMAL MANURE APPLIED TO SOILS	3Da2b SEWAGE SLUDGE APPLIED TO SOILS	3Da2c OTHER ORGANIC FERTILIZERS APPLIED TO SOILS	3Da3 URINE AND DUNG DEPOSITED BY GRAZING ANIMAL	TOTAL EMISSIONS
1990	8.890	2.522	0.013	0.020	1.335	12.780
1995	2.783	1.681	0.008	0.018	0.925	5.415
2000	3.384	1.398	0.003	0.037	0.772	5.595
2005	3.990	1.222	0.011	0.004	0.716	5.944
2010	4.261	1.083	0.003	0.027	0.671	6.044
2011	4.822	1.003	0.001	0.053	0.667	6.547
2012	4.040	1.043	0.002	0.054	0.691	5.831
2013	4.543	1.004	0.002	0.140	0.683	6.371
2014	4.761	1.044	0.001	0.196	0.697	6.700
2015	4.591	1.043	0.001	0.079	0.684	6.404
2016	5.049	0.987	0.002	0.164	0.684	6.886
2017	4.902	1.000	0.0005	0.155	0.668	6.725
2018	5.159	1.049	0.0004	0.157	0.694	7.060
2019	5.141	1.013	0.0001	0.175	0.682	7.012
2020	5.107	0.918	0.000001	0.127	0.667	6.820
2021	5.100	0.865	0.000001	0.150	0.666	6.781
2022	4.614	0.851	0.000001	0.127	0.668	6.261
2023	4.304	0.861	13*10-18	0.105	0.659	5.930

***Figure 5.13:** The share of NH_3 emissions by categories within agricultural soils in 2023*

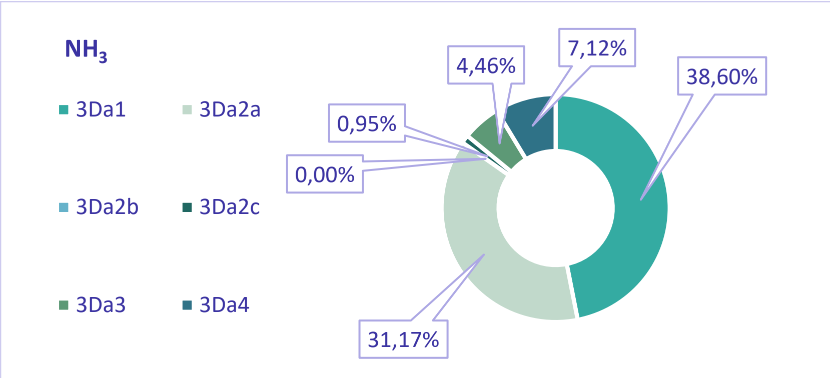
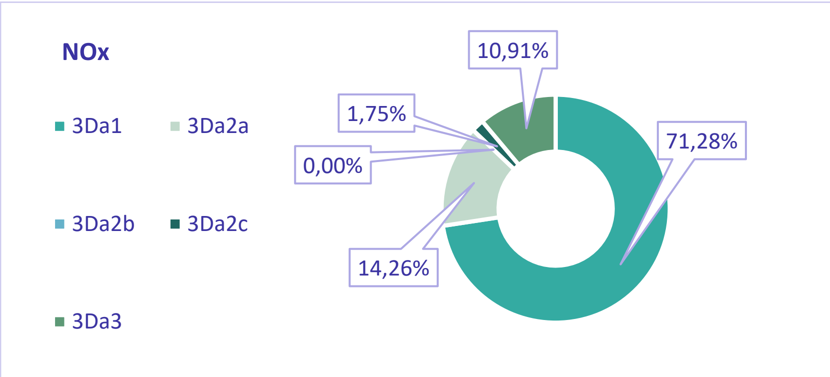


***Figure 5.14:** The share of NOx emissions by categories within agricultural soils in 2023*



5.9.1 Activity Data

Data of sown areas were taken from the ŠÚ SR. Data is available on 20th May every year (***Table 5.29***).

***Table 5.29:** A Sowing area in thousand hectares for the years 1990-2023*

YEAR	WHEAT	RYE	OIL PLANTS	GRASS	BARLEY	OAT
	[ha]					
1990	412 423	40 474	67 087	813 000	199 849	14 361
1995	442 874	31 162	87 883	839 025	239 559	13 572
2000	406 400	29 800	178 300	865 222	245 900	22 800
2005	375 801	32 500	215 547	881 283	222 000	24 500
2010	349 700	29 370	280 000	876 484	138 930	17 240
2011	364 000	13 358	261 600	874 224	136 325	16 158
2012	388 700	28 568	225 100	871 338	147 994	15 773
2013	368 200	35 408	254 800	868 171	121 304	13 901
2014	380 200	29 369	243 400	864 681	138 826	15 367
2015	379 400	15 175	247 400	858 601	138 920	16 422
2016	417 700	12 843	254 000	855 882	115 364	14 834
2017	374 781	10 380	292 854	853 757	121 026	15 932
2018	404 014	13 008	282 076	851 685	124 574	14 122
2019	408 168	14 292	259 801	850 600	126 887	12 817
2020	390 872	13 045	269 463	850 027	132 885	13 408
2021	356 969	10 181	289 801	506 922	117 205	16 342
2022	410 247	9 452	295 793	508 950	108 782	10 701
2023	405 775	11 756	272 899	501 258	113 619	10 083
1990/2023	**-2%**	**-71%**	**307%**	**-38%**	**-43%**	**-30%**
2022/2023	**-1%**	**24%**	**-8%**	**-2%**	**4%**	**-6%**

5.9.3 Inorganic N Fertilizers (NFR 3Da1)

The applied amounts of synthetic fertilizers into cultivated soils were very low in the last 15 years. At present, the consumption of synthetic fertilizers applied to agricultural soils increased again. This fact is the main driver in increasing emissions in the sector. The potential for the volatilization of ammonia emissions can vary in a wide range. The best available information on NH_3 emissions from cultivated soils in the Slovak Republic is based on the amount of applied nitrogen fertilizers. Emissions also depend on the type of fertilizers, soil parameters (pH), meteorological conditions and time of fertilizers' application concerning crop development. Data on the quantity of applied nitrogen fertilizers were provided by the ŠÚ SR.

5.9.3.1 Activity Data

Activity data on synthetic fertilizers consumption is based on the combination of two databases. IFASTAT and database by the Central Control Testing and Testing Institute (UKSÚP). The national total of nitrogen from fertilizers was used from the UKSÚP and the distribution of type of fertilizers was taken from the IFASTAT (1990-2017). The data was disseminated according to Act No 202/2008 Coll. on fertilizers. The farmers have obligation to report the amount of applied fertilizers to the UKSÚP each year. The UKSÚP as the institution in charge of managing databases runs the validation each year.

The consumption of synthetic fertilizers decreased during the last decade of the 20th century, from 222 kt in 1990 to 107.6 kt in 2023 (-51.6 %). Consumption of synthetic fertilizers increased by +7.3 % in 2023 compared with 2005 and then decreased by almost -6.7 % in comparison with the year 2022. Decreasing numbers of domestic livestock caused the demand for inorganic nitrogen to be bigger. Missing organic nitrogen compensates for a higher consumption of synthetic fertilizers.

Table 5.30: *Input parameters in 3Da1 Inorganic N fertilizers*

YEAR	TYPE OF FERTILIZERS [t]				
	AMMONIUM NITRATE	AMMONIUM SULPHATE	CALC. AMM. NITRATE	NITROGEN SOLUTIONS	OTHER N STRAIGHT
1990	85 356	22 156	55 114	1 731	NO
1995	16 000	6 100	24 200	7 600	NO
2000	2 200	4 900	29 000	10 000	8 700
2005	3 000	10 000	31 000	9 000	NO
2010	4 000	9 000	33 000	2 000	NO
2011	2 000	1 000	40 000	17 000	6 000
2012	NO	1 000	41 000	18 000	7 000
2013	NO	2 000	45 000	18 000	12 000
2014	2 000	2 000	45 000	15 000	15 000
2015	2 000	1 300	44 000	17 000	14 000
2016	2 000	1 600	42 800	18 100	13 600
2017	NO	2 000	40 000	23 600	NO
2018	1 100	1 103	31 983	16 463	25 966
2019	880	1 365	34	16 814	53 258
2020	1 413	1 346	85	NO	75 610
2021	1 394	1 744	34 465	40	34 138
2022	714	1 393	32 489	0	31 181
2023	4 605	14 140	23 248	0	18 824

YEAR	TYPE OF FERTILIZERS [t]				
	UREA	AMMONIUM PHOSPHATE	NK COMPOUND	NPK COMPOUND	OTHER NP
1990	8 239	1 939	NO	49 220	500
1995	3 787	NO	NO	11 400	500
2000	3 553	900	11 956	12 600	800
2005	8 317	5 000	18 443	15 000	NO

YEAR	TYPE OF FERTILIZERS [t]				
	UREA	AMMONIUM PHOSPHATE	NK COMPOUND	NPK COMPOUND	OTHER NP
2010	11 873	1 000	19 640	26 000	NO
2011	13 969	1 000	27 586	12 000	NO
2012	19 004	1 000	NO	12 000	2 000
2013	25 581	1 000	NO	10 000	NO
2014	28 036	1 000	NO	10 000	1 000
2015	19 473	1 000	NO	14 000	2 000
2016	30 536	3 300	NO	12 300	2 000
2017	37 741	1 600	900	12 000	4 700
2018	41 299	1 125	NO	9 939	NO
2019	39 779	1 717	3 348	10 982	355
2020	39 434	NO	NO	9 461	328
2021	40 615	0	18	11 193	3 888
2022	35 930	0	32	10 090	3 517
2023	40 900	1 212	39	7 427	784

5.9.3.2 Methodological Issues

NH_3 emissions from Inorganic-N fertilizers were calculated using the Tier 2 methodology according to the EMEP/EEA GB_{2019}. To reflect average Slovak conditions, the emission factors for a cool climate and a pH value lower than 7 were chosen. NOx was calculated using the simpler Tier 1 methodology. Slovakia still uses emission factors from the previous version of the EMEP/EEA guideline.

In the previous version of the guideline, the seasonal distribution of fertilisers of different types and obtaining the weather data for the different seasons were implemented. In the new version of the guidebook, the weather variables from the Tier 2 methodology were omitted, therefore it was decided to estimate emissions with the previous version of emission factors.

Table 5.31: *Emission factors per fertilizer type*

TYPE OF FERTILIZERS	EMISSION FACTOR FOR NORMAL PH [g NH_3 (kg N applied)$^{-1}$)]
Ammonium nitrate (AN)	15
Ammonium sulphate (AS)	90
Calcium ammonium nitrate (CAN)	8
N solutions	98
Other straight N compounds	10
Urea	155
Ammonium phosphates (AP)	50
NK Mixtures	15
NPK Mixtures	50
NP Mixtures	50

Table 5.32: *Input parameters and EFs in 3Da1 Inorganic N fertilizers in particular years*

YEAR	NITROGEN INPUT INTO SOILS	EMISSION FACTOR FOR NH_3	EMISSION FACTOR FOR NOx	NH_3	NOx
	[kg/year]	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1990	222 255 000	0.03	0.04	7.71	8.89
1995	69 587 000	0.04	0.04	2.91	2.78
2000	84 609 000	0.04	0.04	3.22	3.38
2005	99 760 000	0.05	0.04	4.64	3.99
2010	106 513 000	0.05	0.04	4.81	4.26
2011	120 555 000	0.04	0.04	5.39	4.82
2012	101 004 000	0.06	0.04	5.95	4.04
2013	113 581 390	0.06	0.04	6.94	4.54
2014	119 036 050	0.06	0.04	7.14	4.76
2015	114 773 000	0.05	0.04	6.17	4.59
2016	126 235 769	0.06	0.04	8.04	5.05
2017	122 541 152	0.08	0.04	9.59	4.90
2018	128 976 885	0.07	0.04	9.20	5.16
2019	128 532 971	0.07	0.04	9.19	5.14
2020	127 676 520	0.06	0.04	7.50	5.11
2021	127 494 597	0.06	0.04	7.85	5.10
2022	115 346 776	0.06	0.04	6.96	4.61
2023	1 224 195 109	0.08	0.04	8.53	4.30
1990/2023	**-48%**	**-**	**-**	**-11%**	**-52%**
2020/2023	**-10%**	**-**	**-**	**-20%**	**-6%**

5.9.4 Animal Manure Applied to the Soils (NFR 3Da2a) NH_3, NO_x, NMVOC

Livestock numbers and information on animal waste management systems are described in **Chapters 5.8.1** and **5.8.3**. This application is connected with the utilization of NH_3, PMs, NMVOC, N_2O and NOx losses. A detailed description of the methods applied for the calculation of N_2O emissions is given in the report "Slovak Republic National Inventory Report 2022" – Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol". For this calculation was applied country-specific methodology.
At application evaporate around 50 % of ammonia. During this operation are the highest emissions of ammonia. It is a key source of emissions. During application (spreading) is formed on the field's huge evaporating surface. Emissions are highest in the windy, hot weather and high humidity and permeability of the soil.
Each farmer should directly apply manure to the soil as quickly as possible. After the direct incorporation of manure into soils, the ammonia losses are reduced. The crops have sufficient nitrogen for growth. The Ministry of Agriculture and Rural Development issued Regulation Decree No 410/2012 Coll, ordering the solid into the soil organic fertilizers in 48 hours and the liquid from arable land 24 hours after application. This regulation is rather to prevent rafting fertilizers into surface waters to prevent the escape of ammonia because ammonia emissions are substantial immediately after application. The first 6 hours after application evaporate 50% ammonia and then emissions decrease.

5.9.4.1 Activity Data

See **Chapter 5.8.3**.

5.9.4.2 Methodological Issues-Method-NH3, NO_x

Default NH_3 emission factors of the EMEP/EEA GB_{2023} for spreading of slurry and solid manure were applied in the proportion of total ammoniacal nitrogen (TAN) according to ***Table 3.9*** p. 29 of EMEP/EEA GB_{2023} in 1990-2005. In 2006, the abatement technology was applied mainly through deep injection, incorporation within 12 hours and 24 hours and furrow injections. The default emission factors were modified with the implementation of penetration parameters as a share of farms where abatement technology was used and abatement efficiency. The result is the country-specific emission factors, which are lower than default approximately about -10 %.

Table 5.33: *EFs of ammonia in 3Da2a Animal applied to the soils per animal species in particular years*

SPECIFI EFs	DAIRY CATTLE	NON-DAIRY CATTLE	POULTRY	HORSES	BREEDING SWINE	FATTENING SWINE
YEARS	LIQUID [kg NH_3/kg N]					
2006	0.5430	0.5465	NO	NO	0.2815	0.3897
2007	0.5376	0.5458	NO	NO	0.2397	0.3515
2008	0.5377	0.5456	NO	NO	0.2232	0.3326
2009	0.5383	0.5437	NO	NO	0.2460	0.3235
2010	0.5326	0.5456	NO	NO	0.2295	0.3089
2011	0.5210	0.5417	NO	NO	0.2396	0.3285
2012	0.5189	0.5401	NO	NO	0.2299	0.3190
2013	0.5207	0.5398	NO	NO	0.2175	0.3127
2014	0.5225	0.5420	NO	NO	0.2079	0.2990
2015	0.5220	0.5435	NO	NO	0.2067	0.2830
2016	0.5193	0.5378	NO	NO	0.2079	0.2554
2017	0.5182	0.5369	NO	NO	0.2013	0.2621
2018	0.5182	0.5390	NO	NO	0.2141	0.2974
2019	0.5168	0.5387	NO	NO	0.2168	0.2892
2020	0.5140	0.5399	NO	NO	0.2242	0.2953
2021	0.5294	0.5425	NO	NO	0.2736	0.3755
2022	0.5139	0.5418	NO	NO	0.2098	0.2811
2023	0.5101	0.5421	NO	NO	0.2025	0.2735

Table 5.34: *EFs of ammonia in 3Da2a Animal applied to the soils per animal species in particular years*

SPECIFI EFs	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS
YEARS	SOLID [kg NH_3/kg N]					
2006	0.4829	0.4803	0.3179	0.4133	0.3536	0.4243
2007	0.4813	0.4760	0.3359	0.4203	0.3825	0.4590
2008	0.4720	0.4681	0.3389	0.4243	0.3656	0.4388
2009	0.4677	0.4684	0.3438	0.4238	0.4232	0.5079
2010	0.4744	0.4712	0.3479	0.4147	0.4157	0.4988
2011	0.4753	0.4722	0.3492	0.4194	0.4323	0.5188
2012	0.4786	0.4733	0.3640	0.4173	0.4420	0.5304
2013	0.4779	0.4748	0.3625	0.4100	0.3707	0.4448
2014	0.4778	0.4771	0.3658	0.4173	0.4392	0.5270
2015	0.4823	0.4790	0.3650	0.4217	0.4452	0.5343
2016	0.4867	0.4851	0.3685	0.4242	0.4365	0.5238
2017	0.4899	0.4892	0.3688	0.4229	0.4336	0.5203
2018	0.4934	0.4901	0.3695	0.4271	0.4357	0.5229
2019	0.4944	0.4902	0.3701	0.4271	0.4287	0.5144
2020	0.4960	0.4897	0.3689	0.4220	0.4007	0.4809
2021	0.4960	0.4917	0.3438	0.4268	0.4026	0.4832
2022	0.4928	0.4865	0.3718	0.4252	0.3649	0.4379

SPECIFI EFs	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS
YEARS	SOLID [kg NH_3/kg N]					
2023	0.4933	0.4854	0.3703	0.4229	0.3576	0.4291

SPECIFIC EFs	DUCKS	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
YEARS	SOLID [kg NH_3/kg N]				
2006	0.4243	0.6300	0.3260	0.3257	0.7261
2007	0.4590	0.6238	0.3618	0.3527	0.7088
2008	0.4388	0.6171	0.3736	0.3647	0.7188
2009	0.5079	0.5889	0.3482	0.3688	0.7465
2010	0.4988	0.5635	0.3648	0.3737	0.7330
2011	0.5188	0.5663	0.3556	0.3776	0.7331
2012	0.5304	0.6120	0.3627	0.3872	0.7129
2013	0.4448	0.6019	0.3728	0.3947	0.7226
2014	0.5270	0.5986	0.3969	0.3886	0.7165
2015	0.5343	0.5751	0.4020	0.4036	0.7277
2016	0.5238	0.5479	0.4126	0.4240	0.7396
2017	0.5203	0.5912	0.4144	0.4219	0.7367
2018	0.5229	0.5800	0.3961	0.4184	0.7315
2019	0.5144	0.5491	0.3933	0.4129	0.7321
2020	0.4809	0.5979	0.4088	0.4148	0.7220
2021	0.4832	0.6955	0.3378	0.3361	0.6731
2022	0.4379	0.5843	0.4257	0.4198	0.7258
2023	0.4291	0.5471	0.4253	0.4143	0.7081

The default NOx emission factor of the EMEP/EEA GB_{2023} for spreading was used, NH_3 emissions were calculated by using the nitrogen flow approach similarly, to the calculation of EFs for emissions from housing and storage.

5.9.4.3 Methodological Issues-Method – NMVOC

Cattle

All references for calculation are in **Chapter 5.8.6.2**. The used notation key is IE.

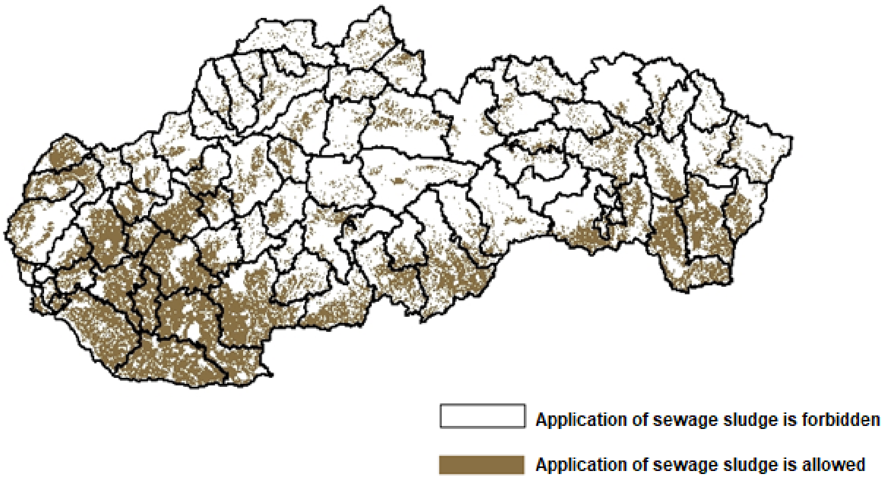
5.9.5 Sewage Sludge Applied to Soils (NFR 3Da2b)

The reduction of organic matter in the soil is dependent on the continuous decline of livestock production. The decrease in the number of organic fertilizers causes pressure to find alternative sources of organic fertilizers. Sewage sludge is one of the ways to resolve this issue. Sludge is a potential source of nutrients and organic matter. Sewage sludge must be stabilized and afterwards applied to the soils. Sludge must be treated biologically, chemically or by heat, long-term storage or any other appropriate process. These processes cause a significant reduction in health risks and save the environment. Act No 188/2003 Coll. regulates the application of sludge to agricultural soils. Sludge from domestic or urban treatment plants can be applied to agricultural soils. Application of other sludge is prohibited by Slovak law.

5.9.5.1 Activity Data

Activity data on sewage sludge consumption in agriculture (***Table 5.36***) is based on the data provided by the Water Research Institute (WRP) (applied sludge from municipal wastewater treatment plants) and the Ministry of Environment of the Slovak Republic (Industrial sludge). The WRP collects data on nitrogen inputs (bottom-up approach) into the soils. The Water Research Institute informed, that municipal sewage sludge was not applied to agricultural soils in the years 2015 – 2023, therefore notation key NO was used. The data are consistent between the **Waste sector**. Missing data were extrapolated to enhance completeness before the year 2003 (municipal sewage sludge) and 2002 (Industrial sewage sludge), due to unavailable statistics. The percentage of pure nitrogen from sewage sludge was provided by the Guidelines for the Sewage Sludge Application by the Soil Science and Conservation Research Institute. Based on the presented publication, the sludge contains 3.31 % nitrogen.

Figure 5.15: *The map of sensitive parts of Slovakia where sludge cannot be applied*



5.9.5.2 Methodological Issues - Method-NH_3. NOx

Default methodology Tier 1 and default emission factors were used for the estimation of direct NH_3 and NOx emissions from sewage sludge applied to soils. The methodology was following the EMEP/EEA GB_{2023}. The Percentage of pure nitrogen in sewage sludge was provided by the Soil Science and Conservation Research Institute.[3]

Emissions were estimated using these equations:

$$A_{sewage\ sludge} = N_{sewage\ sludge} * P_N$$
$$NO_{sewage\ sludge} = A_{sewage\ sludge} * EF_{NO}$$
$$NH_{3\ sewage\ sludge} = A_{sewage\ sludge} * EF_{NH3}$$

Where: $NH_{3\ sewage\ sludge}$. $NO_{sewage\ sludge}$: Emissions from sewage sludge applied into the soil in kg, $N_{Sewage\ sludge}$: the amount of sludge from wastewater treatment in kg, P_N: Weight percentage of nitrogen from sewage sludge (3.31%), EF_{NO}. NH3: Emissions factors for NH_3 and NO kg NO respectively NH_3.

Table 5.35: *Input parameters and EFs in 3Da2b – Sewage Sludge in particular years*

YEAR	MUNICIPAL SLUDGE	INDUSTRIAL SLUDGE	INPUT INTO SOIL	N-INPUT FROM SEWAGE SLUDGE	NH_3	NOx
	[t]	[t]	[t]	[kg]	[kt]	[kt]
1990	6 832	3 160	9 992	330 732	0.0430	0.0132
1995	4 043	2 251	6 294	208 345	0.0271	0.0083
2000	1 254	1 342	2 597	85 957	0.0112	0.0034
2005	5 870	2 231	8 101	268 144	0.0349	0.0107
2010	923	1 102	2 025	67 023	0.0087	0.0027
2011	358	685	1 043	34 536	0.0045	0.0014
2012	1 254	478	1 732	57 340	0.0075	0.0023
2013	518	627	1 145	37 900	0.0049	0.0015

[3] *Guideline for sewage sludge application (In Slovak):*http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

YEAR	MUNICIPAL SLUDGE	INDUSTRIAL SLUDGE	INPUT INTO SOIL	N-INPUT FROM SEWAGE SLUDGE	NH_3	NOx
	[t]	[t]	[t]	[kg]	[kt]	[kt]
2014	8	688	696	23 021	0.0030	0.0009
2015	0	813	813	26 899	0.0035	0.0011
2016	0	1 134	1 134	37 523	0.0049	0.0015
2017	0	362	362	11 987	0.0016	0.0005
2018	0	287	287	9 513	0.0012	0.0004
2019	0	49	49	1 620	0.0002	0.0001
2020	NO	1	1	32	0.000004	0.000001
2021	NO	1	1	33	0.000004	0.000001
2022	NO	1	1	33	0.000004	0.000001
2023	NO	$3{,}02*10^{-10}$	$3{,}02*10^{-10}$	$1{,}0*10^{-11}$	$13*10^{-19}$	$4*10^{-19}$

5.9.6 Other Organic Fertilizers Applied to Soils (NFR 3Da2c)

Emissions of NH_3 and NOx from compost applied to soils contributed less than 1% to the emissions from agricultural soils in 2023.

5.9.6.1 Activity Data

Other organic fertilizers applied to soils include composted waste, digested slurry from digesters, compost and vitahlum, natural harmony and green fertilizers. The Consumption is provided with the total amount of organic waste in soils (**OW**) and the data (***Table 5.38***) is provided by the UKSÚP. The Data are converted into nitrogen content (**NC**). Conversion factors are presented in ***Table 5.37***.
Data is available from 2000 to 2023. Other organic nitrogen fertilizers were applied to the soil even before the year 2000, but there are no available statistics. Missing data was extrapolated by linear extrapolation in Excel spreadsheets.

Table 5.36: *Share pure nitrogen from other nitrogen fertilizers in %*

TYPE OF FERTILIZERS	P_N	SOURCES
	%	
Fugate	0.92	*https://nasepole.sk/digestat-vo-vyzive-a-hnojeni-repky/*
Compost	0.7	*ÚKSÚP*
Natural harmony (organic waste from pharmaceutical production [4]	1	*ÚKSÚP*
Straw	0.82	*https://nasepole.sk/dusikate-hnojenie-po-zbere-obilnin/*
Vitahum (organic - humus fertilizer made from natural substances) [5]	1	*ÚKSÚP*
Green fertilizers	1	*ÚKSÚP*

Table 5.37: *Input parameters in the category 3D12c – Other Organic Fertilizers applied to soils*

YEAR	FUGATE		COMPOST		NATURAL HARMONY		HAY		VITAHLUM		GREEN FERTILIZERS	
	OW	NC	OW	NC	OW	NC	OW	NC	OW	NC	OW	NC
	[t]											
1990	NO	NO	33 430	234	NO	NO	NO	NO	28 290	198	12 013	60
1991	NO	NO	34 303	336	NO	NO	NO	NO	26 501	186	11 752	59
1992	NO	NO	35 177	246	NO	NO	NO	NO	24 713	173	11 493	57
1993	NO	NO	36 050	252	NO	NO	NO	NO	22 924	160	11 231	56
1994	NO	NO	36 924	362	NO	NO	NO	NO	21 136	148	10 970	55

[4] https://www.biotika.sk/
[5] http://www.eba.sk/substraty-a-vyrobky/volne-lozene-vyrobky/

YEAR	FUGATE		COMPOST		NATURAL HARMONY		HAY		VITAHLUM		GREEN FERTILIZERS	
	OW	NC	OW	NC	OW	NC	OW	NC	OW	NC	OW	NC
	[t]											
1995	NO	NO	37 797	265	NO	NO	NO	NO	19 348	135	10 709	54
1996	NO	NO	38 671	271	NO	NO	NO	NO	17 559	123	10 449	52
1997	NO	NO	39 544	388	NO	NO	NO	NO	15 771	110	10 188	51
1998	NO	NO	40 418	283	NO	NO	NO	NO	13 982	98	9 927	50
1999	NO	NO	41 291	289	NO	NO	NO	NO	12 194	85	9 666	48
2000	NO	NO	74 923	524	NO	NO	NO	NO	50 641	354	10 245	51
2001	NO	NO	40 885	286	NO	NO	NO	NO	54 338	380	18 285	91
2002	NO	NO	36 422	255	NO	NO	NO	NO	42 810	300	10 920	55
2003	NO	NO	34 225	240	NO	NO	NO	NO	9 321	65	6 206	31
2004	NO	NO	42 904	300	NO	NO	NO	NO	2 845	20	18 990	95
2005	NO	NO	7 006	49	NO	NO	NO	NO	3 552	25	5 905	30
2006	NO	NO	13 878	97	NO	NO	NO	NO	10 828	76	7 006	35
2007	NO	NO	21 762	152	NO	NO	8 868	73	8 758	61	3 540	18
2008	NO	NO	21 317	149	NO	NO	90 977	746	7 185	50	13 534	68
2009	NO	NO	25 364	178	NO	NO	68 637	569	195	1	16 642	83
2010	NO	NO	40 097	281	NO	NO	36 774	302	4 999	35	11 956	60
2011	NO	NO	50 583	354	11 107	267	66 704	547	2 261	16	25 837	129
2012	108 181	995	18 291	128	205	5	25 020	205	NO	NO	1 401	7
2013	301 580	2 775	63 145	442	395	9	30 698	252	500	4	2 547	13
2014	382 111	3 515	85 907	601	17 819	428	40 912	335	NO	NO	6 375	32
2015	543 489	5 000	90 967	637	46 392	1 089	26 554	218	1 015	7	4 036	20
2016	391 789	2 651	46 701	318	48 703	1 137	NO	NO	NO	NO	NO	NO
2017	732 884	2 842	46 649	327	25 389	583	NO	NO	17 928	125.50	NO	NO
2018	720 233	2 790	43 257	411	30 791	731	NO	NO	NO	NO	NO	NO
2019	776 427	3 057	37 618	300	41 518	994	NO	NO	4 500	31.50	NO	NO
2020	800 393	2 936	43 557	250	NO	NO	NO	NO	NO	NO	NO	NO
2021	796 945	3 347	60 047	401	NO	NO	NO	NO	NO	NO	NO	NO
2022	793 655	2 812	56 181	375	NO	NO	NO	NO	NO	NO	NO	NO
2023	897 094	3 091	20 500	170	NO	NO	NO	NO	NO	NO	NO	NO

5.9.6.2 Methodological Issues – Methods – NOx, NH_3

Default methodology Tier 1 according to EMEP/EEA GB_{2023} and default emission factor (0.08 kg NH_3 kg^{-1} waste N applied and 0.04 kg.NO) were used for the estimation of NOx and NH_3 emissions from compost applied to soils. The percentage of nitrogen in used compost was provided by the Soil Science and Conservation Research Institute.[6] Amount of compost applied to soils provided by the UKSÚP. Emissions were estimated using these equations:

$$A_{compost} = N_{compost} * P_N$$
$$NO_{compost} = A_{compost} * EF_{NO}$$
$$NH_{3\ compost} = A_{compost} * EF_{NH_3}$$

Where: $N_{compost}$ is the input of pure nitrogen in compost applied to the soil in kg, $N_{compost}$ is the amount of compost from the composting plant, P_N is 1 tonne of compost = 7 kg N.

Table 5.38: *Emission factors and emissions in 3Da2c – Other organic fertilizers applied to soils*

YEARS	EMISSION FACTORS FOR NH_3	EMISSION FACTORS FOR NOx	NH_3	NOx
	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1990	0.08	0.04	0.0394	0.0197

[6] *Guideline for sewage sludge application (In Slovak):*http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

YEARS	EMISSION FACTORS FOR NH_3	EMISSION FACTORS FOR NOx	NH_3	NOx
	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1995	0.08	0.04	0.0363	0.0181
2000	0.08	0.04	0.0744	0.0372
2005	0.08	0.04	0.0083	0.0041
2010	0.08	0.04	0.0542	0.0271
2011	0.08	0.04	0.1050	0.0525
2012	0.08	0.04	0.1072	0.0536
2013	0.08	0.04	0.2796	0.1398
2014	0.08	0.04	0.3929	0.1965
2015	0.08	0.04	0.1577	0.0788
2016	0.08	0.04	0.3285	0.1642
2017	0.08	0.04	0.3102	0.1551
2018	0.08	0.04	0.3145	0.1573
2019	0.08	0.04	0.3506	0.1753
2020	0.08	0.04	0.2549	0.1274
2021	0.08	0.04	0.2999	0.1499
2022	0.08	0.04	0.2550	0.1275
2023	0.08	0.04	0.2108	0.1054
1990/2023	-	-	**435%**	**435%**
2022/2023	-	-	**-17%**	**-17%**

5.9.7 Urine and Dung Deposited by Grazing Animals (NFR 3Da3)

Pasture is typical for some livestock categories. Animals such as sheep, goats, horses and some subcategories of cattle are mainly grazed during spring, summer and autumn in the small farms. Animals are in their winter grounds during the winter.
It is supposed that sheep, goats and horses can stay on pasture for 200 days, but 41 % of non-dairy cattle stay only for 150 days. Results of the analysis of AWMS were used for the calculation of nitrogen input from animal husbandry into the N-cycle. Emissions from pasture were based on the proportion of the pasture for housing that was made by the NPPC - VÚŽV. The proportion of the pasture for the category of animals is demonstrated in ***Table 5.18***.

5.9.7.1 Activity Data

This analysis was based on the questionnaires from 222 agricultural subjects (21.3 % of total subjects in Slovakia). These subjects cultivated 14.7 % of total agricultural land and 15.2 % of arable land. The duration of the grazing period can vary significantly depending on weather conditions in different parts of the Slovak Republic. Reliable data for statistical evaluation is not available, but significant differences can be found in this regard. NH_3 and NOx emissions from pasture were based on the proportion of the pasture for housing that was made by the NPPC - VÚŽV. Activity data is summarized in ***Table 5.11-5.14***. Activity data in this category are consistent with the activity data used for estimation in category **3B** – Manure Management.

5.9.7.2 Methodological Issues – Methods –NH_3, NO_x

The estimation of NH_3 and NOx from pasture is based on the Tier 2 method according to the EMEP/EEA GB_{2023}. The emission of urine and dung deposited by grazing animals is based on nitrogen excreted from farm animals, the number of days the animals are on the pasture and the emission factors.

Table 5.39: *Input parameters, EFs and emissions in 3Da3- Urine and dung deposited by grazing animals*

YEARS	NITROGEN EXCRETED DURING PASTURE	IMPLIED EMISSION FACTORS FOR NH_3	IMPLIED EMISSION FACTORS FOR NOx	NH_3	NOx
	[kg/year]	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1990	16 438 343	0.119	0.080	1.987	1.335
1995	13 554 470	0.100	0.068	1.370	0.925
2000	10 911 094	0.105	0.070	1.150	0.772
2005	10 785 914	0.098	0.066	1.063	0.716
2010	11 653 982	0.084	0.058	0.977	0.671
2011	11 578 972	0.084	0.058	0.972	0.667
2012	12 029 771	0.084	0.057	1.006	0.691
2013	12 114 883	0.082	0.056	0.995	0.683
2014	12 375 588	0.082	0.056	1.019	0.697
2015	12 435 841	0.081	0.055	1.009	0.690
2016	12 342 906	0.081	0.055	1.001	0.684
2017	12 145 474	0.080	0.055	0.976	0.668
2018	12 692 944	0.081	0.055	1.022	0.694
2019	12 553 318	0.080	0.054	1.014	0.682
2020	12 376 347	0.080	0.054	0.993	0.667
2021	12 656 637	0.079	0.053	0.994	0.666
2022	12 742 844	0.078	0.052	0.997	0.668
2023	12 636 842	0.078	0.052	0.985	0.659

5.9.7.3 Methodological Issues –Methods – NMVOC

Cattle

All references for calculation are in **Chapter 5.8.6.2**. The used notation key is IE.

5.9.8 Crop Residue (NFR 3Da4)

Directly after the incorporation of the crop residues into the soil, the multilateral interactions between organic compounds and nutrients present in the residues with the mineral and organic components of the soil take place. The knowledge of nutrient potential in crop residues by crop rotation is mostly actual in the present requirements of sustainable land use – greening in plant production. Incorporation of crop residues into the soil is used as a sustainable agricultural practice, due to high nutrition potential.

Table 5.40: *Input parameters and EFs in the category 3.D.1.4 – Crop Residue in particular years*

YEAR	HARVESTED AREA	CROP (T)	CROP RESIDUES	NH_3 EMISSIONS
	[ha]	[kg d.m/ha]	[kg N/year]	[Gg]
1990	2 147 737	67 462	78 466 264	1.632
1995	2 152 852	63 386	65 755 818	1.427
2000	2 080 004	45 812	40 680 816	0.917
2005	1 721 125	68 071	58 191 208	1.294
2010	1 617 786	54 870	44 086 328	1.002
2011	1 680 333	71 666	58 053 855	1.314
2012	1 703 613	63 316	49 566 275	1.097
2013	1 716 326	63 796	56 186 635	1.280
2014	1 745 299	79 312	72 472 343	1.640
2015	1 728 043	66 540	60 237 610	1.367
2016	1 717 480	85 743	75 505 655	1.709
2017	1 722 049	67 595	58 749 087	1.334
2018	1 725 424	76 863	64 962 867	1.473

YEAR	HARVESTED AREA	CROP (T)	CROP RESIDUES	NH_3 EMISSIONS
	[ha]	[kg d.m/ha]	[kg N/year]	[Gg]
2019	1 750 468	76 280	65 934 371	1.494
2020	1 736 499	81 026	70 272 930	1.590
2021	1 741 541	74 003	66 749 560	1.537
2022	1 733 440	62 543	55 418 400	1.274
2023	1 663 263	78 338	69 378 870	1.574

Total NH_3 emissions from crop residues represented 1.57 Gg of NH_3 from 38 127 379 kg of nitrogen in crop residues returned to soils in 2023. Total harvested area (wheat, ray, barley, oat, maize, potato, sugar beet, oil plants, tobacco, maize for silage, leguminous, fodder leguminous, soya, meadows) decreased in comparison with the previous year (-0.5 %). In 2023, harvested area was 1 663.3 kha.

Methodological Issues

According to the EMEP/EEA GB_{2023}, nitrogen input from crop residues was estimated using equation p.18.

There is no comprehensive survey on the amount of crop residues burned as fuel in the Slovak Republic. Therefore, no removal from the burning of fuel was assumed. Also, data on the fraction of above-ground residues of crops removed annually for a purpose such as feed bedding and construction is not available. The seams and leaves are usually utilized as a fodder of domestic livestock. Data on straw exported abroad are missing.

Country specific nutrition potential: The country specific value for sugar beet regarding potential nitrogen nutrition was considered instead of the IPCC default method which is not accurate for the Slovak conditions. According to the national publication Postharvest residues of sugar beet and their role in the nutrient cycle by Stanislav Torma, 20 kg N/ha for sugar beet was taken as country specific value. The default values were considered for other crops. The values are presented in ***Table 5.41***.

Table 5.41: *Parameters used to estimate emissions from crop residues*

CROP TYPE	N (AG)	SLOPE	INTERCEPT	RAG (T)a	DRY MATTER FRACTION OF HARVESTED PRODUCTS (DRY)	NUTRITION POTENTIAL IN CROP RESIDUES
	[kg N (kg d.m.)$^{-1}$]			[kg d.m. (kg d.m.)$^{-1}$]		[kg N/ha]
Wheat	0.006	1.510	0.520	1.300	0.890	-
Rye	0.005	1.090	0.880	1.600	0.880	-
Barley	0.007	0.980	0.590	1.200	0.890	-
Oat	0.007	0.910	0.890	1.300	0.890	-
Maize	0.006	1.030	0.610	1.000	0.870	-
Potato	0.019	0.100	1.060	0.400	0.220	-
Sugar beet	-	-	-	0.000	-	20
Oil plants	0.008	1.130	0.850	1.000	0.910	-
Tobacco	0.015	0.300	0.000	1.000	0.900	-
Maize for silage	0.015	0.000	0.000	1.000	0.900	-
Meadows	0.015	0.300	0.000	0.300	0.900	-
Peas	0.008	1.130	0.850	2.100	0.910	-
Lens	0.008	1.130	0.850	2.100	0.910	-
Beans	0.008	1.130	0.850	2.100	0.910	-
Other leguminous plants	0.027	0.300	0.000	2.100	0.900	-
Soya	0.008	0.930	1.350	0.300	0.910	-
Clover	0.025	0.300	0.000	0.300	0.900	-
Alfalfa	0.027	0.290	0.000	0.300	0.900	-

Country specific $FRAC_{Remove}$: Slovak inventory uses a N-flow approach to calculate the emissions from **3.B** and **3.D**, which is in line with the IPCC Guidelines the N_2O emissions from straw used for bedding is reported in CRF **3.D.a.2** Animal manure applied to soils and this amount of N was taken into account in the value of **$Frac_{Remove}$**. The value of **$Frac_{Remove}$** was calculated for all years from the N content of straw used for bedding divided by the sum of the N content of the above-ground biomass of grain crops of which straw is used for bedding (wheat, barley, rye and oats). The amount of straw used as bedding material was taken from Articles: Livestock breeding by Vojtech Brestenský and Storage of agricultural fertilizers by Vojtech Brestenský (in Slovak) and Removal and storage of fertilizers by Vojtech Brestenský (in Slovak). Publications were provided with litter requirements per species and categories per day in kilograms. Nitrogen input from straw was not available in the presented publications. Nitrogen input from straw was taken from the article Nitrogen fertilization after harvesting cereals by Štefan Gáborík (in Slovak). In the aforementioned article, average nitrogen inputs from straw in selected cereals (wheat, barley) were estimated as 0.82 %. **$Frac_{Remove}$** parameter for silage maize was implemented while only below-ground biomass was considered. It is assumed, that maize for silage is used for fodder purposes in Slovakia.

The amount of forage consumed by livestock was removed from below-ground biomass in meadows. Maize for silage is used for biogas production in biogas stations. Based on expert judgement of ERT and country expert judgement **$Frac_{Remove}$** for maize is 1. According to the publication Guidelines for the support for selected non-projects measures the farmer is obliged to maintain agricultural areas in a condition suitable for grazing or cultivation in accordance with § 5 of the SR Government Regulation no 342/2014 Coll. Areas of permanent grassland or meadows must be managed in accordance with agro-technical practice. For areas of meadows, this means maintaining all areas by mowing, grazing and additionally mulching according to altitude and in the following terms: Mowing 4 times per year from 0-800 meters above sea level, grazing 4 times per year from 0-800 meters above sea level and mulching as well. Based on the presented information, it was impossible to derivate share for **$Frac_{Remove}$**. The review analysis of inventories was done and only in the Polish inventory **$Frac_{Remove}$** parameter was derivated. Poland is a neighbouring country with similar agricultural conditions and value was taken into Slovak inventory. Used **$Frac_{Remove}$** and **$Frac_{Incorp}$** values are presented in ***Tables 5.42*** and ***5.43***.

Table 5.42: *Parameters used to estimate emissions from crop residues*

TYPE OF CROP	$FRAC_{Incorp}$	$FRAC_{Remove}$
WHEAT	1	0.17
RYE	1	0.17
BARLEY	1	0.17
OAT	1	0.17
MAIZE	1	0
POTATO	1	0
SUGAR BEET	1	0
OIL PLANTS	1	0
TOBACCO	1	0
MAIZE FOR SILAGE	1	1
MEADOWS	0.20	0.95
PEAS	1	0
LENS	1	0
BEANS	1	0
OTHER LEGUMINOUS PLANTS	1	0
SOYA	1	0
CLOVER	0.33	0
ALFALFA	0.25	0

Table 5.43: *Nitrogen in bedding materials and $Frac_{Remove}$ in particular years*

YEAR	N INPUT FROM BEDDING MATERIALS	N CONTENT OF ABOVE-GROUND BIOMASS OF GRAIN CROPS USED AS BEDDING MATERIAL	$Frac_{Remove}$ (WHEAT, BARLEY, RYE, OAT)
	[kg]		[%]
1990	415 531	6 167 765	6.74
1995	319 525	5 038 292	6.34
2000	309 934	3 677 159	8.43
2005	299 021	2 921 960	10.23
2010	233 091	1 961 914	11.88
2011	190 096	1 657 890	11.47
2012	202 753	1 789 406	11.33
2013	192 604	1 779 498	10.82
2014	226 830	1 780 288	12.74
2015	228 504	1 818 204	12.57
2016	207 206	1 655 661	12.51
2017	239 565	1 742 469	13.75
2018	253 338	1 828 406	13.86
2019	240 214	1 704 719	14.09
2020	221 479	1 487 173	14.89
2021	212 643	1 316 377	16.15
2022	181 063	1 112 213	16.28
2023	197 405	1 162 191	16.99

Activity Data

Activity data on crop yields and annual area of harvested crops were taken from the ŠÚ SR. To estimate the N added to soils from crop residues and forage/pasture renewal, mainly default parameters from Table 11.2, 11.1A (IPCC 2019 RF) were used. Since yield statistics are reported as field-dry weight, a correction factor was applied to estimate dry matter yields in accordance with Equation 11.7 IPCC 2019 RF):

$$\mathrm{Crop}_{(T)} = \mathrm{Yield\ Fresh}_{(T)} * \mathrm{DRY}$$

Where: **$Crop_{(T)}$** = harvested dry matter yield for crop T in kg d.m/ha, **Yield $Fresh_{(T)}$** = kg of fresh weight per ha, **DRY** = dry matter fraction of harvested crop T in kg of d.m.

Table 5.44: *Growing areas and total nitrogen in crops and legumes in 2023*

CROP		HARVESTED AREA	HARVESTED ANNUAL CROP YIELD $CROP_{(T)}$	ANNUAL AMOUNT OF N IN CROP RESIDUES
		[ha]	[kg d.m. ha^{-1}]	[kg N yr^{-1}]
CEREALS	WHEAT	406 762.14	5 449	17 018 062
	RAY	10 428.50	2 973	143 210
	BARLEY	114 186.55	4 700	3 120 047
	OAT	9 689.59	1 867	97 692
OTHER	MAIZE	138 448.29	6 948	5 945 195
	POTATO	5 428.18	5 504	56 871
	SUGAR BEET	22 126.51	0	0
	OIL PLANTS	272 568.38	2 647	6 523 638
	TOBACCO	0	0	0
	MAIZE FOR SILAGE	63 186.70	27 361	1 263 734
	MEADOWS	494 928.65	2 478	275 986
NITROGEN FIXING CROPS	PEAS	5 386.34	1 932	94 106
	LENS	476.7	362	1 562
	BEANS	0	0	0
	OTHER LEGUMINOUS PLANTS	12 142.31	1 689	166 109

CROP		HARVESTED AREA	HARVESTED ANNUAL CROP YIELD CROP$_{(T)}$	ANNUAL AMOUNT OF N IN CROP RESIDUES
		[ha]	[kg d.m. ha^{-1}]	[kg N yr^{-1}]
	SOYA	50 152.51	2 355	879 276
	CLOVER	10 792.38	5 104	413 131
	ALFALFA	46 560.13	5 839	2 128 760
2023 TOTAL		**1 663 263.22**	**78 338.14**	**38 127 379**

5.9.4 Category-specific Recalculations

Emissions of NH_3 and NOx were recalculated in category **3Da2a** due to the inclusion of previously omitted rabbit emissions, ensuring accurate representation of the category total for the period 1990–2005. From 2007 the recalculations of **3Da2a** category, are connected with the revision of the abatement measures. During the national expert review of the calculations to account for abatement measures revealed calculation of abated emission factors aggregated measures that could not be linked with the type of the manure. In the storage stage, in the calculation for the last submission all measures contributed to the reduction of the default factor by the proportion their penetration across the population of the animal category. The recalculation in this submission linked „Fixed hatch or roof" to EF for solid manure and measures „Covering the surface of the tank with straw", „Covering the surface of the tanks with foil" and „Slurry/liquid with natural crust cover" linked with EF for liquid manure. In the aplication stage, four measures were contributing with the reduction to both default EF, solid or liquid. The recalculation introduced the calculation in which the measures that include „injection" being applicable only for liquid EF (2 measures) and measures using „incorporation within 12/24 hours" being applicable only for solid EF (2 measures). Recalculations of emisisons in category **3Da2a** are also connected with the correction of the wrong transcript for poultry categories. Input file for the calculation of NH3 and NOx emissions has been found incorrect in N-rate in the whole timeseries due to mistakenly inserted 1.1 – 2.5 times higher values of different parameter. In case of turkeys (3B4giii), there has been the only reduction – wrong values were 7 % lower than N – rate. The effect of the recalculation is masked by the changes in the attribution of abatement measures (Ad 1) at the sub-sector level but contributed to the reduction in overall. The impact of the recalculations is shown in ***Table 5.45***.

Table 5.45: *Previous and revised NH_3 emissions from Animal manure applied to soils*

YEAR	NH_3 [kt]		CHANGE	NOx [kt]		CHANGE
	PREVIOUS	REVISED		PREVIOUS	REVISED	
1990	28.54	25.20	-11.72%	2.93	2.52	-13.94%
1991	25.62	22.40	-12.59%	2.65	2.25	-14.80%
1992	22.45	19.67	-12.40%	2.34	2.00	-14.53%
1993	20.13	17.21	-14.49%	2.11	1.76	-16.72%
1994	19.96	16.72	-16.24%	2.11	1.72	-18.57%
1995	19.27	16.18	-16.00%	2.05	1.68	-18.22%
1996	18.88	15.82	-16.22%	2.02	1.65	-18.49%
1997	18.37	15.36	-16.41%	1.97	1.60	-18.71%
1998	16.39	13.69	-16.49.%	1.76	1.43	-18.79%
1999	15.66	13.20	-15.69%	1.67	1.37	-18.00%
2000	16.06	13.50	-15.92%	1.71	1.40	-18.31%
2001	17.05	13.80	-19.05%	1.84	1.44	-21.55%
2002	15.97	13.27	-16.91%	1.72	1.39	-19.24%
2003	15.48	12.76	-17.54%	1.67	1.33	-19.98%
2004	14.13	11.60	-17.95%	1.51	1.20	-20.63%
2005	14.46	11.93	-17.49%	1.53	1.22	-20.28%
2006	13.17	9.99	-24.14%	1.51	1.51	0.19%

YEAR	NH₃ [kt]		CHANGE	NOx [kt]		CHANGE
	PREVIOUS	REVISED		PREVIOUS	REVISED	
2007	12.86	9.59	-25.44%	1.46	1.22	-16.64%
2008	11.87	8.68	-26.84%	1.33	1.10	-17.07%
2009	12.11	8.75	-27.77%	1.38	1.11	-19.45%
2010	11.86	8.50	-28.33%	1.35	1.08	-19.63%
2011	11.52	8.06	-30.05%	1.26	1.00	-20.21%
2012	11.60	8.35	-28.06%	1.31	1.04	-20.18%
2013	10.99	8.02	-26-98%	1.24	1.00	-18.79%
2014	11.39	8.28	-27.34%	1.29	1.04	-19.19%
2015	11.50	8.28	-27.98%	1.30	1.04	-19.76%
2016	11.07	7.94	-28.27%	1.24	0.99	-20.45%
2017	11.08	7.99	-27.87%	1.26	1.00	-20.56%
2018	11.68	8.51	-27.17%	1,32	1,05	-20,49%
2019	11.22	8.24	-26.56%	1,26	1,01	-19,51%
2020	9.63	7.48	-22.39%	1,06	0,92	-13,62%
2021	7.95	7.13	-10.31%	1,02	0,87	-15,50%
2022	7.83	6.94	-11.36%	1,00	0,85	-14,61%

In category **3Da2c** emission changed due to implementation of revised N content coefficients for other organic fertilizers. During inter-institutional QA/QC process with Central Controlling and Testing Institute in Agriculture (ÚKSÚP) responsible for providing data on fertilizer datasets, data were harmonized for the N content of different types of fertilizers accounted in the category **3Da2c**. ÚKSÚP continuously carries out the analysis of N – content in the on-farm samples of fertilizers taken as part of the institutional competencies in the area of agricultural fertilizers. The impact of recalculations is shown in ***Table 5.46***.

Table 5.46: *Previous and revised NH_3 and NOx emissions from Other organic fertilisers applied to soils (including compost)*

YEAR	NH₃ [kt]		CHANGE	NOx [kt]		CHANGE
	PREVIOUS	REVISED		PREVIOUS	REVISED	
1990	0.05	0.04	-22.75%	0.03	0.02	-22.75%
1991	0.06	0.05	-19.24%	0.03	0.02	-19.24%
1992	0.05	0.04	-21.63%	0.02	0.02	-21.63%
1993	0.05	0.04	-21.04%	0.02	0.02	-21.04%
1994	0.05	0.05	-17.32%	0.03	0.02	-17.32%
1995	0.05	0.04	-19.74%	0.02	0.02	-19.74%
1996	0.04	0.04	-19.05%	0.02	0.02	-19.05%
1997	0.05	0.04	-15.18%	0.03	0.02	-15.18%
1998	0.04	0.03	-17.54%	0.02	0.02	-17.54%
1999	0.04	0.03	-16.73%	0.02	0.02	-16.73%
2000	0.11	0.07	-30.79%	0.05	0.04	-30.79%
2001	0.08	0.06	-25.13%	0.04	0.03	-25.13%
2002	0.06	0.05	-23.10%	0.03	0.02	-23.10%
2003	0.03	0.03	-14.94%	0.02	0.01	-14.94%
2004	0.04	0.03	-19.95%	0.02	0.02	-19.95%
2005	0.01	0.01	-27.98%	0.01	0.00	-27.98%
2006	0.02	0.02	-24.52%	0.01	0.01	-24.52%
2007	0.08	0.02	-69.67%	0.04	0.01	-69.67%
2008	0.63	0.08	-87.04%	0.31	0.04	-87.04%
2009	0.48	0.07	-86.19%	0.24	0.03	-86.19%
2010	0.28	0.05	-80.47%	0.14	0.03	-80.47%

YEAR	NH_3 [kt]		CHANGE	NOx [kt]		CHANGE
	PREVIOUS	REVISED		PREVIOUS	REVISED	
2011	0.49	0.11	-78.69%	0.25	0.05	-78.69%
2012	0.26	0.11	-58.89%	0.13	0.05	-58.89%
2013	0.47	0.28	-39.99%	0.23	0.14	-39.99%
2014	0.60	0.39	-34.97%	0.30	0.20	-34.97%
2015	0.63	0.16	-74.96%	0.31	0.08	-74.96%
2016	0.07	0.33	358.51%	0.04	0.16	358.51%
2017	0.04	0.31	638.38%	0.02	0.16	638.38%
2018	0.04	0.31	634.07%	0.02	0.16	634.07%
2019	0.27	0.35	30.56%	0.13	0.18	30.56%
2020	0.26	0.25	-2.54%	0.13	0.13	-2.54%
2021	0.30	0.30	-	0.15	0.15	0.00%
2022	0.31	0.25	-16.61%	0.15	0.13	-16.61%

In category **3Da4** recalculations were made due to revision of Frac Remove connected with an update in the N - content of the above-ground biomass of grain crops used as the bedding material in the poultry category.

Table 5.47: *Previous and revised NH_3 emissions from Crop residues applied to soils*

YEAR	NH_3		CHANGE
	PREVIOUS	REVISED	
1990	1.62	1.63	0.57%
1991	1.73	1.73	0.50%
1992	1.54	1.54	0.51%
1993	1.35	1.36	0.48%
1994	1.53	1.54	0.58%
1995	1.42	1.43	0.56%
1996	1.35	1.35	0.55%
1997	1.41	1.42	0.62%
1998	1.31	1.32	0.67%
1999	1.17	1.18	0.52%
2000	0.91	0.92	0.64%
2001	1.26	1.27	0.66%
2002	1.22	1.23	0.63%
2003	0.94	0.95	0.63%
2004	1.37	1.38	0.74%
2005	1.28	1.29	0.71%
2006	1.13	1.14	0.64%
2007	1.07	1.07	0.72%
2008	1.45	1.46	0.70%
2009	1.22	1.23	0.77%
2010	1.00	1.00	0.65%
2011	1.31	1.31	0.67%
2012	1.09	1.10	0.64%
2013	1.27	1.28	0.67%
2014	1.63	1.64	0.74%
2015	1.36	1.37	0.88%
2016	1.70	1.71	0.76%
2017	1.32	1.33	0.80%
2018	1.46	1.47	0.76%
2019	1.48	1.49	0.84%
2020	1.58	1.59	0.90%

2021	1.52	1.54	0.91%
2022	1.26	1.27	1.09%

5.10 NMVOC EMISSIONS FROM CULTIVATED CROPS (NFR 3DE)

Data on cultivated areas and crop yields were taken from the ŠÚ SR. Data is available on 20th May every year. (According to the NECD recommendation ***SK-3De-2023-0001*** the cultivated areas were expanded by Barley, Oats and other cultivated crops, FAOSTAT data in TERT files was exchanged with country data reported by the Statistical Office of the Slovak Republic. Tables 5.1 and 5.2 provided data from 2005 to 2023.

5.10.1 Activity Data

FAOSTAT data in TERT files were replaced by country data reported by the Statistical Office of the Slovak Republic. Tables 5.1 and 5.2 provided data from 2005 to 2023.

Table 5.48: *Cultivated areas in the time-series*

YEAR	CROPS - CULTIVATED AREAS [HA]						
	WHEAT	RAY	OIL PLANTS	GRASS (MAT<10^{o}C)	BARLEY	OATS	OTHER CULTIVATED CROPS
2005	375 801	32 500	215 547	881 283	222 000	24 500	189 749
2010	349 700	29 370	280 000	876 484	138 930	17 240	230 237
2011	364 000	13 358	261 600	874 224	136 325	16 158	264 034
2012	388 700	28 568	225 100	871 338	147 994	15 773	249 978
2013	368 200	35 408	254 800	868 171	121 304	13 901	266 724
2014	380 200	29 369	243 400	864 681	138 826	15 367	249 313
2015	379 400	15 175	247 400	858 601	138 920	16 422	265 645
2016	417 700	12 843	254 000	855 882	115 364	14 834	248 254
2017	374 781	10 380	292 854	853 757	121 026	15 932	241 925
2018	404 014	13 008	282 076	851 685	124 574	14 122	230 061
2019	408 168	14 292	259 801	850 600	126 887	12 817	243 169
2020	390 872	13 045	269 463	850 027	132 885	13 408	240 338
2021	356 969	10 181	289 801	506 922	117 205	16 342	558 707
2022	410 247	9 452	295 793	508 950	108 782	10 701	505 269
2023	405 775	11 756	272 899	501 258	113 619	10 083	533 805

Table 5.49: *Crop yields in the time-series*

YEAR	CROPS – CROP YIELDS [t/ha]						
	WHEAT	RAY	OIL PLANTS	GRASS (MAT<10^{o}C)	BARLEY	OATS	OTHER CULTIVATED CROPS
2005	4.31	2.84	2.12	2.04	3.62	2.00	NA
2010	3.85	2.41	2.06	2,07	3.48	2.12	NA
2011	3.82	2.63	2.02	2,00	3.14	1.79	NA
2012	4.87	3.10	2.54	1,84	4.18	2.06	NA
2013	4.06	2.87	2.23	2,08	3.45	2.17	NA
2014	3.46	2.23	1.88	2,31	2.72	1.67	NA
2015	4.50	3.18	2.23	2,13	3.87	2.37	NA
2016	3.29	3.14	2.04	2,36	3.18	2.14	NA
2017	4.58	3.86	2.42	2,25	3.68	2.20	NA
2018	5.46	3.67	3.06	2,22	4.87	2.52	NA
2019	5.51	3.60	2.30	2,34	4.78	2.71	NA
2020	5.84	3.51	3.07	2,31	5.08	2.62	NA

YEAR	CROPS – CROP YIELDS [t/ha]						
	WHEAT	RAY	OIL PLANTS	GRASS (MAT<10^{o}C)	BARLEY	OATS	OTHER CULTIVATED CROPS
2021	4.74	3.26	2.66	2,56	4.53	2.36	NA
2022	4.78	2.74	2.83	2,06	3.92	2.31	NA
2023	6.12	3.38	3.11	2,75	5.28	2.10	NA

5.10.2 Methodological Issues – Methods

Emissions were estimated using the combination of EMEP/EEA GB_{2023} Tier 2 methodology for wheat, rye, oil plants, barley, oats and Tier 1 for other crops (the Tier 1 emission factor of 0.86 kg ha^{-1}). The mentioned emission factor is presented in Table 3-1 of EMEP/EEA GB_{2023} Agricultural soils 2023. Tier 2 emission factors were estimated based on country-specific information about crop yield, dry matter content, and crop areas by crop type. Implied emission factors in 2023 are presented in ***Table 5.50***.

Table 5.50: *Implied emission factors in 2023*

TYPE OF CROPS	IMPLIED EMISSION FACTORS [kg NMVOC/ha/year]
WHEAT	0.30
RYE	0.62
OIL PLANTS	1.23
GRASS (MAT<10^{o}C)	0.04
BARLEY	0.13
OATS	0.06

Information about dry matter content was taken from two data sources for oil plants and wheat was the primary source of data from the 2019 IPCC Refinement (Table 11.1A) for others were dry matter content taken from the publication Principles of Using the Potential of Silage and Conservation High-quality and Hygienic Preparations in Producing harmless canned feed (In Slovak language). Implemented contents are lower compared to the 2019 IPCC Values. **Table 5.51** presents all implemented dry matter contents and includes a transparent data source description.

Table 5.51: *Dry Matter Contents in 1990-2023*

TYPE OF CROPS	DRY MATTER CONTENTS [kg/kg]	SOURCE OF DATA
WHEAT	0.89	2019 IPCC Refinement
RYE	0.48	Principles of using the potential of silage and conservation high-quality and hygienic preparations in producing harmless canned feed, p.12. Table 5.
OIL PLANTS	0.88	2019 IPCC Refinement
GRASS (MAT<10^{o}C)	0.38	Principles of using the potential of silage and conservation high-quality and hygienic preparations in producing harmless canned feed, p.25. Table 10.
BARLEY	0.38	Principles of using the potential of silage and conservation high-quality and hygienic preparations in producing harmless canned feed, p.12. Table 5.
OATS	0.36	Principles of using the potential of silage and conservation high-quality and hygienic preparations in producing harmless canned feed, p.12. Table 10.

5.10.3 Category-Specific Recalculations

In category 3De emissions changed due to implementation of revised approach to estimate NMVOC emissions based on TERT recommendation number ***SK-3De-2023-0001***. Country-specific data were identified which allowed to develop Tier 2 estimates using crop yields. Details of the updated method is available in the **Chapter 5.10**. ***Table 5.52*** indicates markedly increased emissions in the category **3De**.

Table 5.52: Previous and revised NMVOC emissions from Cultivated Crops

YEAR	NMVOC		CHANGE
	PREVIOUS	REVISED	
1990	13.74%	43.46%	216.31%
1991	13.83%	45.40%	228.22%
1992	13.97%	39.93%	185.78%
1993	13.21%	29.96%	126.74%
1994	13.86%	35.44%	155.73%
1995	14.56%	36.81%	152.83%
1996	15.02%	38.06%	153.34%
1997	14.97%	40.86%	172.96%
1998	15.02%	38.69%	157.51%
1999	15.31%	37.01%	141.77%
2000	15.59%	31.78%	103.85%
2001	16.16%	54.44%	236.76%
2002	16.13%	52.61%	226.20%
2003	15.19%	43.98%	189.55%
2004	15.59%	54.88%	252.07%
2005	15.91%	51.75%	225.23%
2006	16.09%	51.98%	223.03%
2007	16.04%	48.80%	204.22%
2008	16.38%	62.93%	284.18%
2009	16.67%	56.40%	238.42%
2010	16.40%	49.90%	204.29%
2011	16.21%	56.93%	251.09%
2012	16.06%	47.95%	198.59%
2013	16.22%	62.37%	284.52%
2014	16.14%	72.84%	351.30%
2015	16.05%	61.28%	281.76%
2016	16.52%	74.36%	350.11%
2017	16.52%	68.31%	313.52%
2018	16.69%	69.35%	315.47%
2019	16.44%	66.06%	301.69%
2020	16.37%	69.88%	326.93%
2021	12.81%	84.60%	560.24%
2022	13.49%	75.78%	461.57%

5.11 PM AND TSP EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE. HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCTS (NFR 3DC)

5.11.1 Methodological Issues

Pollution TSP was calculated using the Tier 1 methodology from EMEP/EEA GB_{2023}, $PM_{2.5}$ and PM_{10} were calculated using Tier 2 EMEP/EEA GB_{2023} methodology. Emission factors for wet climate were used. In emission estimation, all operations with crops were considered only one time. Implementation of the Tier 2 approach in PMs emissions caused TSP emissions to be lower than PM_{10} emissions, which indicates an overestimation of PM_{10} emissions. TSP emissions incorporated PM_{10} and $PM_{2.5}$ and other fractions of a particular matter. Tier 2 approach had to be implemented because NFR **3Dc** category is the key category of PM_{10} emissions.

Table 5.53: *Used emission factors in kg/ha (according to the NECD recommendation A9/SK-3Dc-2023-0001of the SVK NECD Final Review Report 2023)*

EF TSP	1.56			
Crop (PM_{10}) [kg/h]	**SOIL CULTIVATION**	**HARVESTING**	**CLEANING**	**DRYING**
Wheat	0.25	2.70	0.19	0.56
Rye	0.25	2.00	0.16	0.37
Barley	0.25	2.30	0.16	0
Oat	0.25	3.40	0.25	1
Other arable	0.25	NC	NC	NC
Grass	0.25	0.25	0	0
Crop ($PM_{2.5}$) [kg/ha]	**SOIL CULTIVATION**	**HARVESTING**	**CLEANING**	**DRYING**
Wheat	0.015	0.0200	0.0090	0.168
Rye	0.015	0.0150	0.0080	0.111
Barley	0.015	0.0160	0.0080	0.129
Oat	0.015	0.0250	0.0125	0.198
Other arable	0.015	NC	NC	NC
Grass	0.015	0.0100	0	0

Emissions of TSP were calculated with the following equation (Tier 1 approach):

$$\mathrm{E_{TSP}} = \mathrm{AR}_{\mathrm{area}} \times EF_{pollutant}$$

Where: $\mathrm{E_{TSP}}$ Emissions PM_{10} and $PM_{2.5}$ (kg.a^{-1}), $\mathrm{EF_{pollutant}}$ Annual default emission factor in (kg ha^{-1}), $\mathrm{AR_{area}}$The annual sown area of the crop in ha.

Emissions of PM_{10} and $PM_{2.5}$ were calculated with the following equation (Tier 2 approach):

$$\mathrm{E_{PM}} = \sum_{t=1}^{l} \sum_{n=0}^{N_{t.k}} \mathrm{EF_{PM\ t.k}} * \mathrm{A_t} \times n$$

Where: $\mathrm{E_{PM}}$ Emissions PM_{10} and $PM_{2.5}$ (kg.a^{-1}), $\mathrm{EF_{PM}}$ Annual default emission factor in (kg ha^{-1}), $\mathrm{A_t}$. The annual sown area of the crop in ha, $\mathbf{n_l}$ is the number of times the $k_{t.h}$ operation is performed on the crop in a^{-1}.

Table 5.54: *Frequency of operations in 1990-2023*

CROP	SOIL CULTIVATION	HARVESTING	CLEANING	DRYING
WHEAT	4	1	1	1
RYE	4	1	1	1
BARLEY	4	1	1	1
OAT	4	1	1	1
OTHER ARABLE	4	0	0	0
GRASS	1	2	0	0

5.11.2 Activity Data

Data of sown areas were taken from the ŠÚ SR. Data is available on 20th May every year (according to the NECD ***Recommendation No A7/SK-3D-2023-0001*** of the SVK NECD Final Review Report 2023).

Table 5.55: *Sowing areas in time series*

YEAR	CROPS - SOWING AREAS [ha]					
	WHEAT	RAY	OIL PLANTS/RAPESEED	MEADOWS	BARLEY	OAT
1990	412 423	40 474	67 087	813 000	199 849	14 361
1995	442 874	31 162	87 883	839 025	239 559	13 572
2000	406 400	29 800	178 300	865 222	245 900	22 800
2005	375 801	32 500	215 547	881 283	222 000	24 500
2010	349 700	29 370	280 000	876 484	138 930	17 240
2011	364 000	13 358	261 600	874 224	136 325	16 158
2012	388 700	28 568	225 100	871 338	147 994	15 773

YEAR	CROPS - SOWING AREAS [ha]					
	WHEAT	RAY	OIL PLANTS/RAPESEED	MEADOWS	BARLEY	OAT
2013	368 200	35 408	254 800	868 171	121 304	13 901
2014	380 200	29 369	243 400	864 681	138 826	15 367
2015	379 400	15 175	247 400	858 601	138 920	16 422
2016	417 700	12 843	254 000	855 882	115 364	14 834
2017	374 781	10 380	292 854	853 757	121 026	15 932
2018	404 014	13 008	282 076	851 685	124 574	14 122
2019	408 168	14 292	259 801	850 600	126 887	12 817
2020	390 872	13 045	269 463	850 027	132 885	13 408
2021	356 969	10 181	289 801	506 922	117 205	16 342
2022	410 247	9 452	295 793	508 950	108 782	10 701
2023	405 775	11 756	272 899	501 258	113 619	10 083

5.11.3 Category-specific Recalculations

Recalculations were made due to the inclusion of information about the cropped area covered by "Other crops" compared to previous submissions where only wheat, rye, oilplants (rapeseed), grass, barley and oat were considered.

Table 5.56: *Previous and revised PM_{10}, $PM_{2.5}$ and TSP emissions from farm-level agricultural operations including storage, handling and transport of agricultural products*

YEAR	PM_{10}		CHANGE	$PM_{2.5}$		CHANGE	TSP		CHANGE
	P	R		P	R		P	R	
1990	3.51	3.95	12.54%	0.19	0.22	13.67%	2.41	3.10	28.45%
1991	3.51	3.94	12.18%	0.19	0.22	13.26%	2.41	3.08	27.64%
1992	3.54	3.93	11.05%	0.19	0.22	12.04%	2.45	3.06	24.88%
1993	3.41	3.82	11.88%	0.19	0.21	13.01%	2.41	3.04	26.24%
1994	3.60	3.94	9.44%	0.20	0.22	10.31%	2.49	3.02	21.26%
1995	3.80	4.07	7.10%	0.21	0.23	7.73%	2.58	3.00	16.32%
1996	3.82	4.04	5.86%	0.21	0.22	6.37%	2.63	2.98	13.24%
1997	3.72	3.94	5.98%	0.21	0.22	6.51%	2.61	2.96	13.27%
1998	3.78	3.97	4.97%	0.21	0.22	5.41%	2.65	2.94	11.08%
1999	3.89	4.04	3.67%	0.21	0.22	3.99%	2.70	2.92	8.25%
2000	3.82	3.93	2.94%	0.21	0.22	3.21%	2.73	2.90	6.43%
2001	3.82	4.32	13.11%	0.21	0.24	14.25%	2.74	3.52	28.58%
2002	3.62	4.13	13.88%	0.20	0.23	15.12%	2.70	3.49	29.01%
2003	3.25	3.83	17.79%	0.18	0.21	19.49%	2.59	3.49	34.85%
2004	3.80	3.96	4.22%	0.21	0.22	4.60%	2.77	3.02	9.03%
2005	3.66	3.85	5.19%	0.20	0.21	5.66%	2.73	3.03	10.83%
2006	3.40	3.62	6.55%	0.19	0.20	7.15%	2.68	3.03	12.96%
2007	3.57	3.75	5.08%	0.20	0.21	5.55%	2.73	3.01	10.37%
2008	3.64	3.80	4.41%	0.20	0.21	4.81%	2.77	3.02	9.04%
2009	3.59	3.74	4.31%	0.20	0.21	4.69%	2.77	3.01	8.71%
2010	3.23	3.46	7.13%	0.18	0.19	7.77%	2.64	3.00	13.61%
2011	3.20	3.46	8.25%	0.18	0.19	8.99%	2.60	3.01	15.85%
2012	3.37	3.62	7.42%	0.19	0.20	8.08%	2.62	3.01	14.90%
2013	3.22	3.48	8.30%	0.18	0.19	9.04%	2.59	3.01	16.05%
2014	3.31	3.56	7.53%	0.18	0.20	8.20%	2.61	3.00	14.91%
2015	3.26	3.53	8.15%	0.18	0.20	8.87%	2.58	3.00	16.04%
2016	3.33	3.58	7.46%	0.18	0.20	8.10%	2.61	2.99	14.86%

2017	3.19	3.43	7.58%	0.18	0.19	8.23%	2.60	2.98	14.50%
2018	3.32	3.55	6.92%	0.18	0.20	7.51%	2.64	2.99	13.62%
2019	3.33	3.57	7.31%	0.18	0.20	7.94%	2.61	2.99	14.54%
2020	3.28	3.52	7.33%	0.18	0.20	7.96%	2.60	2.98	14.39%
2021	2.84	3.40	19.69%	0.16	0.19	21.13%	2.02	2.90	43.06%
2022	3.02	3.52	16.75%	0.17	0.20	17.92%	2.10	2.88	37.60%

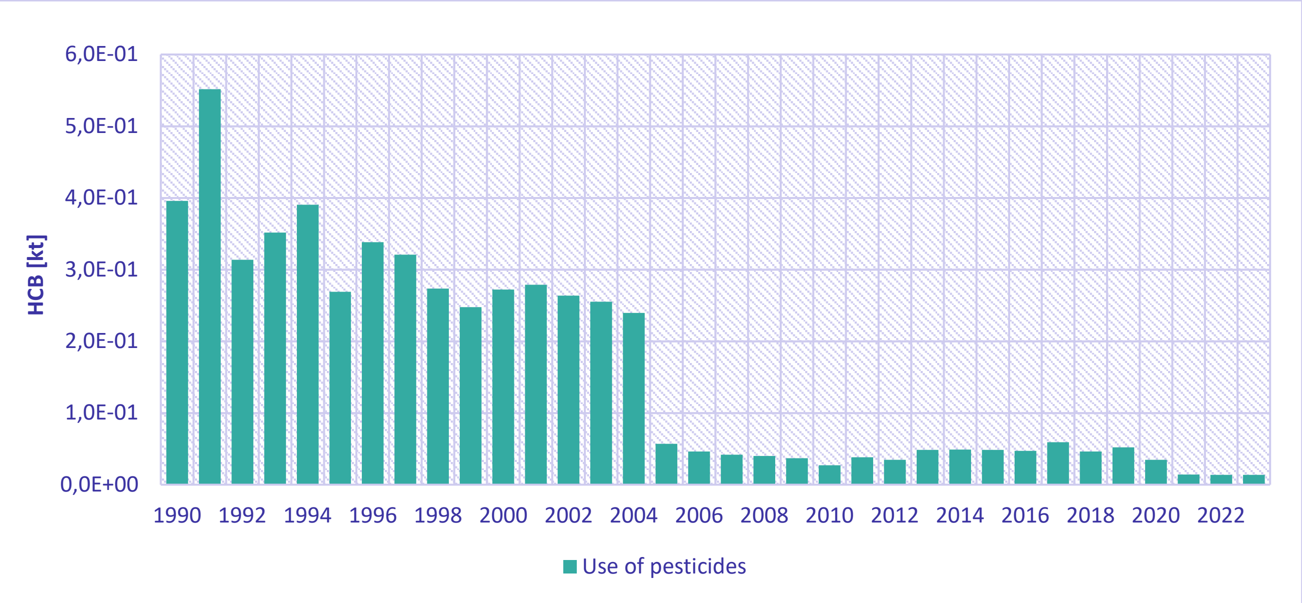
5.12 AGRICULTURE OTHER INCLUDING USE OF PESTICIDES (NFR 3DF)

A scope of pesticides is used in the Slovak agricultural sector and a very small amount of them contain Hexachlorobenzene (HCB) as an impurity. HCB as the active substance is carried out in the Slovak Republic and is forbidden in consonance with the Stockholm Convention on Persistent Organic Pollutants and these substances.

5.12.1 Methodological Issues

The emissions of HCB from the use of pesticides are based on the amount of effectual substance used and emission factors for each type of pesticide. Impurity factors of used pesticides were taken from Table 7-3 p.15 of EMEP/EEA GB_{2023}.

Figure 5.16: *Emissions of HCB from used pesticides*



5.12.2 Activity Data

Data on pesticide consumption was provided by the Central Control and Testing Institute in Agriculture. Consumptions are collected annually directly from the Farmers base of Government Regulation of the Slovak Republic no 186/2012 Coll. on the review of authorized plant protection products. The situation of using pesticides in the Slovak Republic propazine, atrazine, endosulfan, lindane, simazine and pentachlorophenol fenol were not obligated. Atrazine was not used since 2006 and also was not obliged. Only clopiralid, chlorothalonil and picloram are used. The total consumption of pesticides by active substances is available in ***Table 5.57***.

Table 5.57: Consumption of pesticides in kilograms

YEAR	NAME OF PESTICIDE [kg]					
	ATRAZIN	CLOPIRALID	CHLOROTHALONIL	ENDOSULFAN	PICLORAM	SIMAZIN
1990	148 842	5 506	25	19	NO	3 897
1991	208 958	3 755	50	NO	NO	7 848
1992	120 966	509	1 692	NO	NO	2 314
1993	134 141	1 975	1 377	NO	NO	3 207
1994	149 153	3 531	651	30	NO	2 834
1995	90 263	4 583	3 511	111	NO	9 096
1996	122 760	6 810	3 438	32	NO	2 198
1997	115 959	8 255	1 703	5	NO	2 384
1998	100 017	6 181	1 434	2	NO	1 748
1999	89 351	7 424	1 034	NO	NO	1 276
2000	96 329	6 808	4 716	NO	NO	1 036
2001	95 050	8 536	7 151	1	NO	734
2002	84 964	10 208	10 093	NO	NO	213
2003	87 533	5 752	8 074	NO	NO	699
2004	79 208	8 124	7 331	NO	636	481
2005	6 715	9 175	5 437	NO	1 219	250
2006	NO	9 512	7 690	NO	1 261	NO
2007	NO	10 315	4 773	NO	1 591	NO
2008	NO	9 160	5 292	NO	1 522	NO
2009	NO	9 817	2 958	NO	1 965	NO
2010	NO	6 324	3 418	NO	1 094	NO
2011	NO	6 517	7 594	NO	1 199	NO
2012	NO	5 554	7 305	NO	1 071	NO
2013	NO	7 432	10 498	NO	1 542	NO
2014	NO	5 842	12 507	NO	1 165	NO
2015	NO	4 537	13 946	NO	960	NO
2016	NO	4 324	13 728	NO	906	NO
2017	NO	5 320	17 252	NO	1 209	NO
2018	NO	5 146	12 189	NO	1 212	NO
2019	NO	4 901	14 773	NO	1 119	NO
2020	NO	4 238	8 398	NO	1 276	NO
2021	NO	4 509	24	NO	1 209	NO
2022	NO	4 238	122	NO	1 213	NO
2023	NO	4 255	126	NO	1 150	NO

5.12.3 Category-specific Recalculations

No recalculations were made.

5.13 FIELD BURNING OF AGRICULTURAL RESIDUES (NFR 3F)

The Field burning of agricultural residues is strictly prohibited by law in the Slovak Republic. Therefore, no emissions from this category were estimated and the notation key NO was used. The prohibition of activity results from the law mentioned below:

- Act No 223/2001 Coll. on wastes and amendment and implementation of some acts in the wording of Act No 553/2001 Coll., the Act No 96/2002 Coll., Act No 261/2002, the Act No 393/2002, the Act No 529/2002 Coll., the Act No 188/2003 Coll., the Act No 245/2003 Coll., the Act No 525/2003 Coll., the Act No 24/2004

Coll. and the Act No 443/2004 Coll., Act No 314/2001 Coll. on protection against fire and the amendment and implement of some acts.

CHAPTER 6: WASTE (NFR 5)

Last update: 15.3.2025

6.1 OVERVIEW OF THE SECTOR

This chapter represents emissions from the activities involved in the NFR categories listed in ***Table 6.1***. The waste sector emits all reported pollutants (ammonia, sulphur oxides, heavy metals, particulate matter, black carbon, carbon oxides, persistent organic pollutants, non-methane organic pollutants, and nitrogen oxides) due to the variety of activities and diverse waste treatment manners. Emissions from waste incineration with energy use were allocated to the energy sector (**NFR 1A**).

Table 6.1: *Categories included in the Waste sector and method used for calculations (NFR 5)*

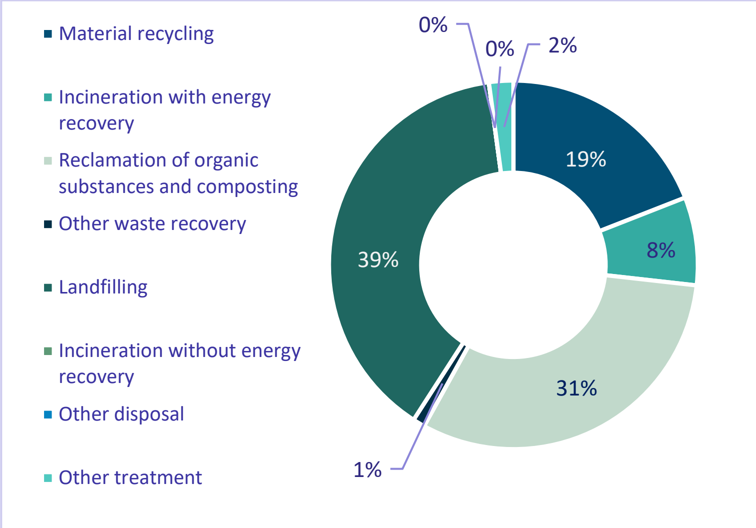
NFR Code	LONGNAME	METHOD
5A	Biological treatment of waste - Solid waste disposal on land	T2/T3
5B1	Biological treatment of waste - Composting	T2
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	T1
5C1a	Municipal waste incineration	T3/T2
5C1bi	Industrial waste incineration	T2
5C1bii	Hazardous waste incineration	T1
5C1biii	Clinical waste incineration	T2
5C1biv	Sewage sludge incineration	T2
5C1bv	Cremation	T1
5C1bvi	Other waste incineration	-
5C2	Open burning of waste	T2
5D1	Domestic wastewater handling	T1/T2/T3
5D2	Industrial wastewater handling	T1/T3
5D3	Other wastewater handling	-
5E	Other waste	T2

The main source of activity data is national statistics represented by data from the ŠÚ SR. In line with statistics, total waste is classified by three ways of treatment:

a) **Recovery** (material recycling – not involved in the inventory, incineration with energy recovery – relevant emissions allocated in energy chapter, backfilling – not included, reclamation of organic substances and composting – included in **Chapter 6.6.1**, other recovery – not involved);
b) **Disposal** (landfilling (**Chapter 6.4**) and incineration without energy recovery (**Chapter 6.6**) – included in the inventory, other disposal – not involved)
c) Waste temporarily stored in place of origin – not included in the inventory.

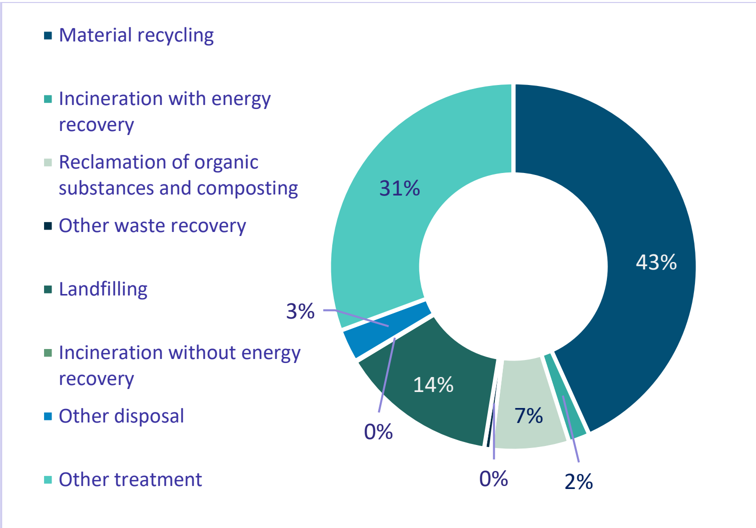
According to the annual statistics of the Statistical Office of the Slovak Republic, the total municipal waste produced in the Slovak Republic in 2023 was 2,560.97 kt. The amount of municipal waste produced decreased compared to the previous year (1%). The generation of municipal waste per capita (471.91) in the Slovak Republic is still below the European average. However, the predominant waste treatment is still landfilling (39%). The amount of waste recovered stayed stable in 2023 to 59%. In 2022, prevailed waste recovery treatment was material recycling (35% of recovered waste, 20% of all waste); in 2023, it was also material recycling (32% of recovered waste, 19% of all waste). The share of composting increased slightly (6%) and energy utilization decreased by 3%. ***Figure 6.1*** shows a detailed share of municipal waste treatment.

Figure 6.1: Municipal waste treatment in the Slovak Republic in 2023



In 2023, total industrial and other waste was produced in the amount of 11,005.38 kt. The amount increased by 4% compared to 2022. The largest share represents waste from construction and demolition (47%) which has increased by 12% annually due to the post-Covid revitalisation of the construction business.

Figure 6.2: Industrial waste treatment in the Slovak Republic in 2023



In general, in most waste categories, the **condensable component of PMs** is not included in emission factors.
Emissions of air pollutants (excluding NMVOC and NH_3) in this sector are emitted into the air by waste incineration plants. The trend in the incineration categories is decreasing until 2008. Since 2009 emissions of all main pollutants have increased. Emissions of heavy metals and POPs have generally decreasing character.
Wastewater handling and composting are the main contributors to ammonia emissions in this sector. The ratio of the population using the connection to no sewage systems or using no septic tanks etc. decreased since 1990 significantly.
Non-methane volatile compounds are formed mainly at waste disposal sites. These emissions are increasing in the long term. Summary values for waste categories are given in ***Table 6.2***. The overall trend has dramatically declined since 1990 due to the continual development of the legislation.
A share of waste sector categories on the emissions of the main pollutants is available in ***Figure 6.3***. For main pollutants, emissions of NOx, SOx and CO are emitted by the sources of waste incineration (**5C**). NMVOC is mostly emitted from landfilled waste (**5A**). Ammonia is emitted mostly by biological treatment (**5B**) of waste and PMs are emitted by accidental fires (**5E**).

Figure 6.3: Share of subsectors of the waste sector on emissions of the main pollutants in 2023

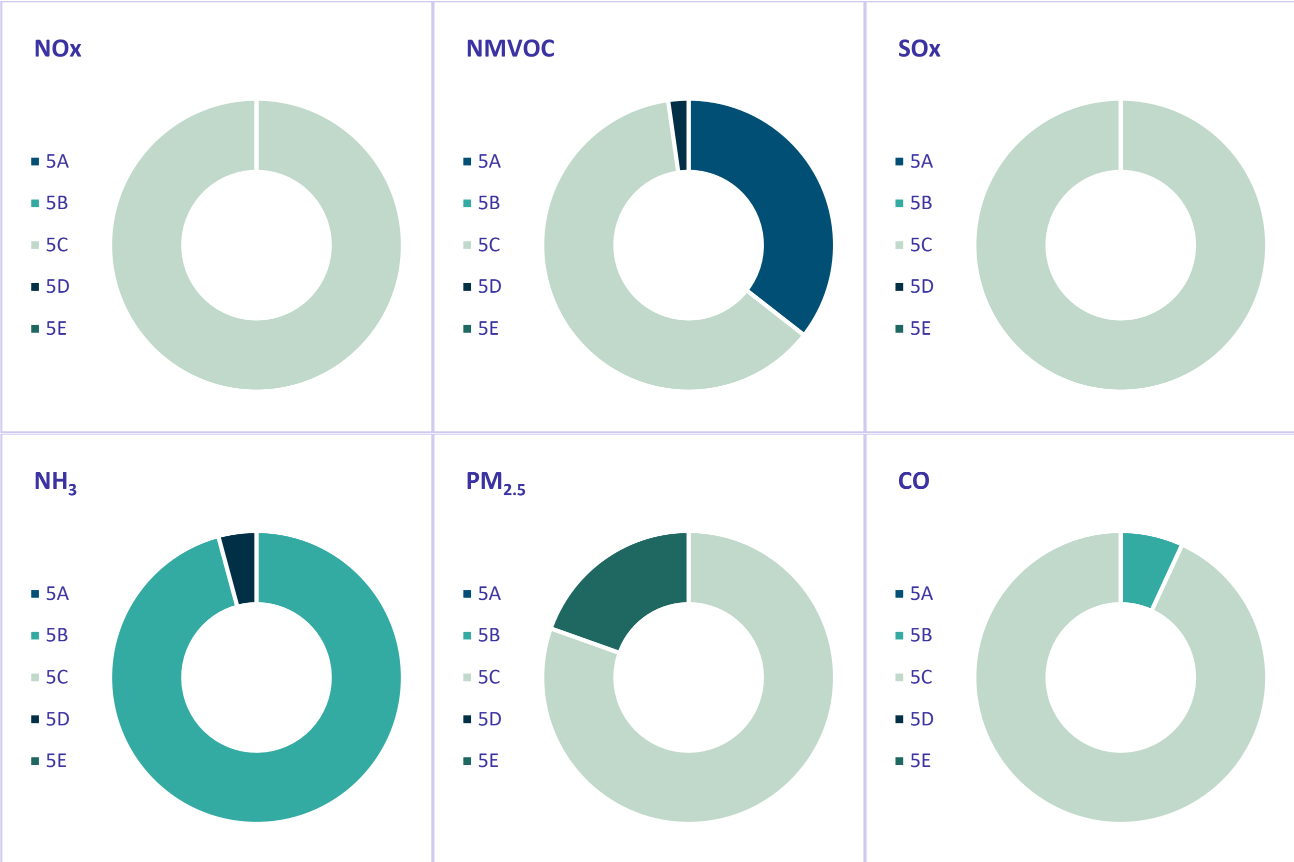


Figure 6.4 presents emissions of HMs and POPs are all emitted mostly from sources in the category of waste incineration (**5C**).

Figure 6.4: Share of subsectors of the waste sector on emissions of the HMs and POPs in 2023

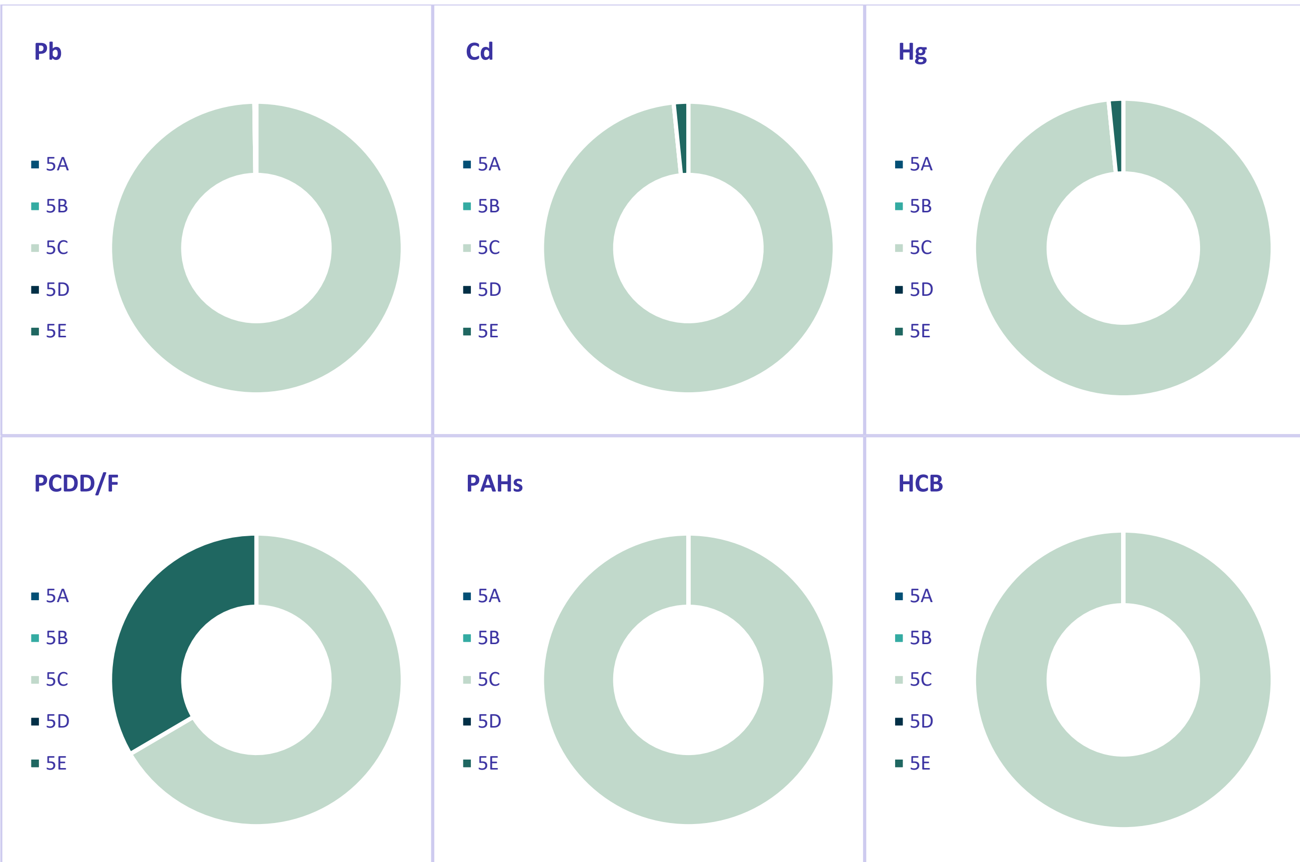


Table 6.2: *The overview of the pollutants in the Waste sector and their trends*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [k]
1990	0.2184	0.2666	0.0289	1.5248	0.5943	0.6654	0.7534	0.1136	7.3165
1995	0.1916	0.2413	0.0283	1.4356	0.5442	0.6092	0.6937	0.0975	6.3532
2000	0.2728	0.3206	0.0315	1.2755	0.7038	0.7854	0.8521	0.1435	9.1705
2005	0.4334	0.4609	0.0559	1.2154	1.0406	1.1601	1.2439	0.2309	14.6377
2010	0.4347	0.4853	0.0289	1.2231	1.0533	1.1602	1.2274	0.2337	14.9114
2011	0.4170	0.4778	0.0267	1.3364	1.0259	1.1212	1.1779	0.2250	14.4448
2012	0.2596	0.3572	0.0304	1.7740	0.7028	0.7656	0.8057	0.1359	8.9119
2013	0.2659	0.3617	0.0333	2.3088	0.7001	0.7650	0.8076	0.1366	8.9336
2014	0.4967	0.5431	0.0348	2.7906	1.1421	1.2510	1.3136	0.2689	17.2888
2015	0.4803	0.5292	0.0368	2.9483	1.1456	1.2589	1.3281	0.2581	16.7144
2016	0.4586	0.5192	0.0298	2.7710	1.0795	1.1677	1.2117	0.2492	16.1422
2017	0.4469	0.5113	0.0366	2.8617	1.0657	1.1508	1.1929	0.2432	15.8668
2018	0.4739	0.5271	0.0388	2.7410	1.1068	1.2056	1.2596	0.2553	16.6243
2019	0.4532	0.5086	0.0381	2.5173	1.0463	1.1420	1.1951	0.2428	15.7978
2020	0.3826	0.4505	0.0364	2.6393	0.9045	0.9821	1.0245	0.2015	13.4247
2021	0.3929	0.4555	0.0350	2.4861	0.9136	0.9858	1.0218	0.2051	13.6729
2022	0.3817	0.4465	0.0324	2.3267	0.9027	0.9767	1.0150	0.2031	13.6954
2023	0.3530	0.4206	0.0339	2.3380	0.8299	0.8973	0.9317	0.1872	12.6103
1990/2023	**62%**	**58%**	**17%**	**53%**	**40%**	**35%**	**24%**	**65%**	**72%**
2022/2023	**-8%**	**-6%**	**5%**	**0%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.8337	0.0581	0.2129	0.1015	0.0147	0.0814	0.0081	0.0107	1.8439
1995	0.8207	0.0557	0.2120	0.0895	0.0147	0.0773	0.0080	0.0092	1.5866
2000	0.9032	0.0650	0.2306	0.1250	0.0158	0.0924	0.0087	0.0136	2.3256
2005	1.1559	0.1011	0.1898	0.2002	0.0351	0.1625	0.0197	0.0220	3.8121
2010	0.7925	0.0801	0.1299	0.1945	0.0268	0.1358	0.0147	0.0224	3.8348
2011	0.6053	0.0728	0.1450	0.1843	0.0257	0.1332	0.0140	0.0216	3.6981
2012	0.5493	0.0686	0.0948	0.1204	0.0343	0.1326	0.0189	0.0133	2.3150
2013	0.6178	0.0784	0.0982	0.1242	0.0419	0.1538	0.0233	0.0135	2.3600
2014	0.5966	0.0899	0.0978	0.2207	0.0389	0.1771	0.0217	0.0260	4.4709
2015	0.7715	0.0913	0.0930	0.2155	0.0367	0.1660	0.0203	0.0249	4.2768
2016	0.2463	0.0754	0.0617	0.2003	0.0384	0.1695	0.0211	0.0242	4.1673
2017	0.2446	0.0830	0.0463	0.1983	0.0468	0.1911	0.0259	0.0237	4.1120
2018	0.4730	0.0900	0.0673	0.2107	0.0452	0.1893	0.0252	0.0248	4.2881
2019	0.4786	0.0863	0.0600	0.2010	0.0430	0.1790	0.0240	0.0237	4.0786
2020	0.3795	0.0791	0.0648	0.1688	0.0436	0.1712	0.0243	0.0199	3.4217
2021	0.2168	0.0726	0.0719	0.1683	0.0417	0.1676	0.0232	0.0204	3.4803
2022	0.2807	0.0744	0.0654	0.1677	0.0415	0.1669	0.0231	0.0200	3.4434
2023	0.2102	0.0591	0.0601	0.1516	0.0306	0.1319	0.0169	0.0184	3.1387
1990/2023	**-75%**	**2%**	**-72%**	**49%**	**108%**	**62%**	**109%**	**71%**	**70%**
2022/2023	**-25%**	**-21%**	**-8%**	**-10%**	**-26%**	**-21%**	**-27%**	**-8%**	**-9%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [t]	PCB [t]
1990	138.9502	0.3571	0.5607	0.6971	0.0001	1.6149	4.0231	36.0810
1995	137.4611	0.3092	0.4827	0.5994	0.0001	1.3914	3.9816	35.7081
2000	133.4897	0.4475	0.7067	0.8796	0.0001	2.0339	4.3276	38.8108

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [t]	PCB [t]
2005	105.8045	0.7142	1.1350	1.4150	0.0002	3.2643	10.6952	54.8167
2010	42.9654	0.7130	1.1441	1.4287	0.0002	3.2861	8.0240	37.0231
2011	29.6322	0.6811	1.0988	1.3737	0.0002	3.1538	7.6850	26.7346
2012	7.7321	0.4161	0.6660	0.8322	0.0002	1.9146	10.6576	28.2349
2013	7.4341	0.4197	0.6700	0.8372	0.0003	1.9272	13.1801	32.8763
2014	8.5962	0.8110	1.3118	1.6413	0.0003	3.7644	12.2922	29.3227
2015	7.8609	0.7849	1.2624	1.5775	0.0002	3.6251	11.3531	38.4297
2016	6.4511	0.7422	1.2108	1.5175	0.0003	3.4708	12.1989	12.7443
2017	5.5381	0.7241	1.1814	1.4813	0.0003	3.3871	15.0252	14.3672
2018	6.1882	0.7670	1.2437	1.5572	0.0003	3.5681	14.4085	25.2341
2019	5.0997	0.7307	1.1836	1.4817	0.0003	3.3963	13.7068	25.7805
2020	4.9597	0.6049	0.9812	1.2290	0.0003	2.8153	13.8905	21.3748
2021	5.1560	0.6109	0.9965	1.2496	0.0003	2.8573	13.3152	12.7313
2022	5.5070	0.6069	0.9878	1.2381	0.0003	2.8331	13.2594	15.8033
2023	4.9124	0.5583	0.9100	1.1404	0.0002	2.6090	9.6666	11.1031
1990/2023	**-96%**	**56%**	**62%**	**64%**	**162%**	**62%**	**140%**	**-69%**
2022/2023	**-11%**	**-8%**	**-8%**	**-8%**	**-27%**	**-8%**	**-27%**	**-30%**

Several categories were recalculated throughout the whole time series. Activity data from the national statistics for incineration of industrial waste were reconsidered since the submission in 2020, as there was a different definition of waste in national legislation and also the methodology for data collection and processing was not transparent and comparable with another national database. National statistics are based on information on waste production and the final waste treatment is not recorded. The same waste can be recorded in the national statistics database several times as it can change its categorisation (according to the waste catalogue) after its processing or sterilisation, which can lead to significant overestimations. Therefore, activity data from the NEIS database were used as these data are reported to the database by each of the operators. Activity data for emissions estimation of waste incineration were disaggregated into waste incineration with and without energy recovery. Emissions from waste incineration with energy recovery are reported under the energy sector (subcategory **1A**) and without energy utilisation are reported under **5C**. The methodology used for each category is summarised in the following table (***Table 6.3***).

Table 6.3: *The overview of the activity data source and methodology used for the Waste categories*

NFR	TIER	AD SOURCE	NEIS CATEGORIES (DECREE NO 410/2012)	METHOD FOR 2021 REPORTING	ALLOC./ NK
5A	T1	ŠÚ SR	-	$E_{TOTAL} = AD * EF_{GB2023}$	
5B1	T2	ŠÚ SR	-	$E_{TOTAL} = AD * EF_{GB2023}$	
5B2	T2	ŠÚ SR	-	$E_{TOTAL} = AD * EF_{GB2023}$	
5C1a	T3*	NEIS*	-	$E_{TOTAL} = AD * EF_{GB2023} - 1 - ATE$	1A1a
	T3	NEIS**	NEIS	E_{TOTAL} = 100% NEIS	1A1a
5C1bi	T2	NEIS	-	$E_{TOTAL} = AD * EF_{GB2023}$	
	T2	NEIS**	NEIS	$E_{TOTAL} = 100\%\ NEIS$	1A1b,1A2c; 1A2f
5C1bii	T2	NEIS	-	$E_{TOTAL} = AD * EF_{GB2023} - 1 - ATE$	
5C1biii	T2	NEIS	-	$E_{TOTAL} = AD * EF_{GB2023} - 1 - ATE$	
5C1biv	T2	VÚVH-SR	-	$E_{TOTAL} = AD * EF_{GB2023}$	
5C1bv	T1	Operators	-	$E_{TOTAL} = AD * EF_{GB2023}$	
5C1bvi	-	-	-	-	NO
5C2	T2	-	-	$E_{TOTAL} = AD * EF_{GB2023}$-	
5D1	T1/T2/T3	ŠÚ SR VÚVH SR	-	$E_{TOTAL} = AD * EF_{GB2023}$	

NFR	TIER	AD SOURCE	NEIS CATEGORIES (DECREE NO 410/2012)	METHOD FOR 2021 REPORTING	ALLOC./ NK
	T3	NEIS*1	NEIS	$E_{TOTAL} = 100\%\ NEIS$	
5D2	T1	ŠÚ SR		$E_{TOTAL} = AD * EF_{GB2023}$	
	T3	NEIS*1	NEIS	$E_{TOTAL} = 100\%\ NEIS$	
5D3					NO
5E	T2	PTaEÚ MV SR	-	$E_{TOTAL} = AD * EF_{GB2023}$	
6A	-	-	-	-	NO
* for POPs and heavy metals, ** with Energy Recovery, *1 emissions from biogas flaring in WWT plants,					
ATE –abatement technology efficiency					

6.2 SECTOR-SPECIFIC QA/QC AND VERIFICATION

QA/QC procedures in the waste sector are linked with the QA/QC plans and follow basic rules and activities of QA/QC as defined in EMEP/EEA GB_{2023}.

The QC checks (e.g. consistency check between NFR data and national statistics) were done during the NFR and IIR compilation, the General QC questionnaire was filled out and archived by the QA/QC manager.

Verification of activity data used for estimation of emissions from solid waste disposal to SWDS was performed by comparing reported year data to the previous year's data and data from the GHG inventory. Data on MSW composition were verified by comparing with the National Waste Management Plan and the National Strategy on Biodegradable Waste Management.

Verification of data on biological treatment was done by comparing data from the Statistical Office of the Slovak Republic (ŠÚ SR) with the National Strategy of Biodegradable Waste Management provided by the Ministry of Environment of the Slovak Republic (MŽP SR). Activity data were also compared with the data from the previous submission.

Verification of activity data and estimated emissions from municipal (MWI), industrial (IWI), hazardous (HWI) and clinical waste incinerators (CWI) was ensured by comparing data from the NEIS database with the data published by operators in their annual reports of operation. NEIS database has its QAQC procedures which ensure verification of the reported data.

Sewage sludge incineration data are verified by the Water Research Institute (VÚVH SR).

Verification of activity data and estimated emissions from Cremation was ensured by comparing data by comparing reported year data from the last submission.

Verification of activity data from Domestic and Industrial wastewater handling was ensured by comparing data with data published by the ŠÚ SR on the website, data used in the GHG inventory and data reported in the previous submission.

Data on population were obtained from the demographic information updated by the ŠÚ SR, from the Report on Water Management prepared by the Water Research Institute of the Slovak Republic (VÚVH SR) and from the national censuses.

Data on the use of retention tanks were based on population censuses done in the years 1991, 2001 and 2011, these censuses were also used to verify population distribution to individual wastewater pathways. Additional information was collected from the SHMÚ and the Association of Wastewater Treatment Experts. The data available in the statistical reports were verified by a comparison of the same category and previous years.

Verification of activity data from Other waste was ensured by comparing data with the previous year's submission.

6.3 IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

The reviews of the Waste Chapter by TERT resulted in one recommendation. This is described below and referenced in relevant paragraphs of this chapter. Improvements are implemented in line with the Improvement Plan for the year 2024.

Recommendation No. SK-5C2-2024-0001 asks to add an explanation of the increase in PM emissions in 2005. This is described in **Chapter 6.6.5**.
Several other improvements were implemented in this submission. Emissions from the categories **5C1bi**, **5C1bii** and **5C1biii** were recalculated using the Tier 2 methodology.
Emissions from sludge gas flaring were reallocated from **5D** in compliance with GHG inventory to category **1A5a**.
Several activity data corrections were implemented in the categories **5A**, **5B2**, **5Cb** and **5D1**

6.4 SOLID WASTE DISPOSAL ON LAND (NFR 5A)

6.4.1 Overview of the Category

The first legislation act, governing the disposal of waste in the Slovak Republic was adopted in 1992. Act No. 238/1991 Coll.[1] stipulated basic requirements for the operation of waste disposal sites and Governmental Regulation No. 606/1992[2] in Annex 5 defined three classes of waste disposal sites and technical requirements for their construction. The next legislative regulation on solid waste management and disposal entered into force on 1st July 2001. Act No 223/2001 Coll.[3] and Decree of the Ministry of Environment No. 283/2001 Coll.[4] contain new instruments for waste disposal minimization, monitoring of waste sites and landfill gas generation. Demand to increase the share of recycled waste resulted in the adoption of Act No. 79/2015 Coll.[5] on waste, which introduces extended responsibility of producers and transfers organisation and financing waste recycling schemes from the state to organisations of waste producers. Regulation No. 372/2015 Coll.[6] describes the technical parameters of landfills. New landfills must be provided with the building of the isolation by bio-membrane or geotextile, a drainage system and a degassing system.
These measurements decrease the release of emissions into the atmosphere. In 2016, new legislation restricting the landfill of bio-waste entered into force[7]. ***Table 6.4*** shows the activity data and emissions from this category.

Table 6.4: *Activity data and emissions in the category 5A*

YEAR	CH_4 [kt]	MINERAL WASTE HANDLED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	27.92	2933.27	2933.27	0.1005	0.0001	0.0006
1995	29.19	2394.27	2394.27	0.0967	0.0001	0.0005
2000	29.04	1886.08	1886.08	0.1113	0.0001	0.0004
2005	33.78	1794.18	1794.18	0.1313	0.0001	0.0004
2010	38.84	2030.78	2030.78	0.1507	0.0001	0.0004
2011	40.47	1759.22	1759.22	0.1561	0.0001	0.0004

[1] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1991/238/
[2] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1992/606/vyhlasene_znenie.html
[3] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/223/20160101
[4] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/283/20011201.html
[5] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/79/20170101
[6] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/372/20160101.html
[7] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/79/20170101

YEAR	CH_4 [kt]	MINERAL WASTE HANDLED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
2012	41.86	1487.65	1487.65	0.1594	0.0000	0.0003
2013	43.37	1701.31	1701.31	0.1616	0.0001	0.0004
2014	44.28	1914.97	1914.97	0.1601	0.0001	0.0004
2015	44.88	1644.90	1644.90	0.1625	0.0001	0.0004
2016	44.46	1374.82	1374.82	0.1625	0.0000	0.0003
2017	45.13	1267.71	1267.71	0.1625	0.0000	0.0003
2018	45.13	1160.60	1160.60	0.1626	0.0000	0.0003
2019	45.15	2147.29	2147.29	0.1614	0.0001	0.0005
2020	45.18	3133.99	3133.99	0.1599	0.0001	0.0007
2021	44.85	2892.13	2892.13	0.1592	0.0001	0.0006
2022	44.43	2650.27	2650.27	0.1542	0.0001	0.0006
2023	44.22	2608.15	2608.15	0.1495	0.0001	0.0006
1990/2023	**58%**	**-11%**	**-11%**	**49%**	**-11%**	**-11%**
2022/2023	**0%**	**-2%**	**-2%**	**-3%**	**-2%**	**-2%**

In comparison with the base year, emissions of NMVOC in this category show increasing character due to the continual disposal of waste on the landfill sites. Emissions of PMs decreased slightly in the long term, although in the last four years, the emissions increased.
To ensure the consistency and transparency of activity data for both GHG and AP inventory, the same amounts of sludge (sewage and industrial) landfilled are shown in ***Table 6.5***.

Table 6.5: *Amounts of sludge landfilled*

YEAR	SEWAGE SLUDGE LANDFILLED [kt]	INDUSTRIAL SLUDGE LANDFILLED [kt]
2000	13.80	NO
2005	8.53	0.79
2010	0.02	11.06
2011	2.31	7.62
2012	1.62	6.35
2013	1.67	1.46
2014	1.07	1.24
2015	1.71	0.90
2016	2.36	5.64
2017	2.64	1.06
2018	2.45	1.01
2019	2.30	1.33
2020	2.30	6.45
2021	0.46	6.03
2022	1.54	5.60
2023	0.49	1.66
2005/2023	**-94%**	**111%**
2022/2023	**-68%**	**-70%**

6.4.2 Methodological Issues

Activity data for this category was obtained from publications Waste in the Slovak Republic[8]. The amount of total mineral waste was calculated using waste categories (Mineral waste from construction and demolition, Other mineral waste, Mineral waste from waste treatment and stabilised wastes and Dredging spoils) handled from the Eurostat database for the period 2010-2022. Activity data in the period 1990-2010 were not available; therefore, extrapolated data were used (the amount of mineral waste landfilled was used as surrogate data).

[8] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

Tier 1 emission factors from EMEP/EEA GB_{2023} were used (***Table 6.6***). Emission factors used for calculation are shown in ***Table 6.6***.

Table 6.6: *Emission factors in the category of Solid waste disposal on land*

POLLUTANT	NMVOC	$PM_{2.5}$	PM_{10}	TSP
Unit	[kg/t CH_4]	[g/t]	[g/t]	[g/t]
Value	3.6	0.033	0.219	0.463

The **condensable component of PMs** is not included in EF.

6.4.3 Completeness

The ammonia and carbon monoxide emissions were reported as not estimated due to no emission factor being available. The notation key for these pollutants is NE.

6.4.4 Source-specific Recalculations

NMVOC emissions were recalculated in line with the recalculation of the CH4 emissions. Recalculations between 2011-202 were: based on revision MSW composition (% share of paper + garden + food) based on consideration of recycling share. In 2022, recovery disposal gas was wrongly reported by the external organisation for 2022 (ÚRSO), data was corrected and lowered. In 2010-2019, the Statistical Office of the Slovak Republic updated activity data for waste disposal with minor changes. Activity data for waste disposal in 2020-2022 was updated according to real data from the disposal companies, approved by MŽP SR, with minor changes of 5-10%.

PM emissions in 2021 and 2022 were recalculated due to an update of the activity data of the mineral waste. ***Table 6.7*** shows the difference between the 2023 and 2024 submissions and the percentage change.

Table 6.7: *Differences of activity data and emissions in the category 5A between previous submission and current submission caused by recalculations*

YEAR	AMOUNT OF MINERAL WASTE TREATED [kt]			NMVOC	$PM_{2.5}$	PM_{10}	TSP
	PREVIOUS	REVISED	CHANGE	CHANGE			
2009	1 227.90	1 227.90	-	0%	-	-	-
2010	2 030.78	2 030.78	-	0%	-	-	-
2011	1 759.22	1 759.22	-	0%	-	-	-
2012	1 487.65	1 487.65	-	-1%	-	-	-
2013	1 701.31	1 701.31	-	-1%	-	-	-
2014	1 914.97	1 914.97	-	-1%	-	-	-
2015	1 644.90	1 644.90	-	-1%	-	-	-
2016	1 374.82	1 374.82	-	-2%	-	-	-
2017	1 267.71	1 267.71	-	-2%	-	-	-
2018	1 160.60	1 160.60	-	-2%	-	-	-
2019	2 147.29	2 147.29	-	-3%	-	-	-
2020	3 133.99	3 133.99	-	-3%	-	-	-
2021	2 896.94	2 892.13	0%	-3%	0%	0%	0%
2022	2 692.17	2 650.27	-2%	-1%	-2%	-2%	-2%

6.5 BIOLOGICAL TREATMENT OF WASTE (NFR 5B)

6.5.1 Overview

Waste Framework Directive 2008/98/EC requires the Member States to reduce the disposal of biodegradable waste in landfills. The EU directive was transposed into the Slovak legislation in Act No 223/2001, Art. 18 (4)m), which stipulates that disposal of biologically degradable waste from parks and gardens together with the MSW is banned in the Slovak Republic from January 2006. There is a range of private and municipal companies, which provide composting of municipal and agricultural waste. With the support of the EU and Governmental grants, the number of municipalities composting waste is growing fast. Decree 348/2020[9] imposes on municipalities the obligation to collect kitchen waste and its subsequent recovery from 1.1.2021.

From this category, only emissions of NH_3 are emitted. An overview of the emission trend is shown in ***Table. 6.8***.

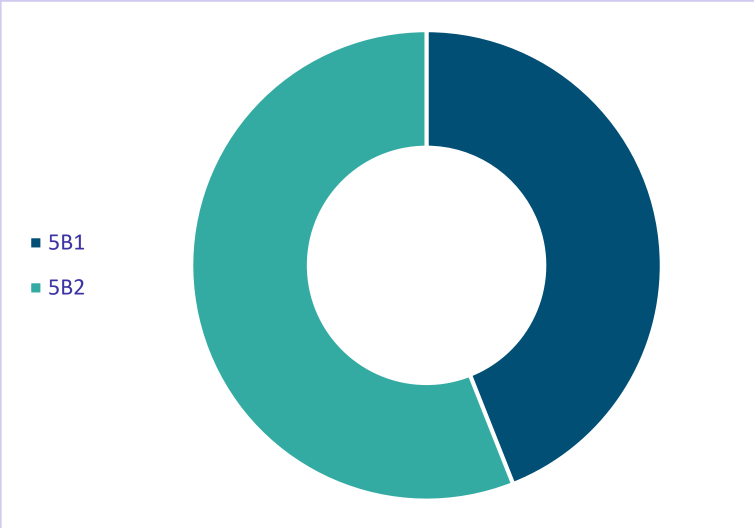
Table 6.8: *Overview of emissions in category 5B*

YEAR	NH_3 [kt]
1990	0.4283
1995	0.4385
2000	0.4391
2005	0.5118
2010	0.6818
2011	0.9327
2012	1.3802
2013	1.9948
2014	2.5401
2015	2.7119
2016	2.6107
2017	2.7939
2018	2.7061
2019	2.5041
2020	2.6296
2021	2.4774
2022	2.3180
2023	2.3293
1990/2023	**444%**
2022/2023	**0%**

Shares of emissions of NH_3 in the individual categories are shown in ***Figure 6.5***.

[9] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2020/348/vyhlasene_znenie.html

***Figure 6.5:** Share of NH_3 emissions of individual categories in 5B in 2023*



6.5.2 Composting (NFR 5B1)

6.5.2.1 Overview of the Category

In 2006 Act No. 223/2001 Coll. [10] came into force, which prohibits the landfilling of biodegradable waste from gardens and parks, including cemeteries and other green waste. The change in legislation also brought the obligation of municipalities to introduce and ensure the implementation of separate collection of biodegradable municipal waste except for that originating from the operator of the cantinas.

In the year 2004, there were four large or medium composting plants and their number increased from the year 2020 to 18. There is a range of private and municipal companies, which provide composting of municipal and agricultural waste. With the support of the EU and Governmental grants, the number of municipalities composting waste is growing fast.

Since the year 2007, the amount of composted biodegradable waste, as well as the NH_3 emissions from this category, is continually increasing. This increase was caused by improving composting plants capacity and political force on municipalities to create conditions for kitchen and garden waste from households to be composted which was strengthened by Decree 378/2020.

The emission of NH_3 and activity data from this source are displayed in ***Table 6.9***.

***Table 6.9:** Overview of the activity data, emissions and trends in the category of Composting of waste*

YEAR	COMPOSTED MUNICIPAL WASTE [kt]	COMPOSTRED INDUSTRIAL WASTE [kt]	COMPOSTED SEWAGE SLUDGE [kt]	COMPOSTED INDUSTRIAL SLUDGE [kt]	NH_3 [kt]	CO [kt]
1990	20.00	629.00	NE	NE	0.4283	0.3634
1995	35.46	629.00	NE	NE	0.4385	0.3721
2000	36.35	629.00	NE	NE	0.4391	0.3726
2005	45.00	579.15	NE	1 037.00	0.4119	0.3495
2010	90.72	578.54	47 140.00	6369	0.4417	0.3748
2011	99.84	652.55	50 111.00	9977	0.4966	0.4213
2012	122.76	726.56	46 446.00	7 099.00	0.5606	0.4756
2013	130.67	619.85	45 261.00	7 727.00	0.4953	0.4203
2014	145.11	728.11	36 524.00	4 632.00	0.5763	0.4890
2015	200.49	934.99	34 689.00	3 248.00	0.7494	0.6359
2016	212.48	713.26	34 695.00	3 353.00	0.6110	0.5184

[10] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/223/20160101

YEAR	COMPOSTED MUNICIPAL WASTE [kt]	COMPOSTRED INDUSTRIAL WASTE [kt]	COMPOSTED SEWAGE SLUDGE [kt]	COMPOSTED INDUSTRIAL SLUDGE [kt]	NH_3 [kt]	CO [kt]
2017	317.37	767.38	34 416.00	3 460.00	0.7159	0.6075
2018	378.56	783.56	32 982.00	3 520.00	0.7670	0.6508
2019	441.87	655.10	32 217.00	3 361.00	0.7240	0.6143
2020	662.87	789.44	36 562.00	3 893	0.9585	0.8133
2021	736.98	680.71	37 289.00	3 191.00	0.9357	0.7939
2022	754.80	996.19	33 509.00	1 905.00	1.1557	0.9806
2023	800.72	752.22	31 050.00	4 418.88	1.0249	0.8696
1990/2023	**3904%**	**20%**	**-**	**-**	**139%**	**139%**
2022/2023	**6%**	**-24%**	**-7%**	**132%**	**-11%**	**-11%**

6.5.2.2 Methodological Issues

Activity data provided by the Statistical Office of the Slovak Republic in the yearbook "*Waste in the Slovak Republic*" [11] was used. The amount of composted municipal solid waste has been published since 1992. The missing data for 1990 and 1991 were extrapolated. Data on industrial waste composting has been collected and published since 1997. Methodology and emission factors of Tier 2 – Windrow composting of garden and park wastefrom GB_{2023} were applied (***Table 6.10***). As a part of the change, the emissions of CO were added to the inventory.

Table 6.10: *Emission factors in the category of Composting of waste*

POLLUTANT	NH_3	CO
Unit	[kg/t]	[kg/t]
Value	0.66	0.56

6.5.2.3 Completeness

Notation keys used were following EMEP/EEA GB_{2023}.

6.5.2.4 Source-specific Recalculations

Emissions were recalculated due to change of the techology used for composting of waste (***Table 6.11***), as it is now in compliance with the approach used in the GHG inventory.

Table 6.11: *Differences of NH_3 emissions in the category 5B1 between previous submission and current submission caused by recalculations*

YEAR	NH_3
1990	175%
1991	175%
1992	175%
1993	175%
1994	175%
1995	175%
1996	175%
1997	175%
1998	175%
1999	175%
2000	175%
2001	175%
2002	175%

[11] Waste in the Slovak Republic – Yearbook – available since 2008, https://slovak.statistics.sk/

2003	175%
2004	175%
2005	175%
2006	175%
2007	175%
2008	175%
2009	175%
2010	175%
2011	175%
2012	175%
2013	175%
2014	175%
2015	175%
2016	175%
2017	175%
2018	175%
2019	175%
2020	175%
2021	175%
2022	175%

6.5.3 Anaerobic Digestion at Biogas Facilities (NFR 5B2)

6.5.3.1 Overview of the Category

No biogas facilities operated in the Slovak Republic until the year 2001. In 2009, only seven biogas facilities were recorded. After Act No. 309/2009 Coll.[12] on Support of Renewable Energy Sources and High-Efficiency Combined Heat and Power (CHP) Generation entered into force, the development of biogas facilities was significant.

After Decree No. 221/2013 Coll.[13], which provides price regulation in the electricity sector, entered into force, emissions started to increase in 2014. ***Table 6.12*** shows the NH_3 emission trend in this category.

Table 6.12: *Overview of the activity data, emissions and trends in the category Anaerobic digestion at biogas facilities*

YEAR	NITROGEN INTO BIOGAS FACILITY [kt]	NH_3 [kt]
2005	91.34	0.0998
2010	219.67	0.2401
2011	399.09	0.4361
2012	749.98	0.8196
2013	1 372.03	1.4994
2014	1 796.88	1.9637
2015	1 795.72	1.9625
2016	1 829.76	1.9997
2017	1 901.41	2.0780
2018	1 774.35	1.9391
2019	1 628.87	1.7801
2020	1 529.10	1.6711
2021	1 410.77	1.5418
2022	1 063.59	1.1623

[12] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2009/309/20150801
[13] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2013/221/vyhlasene_znenie.html

YEAR	NITROGEN INTO BIOGAS FACILITY [kt]	NH_3 [kt]
2023	1 193.54	1.3044
2005/2023	**1207%**	**1207%**
2021/2023	**12%**	**12%**

6.5.3.2 Methodological Issues

The biggest part of biogas facilities is energy producers, so emissions from the incineration of biogas are allocated into **1A5a**. This category includes only the production of biogas. The amount of nitrogen entering the biogas facility was used as activity data. This amount was balanced by the nitrogen cycle used in the agricultural sector and also an amount of waste, energy crops and others were added to the calculation of the total amount of nitrogen entering the biogas facility. Tier 2 emission factor for pre-storage from EMEP/EEA GB_{2023} was used.

6.5.3.3 Completeness

Notation keys used in the inventory follow the EMEP/EEA GB_{2023}.

6.5.3.4 Source-specific Recalculations

Emissions of NH_3 for category **5B2** were recalculated in this submission due to changes in activity data on the production of biogas of other waste. The revision was carried out due to an error in the trend of activity data, which was shifted by one year. For 2021 to 2022, the activity data on biogas production were taken from the National Emissions Information System (NEIS – see Energy chapter). These data cover all biogas plants in Slovakia. Most changes are visible in 2001 and 2022 (-30% and +88%) (***Table 6.13***).

Table 6.13: *Differences of NH_3 activity data and emissions in the category 5B2 between previous submission and current submission caused by recalculations*

YEAR	AMOUNT OF NITROGEN ENTERING INTO BIOGAS FACILITY [kt]			NH_3
	PREVIOUS	REVISED	CHANGE	CHANGE
2001	56.21	73.87	31%	31%
2002	73.87	73.61	0%	0%
2003	73.61	77.87	6%	6%
2004	77.87	85.75	10%	10%
2005	85.75	91.34	7%	7%
2006	91.34	99.86	9%	9%
2007	99.86	117.14	17%	17%
2008	117.14	132.95	13%	13%
2009	132.95	141.66	7%	7%
2010	141.66	219.67	55%	55%
2011	219.67	399.09	82%	82%
2012	399.09	749.98	88%	88%
2013	749.98	1 372.03	83%	83%
2014	1 372.03	1 796.88	31%	31%
2015	1 796.88	1 795.72	0%	0%
2016	1 795.72	1 829.76	2%	2%
2017	1 829.76	1 901.41	4%	4%
2018	1 901.41	1 774.35	-7%	-7%
2019	1 774.35	1 628.87	-8%	-8%
2020	1 628.87	1 529.10	-6%	-6%
2021	1 529.10	1 410.77	-8%	-8%
2022	1 523.38	1 063.59	-30%	-30%

6.6 WASTE INCINERATION AND OPEN BURNING OF WASTE (5C)

6.6.1 Overview

Incineration of waste is an accepted practice in the Slovak Republic. It is regulated following EU waste legislation. After a period of modernisation of the waste incineration sector, smaller and non-compliant facilities were replaced by more modern ones.

The following facilities for waste incineration were in operation in 2022:

- Two large MSW incinerators with energy utilisation;
- Five ISW incinerators (three of them with energy utilisation, one of them is co-incinerating wastewater sludge);
- One clinical waste incinerator without energy utilisation;
- One incinerator for rendering plant residues;
- Five facilities co-incinerating ISW (cement and lime kilns).[14]

Not all emissions from waste incineration follow the same trend. Main pollutants (except NMVOC) are increasing as the amount of incinerated waste is growing slowly. Heavy metals and POPs emissions have generally decreased as many abatement technologies to reduce them were installed (***Table 6.14***).

In this submission, emissions in categories **5C1bi**, **5C1bii** and **5C1biii** were recalculated using the Tier 2 emissions factor of thenew EMEP/EEA GB_{2023}. In category **5C1bv**, activity data was corrected.

Table 6.14: *Overview of emission trends reported in category 5C*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.2184	0.1577	0.0289	0.4559	0.5264	0.6137	0.1136	6.9531
1995	0.1916	0.1354	0.0283	0.3985	0.4631	0.5469	0.0975	5.9811
2000	0.2728	0.1992	0.0315	0.5651	0.6464	0.7127	0.1435	8.7979
2005	0.4334	0.3202	0.0559	0.8895	1.0086	1.0920	0.2309	14.2882
2010	0.4347	0.3243	0.0289	0.8748	0.9812	1.0480	0.2337	14.5366
2011	0.4170	0.3133	0.0267	0.8284	0.9234	0.9797	0.2250	14.0235
2012	0.2596	0.1898	0.0304	0.5101	0.5726	0.6123	0.1359	8.4363
2013	0.2659	0.1910	0.0333	0.5160	0.5806	0.6228	0.1366	8.5133
2014	0.4967	0.3745	0.0348	0.9810	1.0896	1.1518	0.2689	16.7998
2015	0.4803	0.3585	0.0368	0.9579	1.0710	1.1398	0.2581	16.0786
2016	0.4586	0.3481	0.0298	0.8859	0.9738	1.0174	0.2492	15.6238
2017	0.4469	0.3402	0.0366	0.8629	0.9478	0.9896	0.2432	15.2593
2018	0.4739	0.3561	0.0388	0.9233	1.0220	1.0756	0.2553	15.9735
2019	0.4532	0.3386	0.0381	0.8812	0.9764	1.0290	0.2428	15.1835
2020	0.3826	0.2816	0.0364	0.7275	0.8046	0.8462	0.2015	12.6114
2021	0.3929	0.2874	0.0350	0.7285	0.8001	0.8355	0.2051	12.8790
2022	0.3817	0.2843	0.0324	0.7259	0.7994	0.8371	0.2031	12.7149
2023	0.3530	0.2617	0.0339	0.6675	0.7344	0.7682	0.1872	11.7406
1990/2023	**62%**	**66%**	**17%**	**46%**	**40%**	**25%**	**65%**	**69%**
2022/2023	**-8%**	**-8%**	**5%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.8333	0.0573	0.2121	0.1002	0.0135	0.0786	0.0081	0.0107	1.8439
1995	0.8202	0.0548	0.2111	0.0881	0.0134	0.0743	0.0080	0.0092	1.5866
2000	0.9028	0.0642	0.2297	0.1237	0.0145	0.0896	0.0087	0.0136	2.3256
2005	1.1554	0.1002	0.1889	0.1988	0.0338	0.1594	0.0197	0.0220	3.8121

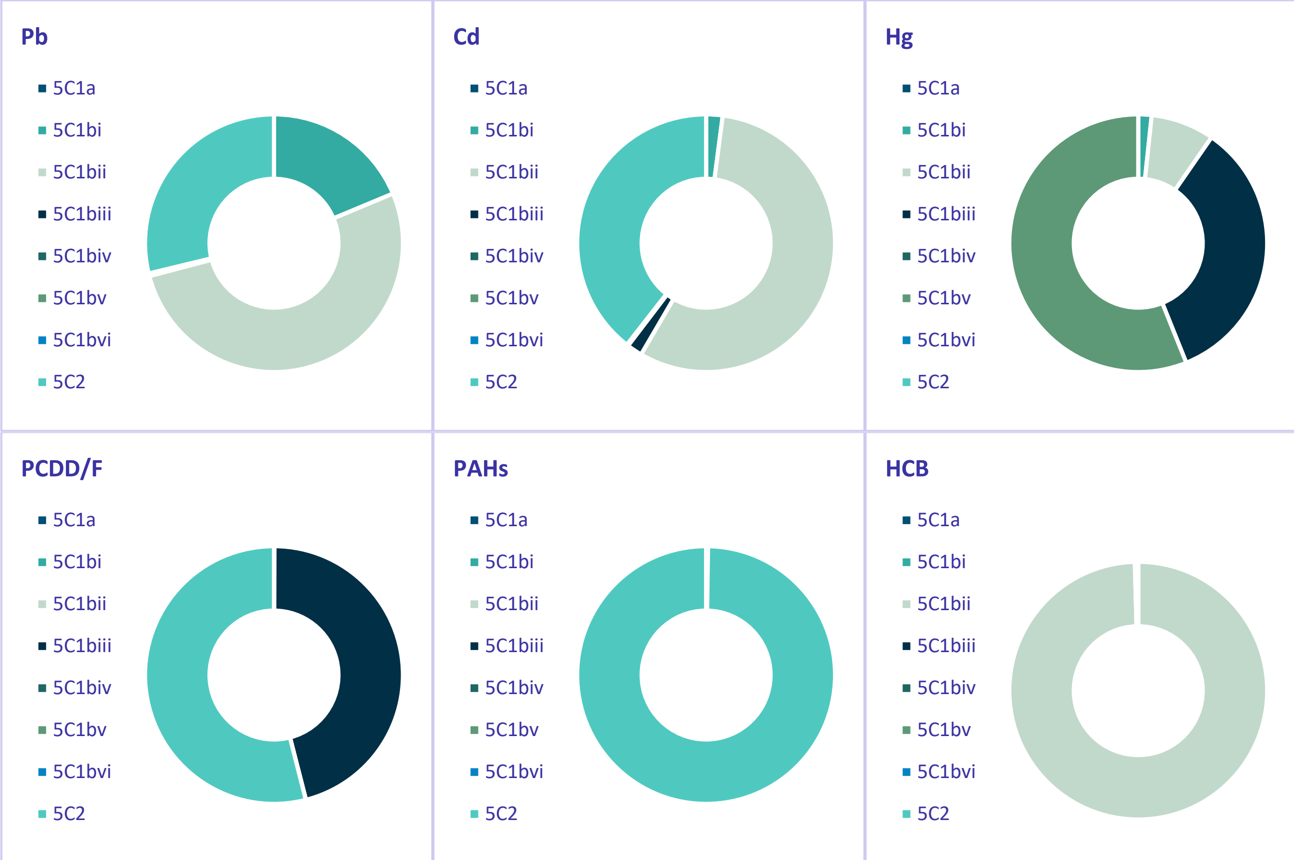
[14] https://www.enviroportal.sk/ovzdusie/zoznam-spalovni-a-zariadeni-na-spoluspalovanie-odpadov-r-2019 (only in Slovak language)

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2010	0.7920	0.0791	0.1288	0.1928	0.0252	0.1321	0.0147	0.0224	3.8348
2011	0.6048	0.0716	0.1438	0.1825	0.0239	0.1292	0.0140	0.0216	3.6981
2012	0.5487	0.0674	0.0936	0.1186	0.0326	0.1286	0.0189	0.0133	2.3150
2013	0.6173	0.0774	0.0971	0.1225	0.0403	0.1500	0.0233	0.0135	2.3600
2014	0.5962	0.0889	0.0968	0.2192	0.0375	0.1738	0.0217	0.0260	4.4709
2015	0.7710	0.0902	0.0919	0.2138	0.0351	0.1621	0.0203	0.0249	4.2768
2016	0.2457	0.0743	0.0606	0.1985	0.0367	0.1655	0.0211	0.0242	4.1673
2017	0.2440	0.0818	0.0451	0.1964	0.0450	0.1869	0.0259	0.0237	4.1120
2018	0.4725	0.0890	0.0663	0.2090	0.0436	0.1855	0.0252	0.0248	4.2881
2019	0.4781	0.0853	0.0591	0.1995	0.0416	0.1756	0.0240	0.0237	4.0786
2020	0.3790	0.0781	0.0637	0.1672	0.0420	0.1676	0.0243	0.0199	3.4217
2021	0.2162	0.0715	0.0708	0.1666	0.0401	0.1638	0.0232	0.0204	3.4803
2022	0.2802	0.0733	0.0644	0.1660	0.0399	0.1633	0.0231	0.0200	3.4434
2023	0.2098	0.0581	0.0591	0.1501	0.0292	0.1286	0.0169	0.0184	3.1387
1990/2023	**-75%**	**2%**	**-72%**	**50%**	**116%**	**64%**	**109%**	**71%**	**70%**
2022/2023	**-25%**	**-21%**	**-8%**	**-10%**	**-27%**	**-21%**	**-27%**	**-8%**	**-9%**

YEAR	PCDD/F [g I-TEQ]	PAHs[t]	HCB [kg]	PCBs [kg]
1990	137.5468	0.3571	0.5607	0.6971
1995	135.9838	0.3092	0.4827	0.5994
2000	132.0845	0.4475	0.7067	0.8796
2005	104.2725	0.7142	1.1350	1.4150
2010	41.1536	0.7130	1.1441	1.4287
2011	27.6327	0.6811	1.0988	1.3737
2012	5.7792	0.4161	0.6660	0.8322
2013	5.5675	0.4197	0.6700	0.8372
2014	6.9610	0.8110	1.3118	1.6413
2015	5.9587	0.7849	1.2624	1.5775
2016	4.4891	0.7422	1.2108	1.5175
2017	3.4848	0.7241	1.1814	1.4813
2018	4.3282	0.7670	1.2437	1.5572
2019	3.4269	0.7307	1.1836	1.4817
2020	3.1682	0.6049	0.9812	1.2290
2021	3.2874	0.6109	0.9965	1.2496
2022	3.7208	0.6069	0.9878	1.2381
2023	3.2693	0.5583	0.9100	1.1404
1990/2023	**-98%**	**56%**	**62%**	**64%**
2022/2023	**-12%**	**-8%**	**-8%**	**-8%**

Waste incineration contributes mostly to emissions of heavy metals and POPs. The figure below represents shares of emissions through the categories of **5C**.

Figure 6.6: Share of emissions of individual categories in 5C in 2023



6.6.2 Municipal Solid Waste Incineration (NFR 5C1a)

6.6.2.1 Overview of the Category

There are two large municipal waste incinerators in the country, in Bratislava and Košice. The MSW incinerator in Bratislava was put into operation in 1978 and significantly modernised in 2002. Currently installed capacity is 135 Gg/y, and the incinerator can be characterised as a continuously operated stoker. The MSW incinerator in Košice with a capacity of 80 Gg/yr was put in full operation in 1992, modernised to achieve compliance with emission standards in 2005 and reconstructed (boiler replacement and electricity generation) in 2014. Both incineration plants generate heat (steam) and electricity. For this reason, emissions from MSW incineration are included completely in the energy sector, category **1A1a**.

The trend of the amount of incinerated municipal waste is displayed in ***Table 6.14***. As shown, the amount of incinerated municipal waste shows a slightly increasing trend since 1990, due to the gradual prioritization of MSW incineration before landfilling.

Municipal waste incineration with energy recovery is a key category for the main heavy metals (Pb, Cd, Hg), several additional heavy metals (As, Ni, Se), PCDD/F and HCB. Emissions of these pollutants decreased significantly in the year 2003 for the OLO in Bratislava due to extensive reconstruction of the incineration plant and the installation of a modern air pollution control system. Incineration plant KOSIT was reconstructed in the year 2005, also part of it was the installation of the new air pollution control system, therefore emissions for this plant decreased significantly since the year 2006 (***Table 6.15***).

Table 6.15: *Overview of the activity data, emissions and trends in the category of Municipal waste incineration*

YEAR	MSW [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	179.61	0.3233	0.0036	0.3053	0.0005	1.6524	2.4606	3.2868	0.0578	0.1257
1995	159.34	0.2868	0.0032	0.2709	0.0005	1.4660	2.1830	2.9160	0.0513	0.1115
2000	220.21	0.3964	0.0044	0.3744	0.0007	1.2825	1.9098	2.5510	0.0449	0.1541

YEAR	MSW [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2005	193.18	0.2224	0.0016	0.0385	0.0006	0.0055	0.0082	0.0110	0.0002	0.0479
2010	191.93	0.1381	0.0018	0.0066	0.0006	0.0007	0.0010	0.0013	0.0000	0.0096
2011	204.13	0.1628	0.0018	0.0069	0.0006	0.0005	0.0007	0.0009	0.0000	0.0084
2012	180.55	0.1578	0.0020	0.0063	0.0005	0.0009	0.0013	0.0017	0.0000	0.0076
2013	181.52	0.1398	0.0026	0.0075	0.0005	0.0008	0.0012	0.0016	0.0000	0.0082
2014	211.89	0.1504	0.0023	0.0109	0.0006	0.0012	0.0018	0.0023	0.0000	0.0173
2015	200.76	0.1239	0.0021	0.0067	0.0006	0.0008	0.0012	0.0016	0.0000	0.0083
2016	216.54	0.1426	0.0016	0.0087	0.0006	0.0008	0.0012	0.0016	0.0000	0.0088
2017	231.89	0.1450	0.0016	0.0096	0.0007	0.0011	0.0016	0.0021	0.0000	0.0133
2018	245.61	0.1541	0.0018	0.0094	0.0007	0.0009	0.0013	0.0017	0.0000	0.0114
2019	243.04	0.1619	0.0007	0.0055	0.0007	0.0013	0.0019	0.0026	0.0000	0.0074
2020	234.51	0.1515	0.0008	0.0051	0.0007	0.0008	0.0013	0.0017	0.0000	0.0068
2021	230.71	0.1564	0.0008	0.0047	0.0007	0.0008	0.0012	0.0015	0.0000	0.0096
2022	239.15	0.1757	0.0007	0.0039	0.0007	0.0009	0.0013	0.0018	0.0000	0.0085
2023	254.65	0.1936	0.0017	0.0064	0.0008	0.0009	0.0014	0.0018	0.0000	0.0088
1990/2023	**42%**	**-40%**	**-54%**	**-98%**	**42%**	**-100%**	**-100%**	**-100%**	**-100%**	**-93%**
2022/2023	**6%**	**10%**	**143%**	**64%**	**6%**	**4%**	**4%**	**4%**	**4%**	**3%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	18.6791	0.6107	0.5029	0.3844	0.0332	0.0167	0.0216	0.0021	0.1616
1995	16.5718	0.5418	0.4462	0.3410	0.0295	0.0148	0.0191	0.0019	0.1434
2000	22.9021	0.7487	0.6166	0.4713	0.0407	0.0205	0.0264	0.0026	0.1982
2005	7.6674	0.2525	0.2096	0.1592	0.0158	0.0091	0.0124	0.0023	0.0986
2010	0.0086	0.0033	0.0054	0.0019	0.0036	0.0048	0.0078	0.0022	0.0518
2011	0.0092	0.0035	0.0057	0.0020	0.0038	0.0051	0.0082	0.0024	0.0551
2012	0.0081	0.0031	0.0051	0.0018	0.0033	0.0045	0.0072	0.0021	0.0487
2013	0.0081	0.0031	0.0051	0.0018	0.0034	0.0045	0.0073	0.0021	0.0490
2014	0.0093	0.0036	0.0059	0.0020	0.0039	0.0054	0.0088	0.0025	0.0572
2015	0.0090	0.0034	0.0056	0.0020	0.0037	0.0050	0.0081	0.0023	0.0542
2016	0.0095	0.0037	0.0061	0.0021	0.0040	0.0056	0.0090	0.0025	0.0585
2017	0.0100	0.0039	0.0065	0.0021	0.0043	0.0061	0.0099	0.0027	0.0626
2018	0.0104	0.0042	0.0069	0.0022	0.0045	0.0067	0.0108	0.0029	0.0663
2019	0.0104	0.0041	0.0068	0.0022	0.0045	0.0066	0.0106	0.0028	0.0656
2020	0.0099	0.0040	0.0066	0.0021	0.0043	0.0064	0.0103	0.0027	0.0633
2021	0.0097	0.0039	0.0065	0.0020	0.0043	0.0063	0.0102	0.0027	0.0623
2022	0.0100	0.0041	0.0067	0.0021	0.0044	0.0066	0.0107	0.0028	0.0646
2023	0.0106	0.0043	0.0071	0.0022	0.0047	0.0071	0.0115	0.0030	0.0688
1990/2023	**-100%**	**-99%**	**-99%**	**-99%**	**-86%**	**-57%**	**-47%**	**42%**	**-57%**
2022/2023	**6%**	**6%**	**6%**	**5%**	**6%**	**7%**	**7%**	**6%**	**6%**

YEAR	PCDD/F [g I-TEQ]	PAHs[t]	HCB [kg]	PCBs [kg]
1990	628.6224	0.0008	0.0006	0.0006
1995	557.7038	0.0007	0.0005	0.0005
2000	770.7454	0.0009	0.0007	0.0007
2005	258.2458	0.0008	0.0006	0.0006
2010	0.6718	0.0008	0.0006	0.0006
2011	0.7145	0.0009	0.0007	0.0006
2012	0.6319	0.0008	0.0006	0.0006
2013	0.6353	0.0008	0.0006	0.0006
2014	0.7416	0.0009	0.0007	0.0007

YEAR	PCDD/F [g I-TEQ]	PAHs[t]	HCB [kg]	PCBs [kg]
2015	0.7026	0.0008	0.0006	0.0006
2016	0.7579	0.0009	0.0007	0.0007
2017	0.8116	0.0010	0.0007	0.0007
2018	0.8596	0.0010	0.0008	0.0008
2019	0.8507	0.0010	0.0008	0.0008
2020	0.8208	0.0010	0.0008	0.0007
2021	0.8075	0.0010	0.0007	0.0007
2022	0.8370	0.0010	0.0008	0.0007
2023	0.8913	0.0011	0.0008	0.0008
1990/2023	-100%	42%	42%	42%
2022/2023	6%	6%	6%	6%

6.6.2.2 Methodological Issues

Activity data on incinerated MSW are based on the data reported to the NEIS database by individual incinerators. Data on total municipal waste incinerated[15] were used to calculate emissions in this category. There are no MSW incinerators without energy recovery in the Slovak Republic, therefore these emissions are reported in category **1A1a** as these operators use waste to produce energy and heat which is sold to the clients through the central heating system.

Activity data from the NEIS database was verified with other sources of data (see **ANNEX VIII**) and for consistency, the NEIS database data was considered the best for the inventory.

For reporting emissions of NO_X, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10} data from the NEIS database for the period 2005-2020 were applied. For the period 1990-2004, extrapolated data based on total MWS incinerated were used. Municipal solid waste incineration (MSWI) sources assigned to category 5.1 (according to Annex No. 6 of Decree No. 410/2012 Coll.[16] as amended) are defined as Waste incineration plants: a/ burning hazardous waste with a projected capacity in t/d; b/ burning non-hazardous waste with a capacity in t/h. Further selection based on the NACE categorisation and SNAP coding in the database is also applied to separate the installation of combusted industrial waste.

Tier 2 emission factors from $EMEP/EEAGB_{2019}$ for heavy metals and POPs were used in calculations of emissions except for Selene and Ideno(1,2,3)Pyrene for which Tier 1 emission factors were used. Abatement technology efficiency for heavy metals was calculated separately for each operator by comparing emissions factors from data from discontinuous measurements of heavy metals on stokes with the value of EMEP/EEA GB_{2019} Tier 2 emission factors for uncontrolled incinerators. The average value of abatement technology efficiency excluding extreme values was used for the calculation of heavy metals emissions in this submission. For the period 1990-2002, no data about abatement technology was recorded, therefore only emission factors for uncontrolled plants were used.

Values of emission factors are given in ***Table 6.16*** and values of abatement technology efficiency, separately for each operator in ***Table 6.17***.

Table 6.16: *Emission factors in the category of Municipal waste incineration*

POLLUTANT	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Unit	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
Value	104	3.4	2.8	2.14	0.185	0.093	0.12	0.0117	0.9

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCB
Unit	[mg I-TEQ/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[g/t]	[mg/t]
Value	3.5	4.2	3.2	3.1	0.0116	10.5116	0.002	5.3

[15] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/
[16] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2012/410/

Table 6.17: Abatement technology efficiency for heavy metals and PCDD/F in the category of Municipal waste incineration from the year 2003

OLO	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn	PCDD/F
Value	99.95%	99.5%	99%	99.4%	90%	80%	75%	70%	99.9%

KOSIT	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn	PCDD/F
Value	99.97%	99.5%	99%	99.8%	90%	60%	50%	70%	99.9%

6.6.2.3 Completeness

Municipal waste incineration without energy recovery is not occurring in the Slovak Republic, therefore notation key NO was used. Emissions from MSW incineration with energy recovery were reported in the energy sector under **1A1a**.

6.6.2.4 Source-specific Recalculations

No recalculations in this submission.

6.6.3 Non-municipal Solid Waste Incineration (NFR 5C1b)

6.6.3.1 Overview of the Category

The non-municipal waste incineration sector has undergone significant changes since 1990, but detailed research on their impact has not been done, yet. The key drivers of these changes were stricter legislation, the new standards (EU approximation) and the commercialisation of waste services. This led to replacing small incineration units in factories with regional incinerators. Existing large incinerators were modernised to comply with the new standards or were decommissioned.

From the total of 12 non-MSW incinerators and co-incineration plants operating in 2023, only the Slovnaft and waste co-incineration plants have installed capacity exceeding 2 t/hour. The following companies are using the largest waste incineration facilities:

- Slovnaft Inc., Bratislava (3.7 t/hour) – incinerate industrial sludge with energy recovery;
- Duslo Inc., Šaľa (1.26 t/hour) – with energy recovery;
- Light Stabilizers Ltd., Strážske (0.18 t/hour) – without energy recovery;
- Fecupral Ltd.., Prešov (0.15 t/hour) – without energy recovery;
- Archiv SB Ltd., Liptovský Mikuláš (0.15 t/hour) – without energy recovery;
- FCC Environment Ltd., Kysucké Nové Mesto (0.4 t/hour) – without energy recovery.

Incineration of medical waste occurs in the following plants:

- University H, Martin (0.098 t/hour) - without energy recovery ;

Co-incineration of waste-derived fuels occurs in the following plants:

- CRH Inc., Rohožník (34.5 t/hour) – cement production – with energy recovery;
- CRH Inc., Turňa nad Bodvou (9 t/hour) – cement production – with energy recovery;
- Carmeuse Ltd., Košice-Šaca (7.2 t/hour) - lime production – with energy recovery;
- Cemmac Inc., Horné Sŕnie (65,5 t/year) - cement production – with energy recovery;
- Považská cementáreň Inc., Ladce (.5 t/hour) - cement production – with energy recovery.

Most of the industrial waste is burned in co-incineration plants producing cement and lime. These emissions are allocated in category **1A2f**. The increasing trend of incinerated waste in this category is caused by the increase in the price of traditional fuels and political support for the energy recovery of waste instead of its disposal.

Emissions from ISW burned with energy recovery in the Slovnaft incineration plant were allocated in **1A1b** and the Duslo incineration plant in **1A2c**.

Emissions from ISW burned without energy recovery are allocated in the category **5C1bi** (including industrial sludge). Emissions from the Light Stabilizers incineration plant were allocated in category **2B10a**. Emissions from the plants which incinerate mostly hazardous waste (Fecupral, Archiv SB, FCC Environment) were allocated in category **5C1bii**, emissions from plants incinerating medical waste in category **5C1biii** and emissions from incineration of sewage sludge in category **5C1biv**.

The trend of incinerated waste in this category is relatively stable except for the peak in 2005 when operators used the last year before stricter emission limits, connected with entering the Slovak Republic to the EU, and burned twice as much waste as the year after. Also, many incineration plants were closed after 2005 due to outdated technology.

In this category, emissions from sources without energy recovery are included. ***Table 6.18*** shows activity data of waste incineration with and without energy recovery and its allocation into NFR categories.

Table 6.18: *Overview of activity data and allocation into NFR categories*

YEAR	NON-MSW INCINERATED WITH E RECOVERY [kt]	NON-MSW INCINERATED WITHOUT E RECOVERY [kt]	1A1b [kt]	1A2c [kt]	1A2f [kt]	2B10a [kt]	5C1bi [kt]	5C1bii [kt]	5C1biii [kt]
1990	49.87	4.19	13.00	35.05	1.82	NO	NO	0.78	3.41
1995	46.69	10.22	13.02	32.20	1.47	NO	6.07	0.77	3.38
2000	41.82	11.10	13.01	27.70	1.11	NO	6.60	0.84	3.67
2005	59.86	13.35	11.98	7.40	40.48	NO	8.45	2.21	2.68
2010	180.75	10.03	1.47	6.73	172.55	1.14	5.56	1.67	1.66
2011	204.78	8.43	5.39	6.75	192.64	1.10	3.69	1.59	2.06
2012	213.32	7.62	3.33	5.48	204.51	0.84	3.42	2.24	1.11
2013	255.89	8.54	12.51	4.80	238.57	0.88	3.84	2.78	1.05
2014	295.81	7.82	3.73	3.81	288.27	0.81	3.33	2.59	1.09
2015	289.03	9.35	3.55	4.51	280.97	0.87	5.21	2.39	0.87
2016	302.04	3.33	3.25	4.52	294.28	NO	0.21	2.58	0.53
2017	323.33	4.61	3.84	5.31	314.18	1.13	NO	3.19	0.30
2018	319.12	6.86	2.16	5.10	311.86	1.16	2.16	3.05	0.48
2019	351.73	6.61	2.39	4.07	345.27	1.02	2.39	2.91	0.28
2020	372.41	5.36	1.51	4.04	366.85	0.57	1.53	2.95	0.32
2021	390.70	3.31	1.48	2.70	386.52	0.15	NO	2.82	0.34
2022	314.71	3.85	1.85	3.00	309.86	NO	0.59	2.81	0.45
2023	343.80	46.91	1.60	2.72	339.48	44.24	0.35	1.94	0.38
1990/2023	**589%**	**354%**	**-88%**	**-92%**	**18554%**	**-**	**-94%**	**149%**	**-89%**
2022/2023	**9%**	**1117%**	**-13%**	**-15%**	**10%**	**-**	**-40%**	**-31%**	**-17%**

6.6.3.2 Category-specific Recalculations

In this submission, several recalculation were made in categories **5C1bi**, **5C1bii** and **5C1biii** due to improvement of the methodology to the Tier 2 level and implementation of the new EMEP/EEA GB_{2023}.

6.6.3.3 Industrial Waste Incineration (5C1bi)

Industrial waste incineration without energy recovery had a decreasing trend. After 2002, emissions from industrial sludge incineration are included in the calculation. Activity data and resulting emissions are shown in ***Table 6.19***.

Table 6.19: *Overview of activity data and emissions in the category 5C1bi*

YEAR	IW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	6.13	0.0110	0.0001	0.0104	0.0564	0.0840	0.1122	0.0020	0.0043
1995	6.07	0.0109	0.0001	0.0103	0.0558	0.0831	0.1110	0.0020	0.0042
2000	6.60	0.0119	0.0001	0.0112	0.0607	0.0904	0.1207	0.0021	0.0046

YEAR	IW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2005	8.45	0.0152	0.0002	0.0144	0.0778	0.1158	0.1547	0.0027	0.0059
2010	5.56	0.0100	0.0001	0.0095	0.0512	0.0762	0.1018	0.0018	0.0039
2011	3.69	0.0066	0.0001	0.0063	0.0339	0.0505	0.0675	0.0012	0.0026
2012	3.42	0.0062	0.0001	0.0058	0.0315	0.0468	0.0626	0.0011	0.0024
2013	3.84	0.0069	0.0001	0.0065	0.0353	0.0526	0.0702	0.0012	0.0027
2014	3.33	0.0060	0.0001	0.0057	0.0306	0.0456	0.0609	0.0011	0.0023
2015	5.21	0.0094	0.0001	0.0089	0.0480	0.0714	0.0954	0.0017	0.0036
2016	0.21	0.0004	0.0000	0.0004	0.0019	0.0028	0.0038	0.0001	0.0001
2017	NO	NO	NO	NO	NO	NO	NO	NO	NO
2018	2.16	0.0039	0.0000	0.0037	0.0199	0.0297	0.0396	0.0007	0.0015
2019	2.39	0.0043	0.0000	0.0041	0.0220	0.0328	0.0438	0.0008	0.0017
2020	1.53	0.0027	0.0000	0.0026	0.0141	0.0209	0.0280	0.0005	0.0011
2021	NO	NO	NO	NO	NO	NO	NO	NO	NO
2022	0.59	0.0011	0.0000	0.0010	0.0054	0.0081	0.0108	0.0002	0.0004
2023	0.35	0.0006	0.0000	0.0006	0.0032	0.0048	0.0065	0.0001	0.0002
1990/2023	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**
2022/2023	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Zn [t]
1990	0.6377	0.0208	0.0172	0.0131	0.0172	0.0131	0.0007	0.0055
1995	0.6311	0.0206	0.0170	0.0130	0.0170	0.0130	0.0007	0.0055
2000	0.6859	0.0224	0.0185	0.0141	0.0185	0.0141	0.0008	0.0059
2005	0.8790	0.0287	0.0237	0.0181	0.0237	0.0181	0.0010	0.0076
2010	0.5783	0.0189	0.0156	0.0119	0.0156	0.0119	0.0007	0.0050
2011	0.3834	0.0125	0.0103	0.0079	0.0103	0.0079	0.0004	0.0033
2012	0.3555	0.0116	0.0096	0.0073	0.0096	0.0073	0.0004	0.0031
2013	0.3991	0.0130	0.0107	0.0082	0.0107	0.0082	0.0005	0.0035
2014	0.3461	0.0113	0.0093	0.0071	0.0093	0.0071	0.0004	0.0030
2015	0.5422	0.0177	0.0146	0.0112	0.0146	0.0112	0.0006	0.0047
2016	0.0216	0.0007	0.0006	0.0004	0.0006	0.0004	0.0000	0.0002
2017	NO	NO	NO	NO	NO	NO	NO	NO
2018	0.2252	0.0074	0.0061	0.0046	0.0061	0.0046	0.0003	0.0019
2019	0.2488	0.0081	0.0067	0.0051	0.0067	0.0051	0.0003	0.0022
2020	0.1589	0.0052	0.0043	0.0033	0.0043	0.0033	0.0002	0.0014
2021	NO	NO	NO	NO	NO	NO	NO	NO
2022	0.0616	0.0020	0.0017	0.0013	0.0017	0.0013	0.0001	0.0005
2023	0.0367	0.0012	0.0010	0.0008	0.0010	0.0008	0.0000	0.0003
1990/2023	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**
2022/2023	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	PAHs [t]	HCB [kg]	PCB [kg]
1990	0.0215	0.0258	0.0196	0.0190	0.0644	0.0123	32.4976
1995	0.0212	0.0255	0.0194	0.0188	0.0637	0.0121	32.1614
2000	0.0231	0.0277	0.0211	0.0204	0.0693	0.0132	34.9559
2005	0.0296	0.0355	0.0270	0.0262	0.0887	0.0169	44.7933
2010	0.0195	0.0234	0.0178	0.0172	0.0584	0.0111	29.4735
2011	0.0129	0.0155	0.0118	0.0114	0.0387	0.0074	19.5361

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	PAHs [t]	HCB [kg]	PCB [kg]
2012	0.0120	0.0144	0.0109	0.0106	0.0359	0.0068	18.1182
2013	0.0134	0.0161	0.0123	0.0119	0.0403	0.0077	20.3399
2014	0.0116	0.0140	0.0106	0.0103	0.0349	0.0067	17.6384
2015	0.0182	0.0219	0.0167	0.0162	0.0547	0.0104	27.6308
2016	0.0007	0.0009	0.0007	0.0006	0.0022	0.0004	1.1009
2017	NO	NO	NO	NO	NO	NO	NO
2018	0.0076	0.0091	0.0069	0.0067	0.0227	0.0043	11.4742
2019	0.0084	0.0100	0.0077	0.0074	0.0251	0.0048	12.6776
2020	0.0053	0.0064	0.0049	0.0047	0.0160	0.0031	8.0960
2021	NO	NO	NO	NO	NO	NO	NO
2022	0.0021	0.0025	0.0019	0.0018	0.0062	0.0012	3.1377
2023	0.0012	0.0015	0.0011	0.0011	0.0037	0.0007	1.8710
1990/2023	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**	**-94%**
2022/2023	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**	**-40%**

6.6.3.3.1 Methodological Issues

Data from the NEIS database was used to analyze industrial waste incineration sources without energy recovery. Using statistical data was reconsidered after a detailed analysis and comparing the data with other sources. Statistical data were assumed as highly overestimated. Detailed descriptions can be found in **ANNEX VIII**. In this submission, Tier 2 methodology for uncontrolled incineration of Municupal waste from the EMEP/EEA GB_{2023} was used to calculate emissions in this category. Emission calculations for of Cr, Cu, Zn, B(a)P, B(b)F, B(k)F and PCB were added in this submission. Emission factors are shown in ***Table 6.20***.
The **condensable component of PMs** is not included in EFs.

Table 6.20: *Emission factors in the category Industrial waste incineration without E recovery*

POLLUTANT	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Unit	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	% of $PM_{2.5}$	[kg/t]
Value	1.8	0.02	1.70	9.2	13.7	18.3	3.5	0.7

POLLUTANT	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
Unit	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
Value	104	3.4	2.8	2.14	0.185	0.093	0.12	0.9

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	PAHs	HCB	PCB
Unit	µg/t I-TEQ	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Value	3.5	4.2	3.2	3.1	10.5	0.002	5.3

6.6.3.3.2 Completeness

Emissions from Industrial waste incineration with energy recovery are reported in the energy sector under **1A1b**, **1A2c** and **1A2f**. Notation keys were used to comply with EMEP/EEA GB_{2023}.

6.6.3.3.3 Source-specific Recalculations

Recalculations in this category are the result of a change to Tier 2 methodology of the EMEP/EEA GB_{2023} (***Table 6.21***).

Table 6.21: *Differences of emissions in the category 5C1bi between previous submission and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	CHANGE							
1990	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%

YEAR	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	CHANGE							
1991	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1992	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1993	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1994	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1995	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1996	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1997	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1998	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
1999	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2000	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2001	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2002	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2003	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2004	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2005	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2006	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2007	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2008	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2009	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2010	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2011	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2012	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2013	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2014	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2015	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2016	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2017	-	-	-	-	-	-	-	-
2018	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2019	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2020	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%
2021	-	-	-	-	-	-	-	-
2022	107%	-100%	3517%	229900%	195614%	182900%	229900%	900%

YEAR	Pb	Cd	Hg	As	Ni	PCDD/F	PAHs
	CHANGE						
1990	7900%	3300%	4900%	13275%	-14%	-65%	52400%
1991	7900%	3300%	4900%	13275%	-14%	-	52400%
1992	7900%	3300%	4900%	13275%	-14%	-	52400%
1993	7900%	3300%	4900%	13275%	-14%	-	52400%
1994	7900%	3300%	4900%	13275%	-14%	-	52400%
1995	7900%	3300%	4900%	13275%	-14%	-	52400%
1996	7900%	3300%	4900%	13275%	-14%	-	52400%
1997	7900%	3300%	4900%	13275%	-14%	-	52400%
1998	7900%	3300%	4900%	13275%	-14%	-	52400%
1999	7900%	3300%	4900%	13275%	-14%	-	52400%
2000	7900%	3300%	4900%	13275%	-14%	-	52400%
2001	7900%	3300%	4900%	13275%	-14%	-	52400%
2002	7900%	3300%	4900%	13275%	-14%	-	52400%

YEAR	Pb	Cd	Hg	As	Ni	PCDD/F	PAHs
	CHANGE						
2003	7900%	3300%	4900%	13275%	-14%	-	52400%
2004	7900%	3300%	4900%	13275%	-14%	-	52400%
2005	7900%	3300%	4900%	13275%	-14%	-	52400%
2006	7900%	3300%	4900%	13275%	-14%	-	52400%
2007	7900%	3300%	4900%	13275%	-14%	-	52400%
2008	7900%	3300%	4900%	13275%	-14%	-	52400%
2009	7900%	3300%	4900%	13275%	-14%	-	52400%
2010	7900%	3300%	4900%	13275%	-14%	-	52400%
2011	7900%	3300%	4900%	13275%	-14%	-	52400%
2012	7900%	3300%	4900%	13275%	-14%	-	52400%
2013	7900%	3300%	4900%	13275%	-14%	-	52400%
2014	7900%	3300%	4900%	13275%	-14%	-	52400%
2015	7900%	3300%	4900%	13275%	-14%	-	52400%
2016	7900%	3300%	4900%	13275%	-14%	-	52400%
2017	-	-	-	-	-	-	-
2018	7900%	3300%	4900%	13275%	-14%	-	52400%
2019	7900%	3300%	4900%	13275%	-14%	-	52400%
2020	7900%	3300%	4900%	13275%	-14%	-	52400%
2021	-	-	-	-	-	-	-
2022	7900%	3300%	4900%	13275%	-14%	-	52400%

6.6.3.4 Hazardous Waste Incineration (NFR 5C1bii)

Emissions in this category have an increasing trend due to legislation that sets the preference for the incineration of waste instead of disposal at landfill sites.

Table 6.22: *Overview of activity data and emissions in the category 5C1bii*

YEAR	HW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.78	0.0020	0.0007	0.0109	0.0009	0.0032	0.0406	0.0000	0.0121
1995	0.77	0.0019	0.0006	0.0108	0.0008	0.0032	0.0402	0.0000	0.0120
2000	0.84	0.0021	0.0007	0.0118	0.0002	0.0008	0.0099	0.0000	0.0130
2005	2.21	0.0055	0.0019	0.0310	0.0001	0.0003	0.0040	0.0000	0.0343
2010	1.67	0.0042	0.0014	0.0103	0.0000	0.0001	0.0011	0.0000	0.0259
2011	1.59	0.0040	0.0013	0.0116	0.0000	0.0001	0.0009	0.0000	0.0246
2012	2.24	0.0056	0.0019	0.0190	0.0000	0.0001	0.0011	0.0000	0.0348
2013	2.78	0.0069	0.0023	0.0208	0.0000	0.0001	0.0016	0.0000	0.0431
2014	2.59	0.0065	0.0022	0.0196	0.0000	0.0001	0.0015	0.0000	0.0401
2015	2.39	0.0060	0.0020	0.0185	0.0000	0.0001	0.0013	0.0000	0.0371
2016	2.58	0.0065	0.0022	0.0203	0.0000	0.0000	0.0004	0.0000	0.0400
2017	3.19	0.0080	0.0027	0.0280	0.0000	0.0001	0.0005	0.0000	0.0494
2018	3.05	0.0076	0.0026	0.0257	0.0000	0.0001	0.0005	0.0000	0.0473
2019	2.91	0.0073	0.0024	0.0248	0.0000	0.0000	0.0005	0.0000	0.0451
2020	2.95	0.0074	0.0025	0.0254	0.0000	0.0000	0.0005	0.0000	0.0457
2021	2.82	0.0071	0.0024	0.0256	0.0000	0.0000	0.0004	0.0000	0.0438
2022	2.81	0.0070	0.0024	0.0231	0.0000	0.0000	0.0004	0.0000	0.0436
2023	2.05	0.0051	0.0017	0.0254	0.0000	0.0000	0.0003	0.0000	0.0317
1990/2023	**162%**	**162%**	**162%**	**133%**	**-99%**	**-99%**	**-99%**	**-99%**	**162%**
2022/2023	**-27%**	**-27%**	**-27%**	**10%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Zn [t]
1990	0.0390	0.0125	0.0018	0.0037	0.0109	0.0312	0.0062	0.0001
1995	0.0386	0.0124	0.0018	0.0036	0.0108	0.0309	0.0062	0.0001
2000	0.0420	0.0134	0.0019	0.0039	0.0118	0.0336	0.0067	0.0001
2005	0.1107	0.0354	0.0051	0.0104	0.0310	0.0886	0.0177	0.0003
2010	0.0835	0.0267	0.0038	0.0078	0.0234	0.0668	0.0134	0.0003
2011	0.0795	0.0254	0.0037	0.0075	0.0223	0.0636	0.0127	0.0002
2012	0.1121	0.0359	0.0052	0.0105	0.0314	0.0897	0.0179	0.0003
2013	0.1390	0.0445	0.0064	0.0131	0.0389	0.1112	0.0222	0.0004
2014	0.1295	0.0414	0.0060	0.0122	0.0363	0.1036	0.0207	0.0004
2015	0.1197	0.0383	0.0055	0.0113	0.0335	0.0958	0.0192	0.0004
2016	0.1292	0.0413	0.0059	0.0121	0.0362	0.1033	0.0207	0.0004
2017	0.1595	0.0510	0.0073	0.0150	0.0447	0.1276	0.0255	0.0005
2018	0.1527	0.0489	0.0070	0.0144	0.0428	0.1222	0.0244	0.0005
2019	0.1454	0.0465	0.0067	0.0137	0.0407	0.1163	0.0233	0.0004
2020	0.1474	0.0472	0.0068	0.0139	0.0413	0.1179	0.0236	0.0004
2021	0.1412	0.0452	0.0065	0.0133	0.0395	0.1130	0.0226	0.0004
2022	0.1405	0.0450	0.0065	0.0132	0.0393	0.1124	0.0225	0.0004
2023	0.1024	0.0328	0.0047	0.0096	0.0287	0.0819	0.0164	0.0003
1990/2023	**162%**	**162%**	**162%**	**162%**	**162%**	**162%**	**162%**	**162%**
2022/2023	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.0312	0.0004	0.0001	0.0005	0.0001	0.0010	3.6689	3.5127
1995	0.0309	0.0004	0.0001	0.0005	0.0001	0.0010	3.6309	3.4764
2000	0.0336	0.0004	0.0001	0.0005	0.0001	0.0011	3.9464	3.7785
2005	0.0674	0.0011	0.0002	0.0014	0.0002	0.0029	10.4085	9.9656
2010	0.0492	0.0009	0.0001	0.0010	0.0002	0.0022	7.8447	7.5109
2011	0.0403	0.0008	0.0001	0.0010	0.0002	0.0021	7.4701	7.1522
2012	0.0470	0.0011	0.0002	0.0014	0.0002	0.0029	10.5377	10.0893
2013	0.0684	0.0014	0.0002	0.0017	0.0003	0.0036	13.0649	12.5090
2014	0.0632	0.0013	0.0002	0.0016	0.0003	0.0033	12.1743	11.6562
2015	0.0568	0.0012	0.0002	0.0015	0.0002	0.0031	11.2535	10.7746
2016	0.0010	0.0013	0.0002	0.0016	0.0003	0.0033	12.1425	11.6258
2017	0.0013	0.0016	0.0002	0.0019	0.0003	0.0041	14.9933	14.3553
2018	0.0012	0.0016	0.0002	0.0019	0.0003	0.0039	14.3535	13.7427
2019	0.0012	0.0015	0.0002	0.0018	0.0003	0.0038	13.6706	13.0889
2020	0.0012	0.0015	0.0002	0.0018	0.0003	0.0038	13.8522	13.2627
2021	0.0011	0.0014	0.0002	0.0017	0.0003	0.0036	13.2768	12.7119
2022	0.0011	0.0014	0.0002	0.0017	0.0003	0.0036	13.2099	12.6478
2023	0.0008	0.0010	0.0001	0.0012	0.0002	0.0026	9.6250	9.2155
1990/2023	**-97%**	**162%**	**162%**	**162%**	**162%**	**162%**	**162%**	**162%**
2022/2023	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**	**-27%**

6.6.3.4.1 Methodological Issues

Data from the NEIS database were used for hazardous waste incineration sources without energy recovery. Using statistical data was reconsidered after a detailed analysis and comparing the data with other sources. Statistical data were assumed to be highly overestimated. Detailed descriptions can be found in **ANNEX VIII**. Since the 2023 submission, hazardous waste has been excluded from category **5C1bi** and has been allocated to this category. Abatement technology installed at the incineration plants is included in the methodology.

Tier 2 methodology from the EMEP/EEA GB_{2023}, where the emission factors for uncontrolled sludge incineration were used to calculate emissions in this category (except for PCDD/PCDF where emission factor 40 mg/t of waste was used). Emission factors and abatement technology efficiencies are shown in ***Table 6.23***.
The **condensable component of PMs** is not included in EFs.

Table 6.23: *Emission factors in the category Hazardous waste incineration without E recovery*

POLLUTANT	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Unit	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	% of $PM_{2.5}$	[kg/t]
Value	2.5	0.84	14	1.1	4.1	0.01	0.035	0.07
ABATEMENT EFFICIENCY								
Acid gas abatement			76%					
Particle abatement only				98.40%	98.30%	98.40%		
Waste incineration directive compliant plants				99.50%	99.60%	99.70%		

POLLUTANT	Pb	Cd	Hg	As	Ni	Se	PCDD/F	PAHs	HCB
Unit	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	µg/t I-TEQ	mg/t	mg/t
VALUE	1.3	0.1	0.056	0.016	0.14	0.06	**10**	38.87	3
ABATEMENT EFFICIENCY									
Controlled combustion; good APC system							**99%**		

6.6.3.4.2 Completeness

Emissions from Industrial waste incineration with energy recovery are reported in the energy sector under **1A1b**, **1A2c** and **1A2f**. Notation keys were used to comply with EMEP/EEA GB_{2023}.

6.6.3.4.3 Source-specific Recalculations

Recalculations in this category are the result of a change to Tier 2 methodology of the EMEP/EEA GB_{2023} and implementation of abatement technologies into calculation (***Table 6.24***).

Table 6.24: *Differences of emissions in the category 5C1bii between previous submission and current submission caused by recalculations*

YEAR	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	CHANGE							
1990	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1991	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1992	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1993	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1994	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1995	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1996	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1997	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1998	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
1999	187%	-89%	29687%	27400%	58471%	519900%	27400%	22043%
2000	187%	-89%	29687%	6126%	13206%	117623%	6126%	22043%
2001	187%	-89%	29687%	16278%	34806%	309585%	16278%	22043%
2002	187%	-89%	29687%	340%	896%	8220%	340%	22043%
2003	187%	-89%	29687%	510%	1214%	11048%	510%	22043%
2004	187%	-89%	29687%	544%	1295%	11773%	544%	22043%
2005	187%	-89%	29687%	872%	1999%	18029%	872%	22043%
2006	187%	-89%	26121%	884%	1958%	17670%	884%	22043%
2007	187%	-89%	20425%	695%	1584%	14337%	695%	22043%
2008	187%	-89%	24317%	109%	315%	3064%	109%	22043%
2009	187%	-89%	16855%	209%	566%	5292%	209%	22043%
2010	187%	-89%	13072%	260%	693%	6421%	260%	22043%
2011	187%	-89%	15403%	228%	615%	5725%	228%	22043%

YEAR	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	CHANGE							
2012	187%	-89%	17928%	195%	530%	4971%	195%	22043%
2013	187%	-89%	15858%	222%	599%	5590%	222%	22043%
2014	187%	-89%	15970%	221%	596%	5556%	221%	22043%
2015	187%	-89%	16354%	216%	583%	5441%	216%	22043%
2016	187%	-89%	16634%	38%	134%	1460%	38%	22043%
2017	187%	-89%	18555%	38%	134%	1460%	38%	22043%
2018	187%	-89%	17799%	38%	134%	1460%	38%	22043%
2019	187%	-89%	18029%	38%	134%	1460%	38%	22043%
2020	187%	-89%	18202%	38%	134%	1460%	38%	22043%
2021	187%	-89%	19161%	38%	134%	1460%	38%	22043%
2022	187%	-89%	17389%	38%	134%	1460%	38%	22043%

YEAR	Pb	Cd	Hg	As	Ni	PCDD/F	PAHs	HCB
	CHANGE							
1990	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1991	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1992	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1993	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1994	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1995	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1996	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1997	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1998	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
1999	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
2000	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
2001	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
2002	3746%	15900%	4007%	29275%	5614%	300%	6350%	234900%
2003	3746%	15900%	4007%	29275%	5614%	149%	6350%	234900%
2004	3746%	15900%	4007%	29275%	5614%	182%	6350%	234900%
2005	3746%	15900%	4007%	29275%	5614%	204%	6350%	234900%
2006	3746%	15900%	4007%	29275%	5614%	-22%	6350%	234900%
2007	3746%	15900%	4007%	29275%	5614%	74%	6350%	234900%
2008	3746%	15900%	4007%	29275%	5614%	-2%	6350%	234900%
2009	3746%	15900%	4007%	29275%	5614%	128%	6350%	234900%
2010	3746%	15900%	4007%	29275%	5614%	195%	6350%	234900%
2011	3746%	15900%	4007%	29275%	5614%	154%	6350%	234900%
2012	3746%	15900%	4007%	29275%	5614%	110%	6350%	234900%
2013	3746%	15900%	4007%	29275%	5614%	146%	6350%	234900%
2014	3746%	15900%	4007%	29275%	5614%	144%	6350%	234900%
2015	3746%	15900%	4007%	29275%	5614%	137%	6350%	234900%
2016	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%
2017	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%
2018	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%
2019	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%
2020	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%
2021	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%
2022	3746%	15900%	4007%	29275%	5614%	-96%	6350%	234900%

6.6.3.5 Clinical Waste Incineration (NFR 5C1biii)

The number of clinical waste incineration plants in the Slovak Republic decreased significantly between the years 2005/2006 due to stricter legislation[17] and emission limits connected to the accession of the Slovak

[17] Act 245/2003 Coll. on Integrated Prevention and Control of Environmental Pollution
Act 532/2005 Coll. on integrated pollution prevention and control
Act 571/2005 Coll. on the protection of the air

Republic to the European Union in the year 2005. Older plants without any (or minimal) abatement technology, non-compliant with emission limits stopped operation. From 2006 to 2010 only reconstructed plants or new plants with air pollution control technologies operated. In the year 2005, there were twenty-four plants incinerated clinical waste, mostly small ones within the hospital facility area, in 2023 there was only one. Over the past five years, mostly large plants focused on the incineration of different types of toxic and hazardous waste have been used to dispose of clinical waste.

The most significant pollutants from clinical waste incineration are heavy metals or dioxins and furans and polycyclic aromatic hydrocarbons, which can be present in hospital waste or can be formed during the combustion and post-combination processes. Organics in the flue gas can exist in the vapour phase or can be condensed or absorbed by fine particulates.

Other pollutants released are sulphur oxides, nitrogen oxides, volatile organic compounds, carbon monoxide, carbon dioxide and nitrous oxide. Carbon monoxide emissions result when carbon in the waste is not completely oxidised to carbon dioxide (CO_2). Nitrogen oxides are products of combustion processes. Nitrogen oxides are formed during combustion through the oxidation of nitrogen in the waste, and the oxidation of atmospheric nitrogen. ***Table 6.25*** shows emissions released into the air from this activity using the methodology described below.

Table 6.25: *Overview of the activity data, emissions and emission trends in the category Clinical waste incineration without E recovery*

YEAR	CW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	3.41	0.0061	0.0024	0.0038	0.0034	0.0051	0.0078	0.0002	0.0051
1995	3.38	0.0061	0.0024	0.0037	0.0033	0.0050	0.0078	0.0002	0.0051
2000	3.67	0.0066	0.0026	0.0037	0.0035	0.0052	0.0080	0.0002	0.0055
2005	2.68	0.0048	0.0019	0.0029	0.0025	0.0038	0.0058	0.0001	0.0040
2010	1.66	0.0030	0.0012	0.0011	0.0009	0.0014	0.0021	0.0000	0.0025
2011	2.06	0.0037	0.0014	0.0011	0.0005	0.0008	0.0012	0.0000	0.0031
2012	1.11	0.0020	0.0008	0.0003	0.0000	0.0000	0.0000	0.0000	0.0017
2013	1.05	0.0019	0.0007	0.0003	0.0000	0.0000	0.0000	0.0000	0.0016
2014	1.09	0.0020	0.0008	0.0003	0.0000	0.0000	0.0000	0.0000	0.0016
2015	0.87	0.0016	0.0006	0.0002	0.0000	0.0000	0.0000	0.0000	0.0013
2016	0.53	0.0010	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0008
2017	0.30	0.0005	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0004
2018	0.48	0.0009	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0007
2019	0.28	0.0005	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0004
2020	0.32	0.0006	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0005
2021	0.34	0.0006	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0005
2022	0.45	0.0008	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0007
2023	0.38	0.0007	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0006
1990/2023	**-89%**	**-89%**	**-89%**	**-97%**	**-100%**	**-100%**	**-100%**	**-100%**	**-89%**
2022/2023	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	PCDD/F [g I-TEQ]	PAHs [t]	HCB [kg]	PCBs [kg]
1990	0.1228	0.0102	0.1842	0.0003	0.0014	0.0205	0.0010	136.4435	0.0000	0.3411	0.0682

DECREE of the Ministry of the Environment of the Slovak Republic 575/2005 Z. on air pollution sources, on emission limits, on technical requirements and general conditions of operation, on the list of pollutants, on the categorization of sources of air pollution and on the requirements for ensuring the dispersion of pollutant emissions as amended (only in Slovak)
https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2005/575/20051227

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	PCDD/F [g I-TEQ]	PAHs [t]	HCB [kg]	PCBs [kg]
1995	0.1215	0.0101	0.1823	0.0003	0.0014	0.0203	0.0010	135.0321	0.0000	0.3376	0.0675
2000	0.1321	0.0110	0.1981	0.0004	0.0015	0.0220	0.0011	130.6964	0.0000	0.3669	0.0734
2005	0.0966	0.0080	0.1449	0.0003	0.0011	0.0161	0.0008	102.0242	0.0000	0.2683	0.0537
2010	0.0598	0.0050	0.0898	0.0002	0.0007	0.0100	0.0005	38.8978	0.0000	0.1662	0.0332
2011	0.0740	0.0062	0.1110	0.0002	0.0008	0.0123	0.0006	25.4686	0.0000	0.2056	0.0411
2012	0.0400	0.0033	0.0600	0.0001	0.0004	0.0067	0.0003	4.4481	0.0000	0.1112	0.0222
2013	0.0379	0.0032	0.0568	0.0001	0.0004	0.0063	0.0003	4.2085	0.0000	0.1052	0.0210
2014	0.0392	0.0033	0.0589	0.0001	0.0004	0.0065	0.0003	4.3596	0.0000	0.1090	0.0218
2015	0.0312	0.0026	0.0468	0.0001	0.0003	0.0052	0.0003	3.4647	0.0000	0.0866	0.0173
2016	0.0192	0.0016	0.0289	0.0001	0.0002	0.0032	0.0002	2.1375	0.0000	0.0534	0.0107
2017	0.0107	0.0009	0.0161	0.0000	0.0001	0.0018	0.0001	1.1896	0.0000	0.0297	0.0059
2018	0.0173	0.0014	0.0259	0.0000	0.0002	0.0029	0.0001	1.9180	0.0000	0.0479	0.0096
2019	0.0102	0.0009	0.0153	0.0000	0.0001	0.0017	0.0001	1.1338	0.0000	0.0283	0.0057
2020	0.0114	0.0009	0.0171	0.0000	0.0001	0.0019	0.0001	1.2657	0.0000	0.0316	0.0063
2021	0.0122	0.0010	0.0182	0.0000	0.0001	0.0020	0.0001	1.3508	0.0000	0.0338	0.0068
2022	0.0162	0.0014	0.0243	0.0000	0.0002	0.0027	0.0001	1.8029	0.0000	0.0451	0.0090
2023	0.0135	0.0011	0.0203	0.0000	0.0002	0.0023	0.0001	1.5021	0.0000	0.0376	0.0075
1990/2023	**-89%**	**-89%**	**-89%**	**-89%**	**-89%**	**-89%**	**-89%**	**-99%**	**-89%**	**-89%**	**-89%**
2022/2023	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**	**-17%**

An increase in 2005 and subsequently a rapid decrease in 2006 for both pollutants were caused by the adoption of strict legislation and emission limits for this activity related to entering the Slovak Republic into the European Union. From 2009 emissions are slightly increasing, but after the year 2011 emissions are decreasing due to strict emissions limits for the clinical waste incineration plants. Most of the hospitals closed their plants because the operation of such a plant is very expensive and its capacity is mostly not covered. Also, other treatments, such as sterilisation of waste became more available in the Slovak Republic.

6.6.3.5.1 Methodological Issues

Activity data for this source of pollution is the NEIS database, which contains detailed information about amounts and types of waste incinerated in each plant for the years 2000-2023. Historical data were extrapolated using the trend of the category hospital and veterinary wastes. Activity data from the NEIS database were used as in the national statistics, separation of clinical and veterinary waste is not possible. Data from national statistics were considered as overestimated for the incineration of waste with or without energy recovery. Detailed information can be found in **ANNEX VIII**.

The **condensable component of PMs** is not included in EFs.

Clinical waste incineration **with energy recovery** was considered in this submission as not occurring. After discussion with the operators, which burn also other hazardous waste and use the heat to produce energy, it was assumed all clinical waste is burned without energy recovery. Several incinerating plants were removed from this category as they burn mostly hazardous waste and only partly clinical waste. Emissions were therefore allocated in the category **5C1bii**.

Data about the technology used to incinerate clinical waste and abatement technologies are available from 2000, when these data were published as part of the Waste Management Program for the period 2001-2005. This program is updated every five years.

Emission estimates were calculated using the Tier 2 approach. Emission factors were taken from the EMEP/EEA GB_{2023}. Technology-specific information was collected from operators and Waste Management Programs, and plants using an abatement technology were identified. ***Table 6.26*** shows the analysis of the distribution of clinical waste burned by combustion technologies from 1990-2023.

Table 6.26.: *Distribution of the incinerated hospital waste without energy recovery by combustion technologies*

YEAR	% OF WASTE BURNED IN UNCONTROLLED WI	% OF WASTE BURNED IN CONTROLLED WI
1990-2000	82%	18%
2001	79%	21%
2002	63%	37%
2003	62%	38%
2004	48%	52%
2005	44%	56%
2006-2023	0%	100%

Operators of clinical waste were assigned to abatement technology based on data from Waste Management Programs and the NEIS database (after 2005).
Emission factors and efficiencies of abatement technologies, which were used in calculations for incineration without energy recovery, are shown in ***Table 6.27.***

Table 6.27: *Emission factors and abatement technology efficiencies in the category of Clinical waste incineration*

POLLUTANT	NOx	CO	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC*
Unit	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[% of TSP]	[% of TSP]	[kg/t]	[% of TSP]
Value	1.8	1.5	0.7	1.1	43	65	2.3	2.3
ABATEMENT EFFICIENCY								
Acid gas abatement				76%				
Particle abatement only					98.4%	98.3%	98.4%	

POLLUTANT	Pb	Cd	Hg	As	Cr	Cu	Ni	PCDD/F	Total 4 PAHs	HCB	PCB
Unit	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[mg I-TEQ/t]	[mg/t]	[g/t]	[g/t]
Value	36	3	54	0.1	0.4	6	0.3	40	0.04	0.1	0.02
ABATEMENT EFFICIENCY											
Controlled combustion; minimal APC system								90%			

6.6.3.5.2 Completeness

All rising pollutants are recorded and reported.

6.6.3.5.3 Source-specific Recalculations

Recalculations were made due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB_{2023} (see ***Table 6.28***).

Table 6.28: *Differences of emissions in the category 5C1biii between previous submission and current submission caused by recalculations*

YEAR	SOx	$PM_{2.5}$	PM_{10}	PCDD/F
	CHANGE			
1990	16%	22%	22%	20%
1991	16%	22%	22%	20%
1992	16%	22%	22%	20%
1993	16%	22%	22%	20%
1994	16%	22%	22%	20%
1995	16%	22%	22%	20%
1996	16%	22%	22%	20%
1997	16%	22%	22%	20%
1998	16%	22%	22%	20%
1999	16%	22%	22%	20%
2000	7%	16%	16%	7%

YEAR	SOx	PM2.5	PM10	PCDD/F
	CHANGE			
2001	10%	21%	21%	12%
2002	35%	52%	52%	44%
2003	32%	54%	54%	41%
2004	61%	93%	93%	78%
2005	72%	112%	112%	93%
2006	218%	5435%	5436%	795%
2007	174%	4153%	4155%	608%
2008	170%	3839%	3841%	562%
2009	147%	3288%	3291%	481%
2010	151%	3315%	3318%	485%
2011	100%	1433%	1437%	210%
2012	10%	-	6%	-
2013	6%	-	6%	-
2014	13%	-	6%	-
2015	3%	-	6%	-
2016	5%	-	6%	-
2017	1%	-	6%	-
2018	-	-	6%	-
2019	-	-	6%	-
2020	-	-	6%	-
2021	-	-	6%	-
2022	-	-	6%	-

6.6.3.6 Sewage Sludge Incineration (NFR 5C1biv)

This activity does not occur in the Slovak Republic.

6.6.4 Cremation (NFR 5C1bv)

An annual increase in cremated bodies gives rise to emissions of heavy metals and persistent pollutants. In comparison to the base year, there was an increase in trends of NO_X, SO_X, TSP, CO, $PM_{2.5}$, and PM_{10} emissions driven by the activity data. As shown in ***Table 6.29***, cremation shows an increasing trend in Slovakia, though in 2017 a slight decrease and subsequently increase in 2018 was recorded. Since then the amount of cremated bodies has increased. In 2020 and 2021, it is a result of the covid-19 pandemic. In the year 2022, amount of cremated bodies decreased as the pandemic ended.

Table 6.29: *Overview of activity data, emissions and emission trends in the category of Cremation*

YEAR	HUMAN BODIES CREMATED [body]	NOx [kt]	NMVOC [kt]	SOx [kt]	PM2.5 [kt]	PM10 [kt]	TSP [kt]	CO [kt]
1990	6 010	0.0050	0.0001	0.0007	0.0002	0.0002	0.0002	0.0008
1995	6 744	0.0056	0.0001	0.0008	0.0002	0.0002	0.0003	0.0009
2000	7 528	0.0062	0.0001	0.0009	0.0003	0.0003	0.0003	0.0011
2005	10 418	0.0086	0.0001	0.0012	0.0004	0.0004	0.0004	0.0015
2010	13 167	0.0109	0.0002	0.0015	0.0005	0.0005	0.0005	0.0018
2011	12 583	0.0104	0.0002	0.0014	0.0004	0.0004	0.0005	0.0018
2012	12 701	0.0105	0.0002	0.0014	0.0004	0.0004	0.0005	0.0018
2013	15 561	0.0128	0.0002	0.0018	0.0005	0.0005	0.0006	0.0022
2014	15 243	0.0126	0.0002	0.0017	0.0005	0.0005	0.0006	0.0021
2015	16 824	0.0139	0.0002	0.0019	0.0006	0.0006	0.0006	0.0024
2016	16 907	0.0139	0.0002	0.0019	0.0006	0.0006	0.0007	0.0024
2017	14 582	0.0120	0.0002	0.0016	0.0005	0.0005	0.0006	0.0020
2018	18 264	0.0151	0.0002	0.0021	0.0006	0.0006	0.0007	0.0026
2019	20 800	0.0172	0.0003	0.0024	0.0007	0.0007	0.0008	0.0029
2020	24 028	0.0198	0.0003	0.0027	0.0008	0.0008	0.0009	0.0034
2021	32 196	0.0266	0.0004	0.0036	0.0011	0.0011	0.0012	0.0045

YEAR	HUMAN BODIES CREMATED [body]	NOx [kt]	NMVOC [kt]	SOx [kt]	PM 2.5 [kt]	PM 10 [kt]	TSP [kt]	CO [kt]
2022	24 973	0.0206	0.0003	0.0028	0.0009	0.0009	0.0010	0.0035
2023	22 258	0.0184	0.0003	0.0025	0.0008	0.0008	0.0009	0.0031
1990/2023	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**
2022/2023	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0002	0.0000	0.0090	0.0001	0.0001	0.0001	0.0001	0.0001	0.0010
1995	0.0002	0.0000	0.0100	0.0001	0.0001	0.0001	0.0001	0.0001	0.0011
2000	0.0002	0.0000	0.0112	0.0001	0.0001	0.0001	0.0001	0.0001	0.0012
2005	0.0003	0.0001	0.0155	0.0001	0.0001	0.0001	0.0002	0.0002	0.0017
2010	0.0004	0.0001	0.0196	0.0002	0.0002	0.0002	0.0002	0.0003	0.0021
2011	0.0004	0.0001	0.0187	0.0002	0.0002	0.0002	0.0002	0.0002	0.0020
2012	0.0004	0.0001	0.0189	0.0002	0.0002	0.0002	0.0002	0.0003	0.0020
2013	0.0005	0.0001	0.0232	0.0002	0.0002	0.0002	0.0003	0.0003	0.0025
2014	0.0005	0.0001	0.0227	0.0002	0.0002	0.0002	0.0003	0.0003	0.0024
2015	0.0005	0.0001	0.0251	0.0002	0.0002	0.0002	0.0003	0.0003	0.0027
2016	0.0005	0.0001	0.0252	0.0002	0.0002	0.0002	0.0003	0.0003	0.0027
2017	0.0004	0.0001	0.0217	0.0002	0.0002	0.0002	0.0003	0.0003	0.0023
2018	0.0005	0.0001	0.0272	0.0002	0.0002	0.0002	0.0003	0.0004	0.0029
2019	0.0006	0.0001	0.0310	0.0003	0.0003	0.0003	0.0004	0.0004	0.0033
2020	0.0007	0.0001	0.0358	0.0003	0.0003	0.0003	0.0004	0.0005	0.0038
2021	0.0010	0.0002	0.0480	0.0004	0.0004	0.0004	0.0006	0.0006	0.0052
2022	0.0007	0.0001	0.0372	0.0003	0.0003	0.0003	0.0004	0.0005	0.0040
2023	0.0007	0.0001	0.0332	0.0003	0.0003	0.0003	0.0004	0.0004	0.0036
1990/2023	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**
2022/2023	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCB [kg]
1990	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0025
1995	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0028
2000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0031
2005	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0043
2010	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0054
2011	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0052
2012	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0052
2013	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0064
2014	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0062
2015	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0069
2016	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0069
2017	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0060
2018	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0075
2019	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031	0.0085
2020	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0036	0.0099
2021	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0048	0.0132
2022	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0037	0.0102
2023	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0033	0.0091
1990/2023	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**	**270%**
2022/2023	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**	**4%**

6.6.4.1 Methodological Issues

The source of activity data for air pollutants came from operators of Cremation facilities, which report the number of bodies incinerated in their crematories. Historical data (1990-2000) is not available, therefore, extrapolation was used.

For the emissions, calculation the statistical activity data were used with the default EMEP/EEA GB_{2023} emission factors. The values are given in the tables below (***Table 6.30***).

The inclusion/exclusion of the ***condensable component of PMs*** is unknown.

Table 6.30: *Emission factors in the category of Cremation*

POLLUTANT	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	CO	Pb
Unit	[kg/body]	[kg/body]	[kg/body]	[g/body]	[g/body]	[g/body]	[kg/body]	[mg/body]
Value	0.825	0.013	0.11	34.7	34.7	38.56	0.14	30.03

POLLUTANT	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Unit	[mg/body]	[g/body]	[mg/body]	[mg/body]	[mg/body]	[mg/body]	[mg/body]	[mg/body]
Value	5.03	1.49	13.61	13.56	12.43	17.33	19.78	160.12

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCB
Unit	[µg/body]	[µg/body]	[µg/body]	[µg/body]	[µg/body]	[µg/body]	[mg/body]	[mg/body]
Value	0.027	13.2	7.21	6.44	6.99	33.84	0.15	0.41

6.6.4.2 Completeness

All rising pollutants are recorded and reported.

6.6.4.3 Source-specific Recalculations

Recalculations between 2004-2022 were made due to error correction in activity data (***Table 6.31***).

Table 6.31: *Differences of emissions in the category 5C1bv between previous submission and current submission caused by recalculations*

YEAR	CORPSES INCINERATED			NOX	NMVOC	SOX	$PM_{2.5}$	PM_{10}	TSP	CO	Pb
	PREVIOUS	REFINED	CHANGE	CHANGE							
2004	9 359	8 733	-7%	7%	7%	7%	7%	7%	7%	7%	7%
2005	10 418	10 241	-2%	2%	2%	2%	2%	2%	2%	2%	2%
2006	10 599	10 682	1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
2007	11 636	11 698	1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
2008	13 187	13 136	0%	0%	0%	0%	0%	0%	0%	0%	0%
2009	8 034	8 022	0%	0%	0%	0%	0%	0%	0%	0%	0%
2010	13 167	13 202	0%	0%	0%	0%	0%	0%	0%	0%	0%
2011	12 583	12 611	0%	0%	0%	0%	0%	0%	0%	0%	0%
2012	12 701	12 659	0%	0%	0%	0%	0%	0%	0%	0%	0%
2013	15 561	15 561	-	-	-	-	-	-	-	-	-
2014	15 243	15 243	-	-	-	-	-	-	-	-	-
2015	16 824	16 773	0%	0%	0%	0%	0%	0%	0%	0%	0%
2016	16 907	16 903	0%	0%	0%	0%	0%	0%	0%	0%	0%
2017	14 582	14 545	0%	0%	0%	0%	0%	0%	0%	0%	0%
2018	18 264	18 309	0%	0%	0%	0%	0%	0%	0%	0%	0%
2019	20 800	20 395	-2%	2%	2%	2%	2%	2%	2%	2%	2%
2020	24 028	23 879	-1%	1%	1%	1%	1%	1%	1%	1%	1%
2021	32 196	30 915	-4%	4%	4%	4%	4%	4%	4%	4%	4%
2022	24 973	21 438	-14%	16%	16%	16%	16%	16%	16%	16%	16%

YEAR	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHS	HCB	PCBS
	CHANGE											
2004	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
2005	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
2006	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
2007	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
2008	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2011	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2013	-	-	-	-	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-	-	-	-	-
2015	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2016	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2017	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2018	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2019	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
2020	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
2021	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
2022	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%

6.6.5 Open Burning of Waste (5C2)

6.6.5.1 Overview of the Category

Open burning of waste is against the law of the Slovak Republic (Decree No. 79/2015 Coll. about Waste.[18] as amended), 314/2001 Coll. on fire protection[19] and 40/1964 Coll. (Civil Code)[20]. It is forbidden to perform the open burning of agricultural waste. The only exception is for the open burning of forest residues.

In general, emissions in this category have increasing trend as this activity use in the forest management also increased. The significant increase in emissions in 2005 was caused by the aftermath of a wind calamity in 2004 when over 12,000 ha of forest, mainly in national park High Tatras, was destroyed by an extreme wind that reached hurricane force and the subsequent attack on the fallen trees and surrounding areas by wood-destroying insects (***Recommendation No. SK-5C2-2024-0001***). Emissions from this activity were removed from category **11B** and allocated to this category following ***Recommendation No. SK-5C2-2023-0001***.

An overview of emissions from this category is shown in ***Table 6.32***.

Table 6.32: *Overview of activity data, emissions and emission trends in the category of Open burning of waste*

YEAR	TOTAL MASS OF BIOMASS BURNED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	105.05	0.1943	0.1544	0.0032	0.3950	0.4339	0.4528
1995	89.95	0.1671	0.1322	0.0027	0.3382	0.3715	0.3877
2000	133.12	0.2460	0.1957	0.0040	0.5005	0.5498	0.5737
2005	215.10	0.3993	0.3162	0.0065	0.8088	0.8884	0.9271
2010	218.68	0.4066	0.3215	0.0066	0.8222	0.9031	0.9425
2011	211.05	0.3923	0.3102	0.0063	0.7936	0.8716	0.9096
2012	127.17	0.2354	0.1869	0.0038	0.4782	0.5252	0.5481
2013	127.68	0.2373	0.1877	0.0038	0.4801	0.5273	0.5503
2014	252.62	0.4697	0.3713	0.0076	0.9498	1.0433	1.0888

[18] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/79/20190101.html
[19] https://www.minv.sk/swift_data/source/hasici_a_zachranari/kinkorova_dokumenty/zakony_vyhlasky_pokyny/314-20001.pdf
[20] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1964/40/

YEAR	TOTAL MASS OF BIOMASS BURNED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
2015	241.85	0.4496	0.3555	0.0073	0.9093	0.9988	1.0424
2016	234.93	0.4368	0.3454	0.0070	0.8833	0.9703	1.0126
2017	229.36	0.4264	0.3372	0.0069	0.8624	0.9472	0.9885
2018	240.10	0.4464	0.3529	0.0072	0.9028	0.9916	1.0348
2019	228.30	0.4243	0.3356	0.0068	0.8584	0.9429	0.9840
2020	189.53	0.3522	0.2786	0.0057	0.7126	0.7827	0.8169
2021	193.47	0.3597	0.2844	0.0058	0.7274	0.7990	0.8338
2022	191.41	0.3552	0.2814	0.0057	0.7197	0.7905	0.8250
2023	176.45	0.3282	0.2594	0.0053	0.6635	0.7287	0.7605
1990/2023	**68%**	**69%**	**68%**	**68%**	**68%**	**68%**	**68%**
2022/2023	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**

YEAR	BC [kt]	CO [kt]	Pb [t]	Cd [t]	As [t]	Cu [t]	Se [t]	Zn [t]
1990	0.1114	6.9307	0.0336	0.0137	0.0830	0.0263	0.0105	1.7859
1995	0.0954	5.9588	0.0288	0.0117	0.0711	0.0225	0.0090	1.5291
2000	0.1411	8.7738	0.0426	0.0173	0.1052	0.0333	0.0133	2.2630
2005	0.2281	14.2425	0.0688	0.0280	0.1699	0.0538	0.0215	3.6567
2010	0.2319	14.5025	0.0700	0.0284	0.1728	0.0547	0.0219	3.7176
2011	0.2238	13.9914	0.0675	0.0274	0.1667	0.0528	0.0211	3.5879
2012	0.1348	8.3957	0.0407	0.0165	0.1005	0.0318	0.0127	2.1620
2013	0.1354	8.4638	0.0409	0.0166	0.1009	0.0319	0.0128	2.1706
2014	0.2679	16.7535	0.0808	0.0328	0.1996	0.0632	0.0253	4.2945
2015	0.2564	16.0341	0.0774	0.0314	0.1911	0.0605	0.0242	4.1114
2016	0.2491	15.5804	0.0752	0.0305	0.1856	0.0587	0.0235	3.9939
2017	0.2432	15.2074	0.0734	0.0298	0.1812	0.0573	0.0229	3.8991
2018	0.2546	15.9214	0.0768	0.0312	0.1897	0.0600	0.0240	4.0817
2019	0.2421	15.1335	0.0731	0.0297	0.1804	0.0571	0.0228	3.8812
2020	0.2010	12.5608	0.0606	0.0246	0.1497	0.0474	0.0190	3.2219
2021	0.2051	12.8304	0.0619	0.0252	0.1528	0.0484	0.0193	3.2889
2022	0.2030	12.6672	0.0613	0.0249	0.1512	0.0479	0.0191	3.2539
2023	0.1871	11.7050	0.0565	0.0229	0.1394	0.0441	0.0176	2.9997
1990/2023	**68%**	**69%**	**68%**	**68%**	**68%**	**68%**	**68%**	**68%**
2022/2023	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	PAHs [t]
1990	1.0505	0.3309	0.5410	0.6776	1.5495
1995	0.8995	0.2833	0.4632	0.5802	1.3267
2000	1.3312	0.4193	0.6856	0.8586	1.9635
2005	2.1510	0.6776	1.1078	1.3874	3.1727
2010	2.1868	0.6888	1.1262	1.4105	3.2255
2011	2.1105	0.6648	1.0869	1.3613	3.1130
2012	1.2717	0.4006	0.6549	0.8203	1.8758
2013	1.2768	0.4022	0.6576	0.8236	1.8833
2014	2.5262	0.7957	1.3010	1.6294	3.7261
2015	2.4185	0.7618	1.2455	1.5599	3.5672
2016	2.3493	0.7400	1.2099	1.5153	3.4653
2017	2.2936	0.7225	1.1812	1.4794	3.3830
2018	2.4010	0.7563	1.2365	1.5486	3.5415
2019	2.2830	0.7192	1.1758	1.4726	3.3675
2020	1.8953	0.5970	0.9761	1.2224	2.7955

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	PAHs [t]
2021	1.9347	0.6094	0.9963	1.2478	2.8536
2022	1.9141	0.6029	0.9858	1.2346	2.8233
2023	1.7645	0.5558	0.9087	1.1381	2.6026
1990/2023	**68%**	**68%**	**68%**	**68%**	**68%**
2022/2023	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**

6.6.5.1 Methodological Issues

The Slovak National Forest Centre provided activity data about wood burned (controlled forest fires in Slovakia) Tier 2 emissions factors for temperate forests from EMEP/EEA GB_{2023} were used to calculate emissions. To maintain consistency with GHG inventory, emissions of NOx and CO were calculated using emission factors and methodology from $IPCC_{2006}$ Guidelines, ***Chapter 2.4: Non-CO₂ Emissions*** (H. Aalde, 2006). The inclusion/exclusion of the ***condensable component of PMs*** is unknown.

Table 6.33: *Emission factors in the category of Open burning of waste*

POLLUTANT	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC
Unit	[g/kg dm]	[kg/t waste]	[kg/t waste]	[kg/t waste]	[kg/t waste]	[kg/t waste]	[% of $PM_{2.5}$]
Value	3	1.47	0.03	3.76	4.13	4.31	28.2

POLLUTANT	CO	Pb	Cd	As	Cu	Se	Zn
Unit	[g/kg dm]	[g/t waste]	[g/t waste]	[g/t waste]	[g/t waste]	[g/t waste]	[g/t waste]
Value	107	0.32	0.13	0.79	0.25	0.10	17.00

POLLUTANT	PCDD/F*	B(a)P	B(b)F	B(k)F	PAHs
Unit	[µg/t]	[g/t waste]	[g/t waste]	[g/t waste]	[g/t waste]
Value	10	3.15	6.45	5.15	14.75

*T1

6.6.4.2 Completeness

All rising pollutants are recorded and reported.

6.6.4.3 Source-specific Recalculations

No recalculations were made.

6.7 WASTEWATER HANDLING (NFR 5D)

6.7.1 Overview

This sector includes emissions of main pollutants from domestic and industrial wastewater treatment. In these categories, also emissions from biogas incineration are included, but these emissions are not the key source of emissions. For wastewater treatment, NMVOC is the most significant pollutant emitted from these sources, but this category is not key for NMVOC emissions.

Total NMVOC emissions from wastewater treatment (including biogas incineration) were 0.26 kt in 2022. Compared to the previous years, these emissions continue to decrease, which is caused mainly by building and connecting the houses to the sewage systems. l

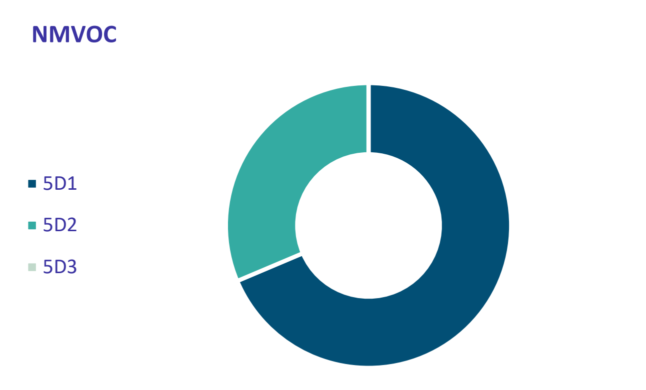
Table 6.34 shows trends of emissions from domestic and industrial wastewater during the last years.

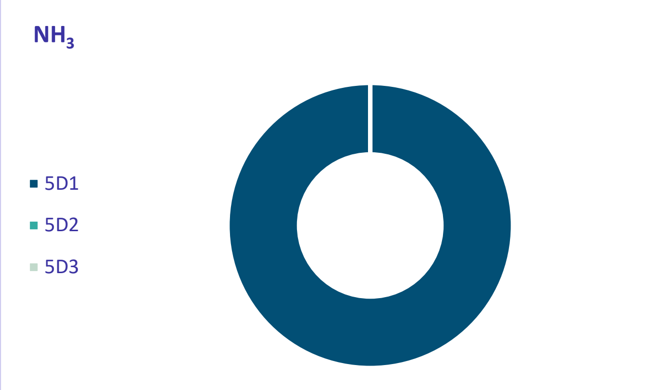
Table 6.34: Overview of emission trends in the category of Wastewater handling

YEAR	NMVOC [kt]	NH_3 [kt]
1990	0.0084	1.0964
1995	0.0092	0.9971
2000	0.0102	0.8363
2005	0.0094	0.7037
2010	0.0103	0.5413
2011	0.0084	0.4037
2012	0.0079	0.3939
2013	0.0091	0.3140
2014	0.0085	0.2505
2015	0.0083	0.2364
2016	0.0086	0.1604
2017	0.0085	0.0678
2018	0.0083	0.0349
2019	0.0086	0.0132
2020	0.0089	0.0097
2021	0.0089	0.0087
2022	0.0079	0.0087
2023	0.0094	0.0087
1990/2023	**12%**	**-99%**
2022/2023	**20%**	**0%**

Shares of NMVOC emission in 2022 NFR categories included in the wastewater treatment are shown in ***Figure 6.7***.

Figure 6.7: Share in NMVOC and NH_3 emissions of individual categories in 5D in 2023





The legislation and practice in wastewater treatment in Slovakia require that sewage sludge must be stabilised directly by the wastewater treatment plant (e.g. Act No 188/2003 Coll. requires that only stabilised sewage sludge can be indirectly applied on agricultural land). Thus, according to the Slovak Technical Norm 75 6401 "Sewage Treatment Plants for more than 500 population equivalents", wastewater treatment plants (WWTPs) with a capacity of up to 10,000 population-equivalents (p.e.) shall have aerobic sludge stabilisation and larger WWTPs shall have anaerobic sludge stabilisation with biogas production. ***Tables 6.35*** and ***6.36*** provide information on the data sources regarding the share of the distribution of domestic and industrial sludge treatment.

Table 6.35: WWT distribution of domestic sludge

YEAR	TOTAL GENERATED	TOTAL USE	DIRECT AGR. LAND APPLIC.	COMPOSTED	INCINER.	LANDFILLED	TEMPORARY STORED ON-SITE
	tons						
1990	55 000	45 207	-	-	-	-	-
1995	55 000	32 687	-	-	-	-	-
2000	56 279	35 358	-	-	-	13 796	7 125
2005	56 360	39 120	5 870	33 250	-	8 530	8 710
2010	54 760	48 063	923	47 140	-	16	6 681
2011	58 718	50 469	358	50 111	-	2 306	5 946
2012	58 760	50 896	1254	46 446	3 196	1 615	6 195
2013	57 433	50 787	518	45 261	5 008	1 666	4 980
2014	56 883	52 570	8	36 524	16 038	1 073	3 240
2015	56 242	51 602	-	34 689	16 913	1 709	2 932
2016	53 054	45 738	-	34 695	11 043	2 359	4 957
2017	54 517	46 654	-	34 416	12 238	2 636	5 227
2018	55 929	44 659	-	32 982	11 677	2 451	8 819
2019	54 832	45 149	-	32 217	12 932	2 296	7 387
2020	55 519	48 490	-	36 562	11 928	2 302	4 727
2021	54 764	50 042	-	37 289	12 753	456	4 266
2022	55 049	43 835	-	33 509	10 326	1 540	9 674
2023	56 420	46 747	-	31 050	15 697	490	9 183

Table 6.36: WWT distribution of industrial treatment sludge since 2005

YEAR	TOTAL GENERATED	TOTAL USE	DIRECT AGR. LAND APPLIC.	COMPOSTED	INCINER.	LANDFILLED	TEMPORARY STORED ON-SITE
	tons						
2005	10307	5577	2231	1037	1501	-	785
2010	25571	19769	1102	6369	1223	5	11058
2011	29388	19460	685	9977	811	110	7620
2012	22567	18483	478	7099	752	791	6351
2013	19632	17167	627	7727	844	876	1456
2014	12377	8434	688	4632	732	1031	1237
2015	11485	7500	813	3248	1147	1349	898
2016	13651	12200	1134	3353	46	1975	5641
2017	22211	15538	362	3460	0	1206	1063
2018	49669	40462	287	3520	476	2831	1006
2019	12935	9223	49	3401	526	2137	1694
2020	32611	28611	1	3893	336	989	6445
2021	20724	10992	1	3191	0	1013	6037
2022	14240	10176	1	1905	130	925	5598
2023	16130	10179	5	4419	353	1064	1657

6.7.2 Domestic Wastewater Handling (NFR 5D1)

6.7.2.1 Overview of the Category

Council Directive 91/271/EEC[21] concerning urban wastewater treatment, as well as obligations arising from the Treaty of Accession of the Slovak Republic to the European Union of 16.4.2003, resulted in the construction of

[21] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31991L0271&from=EN

new sewage systems. The construction of new wastewater treatment plants and restoring the hardware of already functioning sewage treatment plants.

Generally, about two-thirds of the population discharges wastewater through sewers and one-third use retention tanks. Wastewater collection and treatment in Slovakia is developing toward modern, advanced WWT plants with the removal of nitrogen and phosphorus. Sludge from wastewater treatment is anaerobically stabilised on-site in 52 of 734 Domestic WWT plants. On 40 of them, resulting biogas is incinerated to produce energy and on 8 it is flared without energy utilisation.

This category involves also emissions from using latrines in Slovakia. The number of households without connection to the public sewage system decreased significantly in comparison to the base year. ***Table 6.37*** shows the emission trend of NH_3.

Table 6.37: *Overview of emission trends from water treatment and latrines in the category of Domestic wastewater handling*

YEAR	DOMESTIC WW DISCHARGED [th. m³]	POPULATION USING DRY TOILETS [inhab]	NMVOC [kt]	NH_3 [kt]
1990	370 257.35	685 274	0.0056	1.0964
1995	402 528.74	623 177	0.0060	0.9971
2000	447 129.41	522 718	0.0067	0.8363
2005	411 842.63	439 790	0.0062	0.7037
2010	454 069.00	338 340	0.0068	0.5413
2011	364 941.00	252 302	0.0055	0.4037
2012	337 545.00	246 164	0.0051	0.3939
2013	400 954.00	196 245	0.0060	0.3140
2014	377 445.00	156 568	0.0057	0.2505
2015	362 142.00	147 745	0.0054	0.2364
2016	385 463.00	100 235	0.0058	0.1604
2017	382 392.00	42 345	0.0057	0.0678
2018	369 599.00	21 801	0.0055	0.0349
2019	381 036.00	8 252	0.0057	0.0132
2020	404 305.00	6 034	0.0061	0.0097
2021	400 700.00	5 435	0.0060	0.0087
2022	351 547.00	5 429	0.0053	0.0087
2023	430 924.00	5 425	0.0065	0.0087
1990/2023	**16%**	**-99%**	**16%**	**-99%**
2022/2023	**23%**	**0%**	**23%**	**0%**

As shown in ***Table 6.37***, emissions of NMVOC from water treatment decreased from 1996 to 2003, since 2004 emissions show an increasing trend due to the increase of households connected to a public sewage system and water supply. The emission trend of NH_3 is decreasing due to the decrease in inhabitants using dry toilets. In the combustion of biogas, a significant decrease was identified for ammonia in the year 2000, but the cause is unknown.

6.7.2.2 Methodological Issues

The Source of activity data is national statistical data on the volume of handled wastewater released into watercourses. EMEP/EEA GB_{2023} (Tier 1) were used to calculate emissions of NMVOC emitted into the air during wastewater handling. In the table below, the emission factor used to calculate emissions is shown. Notation keys from EMEP/EEA GB_{2023} were applied for other pollutants.

Data from the NEIS database for the incineration of residual gases, previously reported under the **5D1** category, were reallocated to the Energy category **1A5a** in compliance with the GHG inventory.

The NEIS database contains data from the year 2000 for pollutants: NOx, NMVOC, SOx, NH_3, TSP and CO. Emissions of $PM_{2.5}$ and PM_{10} are calculated within the database from the year 2005. These data represent emissions from biogas flaring. Emission factors in the NEIS database comply with Decree 363/2010[22] and emission factors are in ANNEX I of the Decree. The share of $PM_{2.5}$ and PM_{10} emissions was determined from the following sources:

- TESO Praha a.s.: Drafting of emission factors for the Ministry of the Environment.
- COMMUNICATION of the Department of Air Protection, which determines the emission factors and ratios of PM10 and PM2.5 particles in TZL for the assessment of the ecological feasibility of the proposal as part of the energy audit and energy assessment according to the procedure specified in Annex no. 6 of Decree No. 480/2012 Coll., on the energy audit and energy assessment, as amended
- Notification of the Department of Air Protection, which determines the emission factors according to § 12 para. 1 letter b) decree no. 415/2012 Coll., on the permissible level of pollution and its detection and the implementation of some other provisions of the Air Protection Act
- Jana Smutná: Emission factors in the Czech Republic (overview study)

Emission factors for historical years for NOx, NMVOC, SOx, NH_3, and TSP are calculated using the weighted average of implied emission factors from the period 2000-2004 and for shares of PMs as average shares from the period 2005-2009. Emission factors for historical years are listed in ***Table 6.38***.

Table 6.38: *Historical emission factors for biogas incineration reallocated into the category 1A5a*

POLLUTANT	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO
Unit	[g/m³]	[g/m³]	[g/m³]	[g/m³]	[of TSP]	[of TSP]	[g/m³]	[g/m³]
Value	0.01	0.24	0.01	0.09	98.4%	98.5%	0.002	0.01

For the usage of dry toilettes, the principle of calculation consisted of determining the percentage of use of dry toilettes in Slovak households (based on information from censuses 2001 and 2011). Activity data were then calculated by multiplying this percentage by the middle-year population in the Slovak Republic. This parameter has been multiplied with Tier 2 emissions factors for dry toilettes from EMEP/EEA GB_{2023} (***Table 6.39***).

Table 6.39: *Emission factors for wastewater treatment in the category of Domestic wastewater handling*

POLLUTANT	NMVOC	NH_3
Unit	[mg/m³[	[kg/person/year]
Value	15	1.6

6.7.2.3 Completeness

Sources of emissions are well covered.

6.7.2.4 Source-specific Recalculations

Emissions were recalculated due to reallocation of the emissions from biogas burning to the energy category in compliance with the GHG invetory (***Table 6.40***).

Table 6.40: *Differences of emissions in the category 5D1 between previous submission and current submission caused by recalculations*

YEAR	NMVOC	NH_3
	CHANGE	
1990	-94%	-3%
1991	-94%	-3%
1992	-94%	-3%
1993	-94%	-3%
1994	-94%	-3%
1995	-94%	-3%
1996	-94%	-4%

[22] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2010/363/20100915.html

YEAR	NMVOC	NH_3
	CHANGE	
1997	-94%	-4%
1998	-94%	-4%
1999	-94%	-4%
2000	-13%	0%
2001	-92%	-3%
2002	-96%	-6%
2003	-96%	-6%
2004	-97%	136%
2005	-97%	-7%
2006	-97%	-9%
2007	-97%	-9%
2008	-97%	-9%
2009	-97%	-10%
2010	-97%	-11%
2011	-97%	-15%
2012	-97%	-14%
2013	-97%	-17%
2014	-97%	-21%
2015	-97%	-23%
2016	-97%	-31%
2017	-97%	-53%
2018	-98%	-70%
2019	-97%	-86%
2020	-97%	-89%
2021	-97%	-90%
2022	-98%	-90%

6.7.3 Industrial Wastewater Handling (NFR 5D2)

6.7.3.1 Overview of the Category

Water consumption for industrial purposes and the resulting discharge of wastewater have significantly decreased in the period 1990–2023. This decrease is caused by the general modernisation of the Slovak industries and stricter standards for the discharge of industrial wastewater to public sewers or watercourses.

Table 6.41: *Overview of emissions and trends in the category of Industrial wastewater handling*

YEAR	INDUSTRIAL WASTEWATER DISCHARGED [th.m^3]	NMVOC WATER TREAT. [kt]
1990	191 163.24	0.0029
1995	207 824.90	0.0031
2000	230 852.15	0.0035
2005	212 633.64	0.0032
2010	230 670.00	0.0035
2011	198 242.00	0.0030
2012	190 699.00	0.0029
2013	202 692.00	0.0030
2014	189 387.00	0.0028
2015	188 578.00	0.0028
2016	189 571.00	0.0028
2017	187 218.00	0.0028
2018	186 178.00	0.0028

YEAR	INDUSTRIAL WASTEWATER DISCHARGED [th.m^3]	NMVOC WATER TREAT. [kt]
2019	189 901.00	0.0028
2020	190 970.00	0.0029
2021	194 804.00	0.0029
2022	173 822.00	0.0026
2023	197 014.00	0.0030
1990/2023	**3%**	**-9%**
2022/2023	**13%**	**-11%**

In ***Table 6.41***, activity data, emissions and their trends are displayed. Emissions of NH_3 have increased since 2016 due to the increase of emissions from residual gases burning,

6.7.3.2 Methodological issues

The amount of industrial wastewater discharged to watercourses was used as the activity data to estimate emissions of NMVOC. Tier 2 emission factor for industrial wastewater handling from EMEP/EEA GB_{2023} was used and its value is **15mg/m^3**.
Data from the NEIS database for the incineration of residual gases, previously reported under **5D1** category, were reallocated to the Energy category **1A5a** in compliance with the GHG inventory.
The NEIS database contains data from the year 2000 for pollutants: NOx, NMVOC, SOx, NH_3, TSP and CO. Emissions of $PM_{2.5}$ and PM_{10} are calculated within the database from the year 2005. These data represent emissions from biogas flaring. Emissions of $PM_{2.5}$ and PM_{10} are calculated within the database from the year 2005. These data represent emissions from biogas flaring. Emission factors in the NEIS database comply with Decree 363/2010[23] and emission factors are in ANNEX I of the Decree. The share of $PM_{2.5}$ and PM_{10} emissions was determined from the following sources:

- TESO Praha a.s.: Drafting of emission factors for the Ministry of the Environment.
- COMMUNICATION of the Department of Air Protection, which determines the emission factors and ratios of PM_{10} and $PM_{2.5}$ particles in TZL for the assessment of the ecological feasibility of the proposal as part of the energy audit and energy assessment according to the procedure specified in Annex no. 6 of Decree No. 480/2012 Coll., on energy audit and energy assessment, as amended
- Notification of the Department of Air Protection, which determines the emission factors according to § 12 para. 1 letter b) decree no. 415/2012 Coll., on the permissible level of pollution and its detection and the implementation of some other provisions of the Air Protection Act
- Jana Smutná: Emission factors in the Czech Republic (overview study)

Emission factors for historical years for NOx, NMVOC, SOx, NH_3, and TSP are calculated using the weighted average of implied emission factors from the period 2000-2004 and for shares of PMs as average shares from the period 2005-2009. Emission factors for historical years are listed in ***Table 6.42***.

Table 6.42: *Historical emission factors for biogas incineration reallocated into the category 1A5a*

POLLUTANT	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO
Unit	[g/m^3]	[g/m^3]	[g/m^3]	[g/m^3]	[of TSP]	[of TSP]	[g/m^3]	[g/m^3]
Value	0.02	4.51	0.00036	0.02	98.4%	98.5%	0.03	0.02

6.7.3.3 Completeness

Sources of emissions are well covered.

[23] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2010/363/20100915.html

6.7.3.4 Source-specific Recalculations

Emissions were recalculated due to the reallocation of the emissions from biogas burning to the energy category in compliance with the GHG inventory (***Table 6.43***).

Table 6.43: *Differences of emissions in the category 5D2 between previous submission and current submission caused by recalculations*

YEAR	NMVOC
	CHANGE
1990	-100%
1991	-100%
1992	-100%
1993	-100%
1994	-100%
1995	-100%
1996	-100%
1997	-100%
1998	-100%
1999	-100%
2000	-100%
2001	-100%
2002	-100%
2003	-100%
2004	-100%
2005	-100%
2006	-99%
2007	-99%
2008	-99%
2009	-97%
2010	-97%
2011	-90%
2012	-90%
2013	-96%
2014	-80%
2015	-81%
2016	-94%
2017	-94%
2018	-94%
2019	-94%
2020	-94%
2021	-94%
2022	-94%

6.7.4 Other Wastewater Handling (NFR 5D3)

6.7.4.1 Overview of the Category

This activity is not occurring in the Slovak Republic, therefore notation key NO was used.

6.8 OTHER WASTE (NFR 5E)

6.8.1 Overview of the Category

This chapter covers emissions from:

- Car fires
- Detached house fires
- Industrial building fires
- Apartment building fires

In ***Table 6.44*** and ***Table 6.45*** overview of statistical activity data and emission trends are displayed.

Table 6.44: *Overview of the activity data in the category Other waste*

YEAR	CAR FIRE [No. of fires]	CARS DAMAGED BY FIRE [No. of fires]	DETACHED HOUSES [No. of fires]	APARTMENT BUILDINGS [No. of fires]	INDUSTRIAL BUILDINGS [No. of fires]
1990	611.90	101.51	718.89	594.45	268.09
1995	644.09	106.85	756.71	625.72	282.19
2000	587.00	97.00	592.00	960.00	361.00
2005	660.00	98.00	764.00	706.00	314.00
2010	837.00	139.00	989.00	615.00	260.00
2011	784.00	125.00	1119.00	603.00	293.00
2012	785.00	159.00	1098.00	561.00	295.00
2013	822.00	128.00	1061.00	519.00	240.00
2014	772.00	152.00	915.00	494.00	207.00
2015	822.00	135.00	1094.00	514.00	203.00
2016	812.00	122.00	1139.00	496.00	218.00
2017	814.00	119.00	1197.00	521.00	206.00
2018	811.00	119.00	1059.00	520.00	228.00
2019	679.00	99.00	952.00	460.00	230.00
2020	717.00	108.00	1027.00	480.00	229.00
2021	597.00	47.00	1102.00	432.00	225.00
2022	607.00	79.00	1035.00	463.00	219.00
2023	627.00	83.00	947.00	454.00	169.00
1990/2023	**-1%**	**-22%**	**44%**	**-22%**	**-18%**
2022/2023	**2%**	**68%**	**-6%**	**7%**	**-3%**

Table 6.45: *Overview of emissions in the category Other waste*

YEAR	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	Pb [t]	Hg [t]	Cd [t]	As [t]	Cr [t]	Cu [t]	PCDD/F [g I-TEQ]
1990	0.1384	0.1384	0.1384	0.0004	0.0008	0.0008	0.0013	0.0012	0.0028	1.4034
1995	0.1456	0.1456	0.1456	0.0004	0.0009	0.0009	0.0013	0.0013	0.0030	1.4772
2000	0.1386	0.1386	0.1386	0.0004	0.0008	0.0008	0.0013	0.0012	0.0028	1.4052
2005	0.1511	0.1511	0.1511	0.0004	0.0009	0.0009	0.0014	0.0013	0.0031	1.5320
2010	0.1785	0.1785	0.1785	0.0005	0.0010	0.0010	0.0017	0.0016	0.0037	1.8118
2011	0.1974	0.1974	0.1974	0.0006	0.0012	0.0012	0.0018	0.0017	0.0041	1.9994
2012	0.1927	0.1927	0.1927	0.0006	0.0011	0.0011	0.0018	0.0017	0.0040	1.9529
2013	0.1840	0.1840	0.1840	0.0005	0.0011	0.0011	0.0017	0.0016	0.0038	1.8666
2014	0.1610	0.1610	0.1610	0.0005	0.0009	0.0009	0.0015	0.0014	0.0033	1.6352
2015	0.1876	0.1876	0.1876	0.0005	0.0011	0.0011	0.0017	0.0017	0.0039	1.9023
2016	0.1936	0.1936	0.1936	0.0006	0.0011	0.0011	0.0018	0.0017	0.0040	1.9621
2017	0.2027	0.2027	0.2027	0.0006	0.0012	0.0012	0.0019	0.0018	0.0042	2.0533
2018	0.1834	0.1834	0.1834	0.0005	0.0011	0.0011	0.0017	0.0016	0.0038	1.8600
2019	0.1651	0.1651	0.1651	0.0005	0.0010	0.0010	0.0015	0.0015	0.0034	1.6727
2020	0.1769	0.1769	0.1769	0.0005	0.0010	0.0010	0.0016	0.0016	0.0036	1.7915
2021	0.1850	0.1850	0.1850	0.0005	0.0011	0.0011	0.0017	0.0016	0.0038	1.8686
2022	0.1767	0.1767	0.1767	0.0005	0.0010	0.0010	0.0016	0.0016	0.0036	1.7862
2023	0.1623	0.1623	0.1623	0.0005	0.0010	0.0010	0.0015	0.0014	0.0033	1.6432
1990/2023	**17%**	**17%**	**17%**	**17%**	**18%**	**18%**	**18%**	**18%**	**18%**	**17%**
2022/2023	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**	**-8%**

6.8.2 Methodological Issues

Activity data were obtained from the fire statistics provided by the Fire Appraisal Institute of the Ministry of Interior (***Table 6.44***). Emissions from fires were calculated by multiplying activity data (number of fires) with emission factors from EMEP/EEA GB_{2023} (***Table 6.46***). Historical data (1990-1998) were extrapolated.

Table 6.46: *Emission factors for calculation of emissions in the category Other waste*

POLLUTANT	TSP, PM	Pb	Cd	Hg	As	Cr	Cu	PCDD/F
Unit	[kg/fire]	[g/fire]	[g/fire]	[g/fire]	[g/fire]	[g/fire]	[g/fire]	[mg/fire]
Car Fires	2.30	-	-	-	-	-	-	-
Detached house fires	143.82	0.42	0.85	0.85	1.35	1.29	2.99	1.44
Apartment building fires	43.78	0.13	0.26	0.26	0.41	0.39	0.91	0.44
Industrial building fires	27.23	0.08	0.16	0.16	0.25	0.24	0.57	0.27

6.8.3 Completeness

All rising pollutants were recorded and reported.

6.8.4 Source-specific Recalculations

No recalculations in this submission.

CHAPTER 7: OTHER AND NATURAL EMISSIONS (NFR 6, NFR 11)

Last update: 15.3.2025

7.1 OTHER SOURCES (NFR 6A)

7.1.1 Overview of the Category

No other activities have occurred in the Slovak Republic. Notation key NO is used.

7.2 VOLCANOES (NFR 11A)

7.2.1 Overview of the Category

There is no active volcano in Slovakia, therefore notation key NO was used.

7.3 FOREST FIRES (NFR 11B)

7.3.1 Overview of the Category

Fire can occur naturally (lightning, smouldering of organic material under sunny weather) or artificially, and often intentionally by human activity. In general, fires that are deliberately set by humans (including pyromania) in the world can be mentioned. Unfortunately, the situation in Slovakia and Central Europe is very similar.

The main reasons for forest fires are negligence and underestimation of risk, pyromania (a disease tendency to armpit) and attempt to benefit financially from a forest fire (e.g. in protected areas, it is easier to promote developers' interests after the removal of vegetation, the field of fire is easier to pre-categorize to a different kind of land, in some countries the intentional burning of tropical forests is practised to obtain easier agricultural land for large-scale cultivation of commercially lucrative crops).

Lightning-induced fires are exceptional in our country, more often occurring in northern Europe [24]

Forest fires are important sources of a large number of particulates and trace gases produced, including the products of incomplete combustion (CO, NMVOCs) and nitrogen and sulphur. In ***Table 7.1***, emissions in this category are shown.

Table 7.1: *Overview of main pollutants emissions in the category Forest fires*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.0876	0.1160	0.0088	0.0100	0.2629	0.3213	0.4966	0.0237	3.1254
1995	0.0298	0.0352	0.0027	0.0030	0.0893	0.1091	0.1687	0.0080	1.0616
2000	0.4432	0.4636	0.0352	0.0399	1.3296	1.6251	2.5114	0.1197	15.8074
2005	0.2708	0.2640	0.0201	0.0227	0.8123	0.9929	1.5344	0.0731	9.6578
2010	0.1046	0.0960	0.0073	0.0083	0.3139	0.3836	0.5929	0.0283	3.7318
2011	0.2215	0.2013	0.0153	0.0173	0.6644	0.8121	1.2550	0.0598	7.8992
2012	0.9378	0.8417	0.0640	0.0724	2.8135	3.4387	5.3143	0.2532	33.4491
2013	0.1517	0.1351	0.0103	0.0116	0.4552	0.5563	0.8598	0.0410	5.4117
2014	0.1077	0.0959	0.0073	0.0082	0.3231	0.3949	0.6102	0.0291	3.8410
2015	0.1987	0.1763	0.0134	0.0152	0.5962	0.7287	1.1262	0.0537	7.0887
2016	0.0990	0.0874	0.0066	0.0075	0.2971	0.3631	0.5612	0.0267	3.5321
2017	0.1688	0.1488	0.0113	0.0128	0.5065	0.6190	0.9567	0.0456	6.0215
2018	0.1411	0.1242	0.0094	0.0107	0.4232	0.5172	0.7993	0.0381	5.0310
2019	0.2640	0.2311	0.0176	0.0199	0.7920	0.9680	1.4960	0.0713	9.4157

[24] IPCC 2006 GL

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2020	0.2703	0.2363	0.0180	0.0203	0.8109	0.9910	1.5316	0.0730	9.6402
2021	0.0913	0.0795	0.0060	0.0068	0.2740	0.3349	0.5176	0.0247	3.2578
2022	0.6887	0.6053	0.0460	0.0521	2.0660	2.5251	3.9024	0.1859	24.5624
2023	0.0170	0.0147	0.0011	0.0013	0.0509	0.0622	0.0961	0.0046	0.6047
1990/2023	**-81%**	**-87%**	**-87%**	**-87%**	**-81%**	**-81%**	**-81%**	**-81%**	**-81%**
2022/2023	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [kg]	PCB [kg]
1990	0.1460	0.0088	0.0117	0.0050	0.0034	0.0288	0.0026	0.0175
1995	0.0496	0.0030	0.0040	0.0017	0.0011	0.0098	0.0009	0.0060
2000	0.7387	0.0443	0.0591	0.0251	0.0170	0.1455	0.0130	0.0886
2005	0.4513	0.0271	0.0361	0.0153	0.0104	0.0889	0.0079	0.0542
2010	0.1744	0.0105	0.0140	0.0059	0.0040	0.0344	0.0031	0.0209
2011	0.3691	0.0221	0.0295	0.0126	0.0085	0.0727	0.0065	0.0443
2012	1.5630	0.0938	0.1250	0.0531	0.0359	0.3079	0.0275	0.1876
2013	0.2529	0.0152	0.0202	0.0086	0.0058	0.0498	0.0045	0.0303
2014	0.1795	0.0108	0.0144	0.0061	0.0041	0.0354	0.0032	0.0215
2015	0.3312	0.0199	0.0265	0.0113	0.0076	0.0653	0.0058	0.0397
2016	0.1651	0.0099	0.0132	0.0056	0.0038	0.0325	0.0029	0.0198
2017	0.2814	0.0169	0.0225	0.0096	0.0065	0.0554	0.0050	0.0338
2018	0.2351	0.0141	0.0188	0.0080	0.0054	0.0463	0.0041	0.0282
2019	0.4400	0.0264	0.0352	0.0150	0.0101	0.0867	0.0077	0.0528
2020	0.4505	0.0270	0.0360	0.0153	0.0104	0.0887	0.0079	0.0541
2021	0.1522	0.0091	0.0122	0.0052	0.0035	0.0300	0.0027	0.0183
2022	1.1478	0.0689	0.0918	0.0390	0.0264	0.2261	0.0202	0.1377
2023	0.0283	0.0017	0.0023	0.0010	0.0006	0.0056	0.0005	0.0034
1990/2023	**-81%**	**-81%**	**-81%**	**-81%**	**-81%**	**-81%**	**-81%**	**-81%**
2022/2023	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**	**-98%**

7.3.2 Methodological Issues

The Slovak National Forest Centre provided activity data about wood burned (forest wildfires and controlled forest fires in Slovakia) and the Institute of Fire Engineering and Expertise of the Ministry of the Interior of the Slovak Republic data about area burned by wildfires to air pollutants inventory. Tier 2 emissions factors for temperate forests from EMEP/EEA GB_{2023} were used to calculate emissions of main pollutants and particulate matter from this category. To maintain consistency with GHG inventory, emissions of NOx and CO were calculated using emission factors and methodology from $IPCC_{2006}$ Guidelines, ***Chapter 2.4: Non-CO_2 Emissions*** (H. Aalde, 2006). POPs were calculated using country-specific emission factors (Most, et al, 1992). ***Table 7.3*** shows the emission factors used to estimate emissions in this category.

Table 7.2: *Activity data used in the category of Forest fires*

YEAR	AREA AFFECTED BY WILDFIRES [ha]	BIOMASS BURNED BY WILDFIRES [kt]	BIOMASS BURNED BY CONTROLLED FIRES [kt]	TOTAL BIOMASS BURNED [kt]
1990	232.00	29.21	105.05	134.26
1995	70.42	9.92	89.95	99.87
2000	927.25	147.73	133.12	280.85
2005	527.96	90.26	215.10	305.36
2010	191.96	34.88	218.68	253.56
2011	402.55	73.82	211.05	284.88
2012	1683.46	312.61	127.17	439.78

YEAR	AREA AFFECTED BY WILDFIRES [ha]	BIOMASS BURNED BY WILDFIRES [kt]	BIOMASS BURNED BY CONTROLLED FIRES [kt]	TOTAL BIOMASS BURNED [kt]
2013	270.26	50.58	127.68	178.26
2014	191.73	35.90	252.62	288.51
2015	352.57	66.25	241.85	308.09
2016	174.88	33.01	234.93	267.94
2017	297.66	56.28	229.36	285.63
2018	248.38	47.02	240.10	287.12
2019	462.17	88.00	228.30	316.30
2020	472.68	90.10	189.53	279.62
2021	158.94	30.45	193.47	223.91
2022	1210.55	229.56	191.41	420.96
2023	29.46	5.65	176.45	182.10
1990/2022	**-87%**	**-81%**	**68%**	**36%**
2021/2022	**-98%**	**-98%**	**-8%**	**-57%**

Table 7.3: *Emission factors in the category of Forest fires – temperate forests*

POLLUTANT	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	NOx
Unit	[kg/ha area burned]			[g/kg dm]			[% of $PM_{2.5}$]	[g/kg dm]	
Value	500	38	43	9	11	17	9	107	3

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCB
Unit	[mg I-TEQ/t]	[mg/tg	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]
Value	0.005	300	400	170	115	985	0.088	0.6

7.3.3 Completeness

All rising pollutants are recorded and reported.

7.3.4 Source-specific QA/QC and Verification

Verification of activity data from Forest fires is ensured by comparing data with data from the last submission.

7.3.5 Source-specific Recalculations

Recalculations in this submission were made due to the improvement of the methodology (expect for NOx and CO and POPs) to the Tier 2 level of the EMEP/EEA GB_{2023} (***Table 7.4***).

Table 7.4: *Differences of emissions in the category 11B between previous submission and current submission caused by recalculations*

YEAR	NMVOC	SOx	NH_3
	CHANGE	CHANGE	CHANGE
1990	67%	90%	115%
1991	67%	90%	115%
1992	67%	90%	115%
1993	67%	90%	115%
1994	67%	90%	115%
1995	67%	90%	115%
1996	67%	90%	115%
1997	67%	90%	115%
1998	67%	90%	115%
1999	67%	90%	115%
2000	67%	90%	115%
2001	67%	90%	115%
2002	67%	90%	115%

YEAR	NMVOC	SOx	NH_3
	CHANGE	CHANGE	CHANGE
2003	67%	90%	115%
2004	67%	90%	115%
2005	67%	90%	115%
2006	67%	90%	115%
2007	67%	90%	115%
2008	67%	90%	115%
2009	67%	90%	115%
2010	67%	90%	115%
2011	67%	90%	115%
2012	67%	90%	115%
2013	67%	90%	115%
2014	67%	90%	115%
2015	67%	90%	115%
2016	67%	90%	115%
2017	67%	90%	115%
2018	67%	90%	115%
2019	67%	90%	115%
2020	67%	90%	115%
2021	67%	90%	115%
2022	67%	90%	115%

7.4 OTHER NATURAL EMISSIONS (NFR 11C)

7.4.1 Overview of the category

No other natural emissions occur in the Slovak Republic, therefore notation key NO was used.

CHAPTER 8: RECALCULATIONS AND IMPROVEMENTS

Last update: 15.4.2025

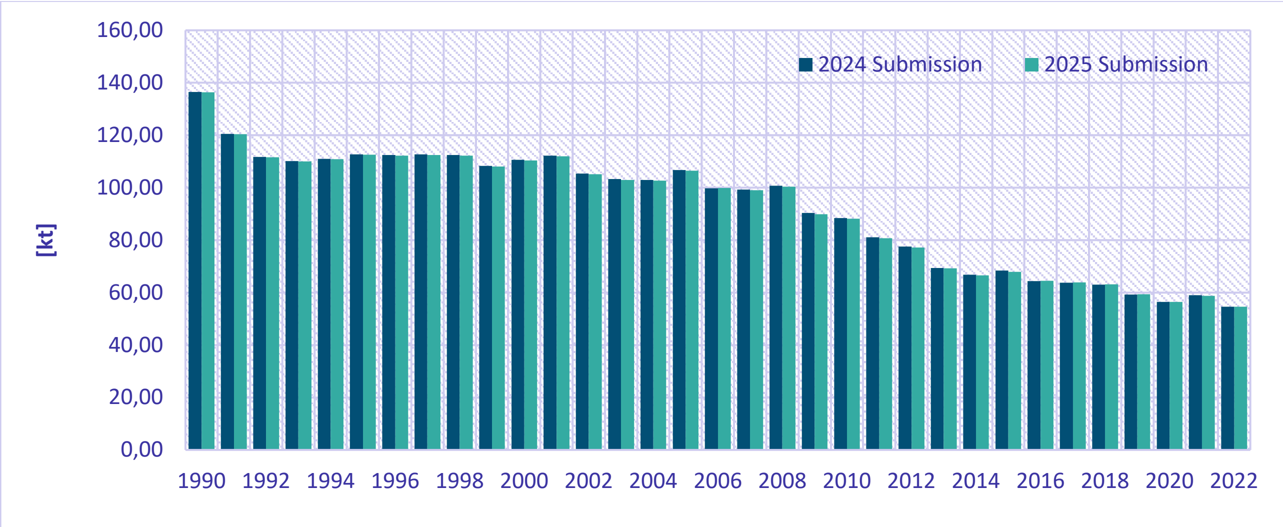
8.1 OVERVIEW BY GASES

Sector specific-recalculations are described within each of the relevant chapters. These chapters should be referred to for details of recalculations and method changes. This chapter summarises the impact of these changes on the emissions totals of final versions of the submissions and highlights the largest changes for each pollutant.

8.1.1 NOx (as NO2)

The impact of recalculations on the NOx emission total in this submission is shown in ***Figure 8.1***.
Minor changes in the whole period were caused due to changes in EF and correction of an error and clarification of the calculation in **1A4bi**. In agriculture sector. Emissions of NOx changed in **3B3, 3Da2a, 3Da2c** categories due to correction of the nitrogen excretion values by animals and implementation of revised N content coefficients in other organic fertilizers.

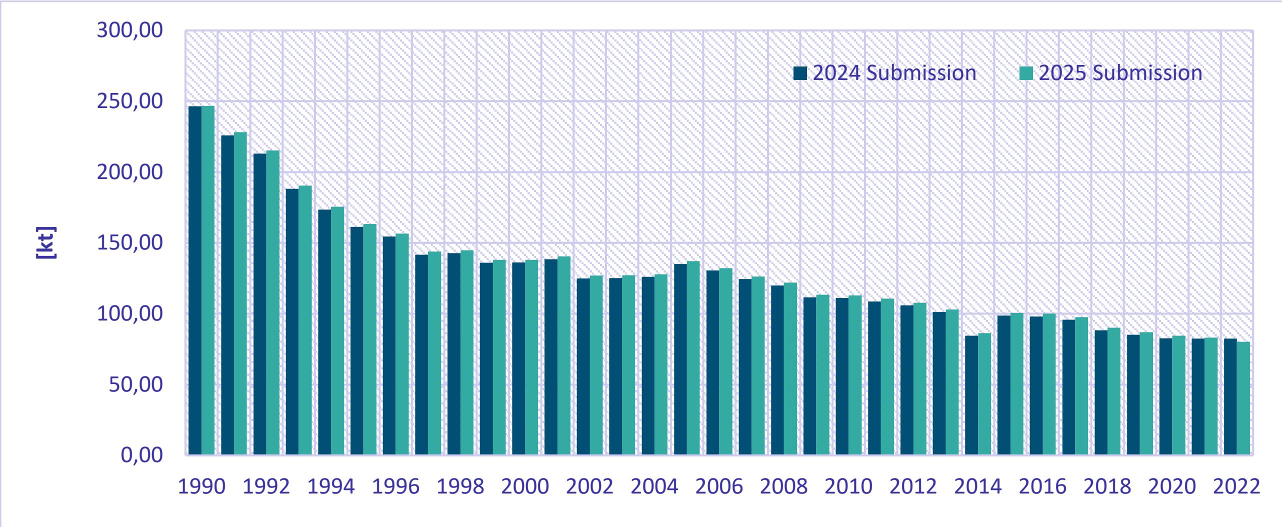
Figure 8.1: *Comparison of NOx emission total between the 2024 final submission and 2025 final submission*



8.1.2 NMVOC

A slight increase in emissions in the whole time series was caused by EF correction and clarification in the calculation in **1A4bi** category. In categories **2H2** and **5C1bv** emissions changed due to activity data correction. In **3B3** category due to correction of calculation error in the distribution of swine population to the categories. In category **3De** NMVOC emissions changed due to implementation of NECD recommendation SK-3De-2023-0001. In category **5A**, emissions changed in line with the recalculation of the CH_4 emissions in GHG inventory. In category **5C** emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB 2023. Emissions changed in category **5D1** and **5D2** due to reallocation of the emissions to the energy category in compliance with the GHG inventory. Emissions also changed in category **11B** due to the improvement of the methodology. (***Figure 8.2***).

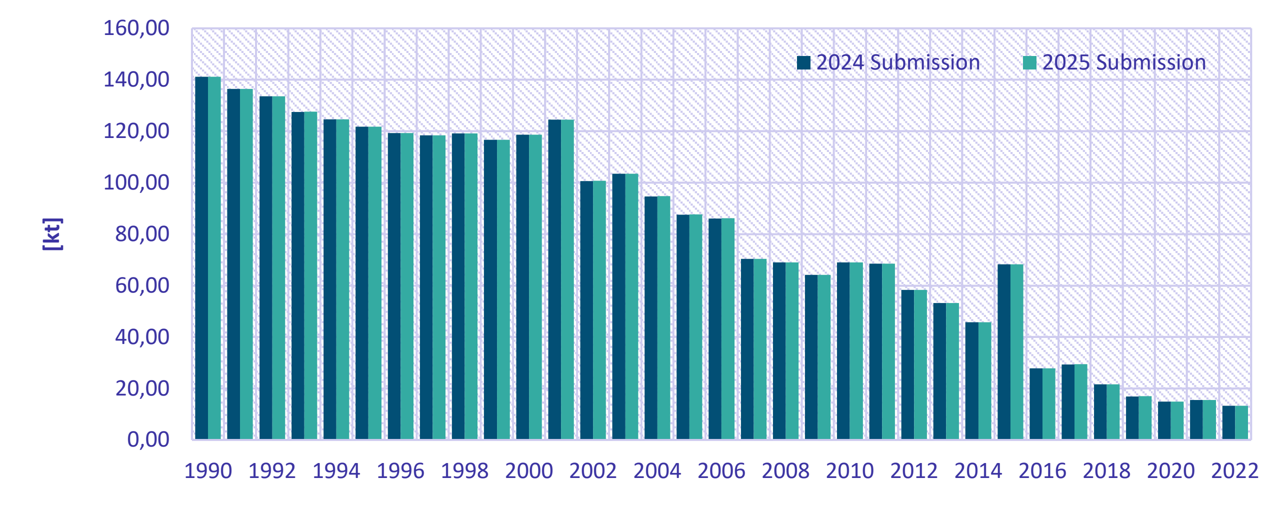
Figure 8.2: *Comparison of NMVOC emission total between the 2024 final submission and 2025 final submission*



8.1.3 SOx (as SO_2)

The impact of recalculations on the SOx emission total in this submission is shown in ***Figure 8.3***.
Minor changes were caused as a result of r In **1A4bi** category emissions changed based on changes in EF, and correction of an error and clarification in the calculation. In category **5C1bi, 5C1bii** and **5C1biii** emissions changed as a result of an improvement to Tier 2 methodology of the EMEP/EEA GB2023 and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023. In category **5C1bv** emissions changed due to error correction in activity data. Emissions changed in category **11B** due to the improvement of the methodology.

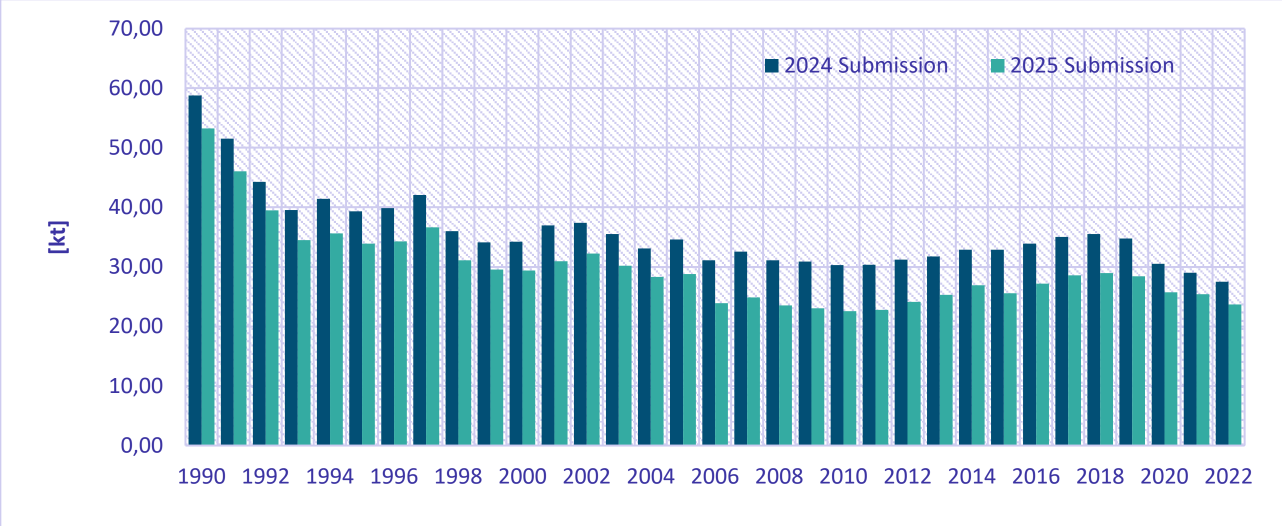
Figure 8.3: *Comparison of SOx emission total between the 2024 final submission and 2025 final submission*



8.1.4 NH_3

The impact of recalculations on the NH_3 emission total in this submission is shown in ***Figure 8.4***. Emissions decreased due to changes in EF, and correction of an error and clarification in the calculation in **1A4bi**. In Agriculture sector emission changed due to correction of the nitrogen excretion values by animals and implementation of revised N content coefficients in other organic fertilizers in categories **3B, 3Da2a, 3Da2c** In category **3Da4** emissions of NH_3 were recalculated due to revision of country-specific coefficient for N content. In category **5B1** emissions changed due to change of the technology used for composting of waste. In **5B2** emissions changed due to changes in activity data. Emissions changed in category **11B** due to the improvement of the methodology.

Figure 8.4: Comparison of NH_3 emission total between the 2024 final submission and 2025 final submission

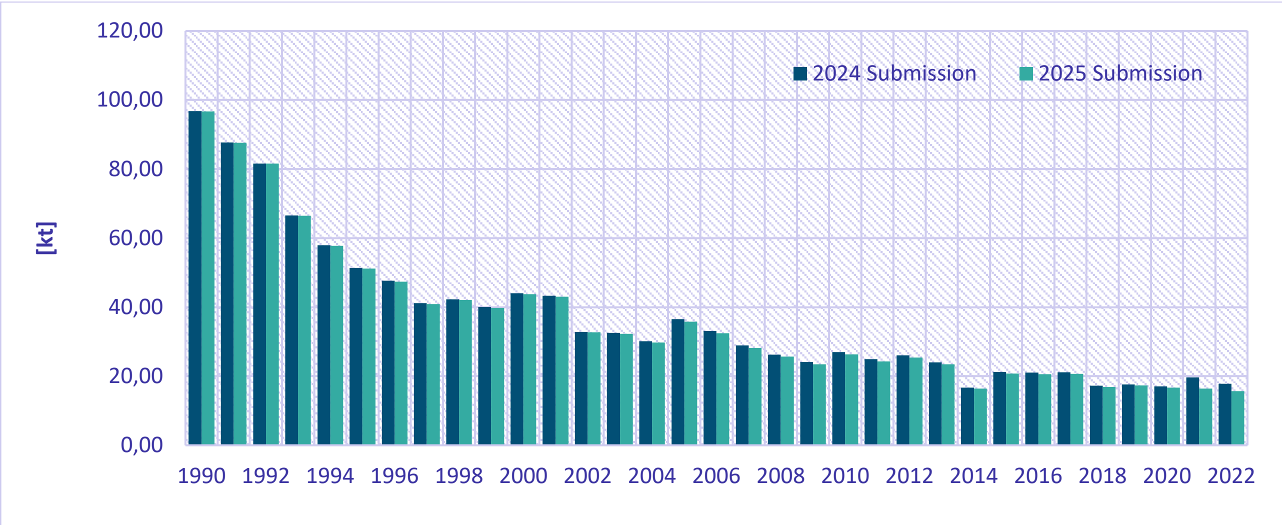


8.1.5 $PM_{2.5}$

An overview of the changes is shown in ***Figure 8.5***.

A sight decrease in emissions was caused by changes in EF, and correction of an error and clarification in the calculationin **1A4bi**. Activity data correction in category **2H2** and **5C1bv** . Due to the correction of calculation aggregation error in categories **3B** and **3Dc** and due to revision of the activity data in category **3Dc**. In **5A** category emission changed due to an update of the activity data of the mineral waste. In category **5C** emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources accordingof the EMEP/EEA GB2023

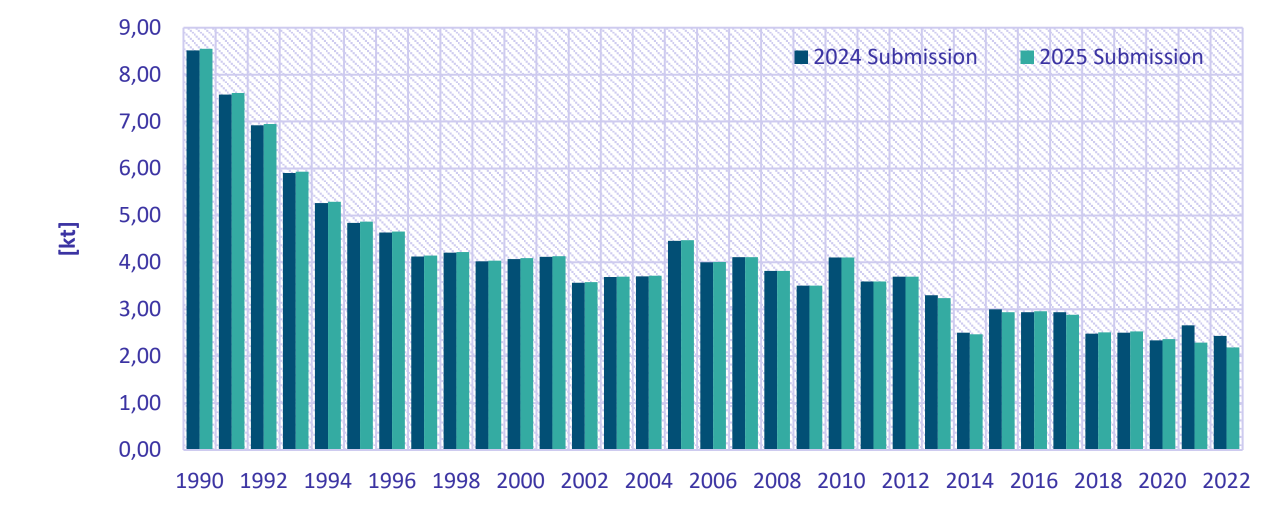
Figure 8.5: Comparison of $PM_{2.5}$ emission total between the 2024 final submission and 2025 final submission



8.1.6 TSP, PM_{10}, BC

Emission changed in **1A4bi** category due to changes in EF, and correction of an error and clarification in the calculation. . Due to the correction of calculation aggregation error in categories 3B and 3Dc and due to revision of the activity data in category **3Dc**. In **5A** category emission changed due to an update of the activity data of the mineral waste. In category **5C** emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources accordingof the EMEP/EEA GB2023. Emissios of BC also changed in categories **1A1a, 1A4ai, 14Aci** and **1A5a** due to corrections of the methodologies focused on the combinations of the installation types/fuels used in our country. And in categories **1A2a, 1A2d, 1A2f, 1A2gviii, 1A4ai, 1A4ci** categories due to changes in activity data and emission factor corrections.
An overview of the changes is shown in ***Figure 8.6***.

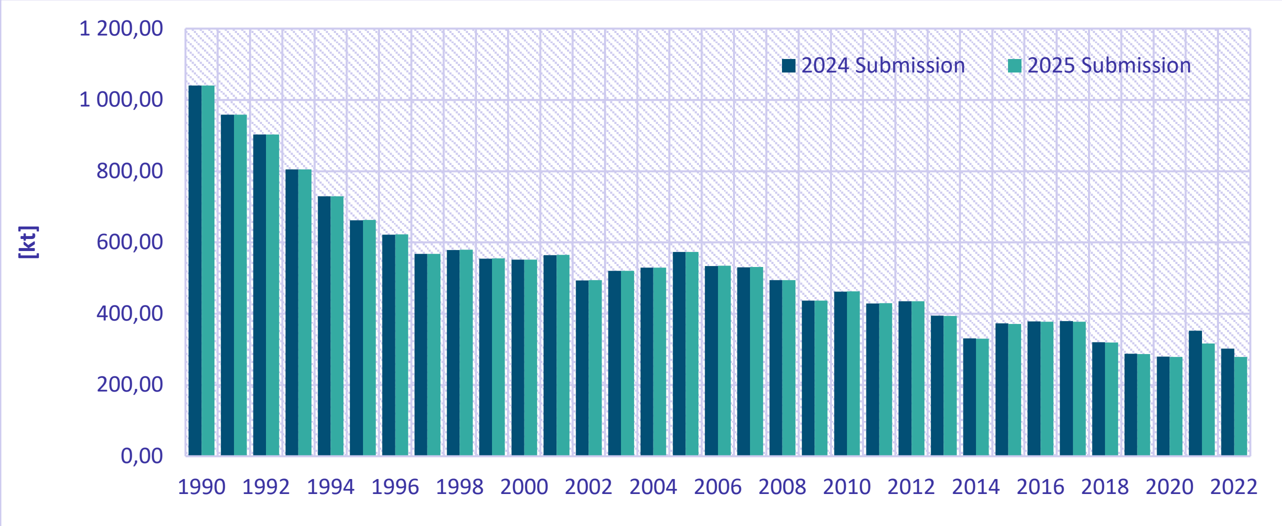
Figure 8.6: *Comparison of BC emission total between the 2024 final submission and 2025 final submission*



8.1.7 CO

Emission slightly changed in 1A4bi category due to changes in EF, and correction of an error and clarification in the calculation. . Due to the correction of calculation aggregation error in categories 3B and 3Dc and due to revision of the activity data in category 3Dc. In 5A category emission changed due to an update of the activity data of the mineral waste. In category 5C emissions changed as a result of an improvement to Tier 2 methodology and due to the reconsideration of abatement technologies used in the sources accordingof the EMEP/EEA GB2023. An overview of the changes is shown in *Figure 8.7.*

Figure 8.7: Comparison of CO emission total between the 2024 final submission and 2025 final submission



8.1.8 Priority Heavy Metals (Pb, Cd, Hg)

Emissions changed due to recalculations in categories **1A1a 1A4ai, 1A4ci and 1A5a** due to corrections of methodologies focused on the combinations of the installation types/fuels used in our country. In **1A2d** category emissions changed based on change of emission factor values and also based on changes in activity data In **1A4bi** category emissions changed based on changes in EF, and correction of an error and clarification in the calculation. In category **5C1bi, 5C1bii** and **5C1biii** emissions changed as a result of an improvement to Tier 2 methodology of the EMEP/EEA GB2023 and due to the reconsideration of abatement technologies used in the. In category **5C1bv** emissions changed due to error correction in activity data.

(***Figure 8.8*** – ***Figure 8.10***).

Figure 8.8: Comparison of Pb emission total between the 2024 final submission and 2025 final submission

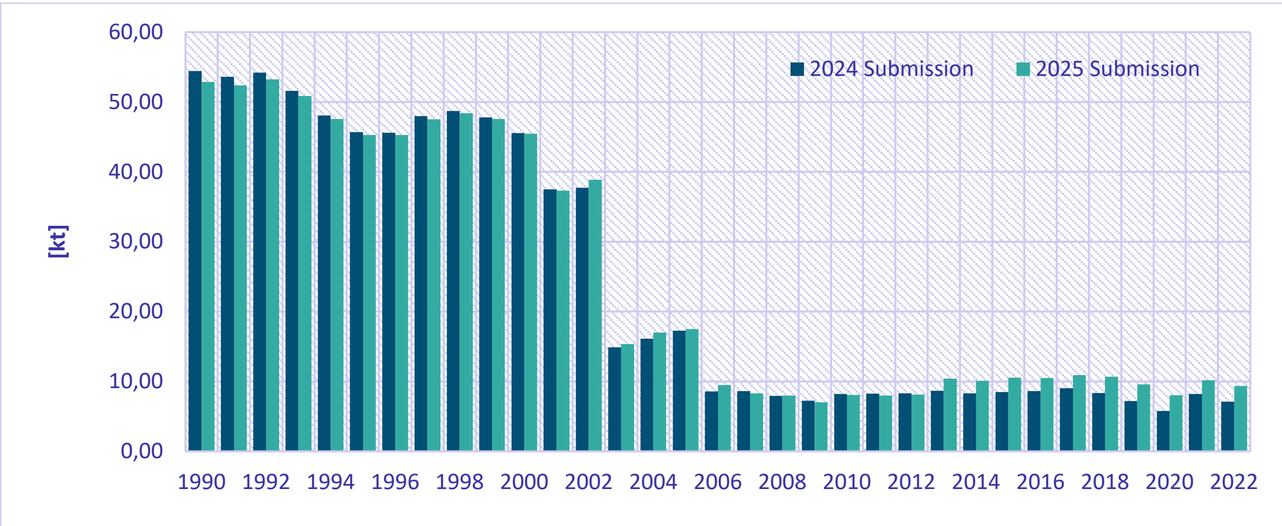


Figure 8.9: *Comparison of Cd emission total between the 2024 final submission and 2025 final submission*

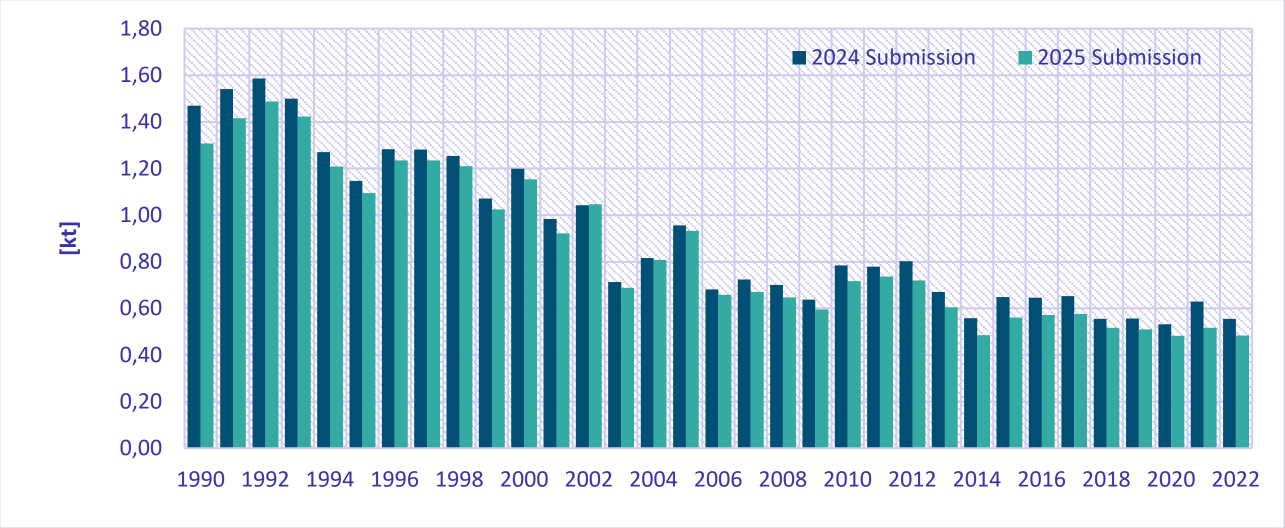
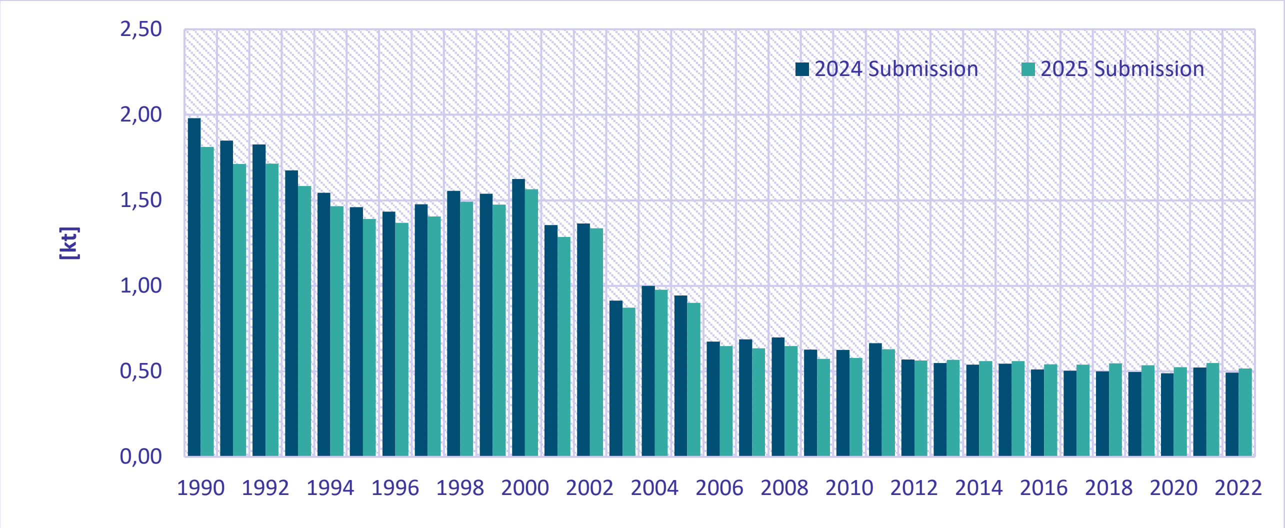


Figure 8.10: *Comparison of Hg emission total between the 2024 final submission and 2025 final submission*



8.1.9 POPs

Emissions changed due to recalculations in categories **1A1a 1A4ai, 1A4ci** and **1A5a** based on corrections of detailed methodologies focused on the combinations of the installation types/fuels used in our country. In 1A2d category emissions changed based on change of emission factor values and also based on changes in activity data In **1A4bi** category emissions changed based on changes in EF, and correction of an error and clarification in the calculation. In category **5C1bi, 5C1bii** and **5C1biii** emissions changed as a result of an improvement to Tier 2 methodology of the EMEP/EEA GB2023 and due to the reconsideration of abatement technologies used in the sources according to the new EMEP/EEA GB2023. In category **5C1bv** emissions changed due to error correction in activity data.

Figure 8.11: *Comparison of PCDD/F emission total between the 2024 final submission and 2025 final submission*

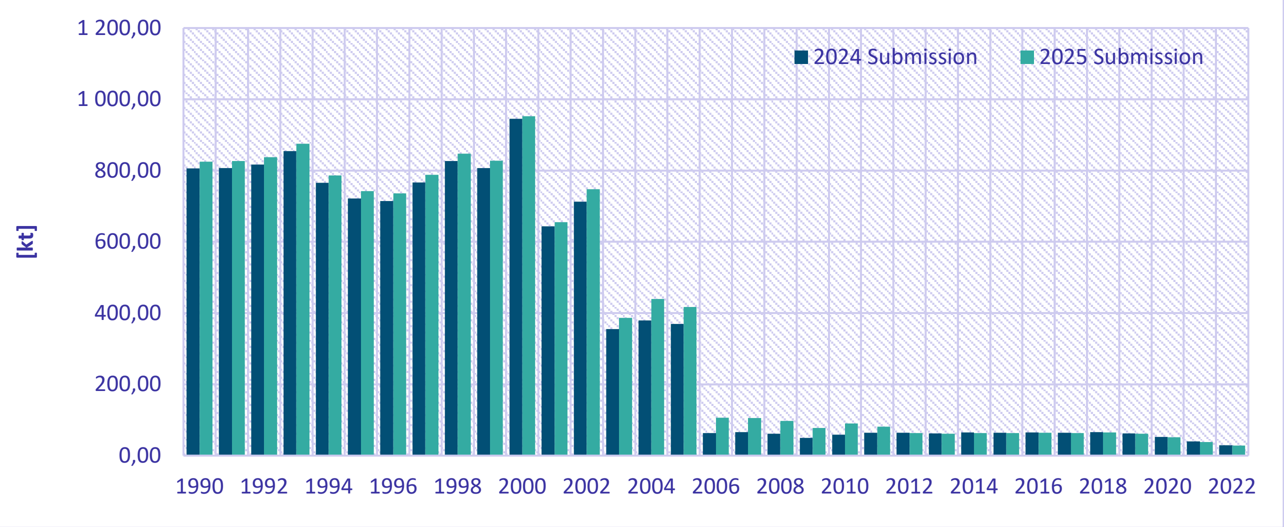


Figure 8.12: *Comparison of PAHs emission total between the 2024 final submission and 2025 final submission*

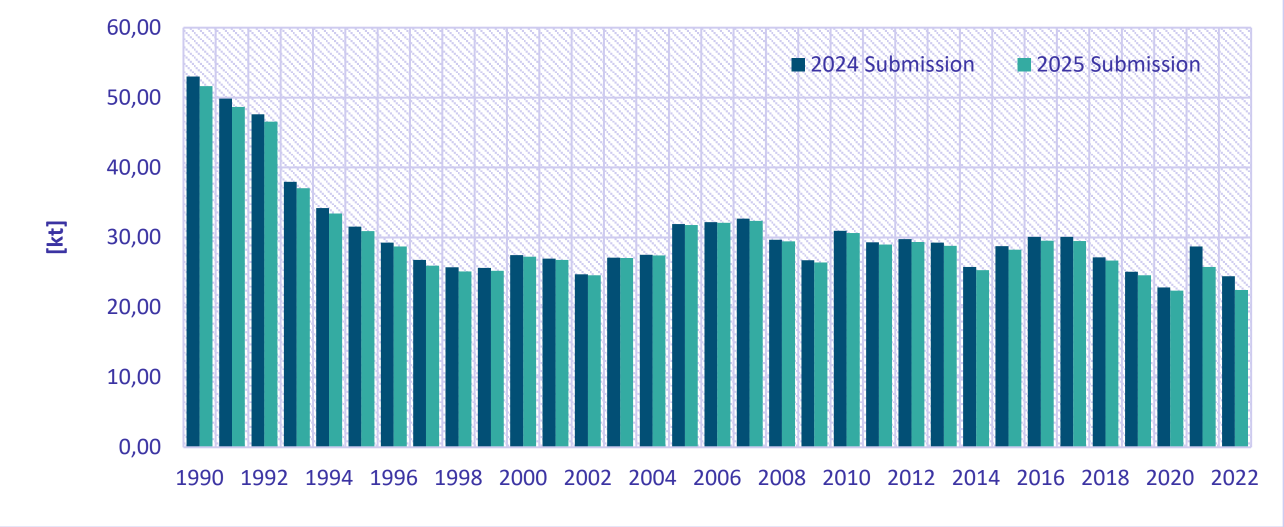


Figure 8.13: *Comparison of HCB emission total between the 2024 final submission and 2025 final submission*

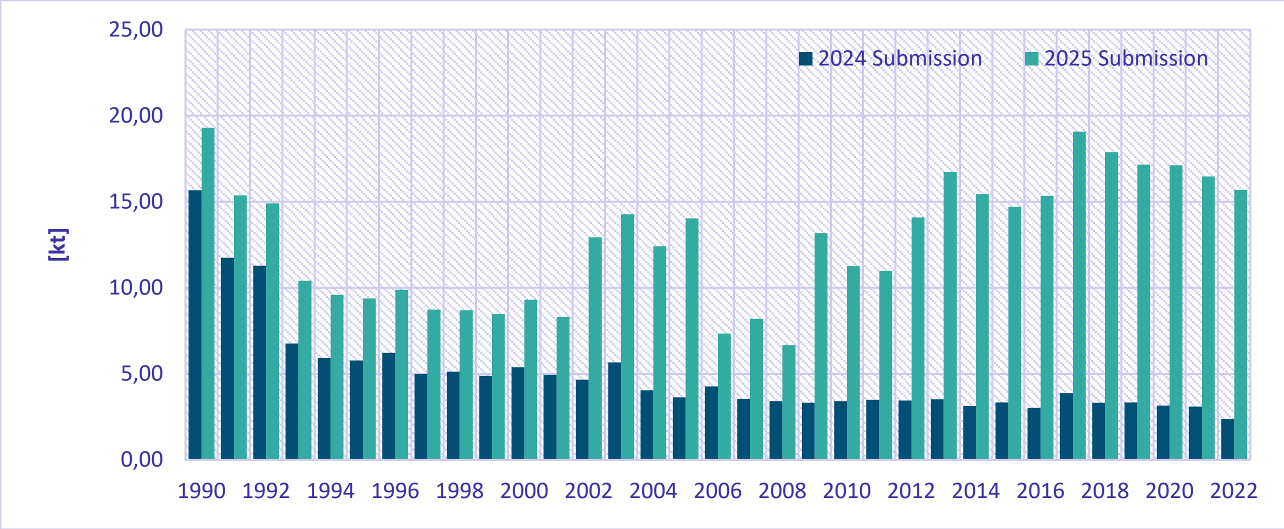
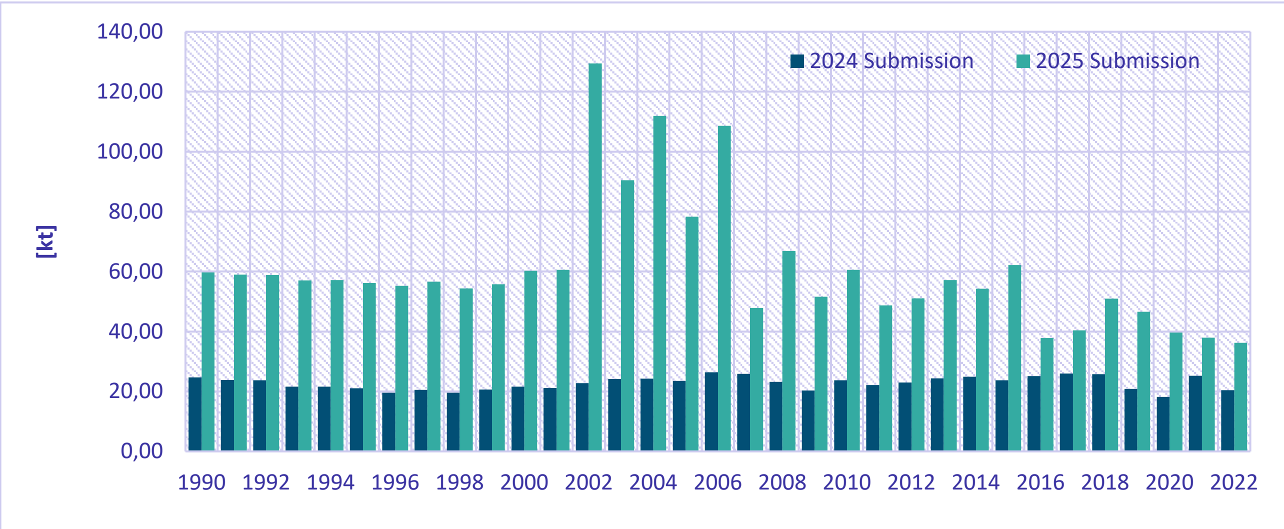


Figure 8.14: *Comparison of PCBs emission total between the 2024 final submission and 2025 final submission*



8.2 RECALCULATIONS BETWEEN 1ST AND FINAL VERSION OF THE NATIONAL INVENTORY

Some calculation error corrections occurred after submitting the first version of the inventory. These changes are shown in ***Table 8.15*** - ***Table 8.17.***

Table 8.15: *Recalculations between 1st and final version of national inventory 2025 – main pollutants and PMs*

YEAR/Pollutant	2025_v1	2025_v2	Change
NOx			
1990	136,6173	136,3992	-0,16%
1991	120,5825	120,3269	-0,21%
1992	111,8279	111,5640	-0,24%
1993	110,2619	110,0048	-0,23%
1994	111,0935	110,8138	-0,25%
1995	112,8132	112,5526	-0,23%
1996	112,5512	112,2606	-0,26%
1997	112,8470	112,4522	-0,35%
1998	112,5512	112,1816	-0,33%
1999	108,4348	108,0609	-0,34%
2000	110,6892	110,3223	-0,33%
2001	112,3364	111,9171	-0,37%
2002	105,4980	105,1509	-0,33%
2003	103,3596	102,9670	-0,38%
2004	103,0907	102,7389	-0,34%
2005	106,7736	106,4322	-0,32%
2006	99,8640	99,8638	0,00%
2007	99,2719	99,0308	-0,24%
2008	100,5530	100,3322	-0,22%
2009	90,1810	89,8766	-0,34%
2010	88,3152	88,1756	-0,16%
2011	80,9586	80,7049	-0,31%
2012	77,5093	77,2332	-0,36%
2013	69,4548	69,2091	-0,35%
2014	66,8277	66,5687	-0,39%
2015	68,1808	67,8452	-0,49%
2016	64,7769	64,4485	-0,51%
2017	64,2734	63,9163	-0,56%
2018	63,4906	63,1359	-0,56%
2019	59,6872	59,3842	-0,51%
2020	56,6875	56,4814	-0,36%
2021	58,9869	58,8037	-0,31%
2022	54,7779	54,6152	-0,30%
2023	51,2736	51,3421	0,13%
SOx			
1990	141,1945	141,2125	0,01%
1991	136,4125	136,4279	0,01%

YEAR/Pollutant	2025_v1	2025_v2	Change
1992	133,5623	133,5754	0,01%
1993	127,5694	127,5853	0,01%
1994	124,5989	124,6150	0,01%
1995	121,7874	121,8041	0,01%
1996	119,3183	119,3327	0,01%
1997	118,4449	118,4518	0,01%
1998	119,1542	119,1593	0,00%
1999	116,6987	116,7019	0,00%
2000	118,6579	118,6621	0,00%
2001	124,4951	124,5017	0,01%
2002	100,7360	100,7428	0,01%
2003	103,5128	103,5168	0,00%
2004	94,7557	94,7596	0,00%
2005	87,6422	87,6470	0,01%
2006	86,1551	86,1599	0,01%
2007	70,4238	70,4300	0,01%
2008	69,0306	69,0359	0,01%
2009	64,1412	64,1451	0,01%
2010	69,0686	69,0725	0,01%
2011	68,5221	68,5262	0,01%
2012	58,3525	58,3562	0,01%
2013	53,2106	53,2142	0,01%
2014	45,7280	45,7314	0,01%
2015	68,2782	68,2781	0,00%
2016	27,8435	27,8432	0,00%
2017	29,4126	29,4110	-0,01%
NH_3			
1990	60,3772	53,2185	-11,86%
1991	53,2799	46,0416	-13,59%
1992	46,2139	39,4851	-14,56%
1993	41,8137	34,4726	-17,56%
1994	43,4527	35,6409	-17,98%
1995	41,5355	33,8904	-18,41%
1996	41,9634	34,2551	-18,37%
1997	43,9339	36,6459	-16,59%
1998	37,6077	31,0985	-17,31%
1999	35,7785	29,5403	-17,44%
2000	35,8172	29,3888	-17,95%
2001	38,6754	30,9316	-20,02%
2002	39,0646	32,2350	-17,48%
2003	37,1641	30,2048	-18,73%
2004	34,9600	28,3327	-18,96%
2005	36,0275	28,7752	-20,13%

YEAR/Pollutant	2025_v1	2025_v2	Change
2006	32,5337	23,9072	-26,52%
2007	33,6918	24,8785	-26,16%
2008	31,6199	23,5097	-25,65%
2009	31,6661	23,0711	-27,14%
2010	31,1367	22,5716	-27,51%
2011	31,0506	22,8053	-26,55%
2012	32,4252	24,1377	-25,56%
2013	33,1424	25,3177	-23,61%
2014	34,0657	26,9146	-20,99%
2015	33,5217	25,5707	-23,72%
2016	35,0820	27,1732	-22,54%
2017	36,3743	28,6087	-21,35%
2018	36,7930	28,9774	-21,24%
2019	35,6301	28,4008	-20,29%
2020	31,5101	25,7537	-18,27%
2021	28,2656	25,4375	-10,01%
2022	26,3425	23,6819	-10,10%
2023	26,0092	25,3707	-2,45%
$PM_{2.5}$			
1990	96,8624	96,7429	-0,12%
1991	87,8074	87,6048	-0,23%
1992	81,7235	81,5609	-0,20%
1993	66,7030	66,4691	-0,35%
1994	58,0491	57,7977	-0,43%
1995	51,4339	51,1682	-0,52%
1996	47,7050	47,3604	-0,72%
1997	41,2225	40,9218	-0,73%
1998	42,3640	42,0652	-0,71%
1999	40,0860	39,7794	-0,76%
2000	44,1323	43,7937	-0,77%
2001	43,3720	42,9892	-0,88%
2002	33,0689	32,6961	-1,13%
2003	32,6793	32,2421	-1,34%
2004	30,3357	29,8108	-1,73%
2005	36,6091	35,8419	-2,10%
2006	33,2389	32,5033	-2,21%
2007	28,9668	28,1508	-2,82%
2008	26,3738	25,6565	-2,72%
2009	24,1208	23,4606	-2,74%
2010	27,0584	26,2973	-2,81%
2011	25,0318	24,3235	-2,83%
2012	26,1517	25,3884	-2,92%
2013	24,1127	23,4206	-2,87%

YEAR/Pollutant	2025_v1	2025_v2	Change
2014	16,8063	16,4284	-2,25%
2015	21,3810	20,8214	-2,62%
2016	21,1803	20,5925	-2,78%
2017	21,2331	20,6662	-2,67%
2018	17,3572	16,9206	-2,52%
2019	17,7259	17,3011	-2,40%
2020	17,1816	16,7056	-2,77%
2021	16,3839	16,3846	0,00%
2022	15,6915	15,6915	0,00%
2023	13,1710	13,1710	0,00%
PM_{10}			
1990	108,0558	107,9363	-0,11%
1991	98,4183	98,2157	-0,21%
1992	91,6891	91,5265	-0,18%
1993	76,3195	76,0856	-0,31%
1994	67,6976	67,4462	-0,37%
1995	61,0253	60,7596	-0,44%
1996	58,3389	57,9943	-0,59%
1997	50,5579	50,2572	-0,59%
1998	53,3185	53,0198	-0,56%
1999	49,5616	49,2550	-0,62%
2000	54,0361	53,6975	-0,63%
2001	53,5386	53,1558	-0,72%
2002	43,2427	42,8699	-0,86%
2003	42,4184	41,9813	-1,03%
2004	39,4053	38,8805	-1,33%
2005	45,4037	44,6365	-1,69%
2006	41,8194	41,0838	-1,76%
2007	36,7686	35,9526	-2,22%
2008	34,0204	33,3032	-2,11%
2009	31,4546	30,7944	-2,10%
2010	33,7993	33,0384	-2,25%
2011	31,5601	30,8518	-2,24%
2012	32,5052	31,7420	-2,35%
2013	30,6158	29,9237	-2,26%
2014	23,1079	22,7300	-1,64%
2015	29,3074	28,7477	-1,91%
2016	27,6263	27,0385	-2,13%
2017	27,9568	27,3899	-2,03%
2018	23,6122	23,1756	-1,85%
2019	24,1038	23,6803	-1,76%
2020	24,0001	23,5241	-1,98%
2021	22,8731	22,8740	0,00%

YEAR/Pollutant	2025_v1	2025_v2	Change
TSP			
1990	135,2595	135,1401	-0,09%
1991	123,0055	122,8029	-0,16%
1992	113,8196	113,6569	-0,14%
1993	97,2133	96,9795	-0,24%
1994	87,4856	87,2342	-0,29%
1995	79,8189	79,5532	-0,33%
1996	79,1523	78,8077	-0,44%
1997	67,9388	67,6382	-0,44%
1998	74,7946	74,4959	-0,40%
1999	67,2254	66,9188	-0,46%
2000	73,6245	73,2859	-0,46%
2001	73,0442	72,6613	-0,52%
2002	62,5564	62,1837	-0,60%
2003	59,6563	59,2192	-0,73%
2004	53,3108	52,7860	-0,98%
2005	61,3572	60,5900	-1,25%
2006	57,6081	56,8725	-1,28%
2007	47,8903	47,0743	-1,70%
2008	44,3276	43,6104	-1,62%
2009	41,0958	40,4356	-1,61%
2010	42,9240	42,1633	-1,77%
2011	40,2173	39,5090	-1,76%
2012	40,2581	39,4949	-1,90%
2013	39,1907	38,4986	-1,77%
2014	31,1733	30,7955	-1,21%
2015	41,4113	40,8516	-1,35%
2016	35,4044	34,8166	-1,66%
2017	37,0934	36,5265	-1,53%
2018	30,9096	30,4730	-1,41%
2019	30,8018	30,3811	-1,37%
2020	31,6077	31,1316	-1,51%
2021	29,9442	29,9453	0,00%
BC			
1990	8,5483	8,5492	0,01%
1991	7,6066	7,6074	0,01%
1992	6,9480	6,9486	0,01%
1993	5,9287	5,9295	0,01%
1994	5,2907	5,2915	0,01%
1995	4,8657	4,8665	0,02%
1996	4,6574	4,6581	0,02%
1997	4,1447	4,1450	0,01%
1998	4,2192	4,2195	0,01%

YEAR/Pollutant	2025_v1	2025_v2	Change
1999	4,0361	4,0363	0,00%
2000	4,0884	4,0887	0,01%
2001	4,1333	4,1336	0,01%
2002	3,5776	3,5780	0,01%
2003	3,6939	3,6941	0,01%
2004	3,7131	3,7133	0,01%
2005	4,4704	4,4706	0,01%
2006	4,0055	4,0057	0,01%
2007	4,1112	4,1115	0,01%
2008	3,8163	3,8166	0,01%
2009	3,5026	3,5028	0,01%
2010	4,1034	4,1060	0,06%
2011	3,5904	3,5906	0,01%
2012	3,6962	3,6964	0,00%
2013	3,2340	3,2341	0,01%
2014	2,4639	2,4640	0,01%
CO			
1990	1 040,5180	1 040,6573	0,01%
1991	958,6009	958,7202	0,01%
1992	902,8358	902,9370	0,01%
1993	805,2238	805,3454	0,02%
1994	729,5792	729,7026	0,02%
1995	662,5498	662,6773	0,02%
1996	622,3667	622,4772	0,02%
1997	568,1652	568,2192	0,01%
1998	579,4328	579,4732	0,01%
1999	554,8754	554,9019	0,00%
2000	552,0918	552,1254	0,01%
2001	564,8163	564,8681	0,01%
2002	494,1245	494,1771	0,01%
2003	520,6386	520,6702	0,01%
2004	529,3666	529,3973	0,01%
2005	573,2025	573,2396	0,01%
2006	534,5330	534,5700	0,01%
2007	530,6991	530,7469	0,01%
2008	494,2049	494,2462	0,01%
2009	436,8264	436,8570	0,01%
2010	462,5457	462,6051	0,01%
2011	429,5446	429,5762	0,01%
2012	435,3411	435,3696	0,01%
2013	393,5124	393,5401	0,01%
2014	329,3844	329,4113	0,01%
2015	371,2509	371,2509	0,00%

YEAR/Pollutant	2025_v1	2025_v2	Change
2016	377,8827	377,8802	0,00%
2017	377,3931	377,3814	0,00%
2018	319,4405	319,4405	0,00%
2019	286,4685	286,4709	0,00%
2020	278,2828	278,2829	0,00%
2021	316,1538	316,2730	0,04%

Table 8.16: *Differences in emissions in % between 1st and final version of national inventory 2025– heavy metals*

YEARS	Pb	Cd	Hg
1990	0,0028%	0,0017%	0,0007%
1991	0,0028%	0,0016%	0,0007%
1992	0,0028%	0,0015%	0,0007%
1993	0,0029%	0,0016%	0,0008%
1994	0,0031%	0,0018%	0,0009%
1995	0,0032%	0,0020%	0,0009%
1996	0,0033%	0,0018%	0,0009%
1997	0,0031%	0,0018%	0,0009%
1998	0,0029%	0,0018%	0,0008%
1999	0,0030%	0,0021%	0,0008%
2000	0,0032%	0,0019%	0,0008%
2001	0,0035%	0,0021%	0,0009%
2002	0,0022%	0,0013%	0,0006%
2003	0,0036%	0,0012%	0,0005%
2004	0,0025%	0,0008%	0,0004%
2005	0,0018%	0,0005%	0,0003%
2006	0,0029%	0,0006%	0,0004%
2007	0,0032%	0,0006%	0,0004%
2008	0,0048%	0,0009%	0,0005%
2009	0,0053%	0,0009%	0,0006%
2010	0,0051%	0,0046%	0,0006%
2011	0,0061%	0,0010%	0,0007%
2012	0,0091%	0,0016%	0,0011%
2013	0,0055%	0,0014%	0,0009%
2014	0,0000%	0,0000%	0,0000%
2015	0,0000%	0,0000%	0,0000%
2016	0,0000%	0,0000%	0,0000%
2017	0,0000%	0,0000%	0,0000%
2018	0,0000%	0,0026%	0,0000%
2019	0,0000%	0,0003%	0,0000%
2020	0,0000%	0,0000%	0,0000%
2021	0,0000%	0,0015%	0,0000%
2022	0,0000%	0,0000%	0,0000%

2023	0,0263%	0,0684%	0,0000%
YEARS	**As**	**Cr**	**Cu**
1990	0,0720%	0,0136%	0,0160%
1991	0,0763%	0,0141%	0,0174%
1992	0,0777%	0,0144%	0,0178%
1993	0,0861%	0,0167%	0,0197%
1994	0,0961%	0,0189%	0,0211%
1995	0,1049%	0,0211%	0,0220%
1996	0,1074%	0,0198%	0,0205%
1997	0,1051%	0,0203%	0,0203%
1998	0,1025%	0,0212%	0,0211%
1999	0,1127%	0,0272%	0,0257%
2000	0,1077%	0,0270%	0,0287%
2001	0,1066%	0,0221%	0,0227%
2002	0,0756%	0,0190%	0,0166%
2003	0,0614%	0,0118%	0,0112%
2004	0,0438%	0,0081%	0,0077%
2005	0,0304%	0,0053%	0,0049%
2006	0,0321%	0,0045%	0,0045%
2007	0,0325%	0,0042%	0,0039%
2008	0,0491%	0,0063%	0,0056%
2009	0,0513%	0,0069%	0,0059%
2010	0,0499%	0,0099%	0,0550%
2011	0,0605%	0,0068%	0,0064%
2012	0,0993%	0,0111%	0,0099%
2013	0,0739%	0,0087%	0,0033%
2014	0,0000%	0,0000%	0,0000%
2015	0,0000%	0,0000%	0,0000%
2016	0,0000%	0,0000%	0,0000%
2017	0,0000%	0,0000%	0,0000%
2018	0,0000%	0,0016%	0,0084%
2019	0,0000%	0,0002%	0,0008%
2020	0,0000%	0,0000%	0,0001%
2021	0,0000%	0,0009%	0,0048%
2022	-0,0001%	0,0000%	0,0000%
2023	0,1808%	0,0037%	0,0012%
YEARS	**Ni**	**Se**	**Zn**
1990	0,0105%	-0,0197%	0,0019%
1991	0,0123%	-0,0232%	0,0021%
1992	0,0142%	-0,0267%	0,0023%
1993	0,0174%	-0,0310%	0,0024%
1994	0,0206%	-0,0345%	0,0024%
1995	0,0232%	-0,0366%	0,0025%
1996	0,0264%	-0,0376%	0,0025%

1997	0,0303%	-0,0376%	0,0025%
1998	0,0317%	-0,0363%	0,0024%
1999	0,0385%	-0,0368%	0,0023%
2000	0,0410%	-0,0358%	0,0024%
2001	0,0338%	-0,0287%	0,0020%
2002	0,0282%	-0,0200%	0,0016%
2003	0,0211%	-0,0119%	0,0009%
2004	0,0177%	-0,0092%	0,0007%
2005	0,0142%	-0,0072%	0,0004%
2006	0,0106%	-0,0066%	0,0004%
2007	0,0107%	-0,0068%	0,0004%
2008	0,0158%	-0,0101%	0,0006%
2009	0,0164%	-0,0110%	0,0006%
2010	0,0296%	-0,0110%	0,0095%
2011	0,0213%	-0,0144%	0,0007%
2012	0,0367%	-0,0231%	0,0011%
2013	0,0262%	-0,0186%	0,0007%
2014	0,0000%	0,0000%	0,0000%
2015	0,0000%	0,0000%	0,0000%
2016	0,0000%	0,0000%	0,0000%
2017	0,0000%	0,0000%	0,0000%
2018	0,0072%	0,0007%	0,0037%
2019	0,0007%	0,0001%	0,0004%
2020	0,0000%	0,0000%	0,0000%
2021	0,0039%	0,0005%	0,0023%
2022	-0,0023%	0,0000%	0,0000%
2023	0,6821%	0,0306%	0,0205%

Table 8.17: *Differences in emissions in % between 1st and final version of national inventory 2025–POPs*

YEARS	PCDD/F	PAHs	PCBs
1990	-0,00001%	0,00009%	0,00000000%
1991	-0,00001%	0,00010%	0,00000000%
1992	-0,00001%	0,00010%	0,00000000%
1993	-0,00001%	0,00013%	-0,00000003%
1994	-0,00001%	0,00014%	0,00000000%
1995	-0,00001%	0,00016%	0,00000000%
1996	-0,00001%	0,00017%	0,00000003%
1997	-0,00001%	0,00018%	0,00000004%
1998	-0,00001%	0,00019%	0,00000000%
1999	-0,00001%	0,00019%	-0,00000001%
2000	-0,00001%	0,00017%	0,00000004%
2001	-0,00001%	0,00016%	-0,00000003%
2002	-0,00001%	0,00012%	0,00000000%
2003	-0,00001%	0,00007%	-0,00000001%

2004	0,00000%	0,00005%	0,00000003%
2005	0,00000%	0,00003%	0,00000001%
2006	-0,00001%	0,00003%	-0,00000003%
2007	-0,00001%	0,00003%	0,00000000%
2008	-0,00002%	0,00004%	-0,00000001%
2009	-0,00002%	0,00005%	-0,00000002%
2010	0,00027%	0,00074%	0,00019067%
2011	-0,00003%	0,00006%	0,00000003%
2012	-0,00006%	0,00008%	-0,00000001%
2013	-0,00005%	0,00007%	-0,00000002%
2014	0,00000%	0,00000%	0,00000000%
YEAR/Pollutant	**PCDD/F**	**PAHS**	**PCBs**
2015	0,00000%	0,00000%	0,00000000%
2016	0,00000%	0,00000%	0,00000000%
2017	0,00000%	0,00000%	0,00000000%
2018	0,00021%	0,00041%	0,00006092%
2019	0,00002%	0,00004%	0,00000627%
2020	0,00000%	0,00000%	0,00000040%
2021	17,66931%	0,00024%	0,00003705%
2022	24,15453%	0,00000%	-0,00000085%
2023	24,67833%	0,00203%	0,06702749%

PCBs	2025_v1	2025_v2	Change
1990	59,7530	59,7532	0,00020%
1991	58,9520	58,9521	0,00020%
1992	58,8722	58,8723	0,00021%
1993	57,0488	57,0489	0,00021%
1994	57,1465	57,1466	0,00021%
1995	56,2311	56,2312	0,00021%
1996	55,2320	55,2321	0,00022%
1997	56,5964	56,5965	0,00022%
1998	54,4050	54,4051	0,00021%
1999	55,7327	55,7328	0,00021%
2000	60,2006	60,2008	0,00020%
2001	60,6127	60,6128	0,00017%
2002	129,4895	129,4896	0,00006%
2003	90,4314	90,4314	0,00005%
2004	111,9800	111,9800	0,00003%
2005	78,2696	78,2696	0,00004%
2006	108,6414	108,6415	0,00002%
2007	47,9025	47,9025	0,00005%
2008	66,8392	66,8392	0,00005%
2009	51,6515	51,6515	0,00005%
2010	60,5455	60,5724	0,04435%
2011	48,6793	48,6794	0,00009%

2012	51,1126	51,1126	0,00011%
2013	57,1731	57,1731	0,00008%
2014	54,2240	54,2240	0,00000%
2015	62,1702	62,1702	0,00000%
2016	37,8685	37,8685	0,00000%
2017	40,3427	40,3427	0,00000%
2018	50,9205	50,9341	0,02675%
2019	46,6049	46,6063	0,00289%
2020	39,6098	39,6099	0,00022%
2021	37,9492	37,9569	0,02009%
2022	36,2609	36,2609	0,00000%
2023	33,7182	33,7217	0,01040%

CHAPTER 9: PROJECTIONS OF EMISSIONS

INTRODUCTION

The general methodology of the emission projections calculations was based on the same structure as the national emissions inventory of Air pollutants. The data structure for activities, input emission factors and emission data, calculations is based on the Nomenclature for Reporting (NFR). The outputs are aggregated.
Dynamic changes in global politics as well as economic developments in recent years and months have also significant impact and they were complications for the preparation of AP emission projections, especially given the constant changes in the estimated development of macroeconomic indicators for the near future.

Despite the existing constraints resulting from dynamic changes in critical parameters, it is possible to reach a state of actual compliance with the emission reduction targets, as well as to create the conditions for further emission reductions after 2025.

The modelling of emission projections was provided consistent with the GHG emission projections reported on 15th March 2023 under Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on Energy Union Governance and Climate Action.

Even use of a wide range of input data and improvement of methodological approach at activity projection in relevant sectors, the results are influenced by the uncertainties of future development, preferably in the case of the macro-economic data and elasticity of the final energy consumption. These uncertainties are predominantly related to the process of economic transformation and privatization and historical data can be hardly used for future development extrapolation.

The year 2022 was determined as the base year for modelling of emissions projections for the actualized scenario for which verified data sets were available from the national emission inventory reported in March 2024.

SCENARIO DEFINITION

Projections of air pollutant emissions were prepared with the base year 2022 for the years 2025-2050 within the following scenarios:

With measures scenario (WEM) – projections reflect all measures implemented or adopted before the date of preparation of the projections (31 December 2022).

With additional measures scenario (WAM) – projections include WEM policies and measures and all other measures planned for an increase of air quality according to the national air pollution control program.

KEY CHANGES IN UPDATED PROJECTIONS

Energy and Industry – The most important change was the wider implementation of the TIMES model in the calculation of emissions in these sectors. Changes were also driven based on new information from producers.

Transport – Actualization based on new methodology with model COPERT using new assumptions and data.

Agriculture – Changes were driven by the improvement of methodology, new model was implemented.

WAM scenario for NMVOC was included. Published policies and measures after 2022 from the national strategies were considered in the WAM scenario.

Waste – New calculations, and improved methodology together with GHG emission projections estimations.

9.1 AGGREGATED AIR POLLUTANTS EMISSION PROJECTIONS

The actualization of the emission projection led to some changes in comparison with previously reported projections. In the tables below are presented national totals of air pollutant emissions and a comparison to the absolute values of emission targets.

Table 9.1: *WEM scenario emission projection trends and targets*

TOTAL EMISSIONS OF SLOVAKIA (*kt*)	2005	2010	2015	2020	*TARGET 2020-2029*	2022*	2025	2030	*TARGET 2030*	2040	2050
NOx	106.67	88.36	68.41	56.39	68.27	54.65	56.78	52.66	54.65	43.74	40.56
NMVOC	135.20	111.21	98.70	82.68	110.86	82.49	77.73	72.61	82.49	62.79	55.19
SOx	87.60	69.05	68.25	14.86	37.67	13.30	10.74	10.26	13.30	9.56	8.59
NH_3	34.61	30.31	32.90	30.54	29.41	27.51	30.27	28.80	27.51	30.27	30.39
$PM_{2.5}$	36.52	26.99	21.25	17.08	23.37	17.85	16.14	13.85	17.85	9.90	7.12

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Table 9.2: *WAM scenario emission projection trends and targets*

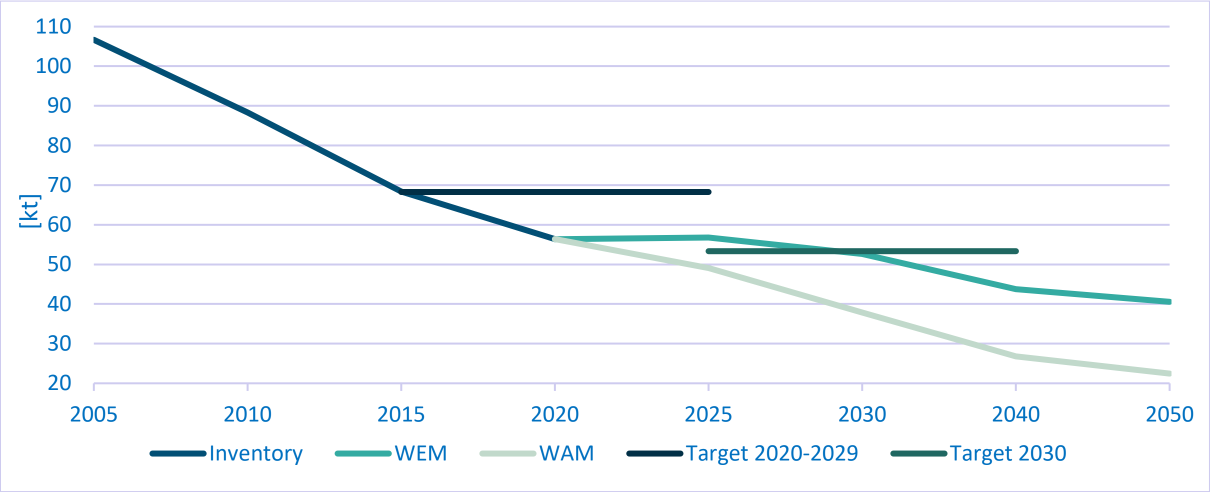
TOTAL EMISSIONS OF SLOVAKIA (*kt*)	2005	2010	2015	2020	*TARGET 2020-2029*	2022*	2025	2030	*TARGET 2030*	2040	2050
NOx	106.67	88.36	68.41	56.39	68.27	54.65	49.11	37.90	54.65	26.79	22.45
NMVOC	135.20	111.21	98.70	82.68	110.86	82.49	73.94	64.66	82.49	48.37	41.15
SOx	87.60	69.05	68.25	14.86	37.67	13.30	10.66	8.03	13.30	5.84	4.59
NH_3	34.61	30.31	32.90	30.54	29.41	27.51	20.75	20.78	27.51	19.75	19.43
$PM_{2.5}$	36.52	26.99	21.25	17.08	23.37	17.85	15.52	12.10	17.85	6.89	4.86

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NOx emissions

Figure 9.1 shows a general view of trends of emissions NOx and estimated emissions projections based on encountered measures. Emissions slightly decrease and adopted and planned measures should be sufficient to meet the 2030 target will be very tight even in the WAM scenario.

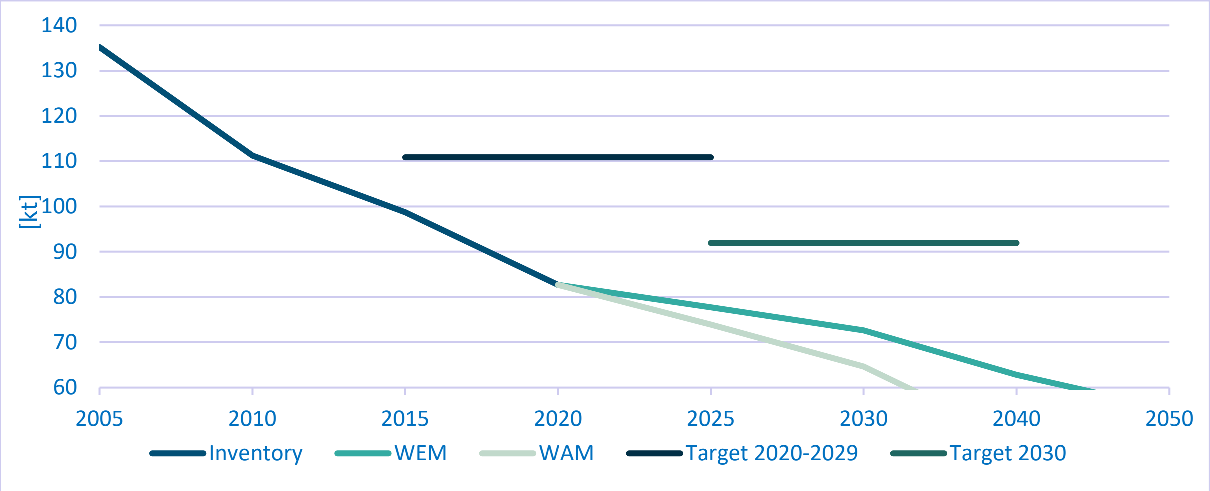
Figure 9.1: *Emission projections trends for pollutant NOx*



NMVOC emissions

Figure 9.2 shows a general view of trends of NMVOC emissions and estimated emissions projections based on encountered measures. Emissions show an overall decreasing trend and the 2030 target should be achieved in both scenarios.

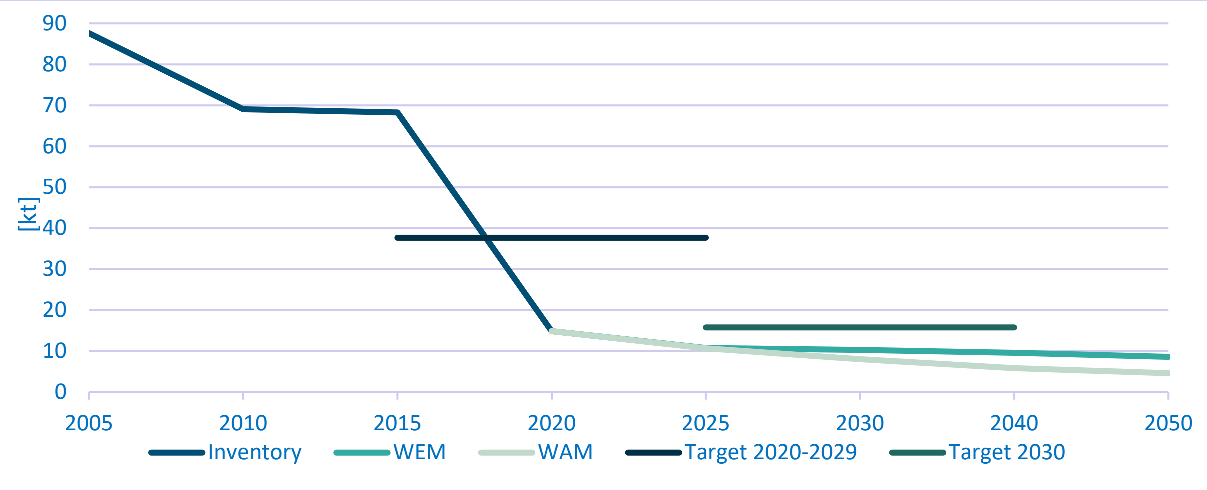
Figure 9.2: *Emission projections trends for pollutant NMVOC*



SOx emissions

Figure 9.3 shows the general view on trends of SOx emissions. After implementing strong measures in the energy sector Slovakia should achieve the 2030 target in the WAM scenario.

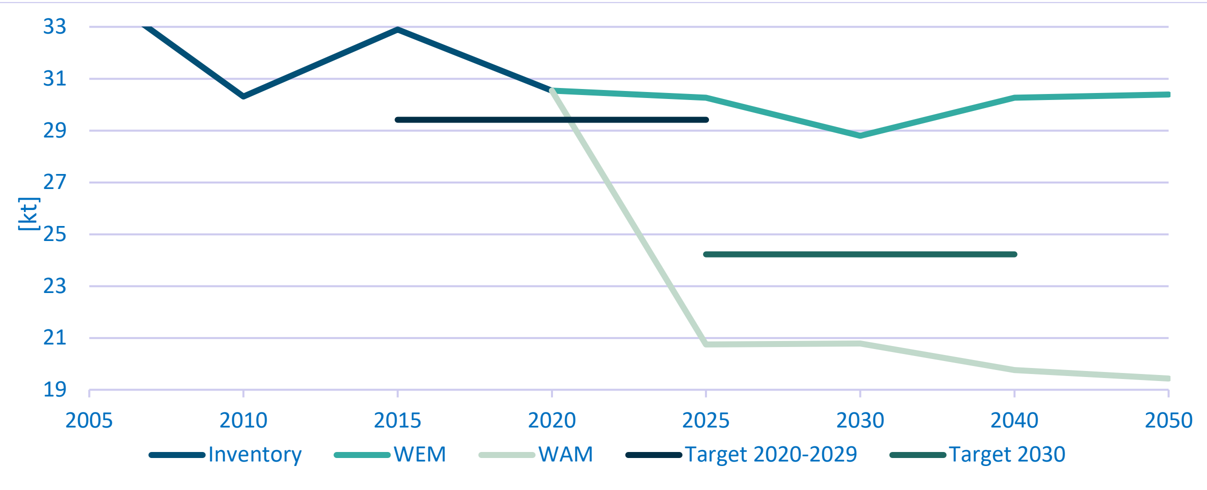
Figure 9.3: *Emission projections trends for pollutant SOx*



NH_3 emissions

Figure 9.4 shows a general view of trends in NH_3 emissions. According to the measures contained in both scenarios will be very hard to achieve the 2030 target. After implementing strong measures in the agriculture sector Slovakia should achieve the 2030 target in the WAM scenario.

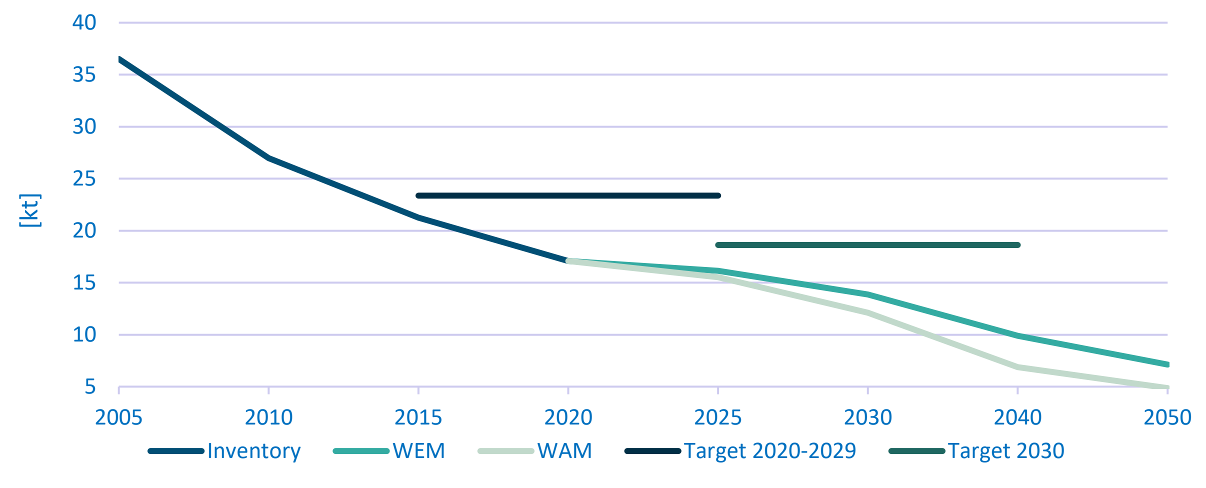
Figure 9.4: *Emission projections trends for pollutant NH_3*



$PM_{2.5}$ emissions

Figure 9.5 shows the estimated trend of $PM_{2.5}$ emissions. This is a key pollutant and the future target achievement mainly depends on development in the household and transport sector. For now, trends of emissions seem to be in the margin of the target 2030.

Figure 9.5: *Emission projections trends for pollutant $PM_{2.5}$*



9.2 EMISSION PROJECTIONS IN THE ENERGY SECTOR

This chapter describes the methodology for calculating emission projections from NFR categories, which includes public heat and electricity production, including industrial energy, emissions from households and processing of fuels. This chapter excludes emissions from fuel consumption in transport. Emissions from small households not connected to a District Heating Network (DHN) were modelled separately and a description of the procedure is given at the end of this chapter.

The long-term development of emissions also depends on other parameters, such as energy market developments, technological developments and the trading of CO_2 emission allowances. The ETS is one of the measures that was implemented before the projected base year, but the new trading period will continue to have an impact in the future, not only on **AP** but also on **GHG** emissions. Nevertheless, the additional impact of this measure is limited due to the technical and economic potential.

Emission projections in the Energy sector were calculated separately for large and medium-sized energy appliances, households, transport and fugitive emission categories.

As with earlier emission projections, the analysis incorporated data derived from the CPS model (Compact Primes for Slovakia). This model was specifically designed, adapted, and implemented by the Institute for Environmental Policy under the Slovak Ministry of the Environment. Detailed explanations of the CPS model's framework and applications are available in the 2023 emission projections report. The outputs from the CPS model were subsequently integrated into the TIMES model, a more granular analytical tool developed and utilized by SHMÚ (Slovak Hydro-meteorological Institute).

TIMES-Slovakia model is suitable for the projection reporting structure and greater detail. Along with the Energy sector, TIMES also calculates emissions from the industry sector which falls under the EU ETS trading scheme.

9.2.1. Methodologies and Key Assumptions/Trends

Energy and Industry model: TIMES

There are several sources of input data among which the most important are the National Emission Information System (NEIS) and activity data from the Slovak statistical office (ŠÚ SR).

Some input parameters for the calculation of AP projections in TIMES-Slovakia, from industry and energy are provided by the CPS + Macro economical model (IEP), which was developed for the needs of the Low Carbon Strategy. Other input data consist of EU ETS reports, National Energy statistics, NEIS and the NIMS.

Fuels data are provided by (ÚRSO) - prices of tradable fuels, if possible also separately for sectors such as industry, households and others: Natural gas EUR/GJ, Heating oils, Brown coal, Black coal, Coke, Fuel wood, waste wood, wood chips EUR/ton or EUR/GJ;

RES technologies (Ministry of Economy or with the association of operators of renewable resources) – available input data on RES, their structure and time development. For individual types of resources, the following data are preliminary:

- Photovoltaics - the estimated potential of electricity production in MWh/year in topographic distribution, i.e. by districts or regions,
- Annual distribution of production - when it can be divided into hours, days, weeks and months, as the case may be, in a different arrangement than this production is balanced;
- Investment costs EUR/kW.
- Wind power plants - similar to photovoltaics:
- Investment costs EUR/kW.
- Annual power distribution as in the case of photovoltaics.
- Biomass - biomass potential in TJ/year according to its type - wood, wood chips, etc.
- Geothermal - Potential TJ/year in geographical distribution, investment costs EUR/GW.

The NEIS remains a major source of data for inventory in the key categories and sectors (Energy, Industry) for the main pollutants.

The energy sector covers the following subsectors: energy industries (NFR 1A1), stationary combustion in manufacturing and construction (NFR 1A2), transport (NFR 1A3), small combustion (NFR 1A4), non-road mobile machinery (NFR 1A5) and fugitive emissions (NFR 1B). The emissions covered by the energy sector originate from fuel combustion (NFR 1A1, 1A2, 1A3, 1A4 and 1A5) and fugitive emissions (NFR 1B). These subsectors are further described in the following chapters. Categories of energy sector are the key categories for most of the main pollutants.

Category energy industries 1A1 covers the following subcategories: Public Electricity and Heat Production (1A1a), Petroleum Refining (1A1b) and Manufacture of Solid Fuels and Other Energy Industries (1A1c). Energy industries are a substantial contributor to most air pollutants.

This activity covers emissions from combustion plants as point sources. The emissions considered in this activity are released by a controlled combustion process (boiler emissions, furnace emissions, emissions from gas turbines or stationary engines) and are mainly characterised by the types of fuels used.

The 2025 Projection Report, which forms the basis for this report, shows how AP emissions might develop up to 2050, assuming the framework data in place and the parametrization of the instruments.

Table 9.3: *Main parameters applied in emission projections*

Item	Units	2022	2025	2030	2035	2040	2045	2050
Gross domestic product: Constant prices	EUR million	109 782	97 678	108 257	117 475	125 398	132 773	139 622
Population	1 000 people	5 429	5 410	5 339	5 260	5 195	5 135	5 075
EU ETS 1 carbon price	EUR/EUA	88*	95	95	100	100	160	190
International coal import prices	EUR/GJ	10.9	4.1	4.1	4	3.8	3.8	4
International oil import prices	EUR/GJ	16.7	12.4	13.9	15.4	15.8	17.2	19.7
International gas import prices	EUR/GJ	35.1	9.4	9	8.2	10.1	9.9	9.6

Even use of a wide range of input data and improvement of methodological approach at activity projection in relevant sectors, the results are influenced by the uncertainties of future development, preferably in the case of the macro-economic data and elasticity of the final energy consumption. These uncertainties are predominantly related to the process of economic transformation and privatization and historical data can be hardly used for future development extrapolation. The emission projections from the Energy sector will be influenced by the main pollutant and GHG emission caps in the new EU ETS regime. Decision 406/2009/EC on effort sharing in the sectors not included in the emission trading plays an important role.

9.2.2. Model Description

Table 9.4: *SWOT analysis of the TIMES model*

Strengths	Opportunities
Compatibility with emission model for emission inventories Detailed data break down **Database is compatible with EU data and national data** **Detailed sectoral break down** **Available Emission trading system** **Finding Objective function (optimal solution)** **Stochastic modelling** **Seasonal availability** **User constraint options (environmental, energy, monetary, supply, production, subsidies…)**	Incorporate to the model new technologies (CHP,HP, ELE) Attach transport (all transport categories) Versatile use on different geographical level (Regional break down of energy demand) Versatile use of time series (Day, Night and Peak availability) Modelling of particulate matter (PM) Stochastic modelling of RES Trading between regions
Treats	**Weakness**
Maintenance fee Infeasibility due to lack of macro economical and technology data **GAMS solvers need to be paid separately**	Disconnected from macroeconomic models Too much pre-calculations needed Lack of economic data Lack of technology data (Investment cost for new technology) Whole structure needed to be built up from scratch

TIMES (an acronym for *The Integrated MARKAL-EFOM System*) is an economic model generator for local, national, multi-regional, or global energy systems, which provides a technology-rich basis for representing energy dynamics over a multi-period time horizon. It is usually applied to the analysis of the entire energy sector, but may also be applied to study single sectors such as the electricity and district heat sector. Estimates of end-use energy service demands (e.g., car road travel; residential lighting; steam heat requirements in the paper industry; etc.) are provided by the user for each region to drive the reference scenario. In addition, the user provides estimates of the existing stocks of energy related equipment in all sectors, and the characteristics of available future technologies, as well as present and future sources of primary energy supply and their potentials.

All VEDA-TIMES model input data is organized in Excel workbooks (or files). VEDA2.0 then integrates information from all of these workbooks into internal databases to facilitate management of the model data and to prepare and submit a TIMES model, generated and solved with the GAMS sub-system. The main goal of the model TIMES (***Figure 9.6***) is to find energy system, that meets all demands over the entire time period at least costs. The scenarios are used specifically for region needed based on the possibilities of energy supplies, energy trade and technology availability. The configuration of production and consumption of commodities and their prices is performed. The optimization is done across all sectors as well as across time periods. The result is optimal mix of technologies and fuels for the specific time period including emissions produced.

The main goal of the model is to find an energy system that meets all demands over the entire time period at the lowest costs. The scenarios are used specifically for regional needs based on the possibilities of energy supplies, energy trade and technology availability. The configuration of production and consumption of commodities and their prices is performed. The optimization is done across all sectors as well as across time periods. The result is an optimal mix of technologies and fuels for the specific time period including emissions produced.

Once all the inputs, constraints and scenarios have been put in place, the model will attempt to solve and determine the energy system that meets the energy service demands over the entire time horizon at least cost. It does this by simultaneously making equipment investment decisions and operating, primary energy supply, and energy trade decisions, by region. **TIMES-Slovakia** assumes perfect foresight, which is to say that all investment decisions are made in each period with full knowledge of future events. It optimizes horizontally (across all sectors) and vertically (across all time periods for which the limit is imposed). The results will be the optimal mix of technologies and fuels at each period, together with the associated emissions to meet the demand. The model configures the production and consumption of commodities (i.e. fuels, materials, and energy services) and their prices; when the model matches supply with demand, i.e. energy producers with energy consumers, it is said to be in equilibrium.

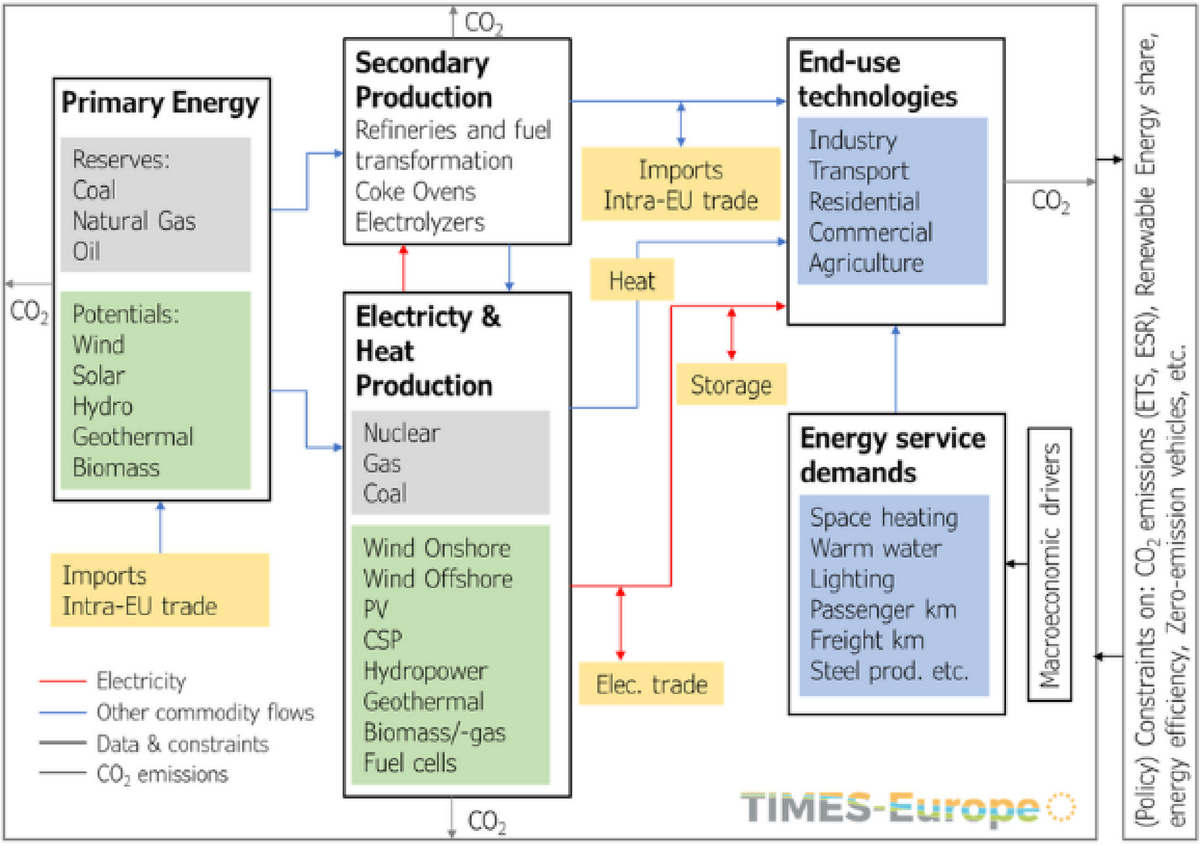
Calculation includes various policies and measures (in numerical formulation) defined according to the **WEM** and **WAM**.

The model itself operates with several sectors:

- POWER (Public electricity and heat production)
- IRON (Iron and Steel production)

- FAT (Food processing)
- CHEM (Chemical production)
- NMM (Non Metallic mineral)
- NFM (Non Ferrous metal)
- PPP (Pulp paper and print)
- OTH (Other categories)
- SUPP (Refinery and Petrochemicals)

Figure 9.6: *Different elements of the TIMES model*



Before preparing input data for the model, it is necessary to prepare a balance sheet, i.e. so. Called the spider, which represents the network of progress and processing of incoming commodities - fuels and materials in the process of processing, energy production, distribution and final consumption of products and energy. In the entire scheme (Figure 3.13) there are several levels that more or less coincide with the energy statistics data processing system for the Statistical Office of the Slovak Republic:

- Primary fuels – simulation**s** of their import or extraction.
- Material inputs. This represents for individual sources a summary of material inputs that participate in the formation of AP. For example by the decomposition of carbonates contained in them - inputs to lime plants, cement plants, ceramic production, glass plants, etc.
- Secondary fuels. In the specific conditions of the Slovak Republic, these are petroleum products, i.e. their production in the **Slovnaft refinery** together with the refinery gas that is

burned in this complex. Furthermore, there are technical gases such as blast furnace gas, coke oven gas and converter gas, all produced and consumed within metallurgy.

- Fuel-mix represents the simulation of the entry of fuels into energy or production processes. At this level, based on the composition of the fuel mixture, the aggregated GHG emission factor is defined for individual appliances and, if necessary, also the other AP.
- Production of energy carriers - electricity and heat. A mixture of fuels enters each such set, and electricity and heat leave in heating and power plants, and only heat in heating plants. Within the framework of the scheme, the distribution of the produced heat is used directly by the source or enters the remote supply system - DH.
- Integration of energy and material flows for the enterprise. This applies to enterprises with their own consumption of electricity and heat, which produce it themselves. Here, the flow of heat and electricity from own consumption is integrated with the material flow as well as the external supply of electricity and heat. In the latter case, the balance of import and export of electricity or heat is calculated.
- Simulation of the public electricity and heat distribution network.
- Simulation of final consumption - Demand according to macroeconomic and/or production indicators = assumption of product volumes, value added (VA) sectors, etc.

AP Emission Projections in Households – Excel Sheet Model

Emission from combustion in households was modelled separately in the MS Excel sheet model, where was taken into account improving efficiency, equipment status and structure and good practice.

The projection calculation is based on inputs from CPS model calculations by Institute of environmental policy (IEP) and in line with the prepared National Energy and Climate Plan.

Information was obtained from the questionnaire surveys in households, new implemented and planned measures were taken into account. Based on this information datasets were improved together with estimations of natural improvement in the structure of households and heating equipment was implemented.

Main characteristic:

- Based on emission inventory methodology – Excel model,
- Estimation of total energy demand per m^2 of living space in the household sector,
- Number of flats - a living area of flats, flats under DH, age and renewal of flats,
- Structure of heating equipment, method of heating,
- Climatic conditions.

9.2.3. Scenarios, Parameters and PAMs

List of policies and measures which have been taken into account in the scenario with measures (WEM):

TIMES-Slovakia model is equivalent to the Reference Scenario of the CPS-PRIMES model. It includes policies and measures (PAMs) adopted and implemented at the EU and national levels by the end of 2021 and the measures being in place to achieve the national renewables (RES) and energy efficiency targets for the year 2021.

Following parameters and PAMs on the EU level were used in the projections of the Energy sector:

- Eco-design Framework Directive (Directive 2005/32/EC).
- Energy Labelling Directive (Directive 2010/30/EU).
- Energy Performance of Buildings Directive, Energy Efficiency Directive (Directive 2012/27/EU).
- Completion of the internal energy market, including provisions of the 3rd package (Directive 2009/73/EC, Directive 2009/72/EC) - Regulation (EC) No. 715/2009, Regulation (EC) No. 714/2009.
- Directive on the promotion of the use of energy from renewable sources - "RES Directive"- incl. amendment on ILUC (Directive 2009/28 EC as amended by Directive (EU) 2015/1513).
- EU ETS Directive 2003/87/EC as amended by Directive 2004/101/EC (international credits), Directive 2008/101/EC (aviation), Directive 2009/29/EC (revision for 2020 climate and energy package), Regulation (EU) No. 176/2014 (back-loading), Decision (EU) 2015/1814 (Market Stability Reserve), and implementing Decisions, in particular 2010/384/EU, 2010/634/EU, 2011/389/EU, 2013/448/EU (cap), 2011/278/EU, 2011/638/EU (benchmarking and carbon leakage list).
- Industrial emissions (Recast of Integrated Pollution and Prevention Control Directive 2008/1/EC and Large Combustion Plant Directive 2001/80/EC) **- Directive 2010/75/EU.**
- Increasing energy efficiency with a number of measures in force since 2014 on the energy consumption side, according to which energy savings are reflected as a reduction in final energy consumption. These measures are broken down by sector (buildings, industry, public sector, transport and appliances). In the buildings sector, it is mainly about improving the thermal technical performance of buildings by carrying out cost-effective deep renovation. Legislation and changes to national technical standards since 2012 have introduced conditions for progressively stricter energy performance requirements for new and substantially renovated buildings, which are regularly reviewed. Measures in the buildings sector represent the most important source of potential energy savings by 2030.
- Optimisation of district heating systems - switching from fossil fuels to biomass and natural gas and installation of combined heat and power (CHP) units in district heating systems. Industrial cogeneration plants produce industrial steam, which can also be used for district heating or is a secondary use of industrial steam. Other measures are also taken into account (e.g. improving the efficiency of the District heating network (DHN), installing innovative district heating technologies, improving the supply of heat from combined heat and power plants).
- Specific emissions limits and specific technical conditions for MCP and LCP - Setting limits on concentration for specific air pollutants for particular combustion plants.
- National Air Pollution Control Program **(NAPCP)** – sectoral measures from NAPCP.
- Support for the replacement of old solid fuel boilers with low-emission ones - Replacement of old non-ecological solid fuel boilers with new ones, low-emission and more energy-efficient boilers in Households.
- The transition of households using solid fuel for heating to another low-emission heat source (e.g. natural gas) - The aim of the measure is to support the transition to low-emission methods

of household heating. The measure assumes that households currently using solid fuel will be connected to a low-emission heat source.

- Awareness campaign and education on good practice in coal and biomass combustion - Raising people's awareness of the importance and risks of poor air quality. And also raising information on the possibilities and simple measures to improve proper heating methods, use of wood, etc.
- Transformation or phase-out of fossil fuel-fired power plants - transition to low-emission fuels. Phase-out of Thermal power plant **Nováky** and **Vojany** combustion brown and hard coal.

With Additional Measures scenario (WAM) – is equivalent to scenario Dcarb2 of the CPS-PRIMES model. This is consistent with the results presented in the LCDS of Slovakia; however, the scenario was updated based on the latest input data and parameters assumption (including consideration of development with the COVID-19 situation).

WAM scenario have been designed as contrasting combinations of energy efficiency and renewable targets, representing the trade-offs between targets. The scenario includes Slovakia's participation in the EU ETS, and median targets for renewable energy efficiency involving the construction of new nuclear electricity-generation capacity, which will ensure continuity of the higher share of nuclear energy in the generation mix. To shape a range of possible contributions by the Slovak Republic in the achievement of the EU targets for 2030, at first a summary of possible flexibilities in targets using several trend-variants was quantified by using the CPS-PRIMES model. The Basic, Median and Ambitious categorisations refer to the possible intensiveness of the policy targets for the year 2030. The specification of the WAM scenario relies on the logic of the design of the EU scenarios and in particular, the EUCO30 scenario, which sets the 2030 targets at the EU level on GHG emissions reductions but also have impact on **AP emissions**. It contain:

▪ GHG emissions reduction;
▪ EU ETS CO_2 emissions reduction;
▪ Non-EU ETS GHG emissions reduction;
▪ RES share: 27% of gross final energy demand in 2030;
▪ Energy efficiency: reduction of primary energy by 30% (1 321 Mtoe – excluding non-energy consumption of energy products) in 2030 compared to the 2007 baseline;
▪ Continuing to reduce final energy consumption in all sectors after 2020. The measure puts emphasis on policies supporting the acceleration of the renewal of the building stock (residential and non-residential, public and private), with a focus on carrying out cost-effective in-depth renovations and applying minimum energy performance requirements for near-zero energy buildings after 2020 for new buildings.

In addition to the national policies included in the **WAM** scenario, the following national policies are also included:

- Earlier decommissioning of solid-fired utility power plants: Vojany and Nováky power plants are assumed to decommission in 2024 and 2023 respectively;

- RES support scheme in power generation: Eligible RES technologies are Solar PV, wind onshore turbines and biomass. The scenarios assume support of 50MW in the period 2021-2025, followed by the support of another 500 MW based on auctions;
- Further development of nuclear energy is possible based on economic optimality;
- Carbon capture and storage are excluded;
- Assessment of the future structure of appliances used for domestic heating based on survey data;
- Support for the replacement of old solid fuel boilers in households with low-emission systems;
- Support for insulation of family houses - Programme Slovakia, Green renovation;
- Awareness campaign and education on good coal and biomass combustion practices;
- Commissioning of new nuclear power sources: MOCHOVCE (Blok 04)after 2026;
- Installation of two Electric Arc Furnace (EAF) processing iron scrap;
- Decommissioning of Coke oven battery;
- Decommissioning of Sinter installation;
- Continuous Casting;
- Decommissioning of two blast and oxygen furnaces;
- Reduction of energy coal consumption in Energy and Manufacturing industry.

9.2.4. Emission Projections in Energy Sector

This projections covers emissions from combustion plants as point sources. The emissions considered in this activity are released by a controlled combustion process (boiler emissions, furnace emissions, emissions from gas turbines or stationary engines) and are mainly characterised by the types of fuels used. Activities listed within this category are shown in ***Table 9.5***, ***Table 9.6***, ***Table 9.7***, ***Table 9.8***, ***and Table 9.9***.

Category 1A1 energy industries includes the power installations for the production of electricity and heat and the combined heat power installations (CHP) 1A1a. The emissions from the combustion of municipal waste are included because of the energy recovery from the combustion process. The emissions from the refineries are allocated in category 1A1b. Emissions from petroleum refining, classified by code 1A1b, concern all combustion activities required to support the refining of petroleum products. Manufacture of Solid Fuels and Other Energy Industries 1A1c. The activity covers coke production and emissions associated with combustion in the coke oven. It is the key category for NOx, SOx, $PM_{2.5}$, PM_{10}, and TSP.

Category manufacturing industries and construction 1A2 is focused on the following combustion subcategories: Iron and steel (1A2a); Non-ferrous metals (1A2b); Chemicals (1A2c); Pulp, paper, and print (1A2d); Food processing, beverages, and tobacco (1A2e); Non-metallic minerals (1A2f); and Other (1A2g). The projections depend on fuel and process activity. Relevant pollutants are generally as described for combustion: NOx, SOx, CO, NMVOC. The iron and steel industry is one of the most energy-intensive industrial branches in the Slovak Republic and it is represented by one biggest iron and steel companies in the Slovak Republic (U.S. Steel Košice)

Small combustion (1A4 and 1A5) appliances are used to provide thermal energy for heating and cooking. In small combustion installations, a wide variety of fuels are used and several combustion technologies are applied. Emissions strongly depend on fuel, and combustion technologies as well as on operational practices and maintenance. Households' heating is a very significant contributor to particulate matter $PM_{2.5}$, PM_{10}, CO and TSP (approximately 80% as well as other emissions in Slovakia).

Projection emissions from leaks and other irregular releases of gases or vapours from a pressurized containment, such as appliances, storage tanks, pipelines, wells, or other pieces of equipment mostly from industrial activities. **Categories included in the chapter are fugitive emission (1B)** from solid fuels: Coal mining and handling (1B1a), Fugitive emission from solid fuels: Solid fuel transformation (1B1b), Fugitive emissions oil: Exploration, production, transport (1B2ai), Fugitive emissions oil: Refining/storage (1B2aiv), Distribution of oil products (1B2av) and Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other) (1B2b). Fugitive emissions are an important source of NMVOC emissions.

Projections of fugitive emissions from the transport and distribution of fossil fuels (oil and natural gas) are important because Slovakia is a critical transit country for oil and natural gas from East-European countries to the European Union. This category is a key category for projections of NMVOC and TSP.For the period from 2023 onwards, all mines are categorized as "closed mines" (WEM and WAM scenarios). The emission factor for fugitive methane emissions from abandoned mines was estimated based on emission factors from **EMEP/EEA** air pollutant emission inventory guidebook 2023.The modelling of emission projections in the Energy sector was based on sectoral trends and development from the CPS-Slovakia and actualization was made by taking into account the results of model **TIMES-Slovakia** in the Energy Industry (**1.A.3 excluded)**). The outputs from modelling were determined also by the reduction potential of measures to reduce emissions. The next tables show trends of emissions for individual pollutants.

NOx emissions

***Table 9.5**: NOx emissions in sector Energy in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	19.10	13.04	8.49	5.47	5.26	4.00	4.03	3.68	3.39
1.A.2	15.32	11.74	10.85	8.41	9.35	9.78	10.01	10.58	10.97
1.A.4	9.19	8.89	8.88	8.37	7.76	7.08	6.64	5.84	5.20
1.A.5	0.20	0.13	0.48	0.45	0.38	0.35	0.32	0.32	0.32
1.B	0.20	0.19	0.21	0.23	0.19	0.19	0.17	0.16	0.14
1 Energy	**44.00**	**33.99**	**28.91**	**22.92**	**22.94**	**21.39**	**21.16**	**20.59**	**20.01**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	19.10	13.04	8.49	5.47	5.26	3.94	3.14	2.06	1.59
1.A.2	15.32	11.74	10.85	8.41	9.35	9.80	8.24	5.98	4.46
1.A.4	9.19	8.89	8.88	8.37	7.76	7.08	6.21	4.79	4.24
1.A.5	0.20	0.13	0.48	0.45	0.38	0.35	0.32	0.32	0.32
1.B	0.20	0.19	0.21	0.23	0.19	0.17	0.17	0.13	0.10
1 Energy	**44.00**	**33.99**	**28.91**	**22.92**	**22.94**	**21.34**	**18.08**	**13.29**	**10.71**

** Base year 2022; 1990 – 2022 based on the AP inventory submission 15. 3. 2024*

NMVOC emissions

***Table 9.6**: NMVOC emissions in sector Energy in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	2.68	1.92	1.83	1.19	1.00	0.97	0.98	0.91	0.83
1.A.2	5.33	4.91	5.72	5.69	5.26	5.60	5.68	6.00	6.23
1.A.4	49.24	47.58	37.91	31.62	33.69	29.15	24.40	16.05	9.90
1.A.5	0.47	0.57	0.82	0.55	0.60	0.55	0.51	0.51	0.51
1.B	6.77	6.32	5.60	4.84	4.12	4.22	4.13	3.92	3.21
1 Energy	**64.50**	**61.29**	**51.88**	**43.89**	**44.68**	**40.49**	**35.70**	**27.40**	**20.68**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	2.68	1.92	1.83	1.19	1.00	0.95	0.64	0.40	0.25
1.A.2	5.33	4.91	5.72	5.69	5.26	5.36	5.48	5.50	5.03
1.A.4	49.24	47.58	37.91	31.62	33.69	29.09	21.88	10.31	5.87
1.A.5	0.47	0.57	0.82	0.55	0.60	0.55	0.51	0.51	0.51
1.B	6.77	6.32	5.60	4.84	4.12	3.83	3.80	2.80	2.03
1 Energy	**64.50**	**61.29**	**51.88**	**43.89**	**44.68**	**39.79**	**32.32**	**19.52**	**13.68**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

***WAM scenario for NMVOC emissions are higher than WEM scenario due to higher biomass consumption in households projected with higher EFs.*

SOx emissions

***Table 9.7:** SOx emissions in sector Energy in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	60.82	52.75	52.04	3.22	4.03	2.44	2.38	2.09	1.81
1.A.2	10.01	4.94	3.29	1.47	1.33	1.17	1.20	1.23	1.25
1.A.4	3.40	2.34	1.93	1.57	1.58	1.20	0.82	0.55	0.45
1.A.5	0.32	0.10	0.21	0.19	0.14	0.12	0.11	0.11	0.11
1.B	1.37	1.34	1.46	1.58	1.32	1.29	1.21	1.14	0.95
1 Energy	**75.92**	**61.47**	**58.94**	**8.03**	**8.40**	**6.22**	**5.72**	**5.12**	**4.58**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	60.82	52.75	52.04	3.22	4.03	2.38	2.06	1.20	0.71
1.A.2	10.01	4.94	3.29	1.47	1.33	1.35	1.03	0.85	0.73
1.A.4	3.40	2.34	1.93	1.57	1.58	1.20	0.77	0.45	0.38
1.A.5	0.32	0.10	0.21	0.19	0.14	0.12	0.11	0.11	0.11
1.B	1.37	1.34	1.46	1.58	1.32	1.21	1.20	0.93	0.71
1 Energy	**75.92**	**61.47**	**58.94**	**8.03**	**8.40**	**6.27**	**5.17**	**3.54**	**2.63**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NH_3 emissions

***Table 9.8:** NH_3 emissions in sector Energy in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	0.08	0.03	0.05	0.02	0.03	0.03	0.03	0.03	0.03
1.A.2	0.02	0.02	0.04	0.07	0.08	0.09	0.09	0.11	0.12
1.A.4	2.06	2.09	1.60	1.39	1.54	1.48	1.37	0.96	0.60
1.A.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00

1 Energy	2.17	2.15	1.69	1.48	1.66	1.61	1.50	1.10	0.76

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	0.08	0.03	0.05	0.02	0.03	0.03	0.01	0.00	0.00
1.A.2	0.02	0.02	0.04	0.07	0.08	0.09	0.09	0.07	0.06
1.A.4	2.06	2.09	1.60	1.39	1.54	1.48	1.22	0.59	0.32
1.A.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00
1 Energy	**2.17**	**2.15**	**1.69**	**1.48**	**1.66**	**1.60**	**1.32**	**0.66**	**0.38**

$PM_{2.5}$ emissions

Households (**1.A.4**) are a dominant contributor to $PM_{2.5}$ emissions.

Table 9.9: *$PM_{2.5}$ emissions in sector Energy in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	8.08	0.89	0.67	0.27	0.29	0.28	0.39	0.42	0.43
1.A.2	0.72	0.41	0.23	0.25	0.24	0.25	0.27	0.32	0.36
1.A.4	22.44	20.99	16.25	13.38	14.24	12.40	10.09	6.37	3.77
1.A.5	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01
1.B	0.13	0.12	0.11	0.09	0.10	0.10	0.09	0.086	0.072
1 Energy	**31.40**	**22.42**	**17.28**	**13.99**	**14.90**	**13.04**	**10.85**	**7.20**	**4.64**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.1	8.08	0.89	0.67	0.27	0.29	0.29	0.30	0.29	0.29
1.A.2	0.72	0.41	0.23	0.25	0.24	0.26	0.26	0.27	0.26
1.A.4	22.44	20.99	16.25	13.38	14.24	12.37	9.04	4.04	2.18
1.A.5	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01
1.B	0.13	0.12	0.11	0.09	0.10	0.09	0.09	0.08	0.06
1 Energy	**31.40**	**22.42**	**17.28**	**13.99**	**14.90**	**13.03**	**9.70**	**4.69**	**2.80**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Projections of AP emissions in the Energy sector

On the basis of available data from the national emissions inventory, updated forecasts of emissions trends to 2030 and 2050 were prepared using models and tools to prepare emission projections. In this step, the existing (valid, adopted) policies and measures implemented so far were included in the projections. Here we are discussing the scenario with measures, or more precisely, with existing measures (the WM - with measures- scenario) and with additional measures - WAM. The following figures display emission trend and projections in sector – **Energy (1.A) – transport 1.A.3 excluded**.

Figure 9.7: *Air pollutants emissions trends in sector Energy*

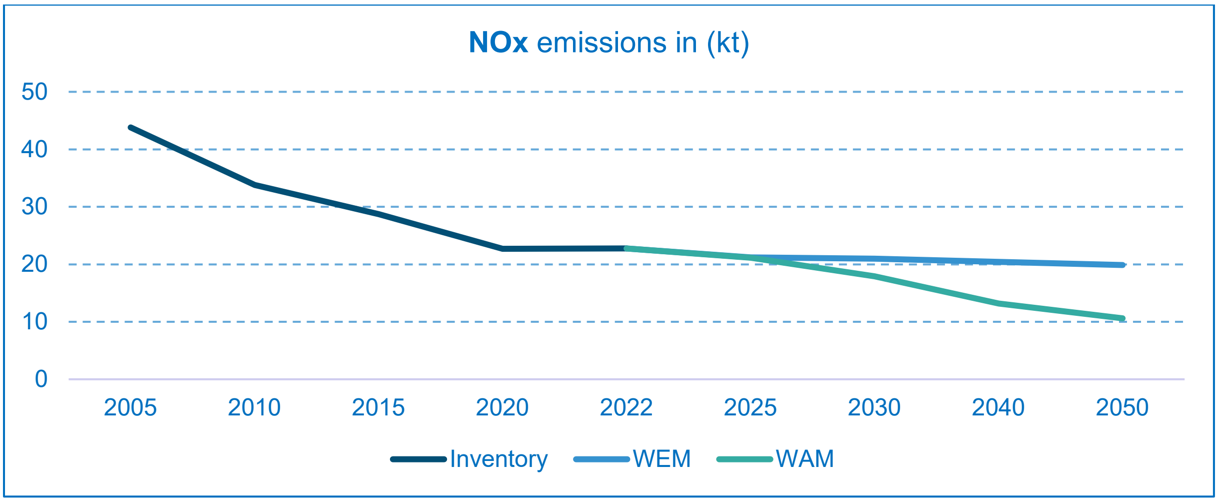


Figure 9.8: *Air pollutants emissions trends in sector Energy*

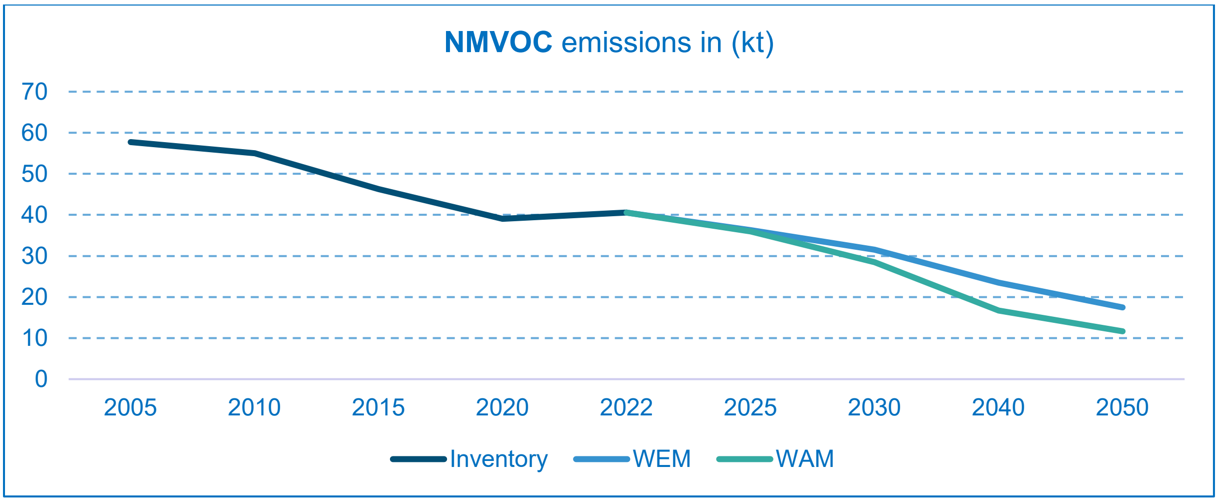


Figure 9.9: *Air pollutants emissions trends in sector Energy*

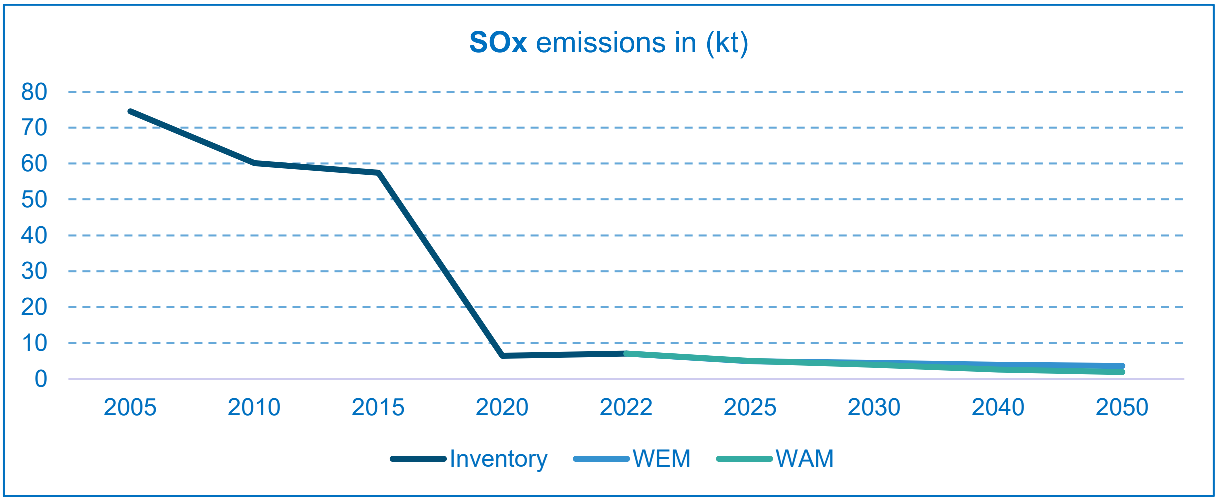


Figure 9.10: *Air pollutants emissions trends in sector Energy*

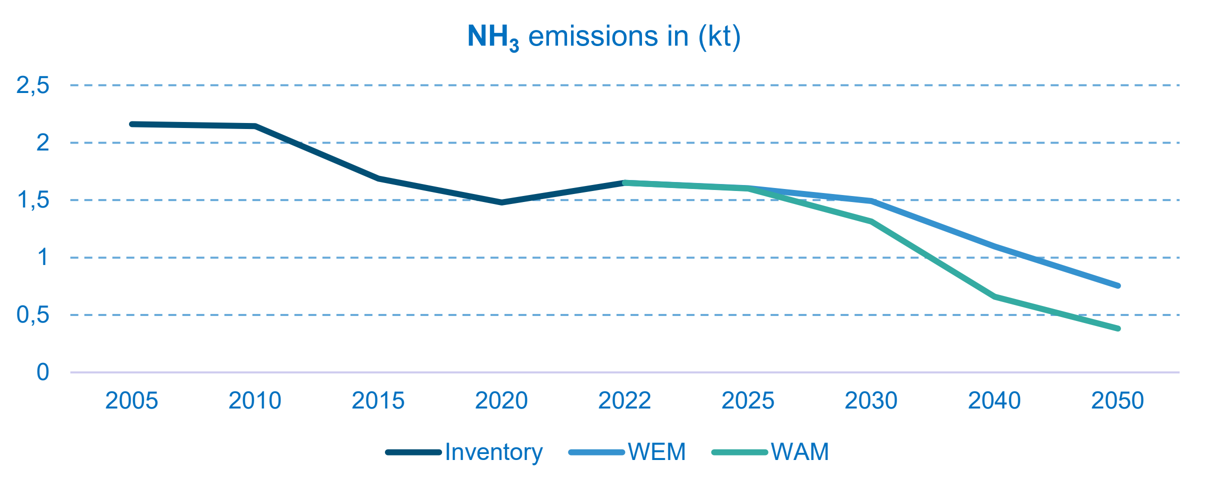
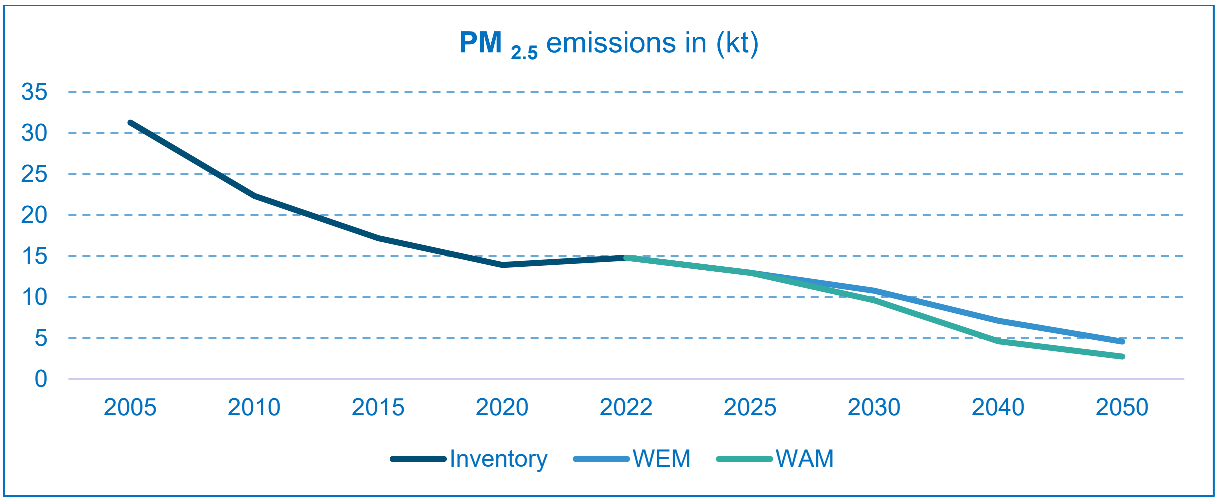


Figure 9.11: *Air pollutants emissions trends in sector Energy*



Emission reduction is visible across all sectors (1A) as well as pollutants. This reduction aligns with Slovakia's National Energy and Climate Plan (NECP) and NAPCP exceeds EU-wide targets. Key drivers include the coal phase-out, industrial electrification, and EU Emissions Trading System (ETS 2) expansion to buildings/transport (2027). Emissions in the energy sector - fuel combustion come mainly from the energy industry (production of electricity and heat), processing industry and construction, fuel pipeline transport and other energy industries. The most important sources of emissions are emissions from electricity and heat production, oil refineries and iron and steel production. Emissions from road, rail, air and ship transport are listed separately in the subsection below. As it is visible, both scenarios contain decarbonisation measure, known as phase-out of solid fossil fuel in Slovakia's biggest thermal power plant in Vojany and Nováky which led to significant decrease of SOx CO, NOx or TSP in category **1A1(a)**. The closure of Nováky (2023) and Vojany (2024) coal plants eliminated 98% of SOx and 74% of PM emissions from category **1A1(a)**.

Emissions of air pollutants in the **WAM scenario** are projected to decline across all sectors between 2025 and 2035, with the most significant reductions expected in the electricity and heat sector. These declines stem from increased renewable energy capacity (solar, wind) and stricter pollution controls. In the **WEM scenario**, a less ambitious electrification pathway (based on SEPS data) is applied, though both scenarios assume the operational start of the MOCHOVCE IV nuclear reactor. By 2030, NOx reduction, emissions are projected to fall by 52% compared to 2005. NMVOC by 45%, SOx by 93%, NH_3 by 30%, and PM 2.5 by 65% levels in the baseline **scenario - WEM**, and by the **WAM scenario** the reduction is follow: NOx by 59%, NMVOC by 50%, SOx by 95%, NH_3 by 39%, and PM 2.5 by 69%. Slovakia's national targets for reducing air pollution are only fully met under the WAM pathway. Post-2035, further reductions are expected, but limited policy frameworks currently detail how major cuts by 2040 will be achieved.

Key drivers for short-term reductions include:

- Electrification of the Košice steelworks (reducing industrial combustion emissions – 1A1(c), 1A2(a).
- Transition to electric vehicles (lowering NOx and PM from transport) – 1A3.
- Closure of coal-fired plants (Nováky in 2023, Vojany in 2024), significantly reducing SOx, CO, NOx and PM – 1A1(a).
- ETS 2 implementation (2027) for buildings and transport, incentivizing cleaner technologies
- Post-coal transition challenges: The Horná Nitra region now relies on a hybrid system: Biomass district heating (30 MW capacity, funded by EU Just Transition Mechanism).Geothermal pilot in Košice.

Air pollutants from Electricity Production

Slovakia's phase-out of coal (Nováky plant closed in 2023, Vojany in 2024) has reduced significantly SOx and PM emissions but raised challenges for regional heat supply. The Horná Nitra region, previously reliant on coal, now requires sustainable alternatives. Options include biomass heat sources, heat pumps, and natural gas backups. The government is prioritizing solutions that balance air quality improvements with economic feasibility. In 2022, the the Slovak authorities finalised their territorial just transition plan and submitted it under the Just Transition Mechanism. The Prievidza Thermal Energy Management (PTH) project includes three main components: renewable energy sources (existing biomass boilers, heat pumps, and possibly solar sources) and small cogeneration units in the HBP complex in the municipality of Cigeľ, as well as hot-water gas boilers on the outskirts of Prievidza, plus a hot water transport pipeline from Cigeľ to Prievidza. The installed capacity is 51.1 MW thermal, including solar sources. It solely addresses the heat supply for the city of Prievidza

Vojany Plant: The shutdown of its 1,210 MW coal units eliminated a major source of PM, NOx and SOx. Residual gas-fired units (220 MW) operated flexibly until 2024. Historically, solid fuels—primarily lower-quality brown coal and lignite mined in the Slovak Republic—were intensively used for this purpose. Due to proactive environmental policies by the Slovak Ministry of Environment, the use of solid and liquid fossil fuels has gradually decreased in recent years, replaced by increased consumption of natural gas and biomass, alongside improved energy efficiency in industries. This phenomenon is termed decoupling—a state where production growth does not align with emission trends, as emissions decline instead.

Air pollutants from Fuel Production (Refinery)

Slovakia's Bratislava refinery (5.5 million-ton capacity) is a major emitter of SOx and NMVOCs due to its processing of high-sulphur crude. Recent shifts to non-Russian oil reduced sulphur intake by 4x in 2023, but technological limitations hinder deeper cuts. Emission reductions in this sector are linked to declining fossil fuel use in transport (modelled via **COPERT**). The WAM scenario projects steeper declines due to synergies with electric mobility and hydrogen adoption.

Steel Production (Manufacture Industrial Combustion)

U.S. Steel Košice's post-pandemic recovery has led to increased production, resulting in higher SOx, NOx, and PM emissions. Planned shifts to electric arc furnaces (replacing blast furnaces) alongside the phase-out of coke battery operations, sinter production, and a transition from combustion of energy-grade coal (category **1.A.2.a**) to natural gas in its main heat and electricity installations (which deliver high-pressure steam and electricity) could achieve significant emission reductions:

- PM: ~42.8% reduction,
- NOx: ~35% reduction,
- SOx: ~60% reduction,
- CO: ~79% reduction.

However, ownership uncertainties and potential delays in adopting hydrogen-based iron ore reduction threaten progress. Current projections assume the WAM scenario's furnace transition (planned for 2026) proceeds as scheduled.

Air pollutants from Fertilizer Production

The major ammonia production DUSLO Šaľa, reliant on natural gas, emits significant NOx and NH_3. A proposed shift to hybrid hydrogen (grey + green) was excluded from projections due to data gaps. An external study found minimal near-term impact on air pollutant reductions. Ammonia production in Slovakia, primarily based on the traditional Haber-Bosch synthesis with a high carbon footprint, faces multiple sustainability challenges. Despite existing national strategies such as the National Energy and Climate Plan (NECP) and the National Emission Reduction Programme (NAPCP), modelling of the WAM (With Additional Measures) and WEM (With Existing Measures) scenarios indicates that implemented measures lack the ambition needed for significant pollutant reduction.

The **WEM** scenario, which assumes a continuation of current trends without new policies, predicts only marginal improvements in AP emissions. This is primarily due to reliance on fossil-based hydrogen (methane) and limited investments in low-carbon technologies, such as electrolyzers for green hydrogen or carbon capture systems (CCUS). The **WAM** scenario also does not reflect structural transformations in practice.

Air pollutants from Heat Production

Decarbonizing district heating focuses on cutting PM and SOx by replacing coal with:

- Biomass/biogas systems (lower PM vs. coal).
- Heat pumps (zero direct emissions).
- Natural gas (transitional, with stricter EU air quality rules).

CHP plants and waste heat integration are prioritized to align with EU air quality directives. Support for insulation of family homes. Support for connecting households to district heating.

Air pollutants from Households

Probably the most important sector for $PM_{2.5}$ emissions and a significant amount of NOx and NMVOC emissions. Based on the information from the questionnaire survey, files with higher data quality were used and on this basis estimates of a natural improvement in the structure of household heating equipment were made. The replacement rate was extrapolated based on historical survey data.

The WEM scenario projects a significant reduction in solid fossil fuel consumption and balanced trend in gas consumption these two trends will lead to decreasing of emission by 2030, keeping them at lower level as in the 2022. Emissions of $PM_{2.5}$ decrease by almost 30%, SO_X by 57% and NMVOC by 27%.

In the WAM scenario, there is a more significant reduction in emissions by 2030. This reduction will be mainly due to significant savings in heating. Due to investments in insulation and more efficient equipment. There will be a decrease in the consumption of natural gas (-19.7%) and solid fuels (-76.1%). Emissions of $PM_{2.5}$ decrease by almost 37%, SO_X by 61% and NMVOC by 34% compare to 2022.

After 2030, the share of heat pumps in heating will increase the use of heat pumps will lead to partial savings in final energy consumption. These will be significantly supported, especially in the WAM scenario, by investments in improving the thermal insulation properties of buildings. The final energy consumption of fuels for heating and hot water (excluding electricity consuption) in households sector between 2030 and 2050 will decrease by 45% in WEM scenario and by 70% in WAM scenario.

Due to decarbonisation in the WAM scenario will also see a significant shift away from natural gas, which will be gradually replaced by biogas and hydrogen and with mix of synthetic gases. In the WEM scenario, the share of natural gas will also be significantly reduced, mainly in favour of electricity. Due to the significant electrification of heating (especially through the use of heat pumps), the use of biomass will decrease between 2030 and 2050 in both scenarios.

Energy Efficiency

Slovakia's 50.8% energy intensity reduction (2000–2015) lowered associated pollutants from power generation. Future gains depend on industrial efficiency upgrades and stricter emission standards for energy-intensive sectors. Energy Efficiency Concept for the Slovak Republic1 - describes energy-saving measures based on advanced and environmentally-friendly technologies, making a significant contribution to reducing greenhouse gas and pollutant emissions;

Renewable Energy

Hydropower: Limited expansion potential, but existing plants aid in reducing grid-related pollutants. Geothermal: Underutilized (48,500 GWh potential) but could displace coal in district heating (e.g., Košice pilot). Data gaps in the TIMES model hinder precise projections.

Air pollutants from Fugitive emissions

The trend is steadily decreasing as an outcome of the introduction of new technologies, methodologies and closing part of mines. Fugitive emissions from the transport and distribution of fossil fuels (oil and natural gas) are significant because Slovakia is an important transit country for oil and natural gas from East-European countries to the European Union. Raw materials are transported through high-pressure pipelines and distribution networks and are pumped by pipeline compressors. The trend in fugitive emissions from the transport and distribution of oil and natural gas in the Slovak Republic was

[1] https://www.enviroportal.sk/energetika/koncepcia-energetickej-efektivnosti-sr?

stabilized and since 2000 slightly decreased. The increase in the past was caused by the expansion of the distribution system for natural gas and the growth of its consumption. Production of coke in **WAM** shows a phase-out trend that reflects also the emissions within this category. This category is key for emissions of TSP, PM_{10} and CO.

Pollutants from mining, post-mining activities, solid fuel transformation, oil/gas transmission, and distribution were projected. These emissions include particulate matter (PM), sulfur dioxide (SOx), nitrogen oxides (NOx), and volatile organic compounds (TOC). In Slovakia, fugitive air pollutants account for ~1% of total emissions, with a declining trend due to stricter regulations. Based on trends in coal mining, oil/gas activity, and fuel transformation, projections under the **WEM** (With Existing Measures) and **WAM** (With Additional Measures) scenarios were calculated and are summarized in ***Tables 9.5 - 9.9 and Figures 9.12 – 9.16.***

- 1.B.1 Solid Fuels

WEM: Assumes current dust control measures (e.g., water spraying in mines). All mines classified as "closed" post-2023, with residual PM emissions from abandoned sites. **WAM**: Additional investments in filtration systems and electrification of mining equipment.

- 1.B.2 Oil and Gas

WEM: Baseline leakage rates (2015–2022 average). Limited upgrades to compressor stations. **WAM**: WAM's LDAR (Leak Detection and Repair) program targets 1,200 km of pipelines, potentially avoiding 740 t/year NMVOC emissions.

Figure 9.12: *Air pollutants emissions trends in fugitive emissions*

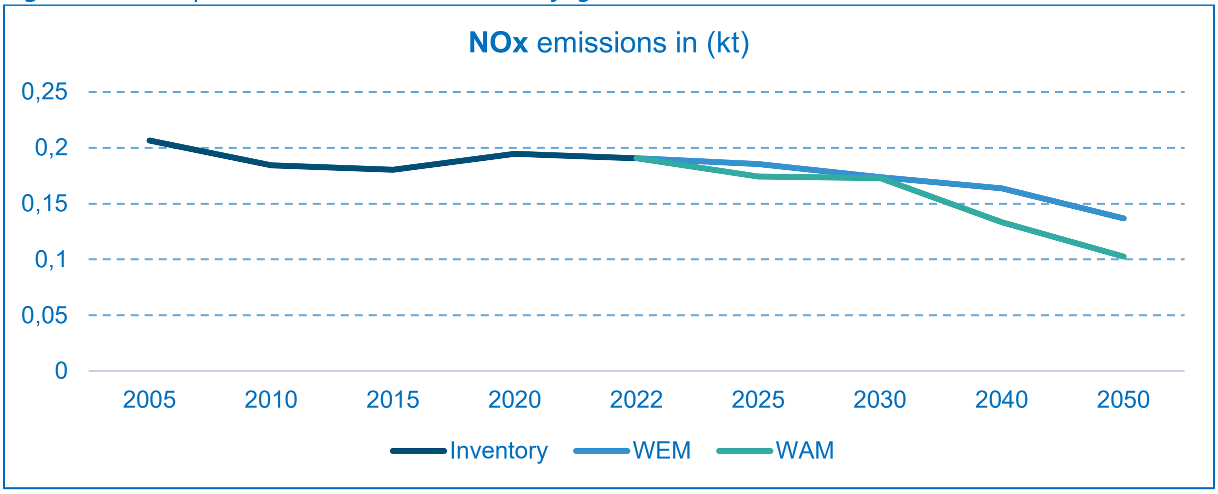


Figure 9.13: Air pollutants emissions trends in fugitive emissions

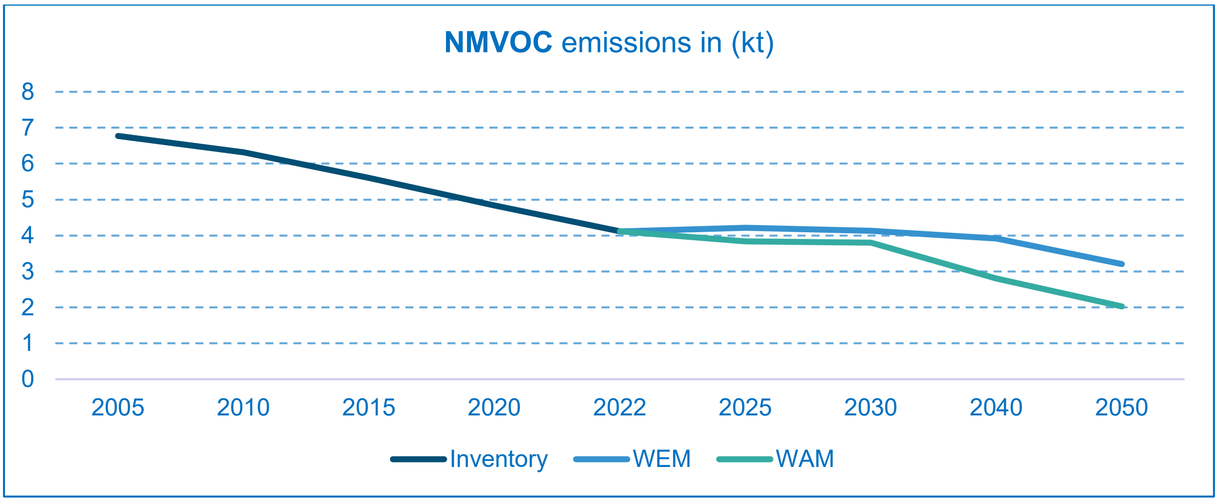


Figure 9.14: Air pollutants emissions trends in fugitive emissions

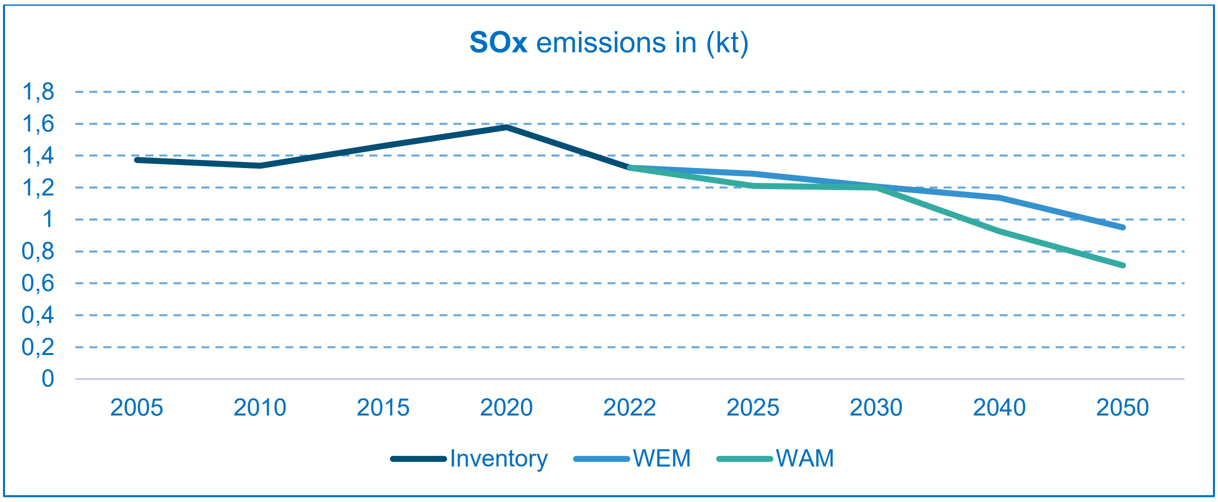


Figure 9.15: Air pollutants emissions trends in fugitive emissions

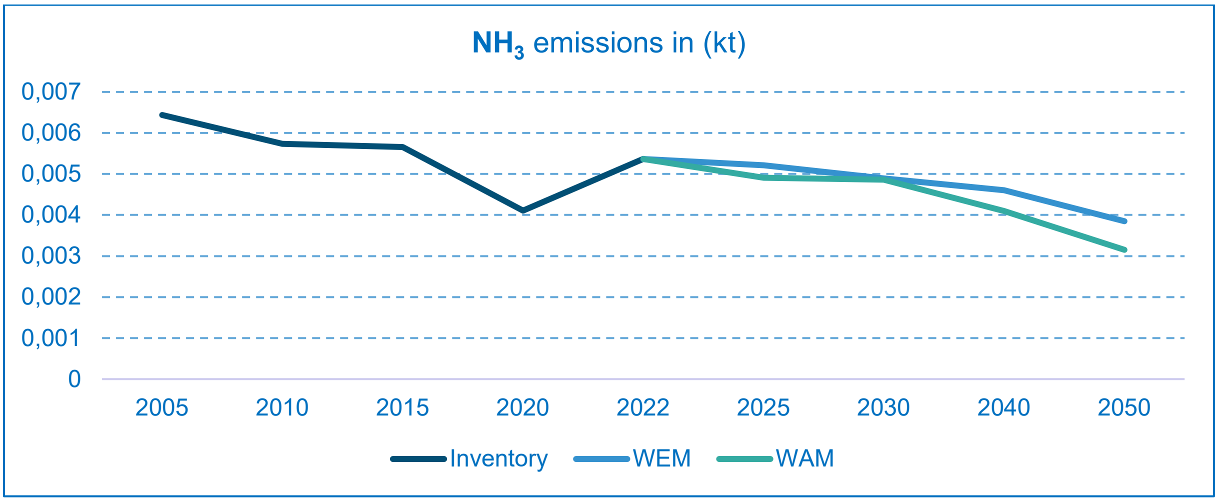
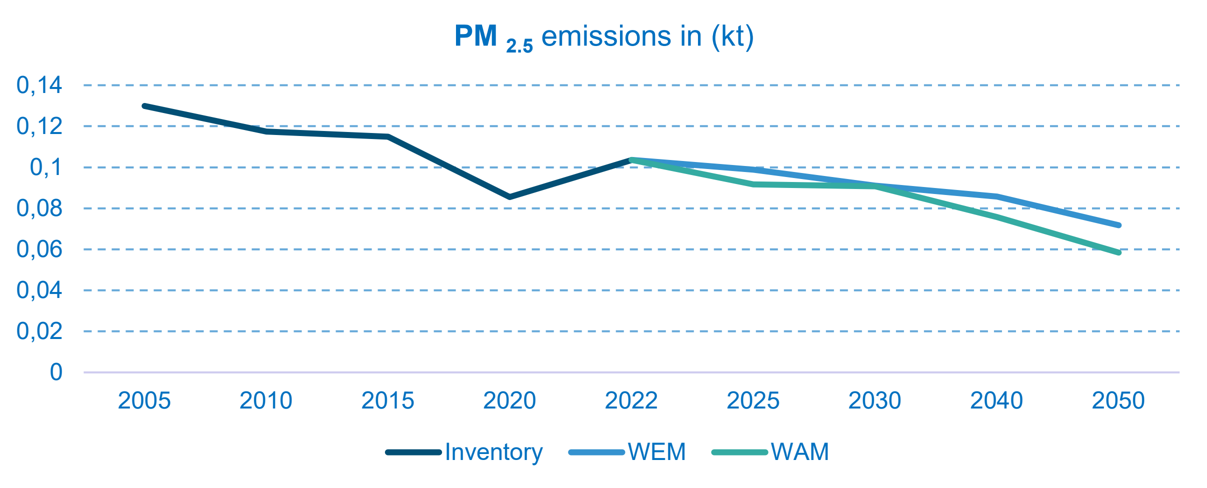


Figure 9.16: *Air pollutants emissions trends in fugitive emissions*



9.3 EMISSION PROJECTIONS IN THE TRANSPORT SECTOR

The transport sector consists of five subcategories:

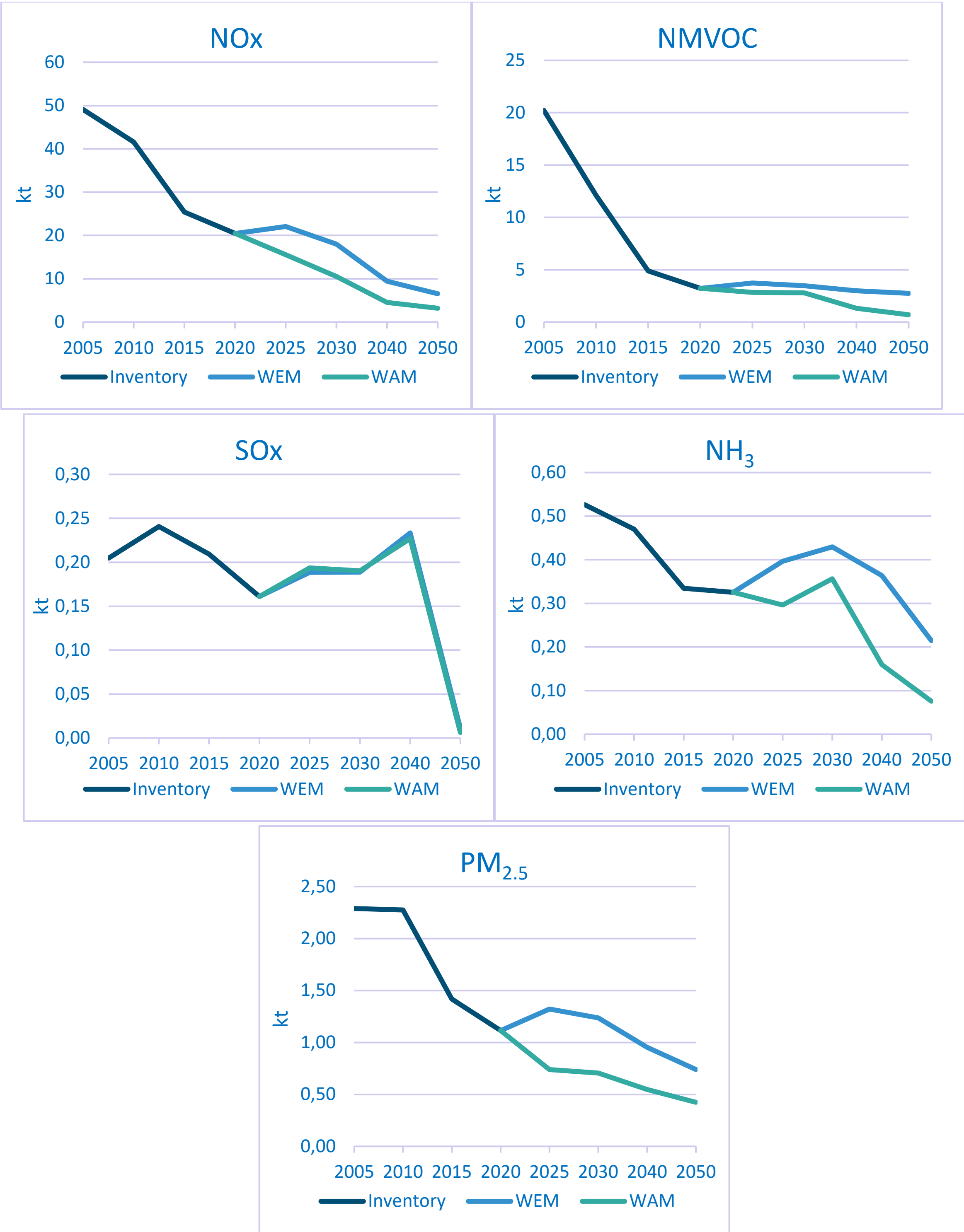
- 1.A.3.a Air transport
- 1.A.3.b Road transport
- 1.A.3.c Rail transport
- 1.A.3.d Water transport
- 1.A.3.e Other mode of transport (e.g. pipeline transport)

The largest contributor to air pollution in the transport sector is road transport, specifically the use of diesel heavy-duty vehicles (HDVs) and passenger cars. The transport sector includes emissions from various sources, including road transport (passenger cars, light-commercial vehicles, heavy-duty vehicles, buses, mopeds, and motorcycles), as well as emissions from petrol evaporation, tire and brake wear, and road abrasion. Additionally, it includes emissions from air, rail, maritime, and pipeline transport (such as the transportation of natural gas). However, the majority of emissions in 2019 originated from road transport. Therefore, Slovakia's focus and detailed analysis are primarily directed towards the potential reduction of emissions from road transport, while the ARIMA model is employed for other transportation categories.

The starting point for gaining control over emissions is a thorough understanding of the current situation and an awareness of how emission trends have changed, both quantitatively and compositionally. By relying on official sources, a detailed, comprehensive, and consistent dataset on vehicles and their activity can be compiled. This dataset serves as the foundation for accurately calculating national-level emissions using advanced emissions modelling tools.

Both the WEM and WAM scenarios demonstrate diverse trends in terms of air pollutants. Emissions of NOx, NMVOC, and the WAM scenario for NH_3 indicate a decrease in emissions, while other pollutants show an increase in emissions (***Figure 9.17***, ***Tables 9.10-9.15***) due to varying factors. The rising trend of SOx and NH_3 emissions is caused by the extensive use of diesel-fuelled vehicles, while the increase in $PM_{2.5}$ emissions is attributed to the introduction and expansion of electric vehicle usage. Electric vehicles, being heavier, result in higher tire and brake wear emissions.

Figure 9.17: *Air pollutants emissions trends in sector Transport*



NOx emissions

Table 9.10: *NOx emissions in sector Transport*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	43.27	36.84	22.84	18.49	17.75	19.82	15.71	7.06	4.10
1.A.3.acde non road	5.82	4.74	2.59	1.99	2.12	2.25	2.30	2.38	2.44
1.A.3	**49.09**	**41.58**	**25.43**	**20.48**	**19.87**	**22.07**	**18.01**	**9.45**	**6.54**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	43.27	36.84	22.84	18.49	17.75	13.33	8.25	2.14	0.76
1.A.3.acde non road	5.82	4.74	2.59	1.99	2.12	2.25	2.30	2.38	2.44
1.A.3	**49.09**	**41.58**	**25.43**	**20.48**	**19.87**	**15.57**	**10.55**	**4.53**	**3.20**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NMVOC emissions

Table 9.11: *NMVOC emissions in sector Transport*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	19.83	11.79	4.50	2.88	4.95	3.41	3.18	2.71	2.41
1.A.3.acde non road	0.39	0.36	0.39	0.35	0.29	0.32	0.30	0.27	0.33
1.A.3	**20.22**	**12.15**	**4.89**	**3.23**	**5.24**	**3.73**	**3.48**	**2.99**	**2.75**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	19.83	11.79	4.50	2.88	4.95	2.52	2.48	1.04	0.37
1.A.3.acde non road	0.39	0.36	0.39	0.35	0.29	0.32	0.30	0.27	0.33
1.A.3	**20.22**	**12.15**	**4.89**	**3.23**	**5.24**	**2.84**	**2.78**	**1.32**	**0.70**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

SOx emissions

Table 9.12: *SOx emissions in sector Transport*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	0.19	0.03	0.03	0.03	0.04	0.03	0.03	0.02	0.01
1.A.3.acde non road	0.01	0.21	0.18	0.13	0.14	0.16	0.16	0.21	0.00
1.A.3	**0.20**	**0.24**	**0.21**	**0.16**	**0.18**	**0.19**	**0.19**	**0.23**	**0.01**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	0.19	0.03	0.03	0.03	0.04	0.04	0.03	0.01	0.01
1.A.3.acde non road	0.01	0.21	0.18	0.13	0.14	0.16	0.16	0.21	0.00
1.A.3	**0.20**	**0.24**	**0.21**	**0.16**	**0.18**	**0.19**	**0.19**	**0.23**	**0.01**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NH_3 emissions

Table 9.13: *NH_3 emissions in sector Transport*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	0.53	0.47	0.33	0.33	0.38	0.40	0.43	0.36	0.21
1.A.3.acde non road	0.00	0.00	0.00	0.00	0.0003	0.00	0.00	0.00	0.00
1.A.3	**0.53**	**0.47**	**0.33**	**0.33**	**0.38**	**0.40**	**0.43**	**0.36**	**0.21**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
1.A.3.b road	0.53	0.47	0.33	0.33	0.38	0.30	0.36	0.16	0.08

1.A.3.acde non road	0.00	0.00	0.00	0.00	0.0003	0.00	0.00	0.00	0.00
1.A.3	**0.53**	**0.47**	**0.33**	**0.33**	**0.38**	**0.30**	**0.36**	**0.16**	**0.08**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

$PM_{2.5}$ emissions

Table 9.14: *$PM_{2.5}$ emissions in sector Transport*

WEM	**2005**	**2010**	**2015**	**2020**	**2022***	**2025**	**2030**	**2040**	**2050**
1.A.3.b road	2.24	2.18	1.34	1.05	1.02	1.25	1.16	0.87	0.65
1.A.3.acde non road	0.05	0.10	0.08	0.06	0.07	0.07	0.07	0.08	0.09
1.A.3	**2.29**	**2.28**	**1.42**	**1.11**	**1.09**	**1.32**	**1.24**	**0.95**	**0.74**
WAM	**2005**	**2010**	**2015**	**2020**	**2022***	**2025**	**2030**	**2040**	**2050**
1.A.3.b road	2.24	2.18	1.34	1.05	1.02	0.67	0.63	0.47	0.34
1.A.3.acde non road	0.05	0.10	0.08	0.06	0.07	0.07	0.07	0.08	0.09
1.A.3	**2.29**	**2.28**	**1.42**	**1.11**	**1.09**	**0.74**	**0.70**	**0.55**	**0.42**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

9.3.1. Methodologies and Key Assumptions/Trends (Road transport)

Input (historical) data for the calculation of air pollution emission projections from road transport are the IS EVO (Vehicle Registration Information System) database provided by the Ministry of Interior of the Slovak Republic – Police department (DI PPZ), the database of the Periodical Technical Inspection (PTI) of the Ministry of Transport and Construction of the Slovak Republic (MDV SR) and the transport indicators from the CPS+ model (Compact PRIMES model) provided by the Institute of Environmental Policy of the Ministry of Environment of the Slovak Republic (IEP MŽP SR). The Sybil database is also an important input source of information in the preparation of emission projections and input parameters. This database is being prepared by EMISIA on the basis of:

- EUROSTAT statistical data (national statistics)
- Project outputs (FLEETS, TRAACS, NMP project) for all EU countries
- EC Statistical Pocketbooks
- ACEA (The European Automobile Manufacturers' Association)
- ACEM (The Motorcycle Industry in Europe)
- CO_2 monitoring database (operated by the EEA)
- EAFO
- NGVA EUROPE/NGV GLOBAL
- UNFCCC reports
- Weibull´s distribution for preparing the age structure until 2050

The data in this database are based on the same input parameters as the EU Reference Scenario for Slovakia, which was discussed and presented in 2018-2019. The EU Reference Scenario for Slovakia was modelled using the PRIMES model and its transport module TREMOVE. The fleet development trends are therefore based on the same parameters and complex calculations, taking into account changes in the market as well as dynamic developments in the sector. This model is not directly applicable to Slovak conditions, as it requires a lot of detailed data, which Slovakia does not have.

Using trends from the Sybil database, an estimate of fleet development was prepared based on real data for the years 2013-2022. The data for this time period were obtained from IS EVO as a by-product of a project. Data and emissions prior to 2013, i.e. the period 1990-2012, were compiled according to official DI PPZ statistics and historical emission inventories.

Another important factor for calculating emissions and energy demand is the average value of annual mileage in each vehicle category and the average value of total vehicle kilometres travelled in each category. These data for the historical years 1990-2012 were taken from emission inventories. Subsequently, for the years 2013-2022, these figures were calculated using the information contained in the Slovak Technical Control database. Specifically, it is the information from the odometer about the kilometres driven. Using the VIN number, the data is matched with the data from IS EVO. A detailed description of the methodology was published in the first phase of the project "Improving the allocation of road transport emissions in the AEA module".

The COPERT model itself operates with 5 vehicle categories:

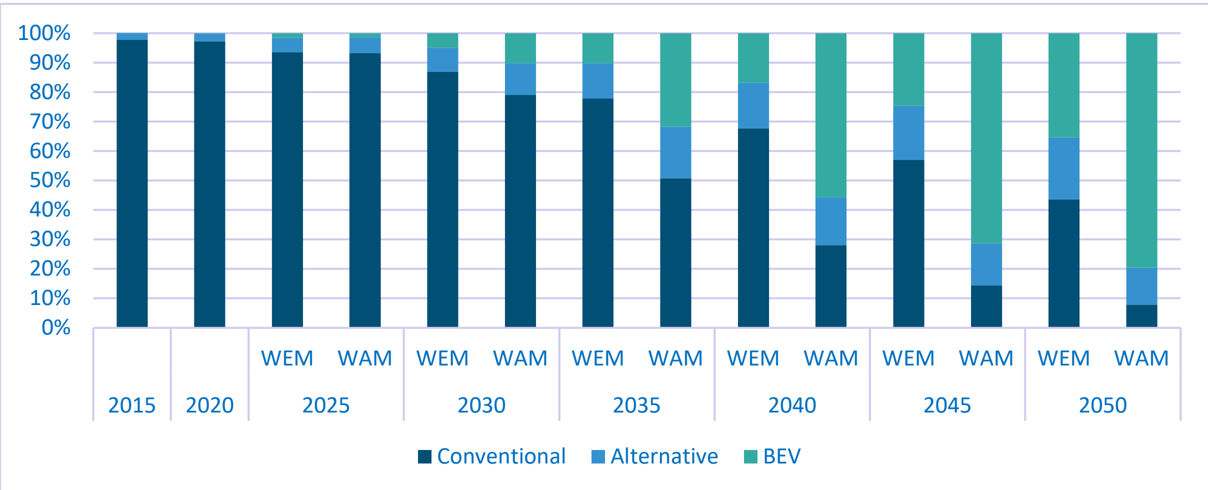
- Passenger cars (M1)
- Light-commercial vehicles (N1)
- Heavy-duty vehicles- trucks (N2 and N3)
- Buses (M2 and M3)
- L-category (L1 to L7)

Estimates for the period 2023-2050 were taken directly from the Sybil database and then broken down into individual fuel bases, segments (by engine capacity or vehicle weight) and emission standards. The model works with up to 620 separate data streams in total. The numbers of vehicles in each data stream each year are determined by an age composition matrix and a "survival rate" calculated from the data of the above-mentioned projects and the Weibull distribution and EUROSTAT data.

Vehicle engines (fuel types) are subdivided and described in detail in the model, but for the purpose of this report, the different types of engines are divided into three groups: conventional, alternative, and zero emission (BEV). Conventional engines are diesel and gasoline with their bio-component. CNG, LPG, LNG, hybrid (both diesel and petrol) and plug-in hybrid (both diesel and petrol) are being considered as alternative engines. BEV is currently represented by electric and hydrogen engine.

The overall evolution of the fleet can be seen in ***Figure 9.18***.

Figure 9.18: *Fleet development by fuel types in WEM and WAM scenarios*

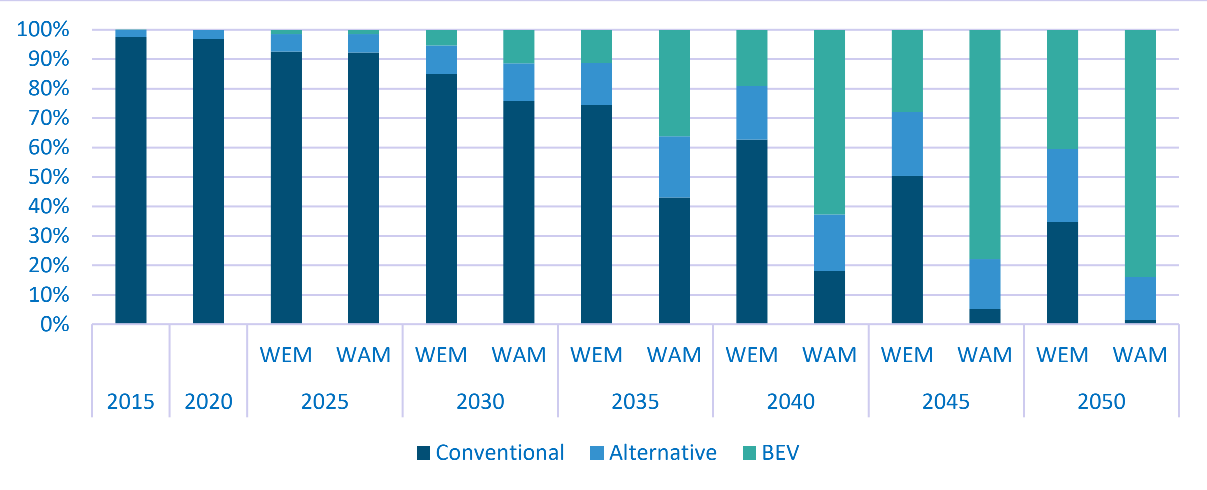


Passenger cars (M1)

Passenger cars account for the largest share of the fleet. In recent years, there has been a significant increase in their number. The main assumption for the projections is that the number of passenger cars in the fleet has still not at its peak. It is expected to peak around 2040, followed by a gradual and slow decline in the number of passenger cars, also driven by a declining demographic curve.

WEM scenario expects conventional passenger car sales will peak in 2030 (***Figure 9.19***). In the case of the WAM scenario, this peak could happen earlier, sometime around the year 2026. For alternative engines, there is a slightly lower increase in the WAM and this is due to the greater weight given to BEV in the fleet development for this scenario, which have exponential growth up to 2050.

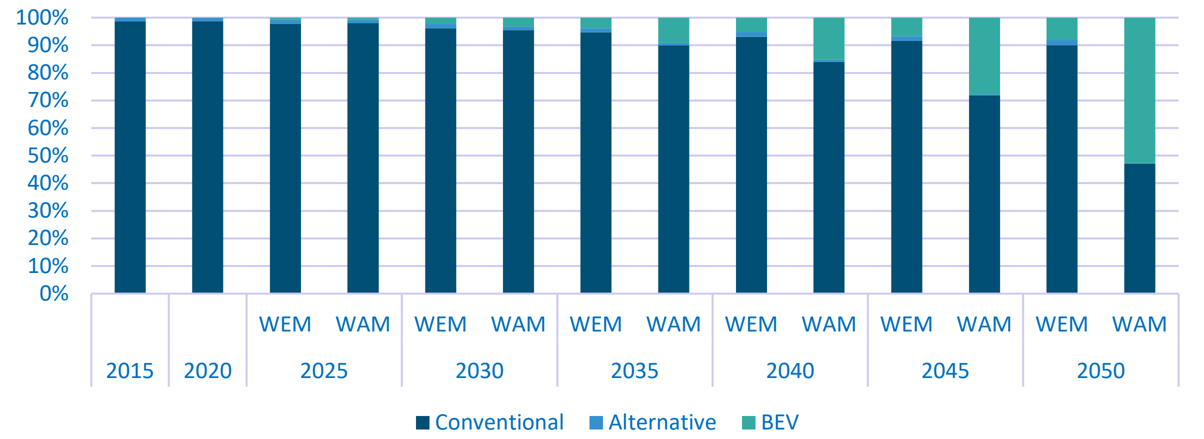
Figure 9.19: *Development of passenger cars in WEM and WAM scenarios*



Light-commercial vehicles (LCV or N1)

The light-commercial vehicle category (category N1 - up to 3.5 tonnes) has undergone a significant change, moving from a category of no major importance in the 1990s to one of the key categories for future decarbonisation. The reason for its significant growth and the assumption of further growth is mainly due to the development of courier services and the "last mile" transport of goods. If the Slovak Republic does not try to decarbonise this part of road transport, the number of these conventionally fuelled vehicles (petrol and diesel) could reach up to 350 000 vehicles in 2050 (***Figure 9.20***). For LCVs, there is little expectation of a turnover to alternative fuels as there would be a reduction in transport space and hence the WAM scenario will not affect this category. For the overall decarbonisation of road transport, it will be necessary to decarbonise in particular the 'last mile' in the form of zero-emission vehicles.

Figure 9.20: Development of light-commercial vehicles fleet in WEM and WAM scenarios

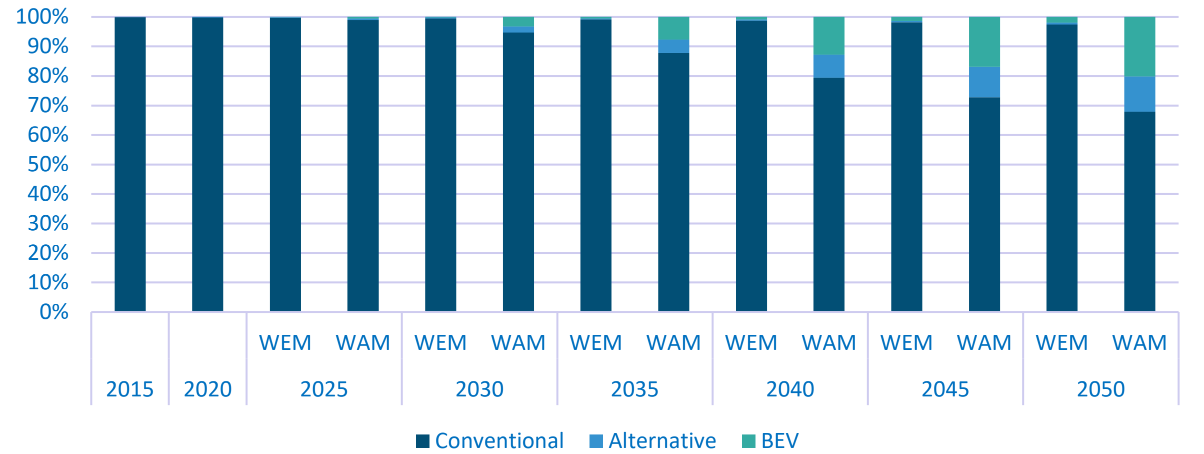


Heavy-duty vehicles – trucks (HDV or N2 and N3)

The heavy-duty vehicles category (traditional freight transport) is also extremely specific within road transport, mainly because of the possibilities of replacing conventional fuels with alternative fuels. This often leads to greenwashing campaigns about emission-free transport in the form of LNG/CNG. Decarbonisation is challenging due to the need for extremely high range and engine power.

In the WEM scenario, there is a steady increase in the number of HDVs (***Figure 9.21***) as the production of goods that will needed to be transported over medium and long distances are projected to increase by the CPS+ model. Alternative fuels can contribute to reducing GHG emissions but cannot be the ultimate solution in this category. The WAM scenario assumes a significant change and an exponential increase and shift away from conventional fuels towards BEV. This is limited, as for the other categories, only by the production capacities of the car manufacturers.

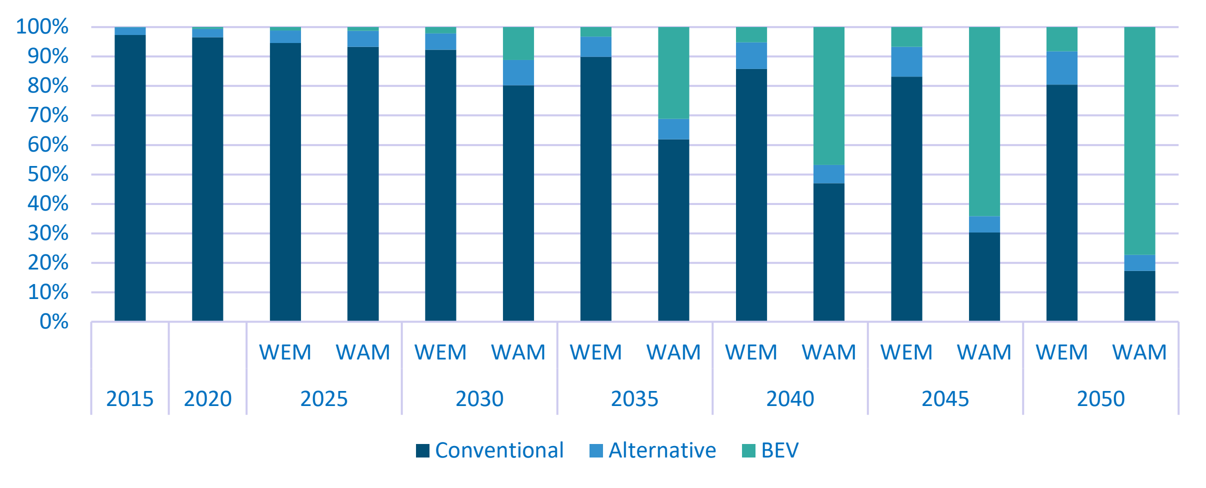
Figure 9.21: Development of HDV fleet in WEM and WAM scenarios



Buses (M2 and M3)

In the case of public passenger transport (PPT), there is no difference between the development in the WEM and WAM fleet scenario in total number of vehicles, but there is a turnover of the fleet (***Figure 9.22***). The WAM scenario assumes a shift of passengers to rail and a densification of PPT intervals, which is reflected in higher annual bus mileage. This assumption was subsequently reflected in the model. Given the small share in road transport, no major interventions in the form of measures to support the fleet turnover have been necessary.
The decline in alternative fuel buses between 2015 and 2020 is mainly due to the phasing out of CNG buses. This trend is changing with the gradual introduction of hybrid buses and their gradual growth, replacing not only conventional buses but also older CNG-powered buses.

Figure 9.22: *Development of buses in WEM and WAM scenarios*



L-category (L1 toL7)

This category includes all two-and three-wheel vehicles. In addition to these, all-terrain vehicles (ATVs) and micro-cars are included. The term micro-car is used in the model to unite all vehicles of category L (1-7) that use diesel as a source of energy. Overall, this category consists of:

- Mopeds
- Motorbikes
- ATVs
- Buggies
- Micro-cars

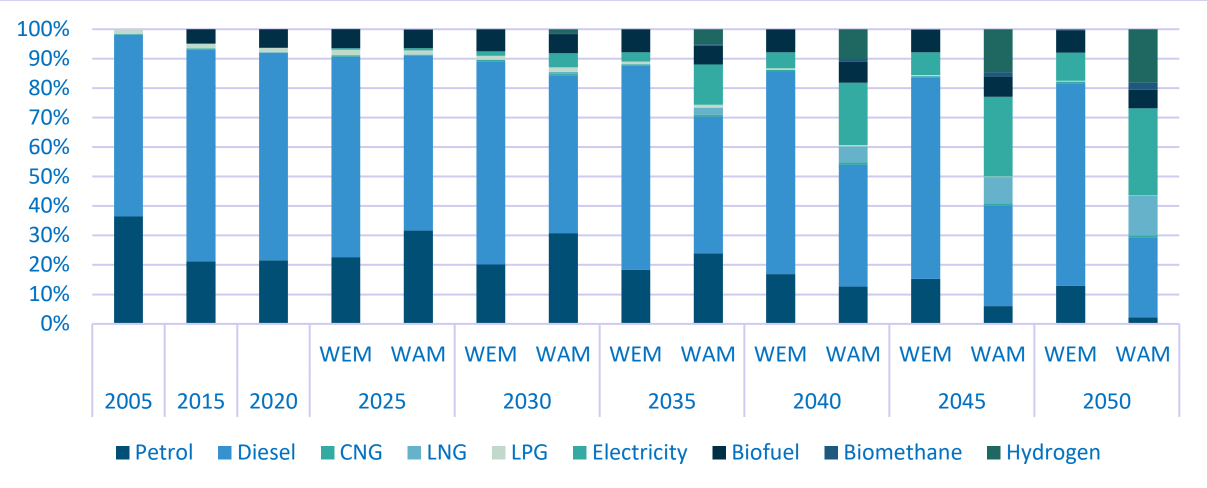
This is the smallest and least important vehicle category in terms of emissions. These vehicles account for around 0.3% of greenhouse gas emissions and projections show that this trend should not change, with the massive decarbonisation of the passenger car category seeing the share rise to around 1% in 2050.

Energy Consumption

In terms of energy, according to the WEM scenario, in Slovakia will dominate consumption of diesel oil until 2050. Its consumption will slowly decrease in this scenario but will still account for up to 69% of the total energy consumption of road transport in 2050.

From other alternative fuels will be the most dominant electricity consumption, rising gradually from a share of 2% (2 178 TJ or 605 GWh) in 2030 to around 10% (7 710 TJ or 2 140 GWh) in 2050 (***Figure 9.23***).

Figure 9.23*: Historical evolution of the energy demand for road transport for the years 1990 – 2020 and WEM and WAM scenarios development assumptions*



In the WAM scenario, significant diversification and an overall decline in fuel and energy consumption is expected in 2050. In this case, electricity will be the most used source of fuel, accounting for 1% (856 TJ or 240 GWh) in 2030 and up to 30% (15 400 TJ or 4 300 GWh) of the total energy demand in 2050. Diesel oil will still have a similarly important but significantly smaller share, with a share of 54% in 2030, falling to half (27%) in 2050. This significant share, despite strong decarbonisation, is mainly due to the heavy-duty vehicles' category, which is extremely difficult to decarbonise while maintaining the parameters required of them.

9.3.2. Model Description (Road transport)

Input data for the calculation of emission projections from road transport are databases provided by the Traffic Inspectorate of the Presidium of the Police Force of the Slovak Republic (IS EVO - Information System of Vehicle Registration) and the Ministry of Transport and Construction of the Slovak Republic (STK=PTI – Periodical Technical Inspection), transport indicators from the CPS+ model (IEP MŽP SR), which was developed for the needs of the Low Carbon Strategy.

An important aspect in the preparation is the Sybil database. This database is being prepared by EMISIA on the basis of:

- EUROSTAT statistics (national statistics),
- Project outputs (FLEETS, TRAACS, NMP project) for all EU countries,

- EC Statistical Pocketbooks,
- ACEA (The European Automobile Manufacturers' Association),
- ACEM (The Motorcycle Industry in Europe),
- CO_2 monitoring database (operated by the EEA),
- EAFO (European Alternative Fuels Observatory),
- NGVA EUROPE/NGV GLOBAL (The Natural & bio Gas Vehicle Association),
- UNFCCC reports,
- Proprietary algorithms for the preparation of the age structure up to 2050.

The data in this database are based on the same input parameters as the EU reference scenario for Slovakia. The EU reference scenario for Slovakia was modelled using PRIMES and its transport module TREMOVE. However, for the conditions of Slovakia, as a small country, this model is directly inapplicable, as it requires many detailed data, which Slovakia does not have.

Using trends from the Sybil database, an estimate of fleet development was prepared based on real data for the years 2013-2022. The data for this time were obtained from IS EVO. Data and emissions prior to 2013, i.e. the period 1990-2012, were compiled from official Traffic Inspectorate of Police statistics and historical emission inventories.

Another important factor for calculating emissions and energy demand is the average value of annual mileage in each vehicle category and the average value of total vehicle kilometres travelled in each category. These data for the historical years 1990-2012 were taken from emission inventories. Subsequently, for the years 2013-2022, these data were calculated using the information contained in the Vehicle Technical Inspection (VTI) database.

The model itself operates with 5 vehicle categories:

- Passenger vehicles (M1)
- Light-commercial vehicles (N1)
- Heavy-duty vehicles - trucks (N2 and N3)
- Buses (M2 and M3)
- L-category (L1 to L7)

Table 9.15: *SWOT analysis of the COPERT CLI model*

Strengths	Opportunities
Compatibility with emission model for emission inventories Detailed data break down Database used is compatible with EU data and national data	Incorporate to the model new technologies Versatile use on different geographical level Versatile use of time series
Treats	**Weakness**
Easy data entry Basic software is free	Disconnected from macroeconomic models Disconnected from national energy models (needs to feed outcomes to energy models) Too much pre-calculations needed

Estimates for the period 2023-2050 were taken directly from the Sybil database. These estimates are based on European statistics and qualified estimates by transport experts. Subsequently divided into individual fuel bases, segments (by engine capacity or vehicle weight) and emission standards, the model works with up to 620 separate data streams in total. The numbers of vehicles in each data stream each year are determined by an age composition matrix and a "survival rate" calculated based on data from the above-mentioned projects and EUROSTAT data.

The COPERT model is used for the actual calculation using the CLI module (Command Line Interface), which allows new technologies that are not directly defined by the model to be brought into the model. This includes emissions-intensive technologies such as LNG, flexi-fuel, e-fuel or hydrogen engines.

The COPERT model always reflects and incorporates the latest developments and scientific knowledge into emissions calculations. The emission calculation methodology is described in the EMEP/CORINAIR Atmospheric Emissions Inventory Guidebook 2023 (EMEP GB 2023) on tailpipe emissions from road transport. The model has roughly 50 predefined (and modifiable) parameters, ranging from environmental conditions (air temperature and humidity) to parameters detailing the generation of emissions in individual vehicle types. When using the CLI module, many of these parameters are unavailable and set to the default value.

Basic emission factors are integrated in the model, which are adjusted based on user-supplied input parameters. Emission factors are defined for each air pollutant separately. Actual values for 2020 were used for the model, except for new technologies where it was necessary to supply emission factors directly.

In terms of technology and the use of different technologies within a single vehicle (plug-in hybrids, CNG, LPG), basic settings were used. In the case of CNG and LPG, it is assumed that 100% of these fuels are used at the expense of petrol, and in the case of plug-in hybrids, the split is 75% in favour of petrol and diesel and 25% in favour of electricity (electric motor). The low share of electric motor use is based on several studies summarised by the ICCT (International council on clean transportation).

Minimum and maximum temperatures have also been introduced into the model, which affect emissions to some extent. The regional climate model KNMI-RACMO22E and its optimistic scenario RCP2.6 were used.

9.3.3. Scenarios, Parameters and PAMs (Road transport)

Slovakia prepared two scenarios for road transport: WEM and WAM scenario. The WEM scenario describes the development of vehicle fleet and GHG emissions using only existing measures in force until end of 2022. In contrast, the WAM scenario foresees a number of additional measures and policies that will need to be put in place both nationally and locally. The policies and measures used are based directly on legislation or on national and EU strategies and action plans. The reference year to compare to the WAM scenario was 2005. The reason for choosing this year as a reference year for comparison is that in 1990 road transport in Slovakia was not yet developed in all areas and did not reflect the current situation. In 1990, the light-commercial vehicle segment, which plays an important role today and especially in the future, was almost non-existent. At the same time, the last validated year with real values was determined to be 2022.

The policies affecting emissions from road transport can be split to three types: energy policies, transport policies and environmental policies. Energy policies and measures focus mainly on energy efficiency and renewable energy sources in transport. Transport policies and measures focus on transport infrastructure and intensity, and environmental policies and measures focus directly on reducing emissions of greenhouse gases and pollutants. The policies and measures taken into account in each scenario are based on a number of national documents:

- Low-Carbon Development Strategy of the Slovak Republic until 2030 with a view to 2050 (NUS SR)
- Action plan for the development of electromobility in Slovakia
- National Air Pollution Control Program (NAPCP)
- Strategic plan for the development of transport in Slovakia up to 2030
- Integrated National Energy and Climate Plan of Slovakia (NECP)
- Review and update of the National Policy Framework for the Development of the Alternative Fuels Market
- EU hydrogen strategy

In addition to these documents, separate acts and European directives also intervene in the preparation of individual scenarios:

- Act No. 277/2020 amending Act No. 309/2009 Coll. on the Promotion of Renewable Energy Sources and High Efficiency Combined Heat and Power Generation
- Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action
- Regulation (EU) 2021/1119 of the European Parliament and of the Council establishing the framework for achieving climate neutrality

WEM Scenario

The baseline scenario is the WEM (With Existing Measures) scenario, which includes only policies and measures in place by the end of 2022. The WEM scenario contains only five known measures that affect the energy mix and the vehicle fleet. They are:

- Act No. 277/2020, which is a partial national transposition of consolidated Directive (EU) 2018/2001 of the European Parliament and of the Council (RED III) on the promotion of the use of energy from renewable sources
- Sale of low-emission vehicles (electric hybrids or plug-in hybrids) or directly zero-emission vehicles (battery electric cars and fuel-cell electric cars)
- Energy efficiency
- Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and light-commercial vehicles
- Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO_2 emission performance standards for new heavy-duty vehicles

The RED III Directive on the promotion and use of energy from renewable sources is currently still not fully transposed into national legislation. Its validity and inclusion in the WEM scenario was necessary and mandatory based on the scenario preparation framework. The RED III Directive sets new targets for the blending of renewable fuels (biofuels) into fossil fuels.

The new, increased targets are:

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
7.6%	8.0%	8.2%	8.6%	8.8%	9.2%	9.5%	10.0%	10.4%	10.8%	11.4%

At the same time as this increased target, the possibility of double counting of the energy share of advanced biofuels has also been introduced. However, the double counting of advanced biofuels has no impact on the production of greenhouse gas emissions.

The historical and projected promotion of zero-emission vehicles (BEV) can be seen in ***Figures 9.24***. Total BEV accounts for 4.9% of the vehicle fleet in 2030, 35% in 2050 according to the WEM scenario and 9.2% in 2030 and 44% in 2050 according to the WAM scenario. Passenger cars account for the largest share of eBEV, accounting for 75% in 2022, 86% in 2025 and up to 93% of all BEV on the road in 2030 and up to 96% in 2050 in the WAM scenario.

Figure 9.24: *Share of zero-emission vehicles in the total vehicle fleet of the Slovak Republic - historical development and projections to 2050*

Energy efficiency is converted into the model identically to the real options. The potential for improving combustion and engine efficiency to the level of "ultra-efficiency" was estimated at 15% in the ERTRAC report for passenger cars with spark-ignition engines. For diesel engines for passenger cars, this estimate was a 12% improvement by 2050, but for light and heavy duty vehicles there is only a 10% level by making the engine more efficient. In the model it is represented by coefficient directly reducing the outputs of energy demand and emissions. Both EU regulations (2019/631 and 2019/1242) are also incorporated into the model this way.

WAM Scenario

WAM (With Additional Measures) scenario is built on policies and measures, strategies and action plans that have not been put into force before 2020. The list of policies and measures used is summarised in ***Table 9.16***.

Table 9.16: *List of policies and measures used in WAM scenario*

Name of the measure	Scenario	Short description for WAM
Regulation for CO_2 emission standards for new passenger cars & light commercial vehicles	WEM, WAM	WEM: 2021 Targets WAM: 2025, 2030, 2035 targets (Fit for 55) achieved
Regulation for CO_2 emission standards for new heavy-duty vehicles	WAM	2030, 2035, 2040 targets partially achieved
Freight Modal Shift	WEM, WAM	WEM: Low Modal Shift - e.g. Trucks to Rail WAM: High Modal Shift - e.g. Trucks to Rail
Passenger Modal Shift	WAM	High Modal Shift - e.g. cars to cycling or public transport
Euro 7: Council adopts new rules on emission limits for cars, vans and trucks	WAM	In compliance
Support for the use of low-emission vehicles	WEM, WAM	WEM: Moderate transition to low-emission forms of transport WAM: High transition to low-emission forms of transport
Promotion of biofuels	WEM, WAM	WEM: In compliance WAM: High increase of biofuels share
Low-emission zones in cities	WAM	UVAR for conventional vehicles
Regulation for CO_2 emission standards for new heavy-duty vehicles	WAM	2030, 2035, 2040 targets partially achieved

The measure to support the continuation of direct support for the use of low-emission vehicles is mentioned in the Action Plan for the Development of Electromobility in the Slovak Republic and is also referred to in the National Air Pollution Control Program. In this measure, the penetration of electric vehicles in the passenger car segment is assumed to be more efficient, up to twice as strong, than in the WEM scenario.

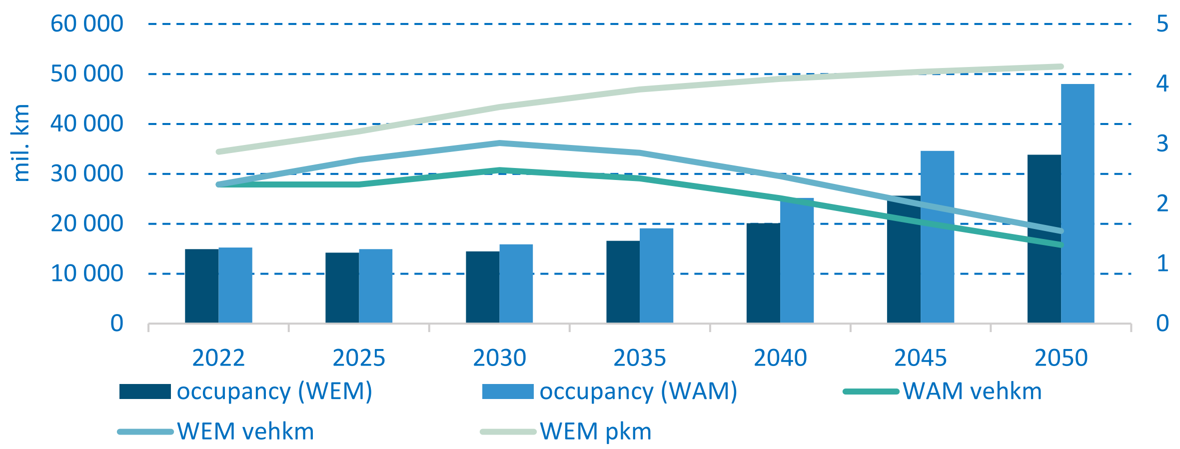
Stricter technical and emission inspections should result in the capture and removal of the oldest and non-compliant vehicles from transport. Strict rules are now in place for technical and emission inspection stations, but despite these measures, there is still circumvention of the rules. According to some research there can be up to 60% of tampered heavy-duty vehicles. This measure is expected to have a gradually diminishing effect under the influence of positive changes in the behaviour of vehicle owners. In the model, this measure manifests itself as a change in the age structure of the passenger car fleet.

Modal shift in passenger transport implies a shift of passengers from passenger vehicle transport to public passenger transport (PPT) or cycling in cities. As a result, the occupancy rate of passenger vehicles is expected to increase by 50% compared to 2022, reducing in particular the number of kilometres travelled by passenger vehicles up to 33% by 2050. The transfer of passengers to the PPT will go in two directions at the same time: road PPT and rail PPT. In the case of the rail PPT, it is expected that there will be an improvement in the quality of transport as well as the restoration of a number of railway connections. The prerequisite for this is the approved new Transport Service Plan for railways passenger transport. In the case of bus services, it is expected that there will be a slight increase in kilometres travelled. This effect on public bus services was reflected in a 10% increase in average annual mileage.

For shorter distances and in the city, it is also possible to use bicycle transport in addition to PPT. This possibility should also results from the National Strategy for the Development of Cycling Transport and Cycling Tourism in the Slovak Republic. It is estimated that it could reduce the share of road passenger transport in cities up to 10% by 2030. For the purposes of the projections, more conservative estimates of 6% have been used (3% for traffic peak and 3% for off-peak traffic).

The input data are pkm (person-km), which is a macroeconomic indicator from the CPS+ model for the Low Carbon Development Strategy of the Slovak Republic. From this data, the vehicle occupancy was then calculated, to which the increased occupancy was applied. It was then possible to calculate the new mileage with increased vehicle occupancy while maintaining passenger kilometres (***Figure 9.25***).

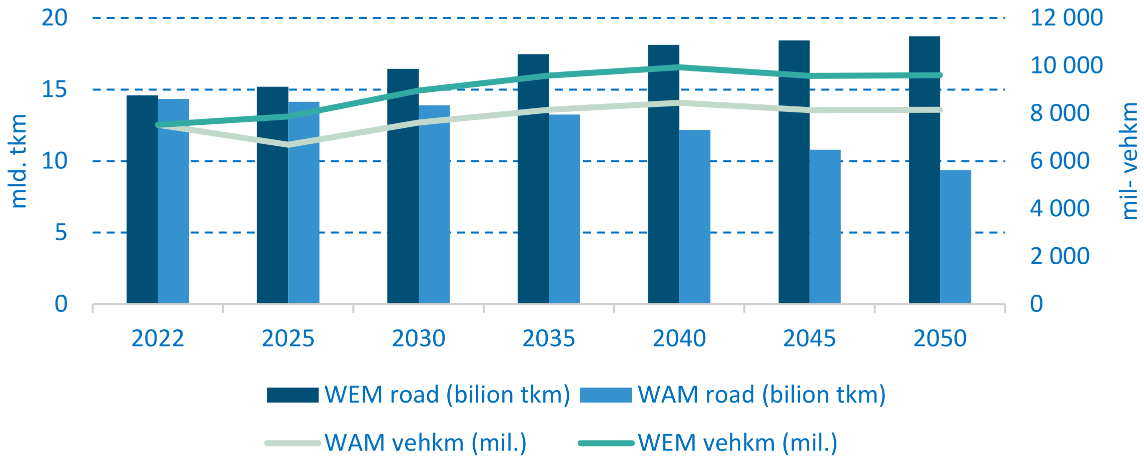
Figure 9.25: *Changes in passenger vehicle occupancy, annual passenger vehicle miles travelled, and passenger vehicle miles travelled by CPS+ model*



Modal shift in freight transport or the movement of goods in Slovakia is currently mainly carried out by freight road transport. From this point of view, modal shift in freight transport is more than necessary. According to the freight modal shift policy, the volume of goods transported by trucks is

expected to decrease by 50% by 2050. This goal is foreseen in the Low Carbon Development Strategy of the Slovak Republic. As a consequence of shifting some of the goods to the railways, the annual vehicle mileage will be reduced and ultimately the number of trucks will also be reduced. A possible reduction in the number of trucks has not been estimated, as the WAM scenario currently only assumes a reduction in annual mileage.
The calculation procedure is analogous to the modal shift in passenger transport. In this case, tonne-kilometres (tkm) play a role, which were also obtained from the CPS+ model for the Low Carbon Development Strategy of the Slovak Republic as a macroeconomic indicator (***Figure 9.26***).

Figure 9.26: *Changes in freight transport, annual boarding and goods transported by road and rail (billion tkm)*



The most effective measure in this scenario appears to be the phasing out of fossil fuelled cars and light-commercial vehicles and their replacement by electric and hydrogen vehicles, especially for last mile goods movements. A complete ban on the sale of these pure fossil fuel vehicles (diesel and petrol) is due to take place in 2035. This measure will result in an exponential growth of BEVs in the light-commercial vehicle category. This measure will be also facilitated by the introduction of low emission zones in cities.
The introduction of hydrogen passenger vehicles, similar to trucks, was estimated in the European Hydrogen Strategy report to reach a maximum possible implementation rate of 20% of the vehicle fleet by 2050. In Slovakia, this level is reduced to 10% in the WAM scenario following a consensus of experts in the field.
The addition of bio-based methane (bio-methane) to vehicle fuels is now common practice in other EU countries. In Slovakia, this obligation will be introduced by the amendment of Act No. 309/2009 on the Promotion of Renewable Energy Sources and High Efficiency Combined Production. This amendment introduces an obligation to add a bio-component to compressed natural gas (CNG) and liquefied natural gas (LNG) from 2023. The minimum energy content of this bio-ingredient is determined as follows:

2023	2024	2025	2026	2027	2028	2029	2030
2.0%	3.0%	4.0%	6.0%	8.0%	10.0%	12.0%	14.0%

Even at the highest achievable share in 2030 (14% of the bio-based component), this does not have a significant reduction impact on emissions and traffic intensity in the scenario.

9.3.4. Emission Projections in Road Transport

NOx emissions

The NOx emissions are continuously decreasing (***Figure 9.27***), and according to the WEM scenario, 65% of the remaining emissions in 2050 are from freight transport. The decrease in emissions is based on fleet turnover towards newer technologies (EURO 6 D/E and EURO 7) but with only a minor inclination towards alternative fuels. On the oter hand, the WAM scenario shows a higher diversification of fuel technologies and a significant reduction in emissions by 2050. (**Figure 9.28**)

Figure 9.27: *Historical emissions and projections of NOx emissions according to WEM scenario*

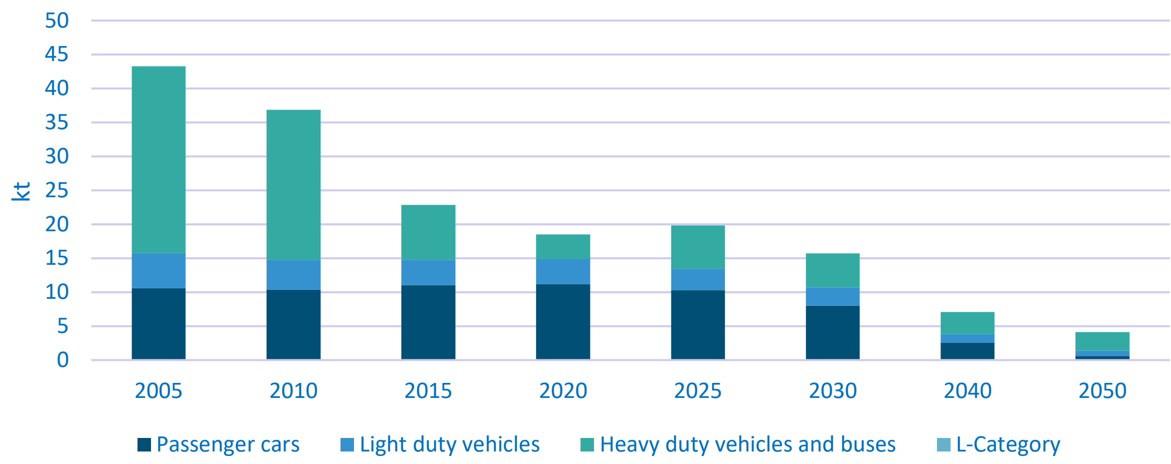
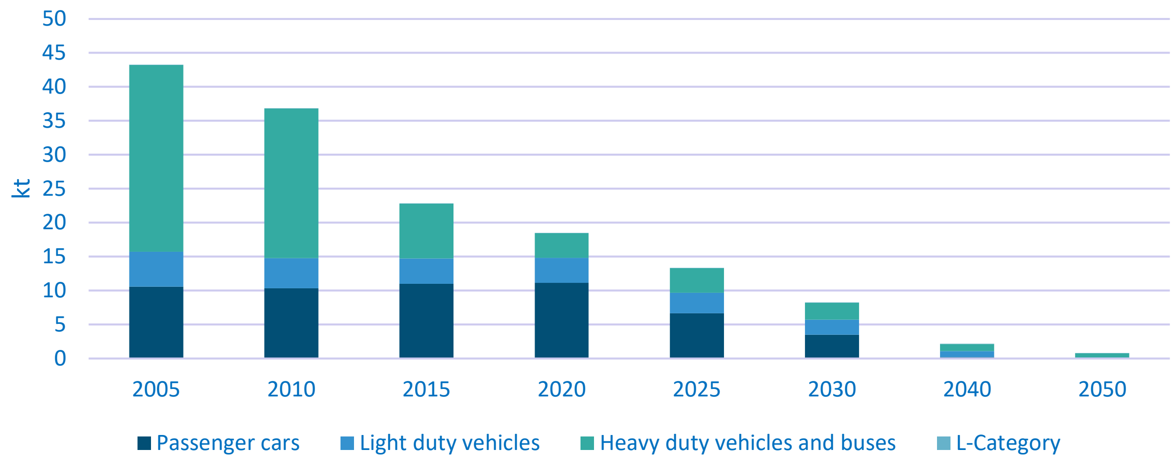


Figure 9.28: *Historical emissions and projections of NOx emissions according to WAM scenario*



$PM_{2.5}$ emissions

Most of the $PM_{2.5}$ emissions come from tire and brake wear abrasion, and road abrasion. Reduction of these emissions is possible only by decreasing the total traffic. In the WAM scenario (***Figure 9.29***), these emissions from electric and fuel cell electric vehicles are accounted for in the vehicle category since the COPERT model is currently unable to distinguish between exhaust and non-exhaust emissions for new vehicle categories. Even though the total emissions are 50% lower than the emissions in the WEM scenario (***Figure 9.30***).

A fraction of PM is also reported as black carbon (BC). There is a slight increase in these emissions in the WAM scenario from passenger cars. This increase is a result of the aforementioned missing capability of the COPERT model and higher average mileage. In the WAM scenario, it is assumed that there will be a more radical turnover of the vehicle fleet, which temporarily increases the total mileage of the fleet. BC is calculated as a fraction of $PM_{2.5}$, and these emissions come not only from exhaust emissions but also from brake and tire wear and road abrasion. The emissions from the last source depend only on the total mileage of the vehicle fleet, thus these emissions will be temporarily higher. With the predicted decrease in traffic after 2030, the emissions of $PM_{2.5}$ and BC will also decrease.

Figure 9.29: *Historical emissions and projections of $PM_{2.5}$ emissions according to WEM scenario*

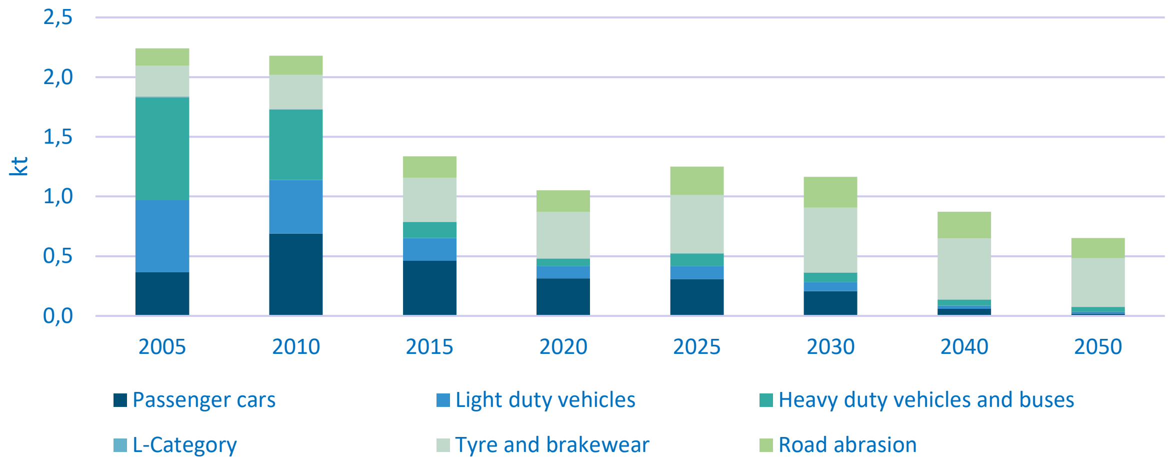
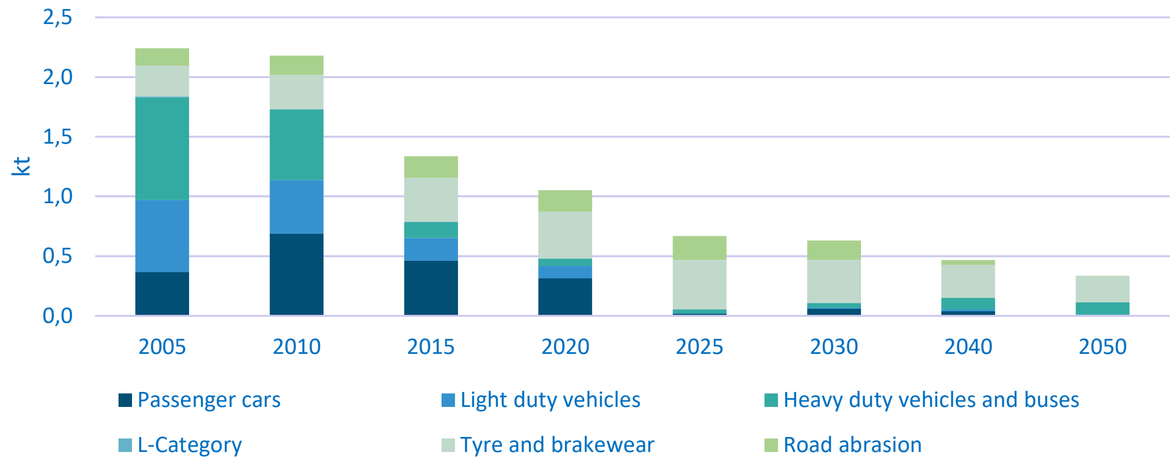


Figure 9.30: *Historical emissions and projections of $PM_{2.5}$ emissions according to WAM scenario*



NMVOC emissions

The most important source of NMVOC emissions from road transport is gasoline evaporation and passenger cars. These emissions depend on technological advantage of the vehicle and ambient temperature. There is a predicted decrease in NMVOC emission in the WEM scenario, but only a slight change in the ratio between the two major categories (***Figure 9.31***). In the WAM scenario (***Figure 9.32***), passenger cars (17 %) and gasoline evaporation (79 %) are responsible for 97% of NMVOC emissions in 2030, while in 2050, 82% of NMVOC emissions come from gasoline evaporation. At the same time, there is a significant decrease in these emissions, which is caused by the electrification of road transport.

Figure 9.31: Historical emissions and projections of NMVOC emissions according to WEM scenario

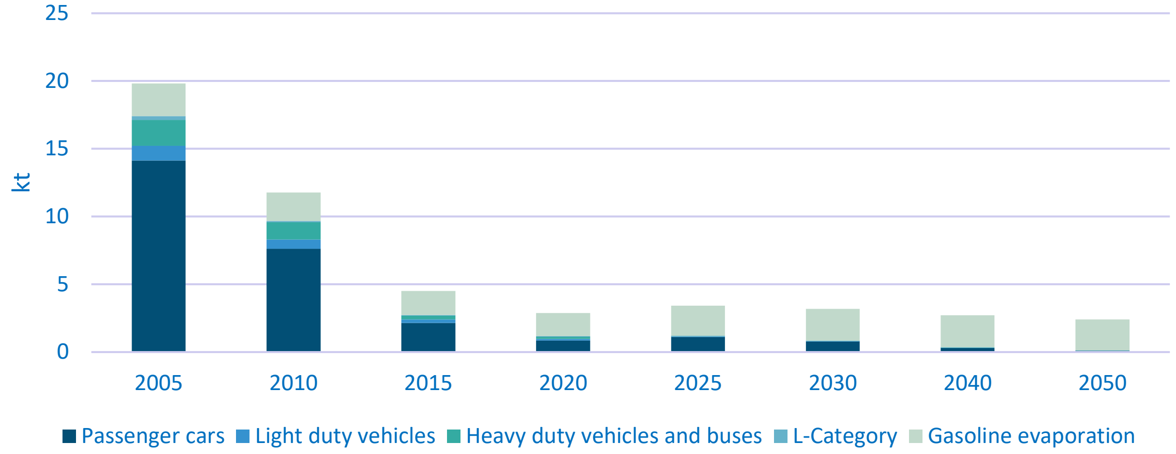
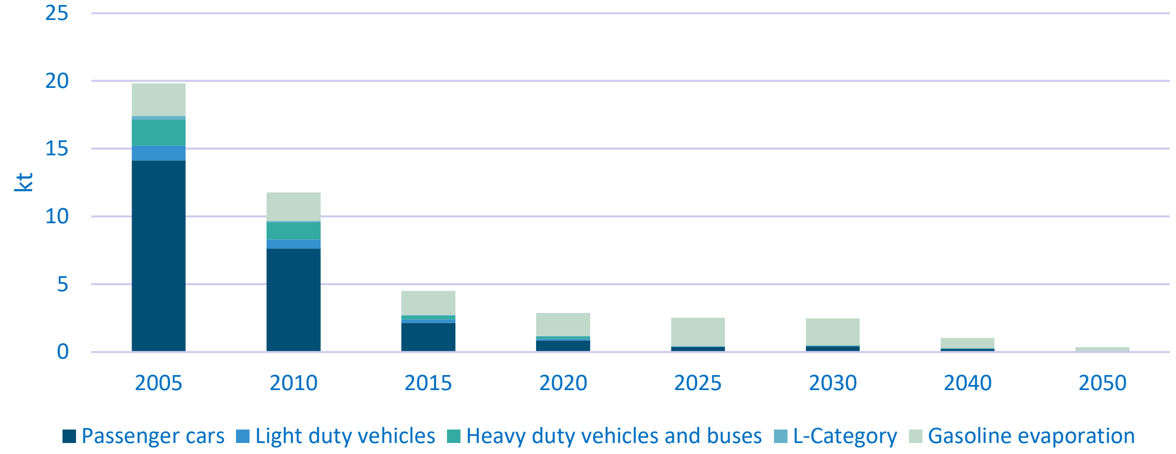


Figure 9.32: Historical emissions and projections of NMVOC emissions according to WAM scenario



SOx emissions

Sulphur oxide emissions significantly decreased after 2005 as a result to banning high-sulphur content fuels. These emissions depend on the fuel consumption, and in the WEM scenario (***Figure 9.33***), a decrease of SOx is assumed after 2030. The tipping point of SOx in the WAM scenario (***Figure 9.34***) is assumed to be much earlier, around the year 2025.

__Figure 9.33:__ Historical emissions and projections of SOx emissions according to WEM scenario

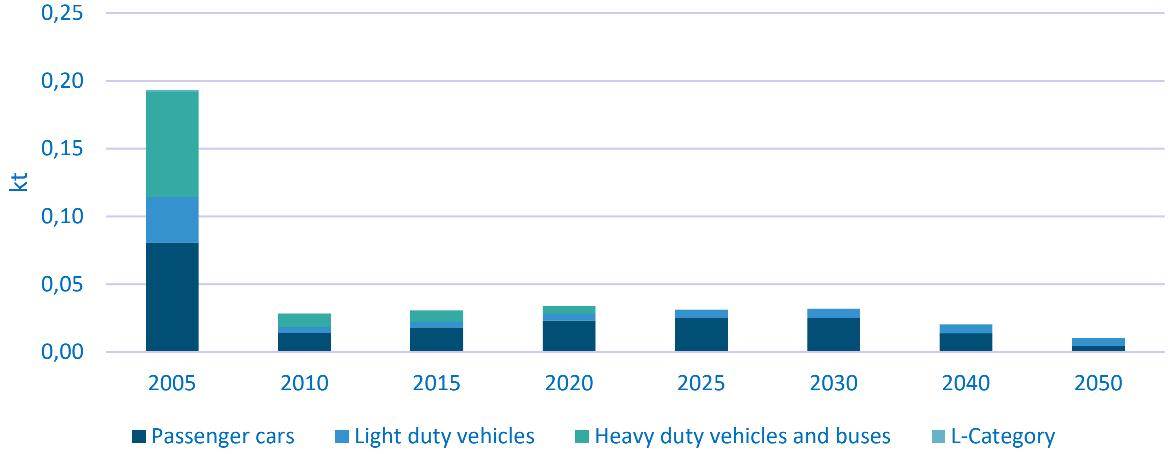
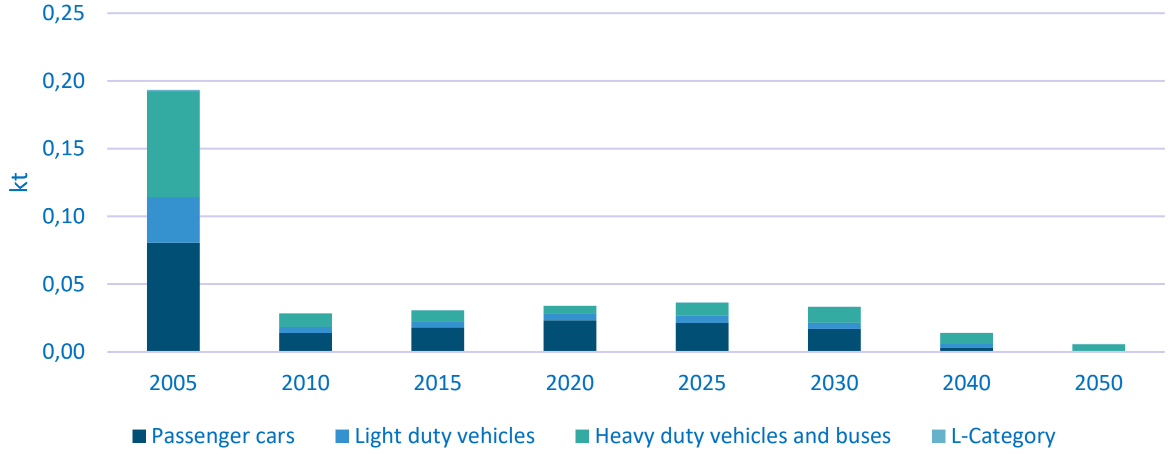


__Figure 9.34:__ Historical emissions and projections of SOx emissions according to WAM scenario



NH_3 emissions

Ammonia emission trends are mainly a result of a phenomenon is known as "emission control technology rebound" or "emission shifting." This phenomenon slows down the possible reduction of ammonia emissions in the road transport. This will cause the ammonia emission according to the WEM scenario, to stay at the same level as in 2020 (***Figure 9.35***). In the WAM scenario (***Figure 9.36***) alternative fuels (electricity and hydrogen) are introduced, and ammonia emissions will fall to 35% of the emissions compared to the WEM scenario by 2050.

Figure 9.35: *Historical emissions and projections of NH_3 emissions according to WEM scenario*

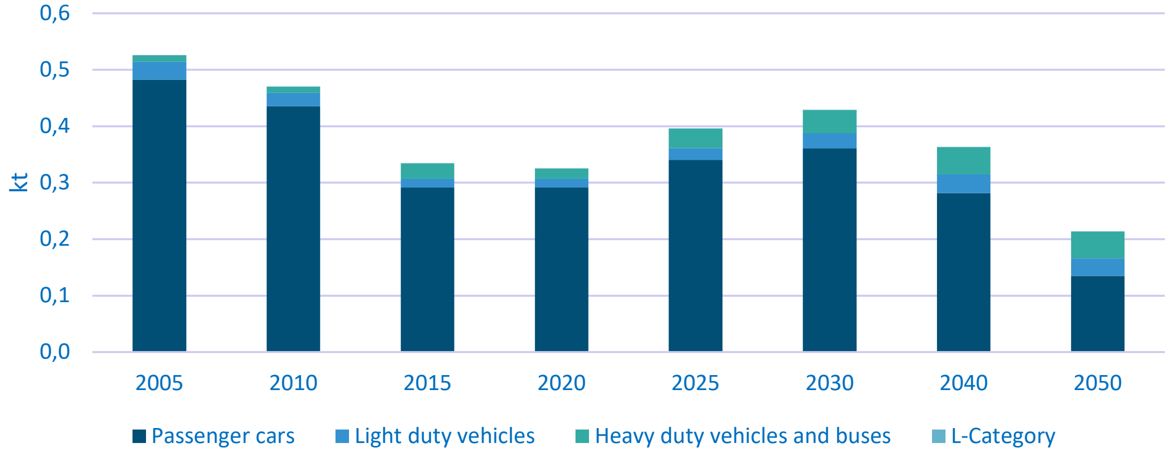
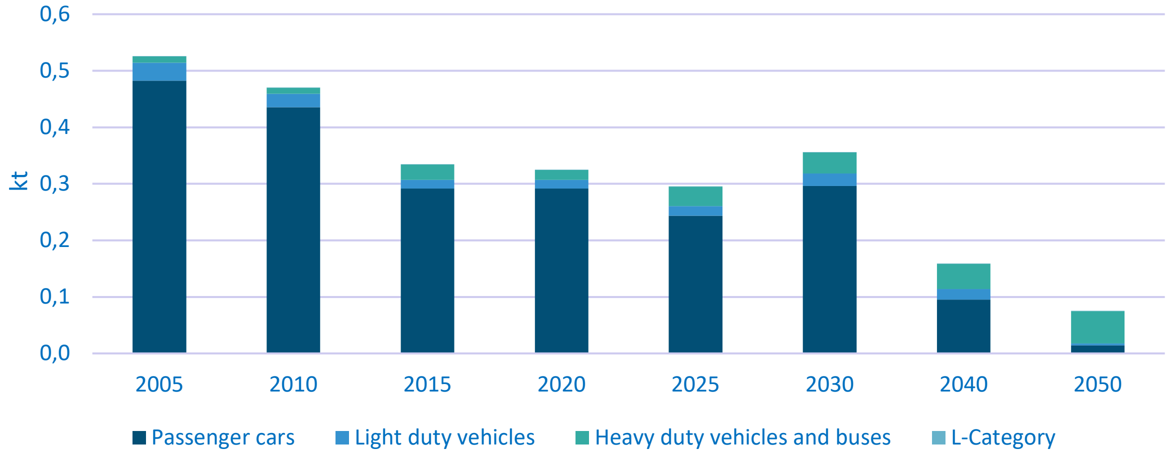


Figure 9.36: *Historical emissions and projections of NH_3 emissions according to WAM scenario*



9.3.5. Emission Projections in other Transport Categories (1.A.3.a, c, d, e)

In addition, projections of air pollutants from non-road transport in the Slovak Republic have been prepared (according to recommendation SK-1A3a,c,d,e-2021-0004), but their relevance is currently to overall air pollution emission projections negligible, so only the WEM scenario has been prepared. Highest ratio of non-road transport have the NOx with a 12% share (excluding SOx as these emission from the whole transport are negligible).

Projections of non-road emissions were calculated using ARIMA (AutoRegressive Integrated Moving Average) modelling. Emissions from pipeline transport have been prepared based on information about projections of long distance transmission of natural gas through the pipelines system. The outcome are in ***Tables 9.10 – 9.15***.

9.4 EMISSION PROJECTIONS IN THE IPPU SECTOR

9.4.1. Methodologies and Key Assumptions/Trends

Emission projections from industrial processes (IPPU) primarily arise from non-combustion activities. A core assumption for the sector remains the durability of equipment and availability of raw materials, with GDP trends continuing to drive production demand. While emission reductions are typically tied to declines in output, modernization and decarbonisation measures now offer pathways to cut emissions without sacrificing productivity. In Slovakia, iron and steel production remains the largest contributor to IPPU emissions.

Slovakia's metal production sector, deeply rooted in its industrial history, has rebounded post-pandemic. After a 40% production drop in 2020 due to COVID-19, output stabilized by 2022, aligning with pre-pandemic levels. However, geopolitical tensions (e.g., the Ukraine conflict) and energy market volatility in 2022 introduced new challenges, including rising natural gas prices and supply chain disruptions. Despite this, the sector aims to maintain production through investments in electric arc furnaces (EAFs) and phased closure of coke batteries and sinter plants.

In the iron and steel sector, it is possible to reduce **AP** emissions by reducing the consumption of coke as a fuel for energy processes and as a reducing agent in blast furnaces. However, this would result in a reduction in steel production and hence economic problems for the region. One of the most recent measures in the iron and steel sector is electric arc furnaces (**EAF) or Phase-out Coke battery alongside with Sinter production decommissioning**. The current set of measures foresees investments in technology, which should lead to significant emission savings in the sector.

The share of enterprises in the non-metallic and chemical industries is also significant.

One of the most effective measures in reducing emissions in the non-metallic industry is waste recovery. Specific waste mineral wastes can, by their chemical composition, replace natural raw materials such as limestone or clay that have to be extracted from nature. Many of them also contribute to reducing emissions of air pollutants. Waste recovery (e.g., using mineral by-products to replace limestone/clay) remains a top measure, cutting both raw material extraction and PM/SOx emissions.

The trend in the chemical industry is influenced by various segments. Slovakia has a strong tradition in all major segments of the chemical industry including oil refining, fertilizer production, rubber and plastics. The product portfolio is also influenced by the strong automotive and electronics sectors in Slovakia, which serve as regular high-capacity clients for various companies in the chemicals and plastics industries.

No closure of existing chemical facilities is currently anticipated or planned. As regards the trend in emissions from the chemical industry, it is expected to be fairly constant and no significant decrease is foreseen. However, the largest reductions in this sector could be due to reductions in the production or consumption of fuels by cars and trucks, or reductions in the consumption of artificial fertilisers in agriculture. By transforming the production of petroleum-based fuels to the production of green hydrogen as a fuel using RES, or by producing more advanced biofuels and bioplastics.

Sectors 2D and 2G are key sources for NMVOC emissions. The calculation of emission projections are based on following parameters: gross value added for relevant sector, expected population trend and extrapolation of trends from the past. Since these are key categories, in the future it will be necessary to improve the methodology for calculating emissions projections.

9.4.2. Model Description

Model description used for the EU ETS part of IPPU emissions (large sources of technological emissions) is provided in the **Chapter 9.2**. MS Excel tools were used for modelling emission projections in the sources outside of the EU ETS system. Emission projections were prepared in accordance with the methodology of the **EMEP/EEA air pollutant emission inventory guidebook 2023**. The calculation analysis tool is based on the Excel platform and the calculation includes different policies and measures (in numerical formulation) defined according to the WEM and WAM scenarios. The model that was developed in connection with the implementation of Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No. 525/2013 and Decision No. 529/2013/EU.

9.4.3. Scenarios, Parameters and PAMs

The IPPU sector allocates emissions from sources regulated by EU ETS Directive 2003/87/EC of the European Parliament and of the Council and non-EU ETS sources (ESR).

While EU ETS emissions have their reduction mechanisms set by the allocation of allowances at the operator level, ESR emissions are not sectoral regulated and the ESR reduction target is set only at the level of the country as a whole. It is therefore very important to identify potential areas for reduction, regulation or promotion. This sector accounts for process (technological) emissions, i.e. not emissions from fossil fuel combustion (which are accounted for in the Energy or Buildings sectors).

ESR emissions in categories 2.A-2.I were mainly prepared by forecasting the development of value added for the identified industrial category and also based on population trends. In the absence of relevant direct policies and measures in these sectors, it is very difficult to predict developments up to 2050. It is likely to be influenced only by the availability of raw materials, energy and material prices, and supply and demand. We foresee regulation mainly at EU level. The nature of process (technological) emissions does not allow much room for manoeuvre for their regulation (they are dependent on chemical reactions and processes).

The base (reference) year for modelling the AP emission projections was the latest revised inventory year 2022 in all scenarios.

Projections of air pollutants emissions for the EU ETS emissions component have been developed for the years 2022 – 2050 under the following scenarios:

Two scenarios, **WEM** and **WAM,** have been prepared for the purpose of determining the target for 2030 and subsequently for 2050 in the different categories of industrial activities.

The data sources: The NEIS database of stationary large and medium sources of air pollution providing facility data for nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) sulphur oxides (SOx), ammonia (NH_3), total suspended particles (TSP, PM_{10} and $PM_{2.5}$ are consequently compiled) and carbon monoxide (CO). All data that comes from the database is considered as T3 methodology.

The policies and measures taken into account in each scenario are based on a number of national documents:

- Low Carbon Development Strategy of the Slovak Republic until 2030 with a view to 2050 (NUS SR)
- National Air Pollution Control Programme **(NAPCP)**
- Integrated National Energy and Climate Plan of Slovakia **(NECP)**

In addition to these documents, separate laws and European legislation also intervene in the preparation of individual scenarios. Act No. 277/2020, which amends Act No. 309/2009 Coll. on the Promotion of Renewable Energy Sources and High Efficiency Combined Production, significantly interferes with the preparation of laws. Within the framework of common European legislation, these are mainly directives setting emission limits and the European Parliament's Energy Union Governance Regulation 2018/1999, complemented by Regulation 2021/1119, which establishes a framework for achieving climate neutrality.

The policies and measures used were taken from the Low Carbon Strategy of the Slovak Republic (LCDS) from the National Air Pollution Control Programme and from the Slovak Recovery Plan.

The reduction potential presented is based on the WEM and WAM scenarios reported for emission projections in 2021 under Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action.

The specification of the WAM scenario according to the Low Carbon Development Strategy of the Slovak Republic depends on the logic of the draft EU scenarios and in particular on the EUCO3030 scenario, which sets the EU target for energy efficiency for 2030 at 30%.

Most of the above measures were applied at the level of the CPS-PRIMES model, from which trends in energy consumption or other parameters were taken for modelling emissions in the TIMES model.

Existing Measures Scenario (WEM) - includes policies and measures adopted and implemented at EU and national level by the end of 2021. In industrial processes, improving energy efficiency is essential for productivity growth, which is part of sustainable growth in added value.

The scenario with additional measures (WAM) - is equivalent to the Dcarb2 scenario of the CPS-PRIMES model, in the IPPU sector the outputs from CPS-PRIMES were used to obtain trends in the different industry types.

The trend of emission projections below the ESR in categories 2.A to 2.I is very complicated to express due to the lack of legislative and market mechanisms, which are mainly driven by energy policy. The trend of emission projections depends on the technologies used, which are mainly influenced by the EU ETS Directive, therefore emission reductions cannot be expected as production grows.

9.4.4. Emission Projections in the IPPU Sector

The modelling of emission projections in the IPPU sector was based on sectoral trends and development from the CPS model and actualization was made by taking into account results of model TIMES-Slovakia and new information from producers. Significant impact has planned new installations in steel production.

The emissions covered by the industry sector originate from industrial processes but also from combined combustion and technology processes, which are united and reported for the basic unit (source). The emissions and facility data reported directly from an operator that is recorded in the NEIS database cannot be in some cases divided into separate combustion and technology emissions. The reported data involve emissions and activity data from the technological processes in the mineral products industry (2A), chemical industry (2B), metal production (2C), solvent use (2D), other product manufacture (2G) and other industrial activities (2H, 2I, 2K).

MINERAL INDUSTRY

The category covers these NFR activities: Cement production (2A1), Lime production (2A2), Glass production (2A3), Quarrying and mining of minerals other than coal (2A5a), Construction and demolition (2A5b), Other Mineral Products (2A6). Most of the producers, which are important concerning the release of emissions in the sector, belong to international concerns and operate in several states. The Slovak Republic produces a moderate range of mineral products and does not belong to a significant world producer of mineral commodities. The mining and quarrying sector is not a significant contributor to the country’s economy.

CHEMICAL PRODUCTS

The category covers the NFR activities: Ammonia production (2B1), Nitric acid production (2B2), Adipic acid production (2B3), Carbide production (2B5), Titanium dioxide production (2B6), Soda ash production (2B7), Chemical industry: Other (2B10a), Storage, handling and transport of chemical products (2B10b). Emissions from this category have a general decreasing trend. Emissions of NOx originate mostly from category 2B10a which includes the production of various organic and inorganic compounds, fertilizers etc.

METAL PRODUCTION

Metal production is an important sector in the national economy. The category covers the NFR activities: Iron and steel production (2C1), Ferroalloys production (2C2), Aluminium production (2C3), Magnesium production (2C4), Lead production (2C5), Copper production (2C7a), Other metal production (2C7c) and Storage, handling and transport of metal products (2C7d). The major contributors of emissions of main pollutants are Iron and steel production 2C1

SOLVENTS AND OTHER PRODUCT USE

The sector solvents, covers NFR categories 2D3a, 2D3b, 2D3c, 2D3d, 2D3e, 2D3f, 2D3g, 2D3h, 2D3i and 2G. Categories 2D3b and 2D3c are relevant emissions of PMs, TSP. Concerning air protection, the most important emissions rising from the categories of so-called solvents are non-methane volatile organic compounds (NMVOC). They are part of many different substances, which are used in industry and human activities

OTHER PROCESSES

The category is divided into 3 industrial activities: Pulp and paper industry (2H1), Food and beverages industry (2H2) and other industrial processes (2H3).

WOOD PROCESSING

The present chapter 2I addresses emissions of dust from the processing of wood. This includes the manufacture of plywood, reconstituted wood products and engineered wood products. This source category is only important for particulate emissions, NMVOC.

NOx emissions

The NO_X emission projections in the IPPU sector are mostly driven with the EU ETS emissions from metal production, in addition with the chemical industry. The trends according to the WEM and WAM scenarios are provided in the ***Table 9.17***.

Table 9.17: *NOx emissions in sector Industry in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.45	0.33	0.23	0.29	0.31	0.34	0.34	0.35	0.35
2B	0.75	0.52	0.79	0.86	0.75	0.83	0.83	0.78	0.72
2C	4.90	4.86	5.01	4.19	3.90	4.11	4.11	4.13	4.14
2D, G, H	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
2 I,J,K,L	0.32	0.08	0.22	0.23	0.22	0.20	0.20	0.20	0.20
2 Industry	**6.44**	**5.80**	**6.27**	**5.60**	**5.19**	**5.51**	**5.51**	**5.48**	**5.43**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.45	0.33	0.23	0.29	0.31	0.31	0.31	0.31	0.32
2B	0.75	0.52	0.79	0.86	0.75	0.79	0.79	0.61	0.50
2C	4.90	4.86	5.01	4.19	3.90	4.11	1.19	1.19	1.17
2D, G, H	0.01	0.02	0.02	0.00	0.00	0.02	0.02	0.02	0.02
2 I,J,K,L	0.32	0.08	0.22	0.23	0.00	0.20	0.20	0.20	0.20
2 Industry	**6.44**	**5.80**	**6.27**	**5.58**	**4.96**	**5.44**	**2.51**	**2.33**	**2.21**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NMVOC emissions

NMVOC emission projections in the IPPU sector arise mainly from the Coating applications, Domestic solvent use and Degreasing. Significant impact have also Food and beverages industry. The trends according to the WEM and WAM scenarios are provided in the ***Table 9.18***.

Table 9.18 *NMVOC emissions in sector Industry in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.16	0.05	0.07	0.09	0.15	0.16	0.16	0.17	0.17
2B	3.17	1.99	2.20	2.10	2.03	2.11	2.11	2.00	1.82
2C	0.78	0.66	0.79	0.69	0.67	0.74	0.74	0.74	0.75
2D, G, H	35.12	26.19	29.76	24.87	22.13	22.04	22.04	21.52	21.10
2 I,J,K,L	0.40	0.22	0.50	0.52	0.63	0.59	0.59	0.59	0.59
2 Industry	**39.63**	**29.12**	**33.33**	**28.26**	**25.60**	**25.64**	**25.64**	**25.01**	**24.42**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.16	0.05	0.07	0.09	0.15	0.15	0.15	0.15	0.15
2B	3.17	1.99	2.20	2.10	2.03	1.99	1.97	1.44	1.10
2C	0.78	0.66	0.79	0.69	0.67	1.97	0.37	0.38	0.38

2D, G, H	35.12	26.19	29.76	24.87	22.13	20.58	19.35	18.22	17.88
2 I,J,K,L	0.40	0.22	0.50	0.52	0.63	0.59	0.59	0.59	0.59
2 Industry	**39.63**	**29.12**	**33.33**	**28.26**	**25.60**	**25.29**	**22.44**	**20.78**	**20.10**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

SO_X emissions

The SO_X emission projections in the IPPU sector are mostly driven by the emissions from metal production and in addition with the chemical industry. The trends according to the WEM and WAM scenarios are provided in the ***Table 9.19***.

Table 9.19: *SOx emissions in sector Industry in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.50	0.33	0.36	0.45	0.35	0.38	0.38	0.39	0.39
2B	1.08	1.20	1.37	1.27	1.50	1.58	1.58	1.43	1.22
2C	9.85	5.77	7.32	4.91	2.82	2.33	2.33	2.34	2.35
2D, G, H	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03
2 I,J,K,L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Industry	**11.45**	**7.33**	**9.08**	**6.65**	**4.70**	**4.32**	**4.32**	**4.19**	**3.99**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.50	0.33	0.36	0.45	0.35	0.34	0.34	0.35	0.35
2B	1.08	1.20	1.37	1.27	1.50	1.49	1.44	0.87	0.50
2C	9.85	5.77	7.32	4.91	2.82	2.33	0.83	0.82	0.81
2D, G, H	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03
2 I,J,K,L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Industry	**11.45**	**7.33**	**9.08**	**6.65**	**4.70**	**4.19**	**2.64**	**2.07**	**1.69**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NH_3 emissions

The NH_3 emission projections in the IPPU sector are in general negligible, the largest share comes from the chemical industry primarily from Nitric Acid, Calcium Carbide. The trends of emissions are provided in the ***Table 9.20*** and both scenario are projected based on sectoral value added respectively projected demand.

Table 9.20: *NH_3 emissions in sector Industry in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.00	0.01	0.02	0.03	0.07	0.07	0.07	0.08	0.08
2B	0.22	0.07	0.09	0.20	0.12	0.13	0.13	0.11	0.10
2C	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
2D, G, H	0.03	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04
2 I,J,K,L	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2 Industry	**0.26**	**0.12**	**0.16**	**0.26**	**0.23**	**0.25**	**0.25**	**0.23**	**0.22**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.00	0.01	0.02	0.03	0.07	0.07	0.07	0.07	0.07
2B	0.22	0.07	0.09	0.20	0.12	0.12	0.11	0.07	0.04

2C	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
2D, G, H	0.03	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04
2 I,J,K,L	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2 Industry	**0.26**	**0.12**	**0.16**	**0.26**	**0.23**	**0.23**	**0.23**	**0.18**	**0.15**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

$PM_{2.5}$ emissions

The $PM_{2.5}$ emission projections in the IPPU sector do not have a significant source and also their share in the national totals are very small. The trends of emissions are provided in the ***Table 9.21***.

Table 9.21: *$PM_{2.5}$ emissions in sector Industry*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
2A	0.38	0.16	0.17	0.11	0.11	0.15	0.15	0.16	0.16
2B	0.20	0.08	0.15	0.08	0.04	0.09	0.09	0.09	0.08
2C	0.63	0.40	0.45	0.21	0.17	0.11	0.11	0.11	0.11
2D, G, H	0.23	0.26	0.24	0.23	0.25	0.26	0.26	0.25	0.25
2 I,J,K,L	0.03	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
2 Industry	**1.47**	**0.91**	**1.02**	**0.64**	**0.59**	**0.61**	**0.61**	**0.61**	**0.60**

WAM	2005	2010	2015	2020	2022*	2025	2030	2030	2030
2A	0.38	0.16	0.17	0.11	0.11	0.14	0.14	0.15	0.15
2B	0.20	0.08	0.15	0.08	0.04	0.08	0.08	0.07	0.05
2C	0.63	0.40	0.45	0.21	0.17	0.10	0.08	0.08	0.08
2D, G, H	0.23	0.26	0.24	0.23	0.25	0.26	0.26	0.25	0.25
2 I,J,K,L	0.03	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
2 Industry	**1.47**	**0.91**	**1.02**	**0.64**	**0.59**	**0.59**	**0.57**	**0.55**	**0.53**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Air Pollutant Emissions from Iron and Steel Production

Industrial processes in Slovakia have long been dominated by traditional sectors including metallurgy, iron and steel production, coke and refined petroleum product manufacturing, chemical production, paper/pulp industries, food processing, mineral product manufacturing, and related activities. This sector also encompasses solvent use and other product applications (e.g., pyrotechnics). SOx emissions primarily originate from iron and steel production (22% in 2022) and aluminium manufacturing (nearly 15%, with additional contributions from oil refining).

The metal processing industry remains the largest contributor. While $PM_{2.5}$ emissions have shown a declining trend, the IPPU (Industrial Processes and Product Use) sector contributes minimally to these emissions. However, under the WAM (With Additional Measures) scenario, significant reductions in AP (Air Pollutant) emissions – particularly SOx from fuel refining and CO from coke production – are anticipated through:

- Decommissioning of coke oven batteries
- Cessation of sinter production
- Reduced petroleum processing aligned with transport sector decarbonisation pathways

Air Pollutant Emissions from Mineral Production

The manufacture of cement is a strongly regulated process by legislative limits for pollution. The primary fuel used is usually finely ground coal dust, products based on coal dust (coal, stern pellets) petroleum coke, and pyrolysis. All four cement producers (large point sources) in the Slovak Republic have the approval to utilize alternative fuels (refuse-derived fuel – RDF and used tires, sludge, fly ash, beef and bone meal or similarly categorized fuel waste) and raw materials for energy and resource recovery. The plant provides a yearly report on types and amounts of alternative fuel used.

Cement production is a major contributor to industrial air pollution, releasing particulate matter (PM), nitrogen oxides (NOx), sulfur dioxide (SO_2), and non-volatile organic compounds (NMVOCs). In Slovakia, this sector is critical for meeting infrastructure demands but requires stringent emission controls to align with EU air quality standards.

Replacement of an existing electrostatic precipitator by a bag textile filter, including reconstruction and modification of the housing and connecting pipes, installation of new internal parts of the filter, compressed air regeneration system and necessary auxiliaries. The bag filter will significantly reduce electricity consumption comparing the electrostatic filter and can achieve the lowest dust particle limits defined by BAT Directive for cement production.

WAM Scenario cuts emissions by 30–35% through alternative fuels (Biomass) and reduction of refinery coke and waste. It concerns mainly NOx, CO and SOx. The installation of DECONOX is related to the reduction of organic carbon emissions (TOCs), the reduction of carbon monoxide (CO) emissions and the reduction of nitrogen oxides (NOx) emissions, which mainly come from alternative raw materials. Installation of the equipment will make it possible to reach the lowest limits defined by the BAT Directive for cement production.

Slovakia's cement industry faces dual challenges: meeting production demands while reducing air pollutants. The WAM scenario provides alternative raw materials (e.g., blast furnace slag) could reduce process emissions by 20% in 2050 with comparison in 2022.

Air Pollutant Emissions from Chemical Production

Chemical production also has a long-term presence in Slovak industry, e.g. production of urea, nitric acid, mineral fertilizers (Duslo, a. s.) and various other chemicals (FORTISCHEM, a. s.). This category is not one of the most significant sources of pollutant emissions.

Nitric acid production consumes approximately 20% of all ammonia produced. The production volume increased in 2022 compared to 2021, despite this, a decrease in N_2O emissions of approximately 16% was recorded, thanks to the use of secondary YARA catalysts. In this category, the WAM scenario does not include any fundamental measures to reduce air pollutants. One of the measures in future projections may be the so-called green hydrogen, which will replace natural gas as a raw material in the production of ammonia and the installation of catalytic systems for the decomposition of N_2O in the production of nitric acid. Both scenarios are quite conservative due to conservative assumptions over almost all sector. Use of BAT technologies in industry represent only significant measure in this sector,

Air Pollutant Emissions from use of Solvents

A significant influence on emissions in this area is the volume of production. HFCs (hydrofluorocarbons) and SF6 (sulfur hexafluoride) are the fastest-growing emissions in this sector, resulting from industrial demand for these substances in construction, building insulation, electrical engineering, and the automotive industry.

Production volumes critically influence sectoral emissions. HFCs (hydrofluorocarbons) and SF6 (sulfur hexafluoride) represent the fastest-growing emission categories, driven by industrial demand for these substances in:

- Construction (thermal insulation)
- Electrical engineering (switchgear manufacturing)
- Automotive industry (air conditioning systems)

The use of solvents is a significant source of emissions. A wide range of substances is used in both industry and households, which also contain non-methane volatile organic compounds (NMVOC), leading to NMVOC emissions. These include pure organic solvents or various mixtures used in industry, cleaning agents, paints, thinners, adhesives, cosmetics, toiletries, and various household or automotive care products. Emissions from road asphalt application are also included. The versatile use of these substances leads to complex tracking of their flows. Some categories are estimated (particularly emissions from household products) NMVOC emission projections in the IPPU sector arise mainly from the Coating applications, Domestic solvent use and Degreasing. Significant impact have also Food and beverages industry. The trends according to the WEM and WAM scenarios are relativity stable and we expecting slightly decreasing in accordance of BAT use.

Air Pollutant Emissions from Other processes

The category is divided into 3 industrial activities: Pulp and paper industry (2H1), Food and beverages industry (2H2) and other industrial processes (2H3). Emissions of PMs and NH_3 have a decreasing trend due to the installation of abatement technologies on the plants during the time series. Emissions of NOx, NMVOC, SOx and CO have a substantially increasing trend, but this category does not belong among key categories for the Slovak Republic and both scenarios are based on sectoral value added.

Air Pollutant Emissions from Wood processing

Category wood processing addresses emissions of dust from the processing of wood. This includes the manufacture of plywood, reconstituted wood products and engineered wood products. This source category is only important for particulate emissions $PM_{2.5}$, PM_{10} and TSP. Emission projections in this category decrease slightly in general for both scenarios.

The following figures display inventory and projection of main pollutants:

Figure 9.37: *Historical emissions and projections of NOx emissions according to WEM and WAM scenario*

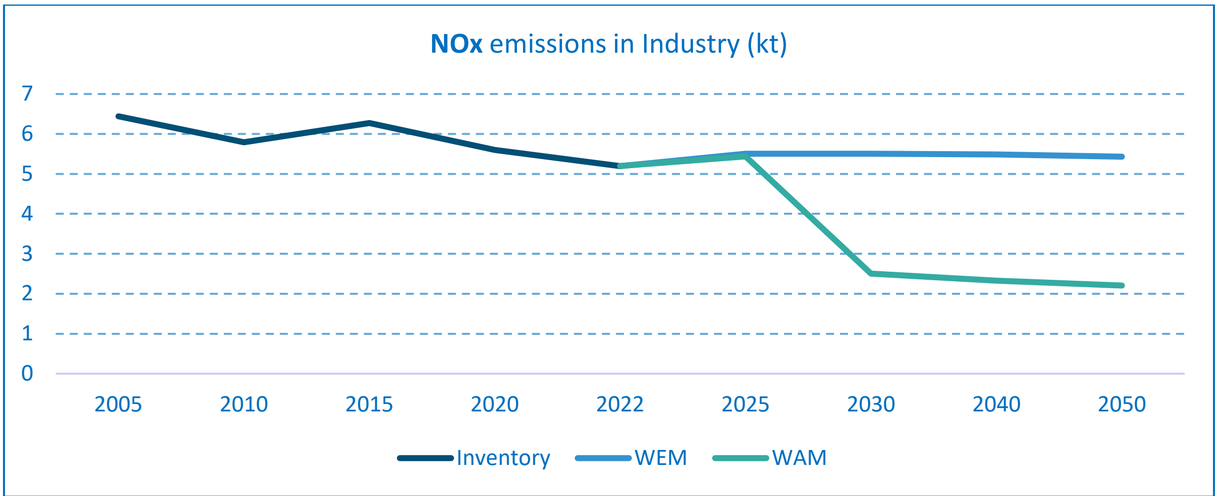


Figure 9.38: Historical emissions and projections of NMVOC emissions according to WEM and WAM scenario

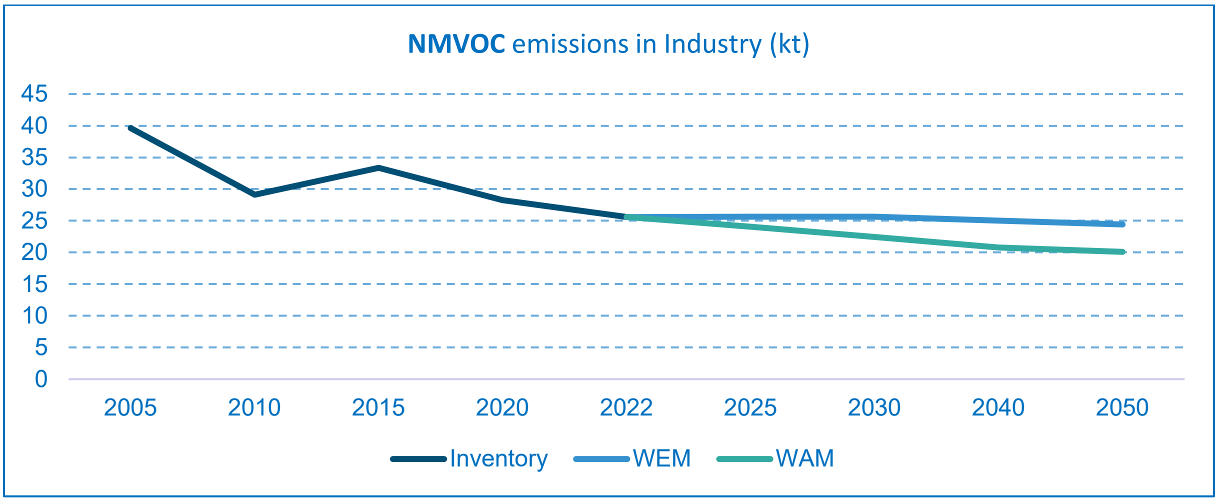


Figure 9.39: Historical emissions and projections of SOx emissions according to WEM and WAM scenario

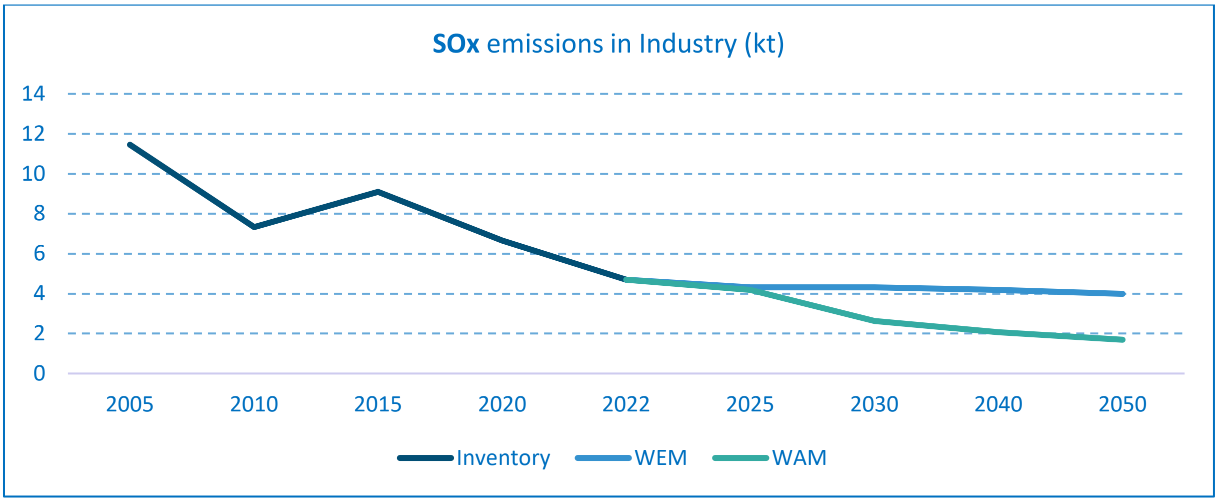


Figure 9.40: Historical emissions and projections of NH_3 emissions according to WEM and WAM scenario

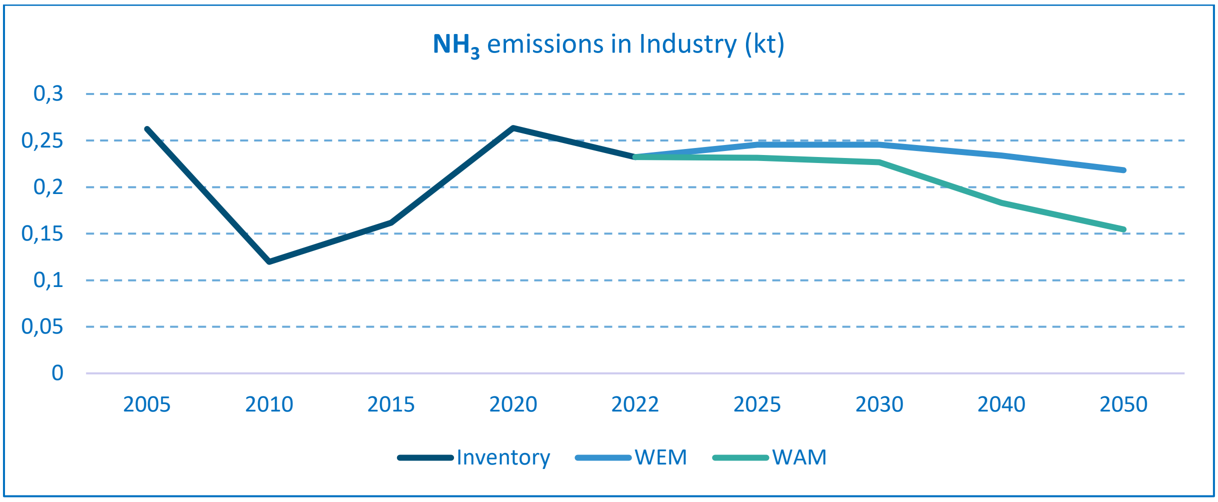
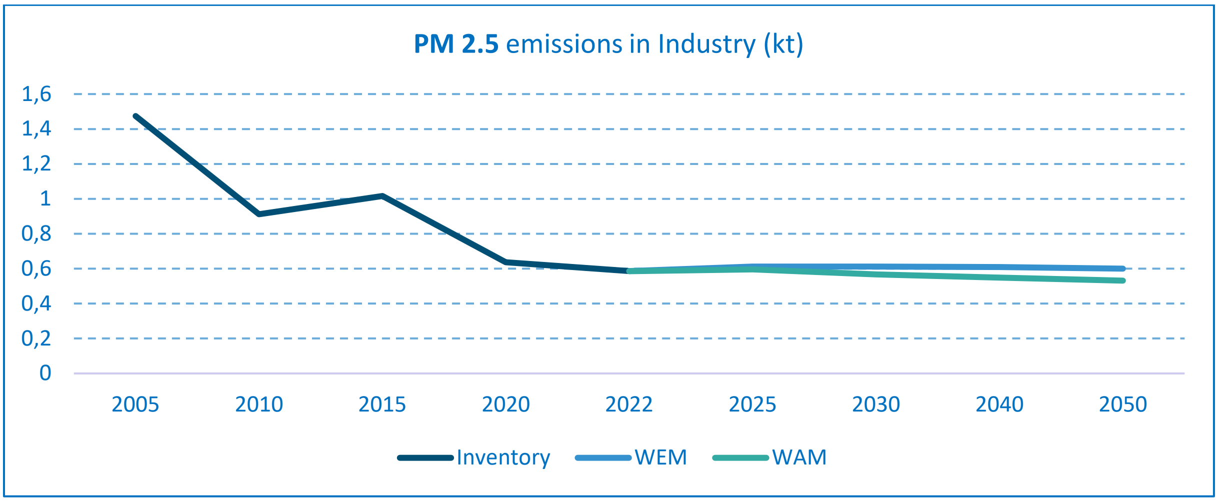


Figure 9.41: *Historical emissions and projections of $PM_{2.5}$ emissions according to WEM and WAM scenario*



9.5. EMISSION PROJECTIONS IN THE AGRICULTURE SECTOR

9.5.1. Methodologies and Key Assumptions/Trends

Emission calculation: The Slovak Hydrometeorological Institute compiles an annual emissions balance and uses emission factors according to the EMEP/EEA GB_{2023}. During the preparation of projected emissions of ammonia were considered the same input data and policies and measures as in the preparation of projected GHG emissions. Emissions of NOx and NH_3 from manure storage and application were estimated taking into account the abatements requirements to reduce emissions from livestock farms.

$PM_{2.5}$, emissions from manure management and agricultural soils were calculated using the default Tier 1 emissions factors for each category of farm animals. $PM_{2.5}$ from 3.D Agricultural soils are calculated with Tier 2 methodology and emission factors for wet climate outlined in EMEP/EEA $GB_{2023.}$ The same emissions factors were used for all years.

NMVOC was estimated by the available parameters time of housing feeding situation – the amount of silage in the ration and gross feed intake. Dairy cattle and non-dairy cattle have been calculated using Tier 2 methodology by EMEP/EEA GB_{2023}. NMVOC emissions from other animal categories were calculated using the Tier 1 methodology and emission factors outlined in the EMEP/EEA GB_{2023}. NMVOC emissions from Agricultural soils were calculated using the Tier 1 methodology and emission factors outlined in EMEP/EEA $GB_{2023.}$

The NH_3, NOx emission projections were estimated according to the EMEP/EEA GB_{2023} Guidebook methodologies, the Slovak Republic did not use the specific model for forecasting emissions. NH_3 and NO_x emission projections were modelled following the Tier 2 approach based on analysing the nitrogen cycle. To prepare the model for agricultural emissions projections, it is necessary to obtain a wide range of input data and parameters along with their historical time series. (Selected activity data is available in Annex of this report according to the NECD recommendation). Emissions projections have been modelled in various areas of the agricultural sector for different pollutants (NH_3, NMVOC, PM, NOx, TSP).

The revision of projections was done due to new policies and measures with calculated costs for the use of individual measures. The analysis was done in National Food and Agriculture Center and was taken by Ministry of Environment of the Slovak Republic. Emission projection revision was done in Slovak Hydrometeorological Institute.

Activity data

The available time series of input data have varied lengths (the longest covering the period 1970-2022, the shortest covering the period 2003-2022) and were obtained from various sources (Green Report of the Slovak Republic, Statistical Office of the Slovak Republic, situational and outlook reports of NPPC-VÚEPP, Central Control and Testing Institute of Agriculture - ÚKSUP). This chapter was included based of Recommendation number ***SK-3B-2019- 0002*** from National Air Pollution Projection Review.

The input data required for the preparation of projections are as follows:

- Number of cattle in the head (data available by regions for the period 1990-2022, source: Statistical Office of the Slovak Republic - ŠÚ SR)
- Number of pigs in the head (1990-2022, ŠÚ SR, data available by regions)

- Number of sheep in the head (1990-2022, ŠÚ SR, data available by regions)
- Number of poultry in the head (1990-2022, ŠÚ SR, data available by regions)
- Number of goats in the head (1990-2022, ŠÚ SR, data available by regions)
- Number of horses in the head (1990-2022, ŠÚ SR, data available by regions)
- Milk yield per cow - average annual milk yield per dairy cow in kilograms (1990-2019, ŠÚ SR, data available by regions)
- Milk yield per ewe - average annual milk yield per dairy ewe in kilograms (1990-2019, ŠÚ SR, data available by regions)
- Consumption of nitrogen fertilizers in tons (1990-2022, sources: IFASTAT and ÚKSUP), data available for Slovakia by types

The input data for the given time period were subsequently processed for use in preparing projections of parameters in Slovak agriculture for 2022-2040. The exponential smoothing model SAS 9.3 was modelled at the Research Institute of Agricultural and Food Economics in Bratislava (NPPC-VÚEPP). Subsequently, projections of input parameters such as livestock populations and quantities of applied organic and mineral fertilizers were calculated until 2040-2050 at the Slovak Hydrometeorological Institute (SHMÚ) using the exponential smoothing function in MS Excel's forecasting tool, Projections. The principle of exponential smoothing is an adaptive method for forecasting time series, which means that the values of parameters in the model change over time. The forecast is based on smoothing weights that assign different importance to individual observations. The most recent observations have the highest weight, exponentially decreasing to the past. The values of the weights are optimized by the statistical software itself.

Slovakia still uses the Grade 1 method in the 2023 submission due to the unavailability of public policies and strategies. In terms of data revision, SHMÚ conducted a review of livestock numbers and fertilizer consumption using exponential smoothing. The results underwent a thorough review process involving relevant ministries (Ministry of Environment of SR, Ministry of Agriculture and Rural Development of SR), research institutes (National Agriculture and Food System, Institute of Environmental Policy), and other entities such as breeding unions and NGOs. Information was included based of Recommendation number ***SK-3B-2021- 0002*****.**

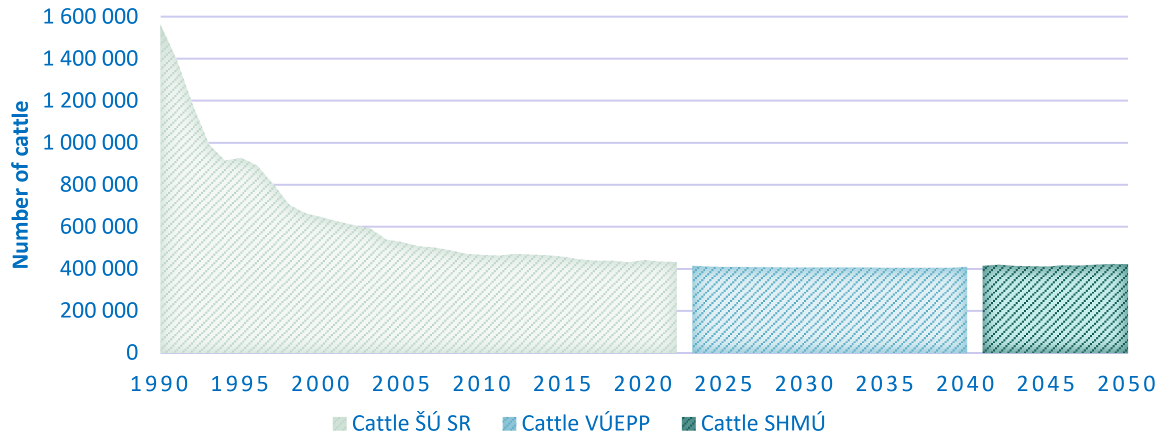
The input from breeding unions provided a more accurate view of the development of livestock numbers in Slovakia. Furthermore, it is mentioned that future Common Agricultural Policy (CAP) measures are expected to impact increasing the mentioned livestock species, particularly through increased grazing breeding. Additionally, the consumption of inorganic fertilizers was modified based on planned European Farm to Fork Strategies and national measures to reduce urea use

Number of cattle

Due to the transformation of the Slovak Republic into a market economy, there was a significant decline in the cattle population compared to the base year of 1990, especially in the first four years. The population dropped to approximately 993 000 head in 1993, and although at a slower pace, this downward trend continued in the following years. By 2004 (Slovakia's accession to the EU), the cattle population was already only about one-third of the 1990 level, reaching 540 000 head. Thanks to higher subsidies under the EU Common Agricultural Policy, this decline was mitigated, and in 2020, Slovakia recorded 433 175 head of cattle, representing a decrease of approximately 72% compared to 1990.

According to an analysis that was conducted, the cattle population, especially the meat breeds predominantly raised on pasture, is expected to increase. Given the current state of the cattle population, the dairy cattle population is likely to decline while the meat cattle population is projected to increase to around 420 768 head by 2050.

Figure 9.42: *Development of number of cattle (1990-2023) and their projections until 2050*

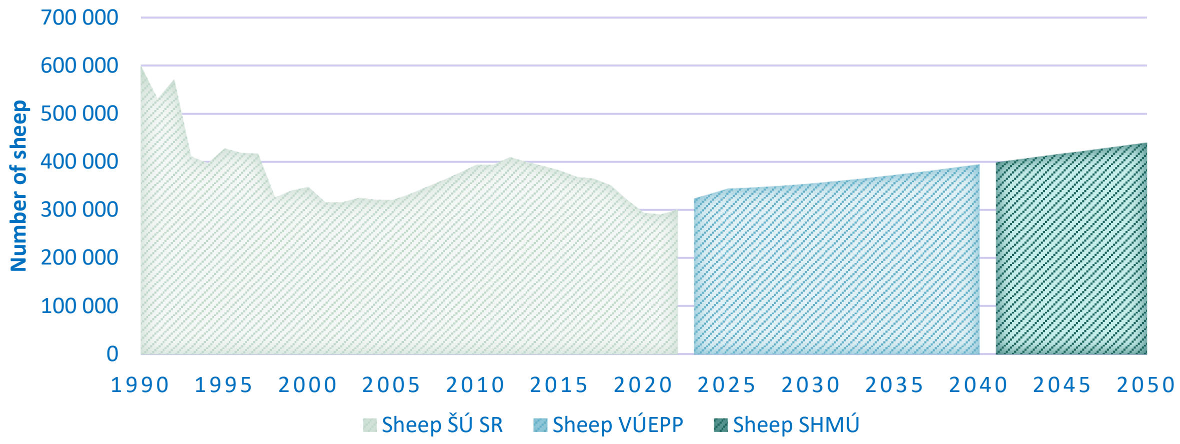


Number of sheep

Slovakia had the highest number of sheep in the 1990s, as the centrally planned economy system was coming to end, with the population reaching approximately double the current level (***Figure 9.43***). However, their development exhibited a cyclical pattern. After a decline from 698 000 head in 1970 to 541 000 head in 1976, there was a gradual increase to nearly 600 000 head in 1990, followed by another decline to around 400 000 head in 2001 and 2002. After reaching this minimum, the sheep population in Slovakia began to stabilize, reaching almost 410 000 head in 2012. In recent years, there has been a decline to less than 301 131 head in 2022, which is just over half of the population at the beginning of the observation period.

Sheep farming in Slovakia has a tradition mainly due to favourable conditions and an abundance of pastures. The model predicts an increase in the sheep population, expecting 439 518 head in Slovakia by 2050.

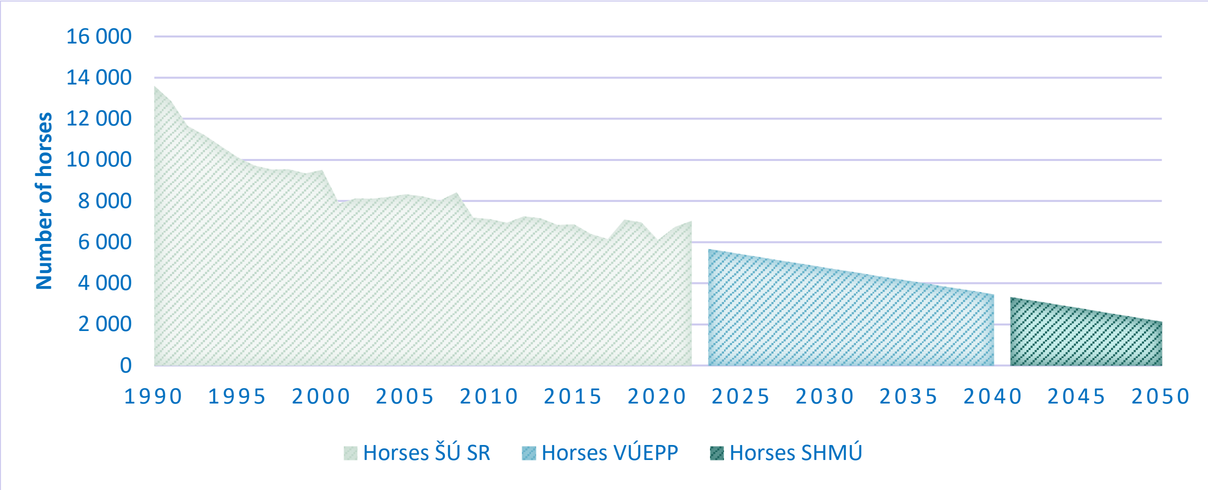
Figure 9.43: *Development of number of sheep (1990-2023) and their projections until 2050*



Number of horses

The highest number of horses in Slovakia was recorded in 1990 (13 595 head). Throughout the observed period, it is evident that the horse population has generally had a declining trend. This downward trend can be attributed to the transformation of the agricultural sector after 1990 and the transition to a market mechanism. The decline represents approximately two-thirds compared to the level at the beginning of the observation period (1990). The declining trend during the observed period (***Figure 9.44***) also had an impact on the analysis of projections until 2050, which indicates that the horse population in Slovakia is expected to continue to decline. By 2050, the projected number of horses in Slovakia is only 2 132 head (-84%).

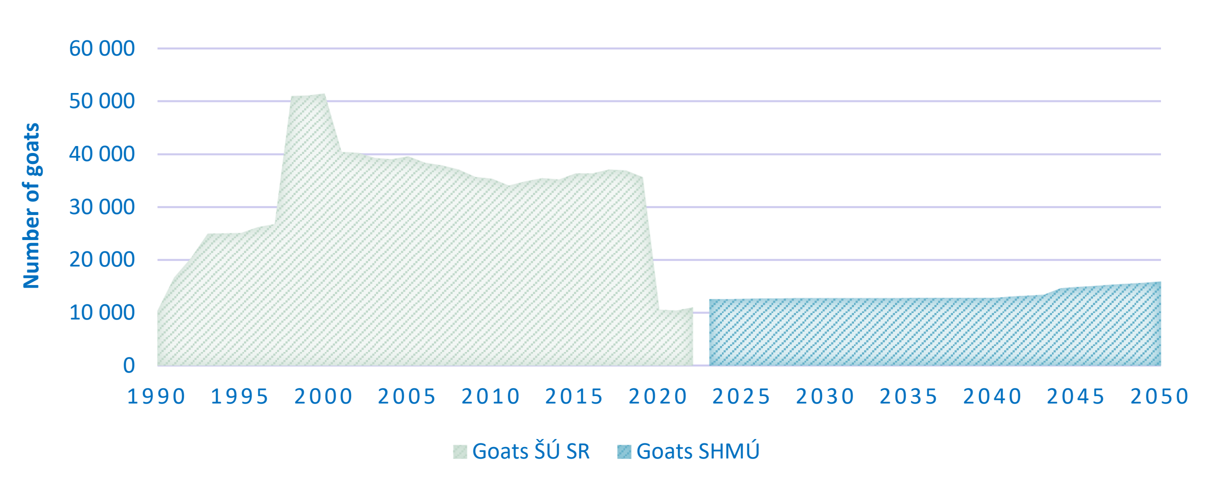
Figure 9.44: *Development of a number of horses (1990-2023) and their projections until 2050*



Number of goats

The data for goat populations in Slovakia is available from 2000 onwards, with extrapolated data for the period from 1990 to 2000 based on ŠÚ SR records. The number of goats decreased by more than a fifth in 2001 compared to the previous year (from 51.4 thousand to 40.4 thousand head) (***Figure 9.45***). Following this sharp decline, there was a gradual decrease in the goat population throughout the next decade, stabilizing at just over 34 thousand head in 2011. In 2020, the goat population further decreased to 11 thousand head. This decline continued in 2021 (10 thousand head) and was caused by the poor economic situation among breeders. Compared to 1990, this represents an increase of 3%. Based on the annual fluctuations in population, the model predicts a gradual increase in the goat population in Slovakia in the future, albeit at a slower pace. From the level of 11.008 thousand head in 2022, the goat population is projected to reach approximately 15.9 thousand head by 2050. The increase in population will also be supported by financial subsidies for pastoral farming methods from the upcoming EU Common Agricultural Policy (CAP) for the years 2023-2027.

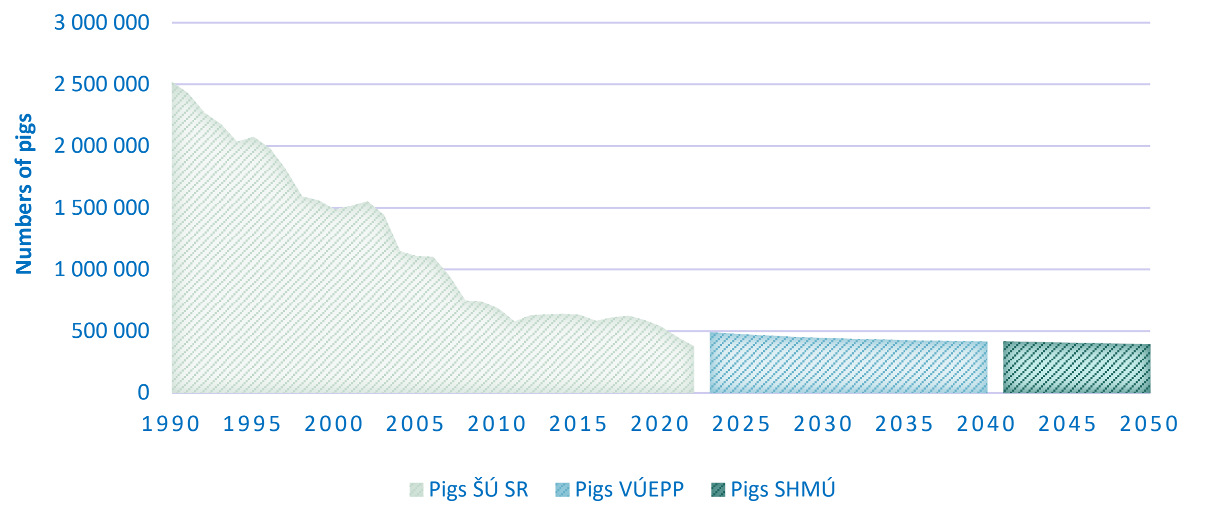
Figure 9.45: *Development of number of goats (1990-2023) and their projections until 2050*



Number of pigs

Similarly to the stocks of cattle and sheep, we can observe high numbers of pigs in the 1990s (***Figure 9.46***). In 1990, there were 2.52 million pigs registered in Slovakia, reaching the maximum level. Since 1991, during the transformation to a market economy, there has been a continuous decline in the pig population from the level of 2.43 million pigs, which continued even after the country's accession to the EU (1.15 million pigs in 2004), until reaching the lowest point in 2016 (586 000 pigs), representing a decrease of almost 76% compared to 1990. Only in recent years, in 2017 and 2018, we can observe a slight increase in the pig population, with 627 000 pigs recorded in Slovakia in 2018. In 2019, a decline in pig numbers was recorded. The reasons for this decline are of an economic nature. Based on the results of the modelling, a decrease in pig numbers can be expected from the level of 492 000 pigs in 2022 to approximately 393 000 pigs in 2050.

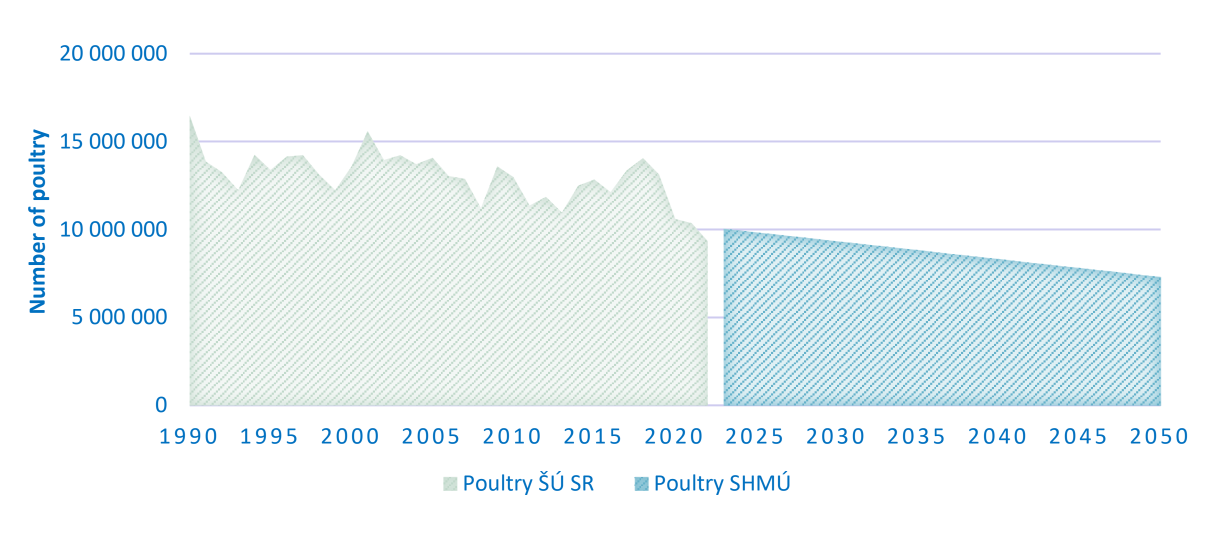
Figure 9.46: *Development of number of pigs (1990-2023) and their projections until 2050*



Number of poultry

A relatively dynamic trend can be observed in the poultry stocks (***Figure 9.47***). In the period leading up to 1990, poultry numbers remained at around 16.3-16.6 million birds, but in the following three years, they decreased by approximately a quarter (to 12.2 million birds in 1993). This was followed by a period of frequent fluctuations in poultry stocks in Slovakia, with the peak level after 1990 reached in 2001 (15.6 million birds) and the lowest point recorded in 2019 (less than 11 million birds). In 2020, the poultry population was at the level of 10.6 million birds, which is roughly 36% compared to the beginning of the analysed period. The results of projection modelling suggest that poultry numbers will decrease to approximately 8.3 million birds by 2040 and to less than 7.3 million birds by 2050.

Figure 9.47: *Development of number of poultry (1990-2022) and their projections until 2050*

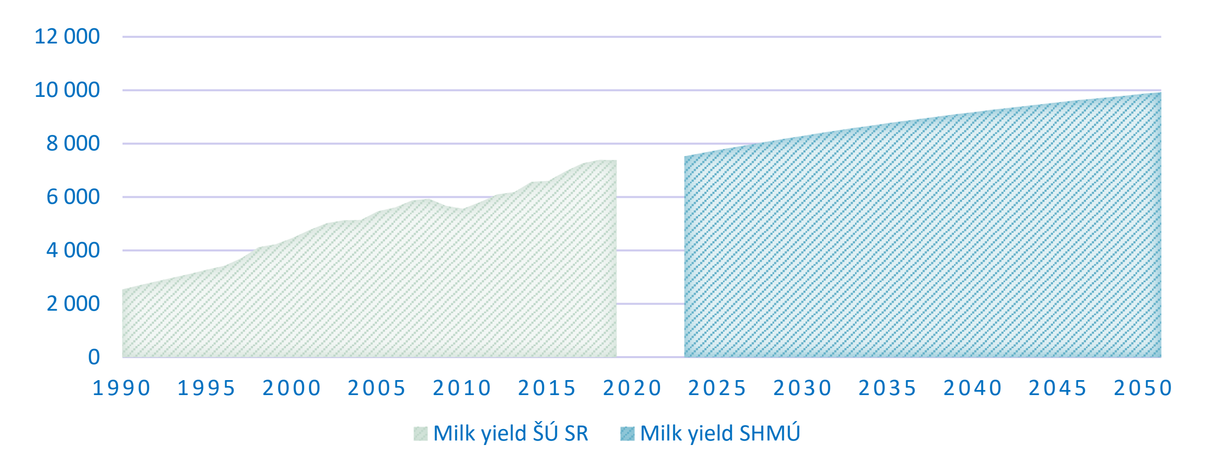


Milk yield of cows

This parameter was forecasted at the regional level. The model results indicate a growing trend in milk production per cow, which is expected to continue in the coming years. The average value could increase from 8 362 liters per cow in 2022 to nearly 9 919 liters per cow in 2050. ***Figure 9.48*** illustrates the trend of average milking yield for the entire Slovak Republic.

The increase in milking yield until 2050 will depend on several factors, primarily the composition of the cattle population in Slovakia in terms of the prevalence of meat or dairy breeds. Nutrition is also a crucial factor in increasing milking yield. Modernizing and improving housing conditions also play a significant role in enhancing cow productivity.

Figure 9.48: *Development of milk yield (1990-2022) and their projections until 2050*

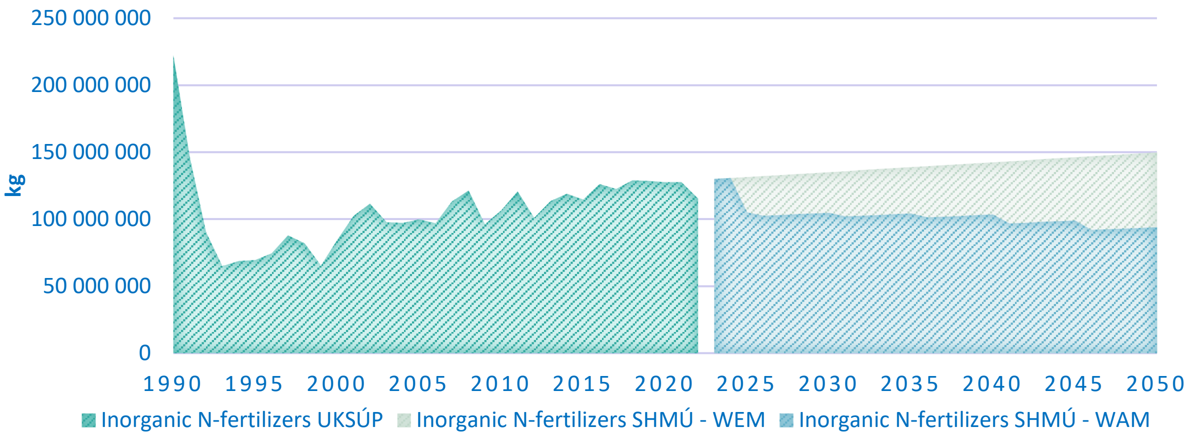


Consumption of Inorganic nitrogen fertilizers

Data on the consumption of inorganic nitrogen fertilizers were available in the database of the Statistical Office of the Slovak Republic (ŠÚ SR) from 1990 to 2020. The consumption of nitrogen fertilizers in the first year of observation was 69.6 thousand tons of pure nitrogen nutrients, characterized by alternating periods of growth and decline with a slight upward trend (***Figure 9.49***). The minimum consumption of nitrogen fertilizers, 65.4 thousand tons, was recorded in Slovakia in 1999. Particularly in the recent years of the observed period, this indicator was significantly above average and reached its maximum level in 2022 at 115 thousand tons, representing an increase of almost 59% compared to 2005. In comparison to 1990, their consumption decreased by 42%.

It is expected that the consumption of nitrogen fertilizers will continue to increase until 2023, stabilizing at a level of approximately 149 thousand tons. In the WAM scenario, the consumption of fertilizers is projected to decline after 2024 to a level similar to that of 2001, at approximately 105 thousand tons. Subsequently, by 2050, fertilizer consumption is expected to decrease to 93.9 thousand tons of pure nitrogen applied to the soil. Information was included based of Recommendations number ***SK-3D-2023- 0001*** and ***SK-3D-2019- 0001***.

Figure 9.49: *Development of Inorganic N-fertilizers consumption (with urea) (1990 - 2022) and their projections until 2050*



9.5.2. Model Description

The principle of exponential smoothing is based on adaptive methods for time series parameters projections; the projections of parameters made according to exponential smoothing. Exponential smoothing is the weighted average of the past data, with the recent data points given more weight than earlier data points. The weights decay exponentially towards the earlier data points (NPPC, 2017).

The whole model of calculating emissions from livestock breeding is based on regional differences, which means that the input parameters and stocks of animals had to be re-modelled at the level of smaller territorial units - regions. Projections of the number of livestock, which were delivered to NPPC-VÚEPP only at the level of the Slovak summary, were distributed by the SHMÚ to the regional level and only after this re-division were they implemented into the calculations of emission projections.

At the time of preparation of projections of emissions from agriculture, there was no national strategic document, except for a case study prepared by the NPPC-VÚEPP, which would model the development of livestock numbers and consumption of fertilizers in the Slovak Republic.

The algorithm in the system Python was developed, which is an automated version of the N-Tool, developed following the methodology EMEP/EEA GB_{2023}.

The calculation model is based on regional differences, which means the input parameters and number of livestock was modelled on a regional (district) level. After, this redistribution was implement to calculate emission projections.

Measures in compound feed (CF) composition: The measures in the CP composition concerned the addition of additives reducing NH_3 emissions. In order to determine the costs for their application, it was necessary to establish the consumption of the CP and their price in relation to the livestock species (LFA) and their categories cited above. To determine the consumption of CP we used the manuals Nutrient requirements for pigs, Nutrient requirements and nutritional value of feed for poultry, as well as data from livestock associations (Pig Breeders Association, Union of Poultry Breeders, Association of Meat Cattle Breeders, Slovak Holstein Association...) and farmers (Hyza, Branko...). We determined the consumption of CP per animal (of a given species and category) and per day. We then converted it to all animals of a given species and category per day and multiplied by 365 to obtain the consumption of CP for each category of a given species per year. We then obtained the price of CF for the species and category (€/t and €/q of feed, respectively) through compound feed manufacturers and farmers. We multiplied the consumption of CF of a given species and category by the price of CF attributable to that species and category. Thus, we obtained the total price of CF of each category of the species. By summing them, we determined the resulting price of CP for the species. We repeated the above for all the species quoted above. We increased the final price of CP by 2% (feed manufacturers', farmers' data), which covers the cost of adding additives to the CP to reduce NH_3 emissions. However, the final price of CF had to be increased by a further 8 % (feed manufacturers' figure), which covers the cost of feed treatment (heat treatment, granulation....), bagging and transport. The resulting price of CF was thus increased by 10 %, which quantifies the total cost of reducing NH_3 emissions when using the addition of additives to the CF, its treatment, bagging and transport.

In the case of additives - synthetic essential amino acids (SAMA), which also reduce NH_3 emissions, it is possible for monogastric animals (pigs, poultry) to incorporate them into the CP or premixes as standard, i.e. they are 100% available to all farmers, and therefore the applicability in livestock farms has been kept at 100%.

Manure and slurry storage measures: For manure and slurry storage, we have chosen only one measure to reduce NH_3 emissions, namely covering the manure and slurry stores with a plastic sheet. This can be made of plastic, tent canvas or any other suitable material. This measure best met the requirements of BAT techniques as it reduced NH_3 emissions by 60 %, the cost per kg of emission reduction per year was 1.3€ , i.e. it did not require a large financial investment compared to converting storage lagoons to high tanks or building hard covers over existing tanks.

The calculation of the investment for the measure was based on the cost per kg of NH_3/year reduction, which we obtained from the Code of Good Agricultural Practice for the reduction of ammonia emissions from livestock farming and land application of fertilisers, and the amount of NH_3

emitted from storage for the livestock species quoted above. To determine the amount of NH_3 emitted from storage for the given livestock species and their categories, we used the ammonia emission inventory for the year 2022, where the emission factor for storage was input into the calculation of the amount of NH_3 emitted, which was calculated from the amount of excreted nitrogen (Nex, expressed in kg/animal/year) calculated in the calculation of N_2O emissions (a very accurate TIER 2 procedure using the new methodology of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). In addition to the amount of nitrogen excreted and the contribution of this amount to ammonia emissions, the volatilization of manure, slurry in storage also entered into the calculation of NH_3 emissions from storage. The amount of ammonia emitted from storage was expressed per animal (species and category) and year, i.e. as an emission factor (EF). From the EF of all categories of a given species, the NH_3 emissions from storage were calculated by multiplying the EF of a given category by the number of animals of that category to determine the ammonia emissions from storage from all categories of a given species. We then calculated the amount of reduction in NH_3 emissions from storage for each category of a given species, by the % reduction in the amount of emissions by the measure used. We further adjusted the amount of ammonia emission reduction from storage after the measure for the % of its applicability to farmers. Finally, we multiplied the amount of reduction in NH_3 emissions from storage by the cost per kg of its reduction per year to determine the cost of reducing its emissions after application of the measure in a given percentage of farms within each category of a given species. By summing the costs for each category of a given species, we determined the cost of reducing NH_3 after the measure and its application for that species.

Measures for manure and slurry application: The calculation was based on manure production management, where the amount of manure and slurry entered into the application. For manure, we chose one measure to reduce emissions from the application, namely incorporation within 4 hours after application, with a maximum ammonia emission reduction efficiency of 65% and a reduction cost per kg NH_3/year of 1.5 euro. For slurry, we used 3 measures to reduce NH_3 emissions, namely band application with a trailing hose with a foot with a max efficiency of 60% and a cost of 1.5 euro/kg NH_3/year, subsurface application with an open slot with an efficiency of 70% and a cost of 1.5 euro/kg NH_3/year, and incorporation of surface-applied slurry within 4 hours with a max efficiency of 65% and a cost of 1.0 euro/kg NH_3/year. The above measures were applied in cattle and pig farming. In poultry farming only 1 measure was used, namely incorporation of manure within 4 hours after application, as in this case it was always only manure application and not slurry application. In selecting the measures, we again used the BAT system and selected measures that are highly effective, available and feasible at a 'reasonable' financial cost.

To calculate costs, we used the Code of Good Agricultural Practice for reducing ammonia emissions from livestock and fertilizer land application and the NH_3 emission inventory for 2022. The application EFs (amount of emissions per animal and year) were entered into the application emission calculation. For their calculation, Nex (from the calculation of N_2O emissions by the TIER 2 procedure of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories), the ammonia fraction of this amount, and the volatilization of manure, slurry at application were used. Subsequently, from the EF of the application of each category of a given species, the NH_3 emissions from the application were determined by multiplying the EF of a given category by the number of animals of that category. We then used the % reduction in NH_3 emissions after application of the measure to obtain the amount of emissions after application of the measure for all categories of a given species. Next, we used the % application of the measure to farmers to calculate the % application of the measure to farmers, thus obtaining the amount of emissions from each category of a given species after application of the measure and application to farmers. We further multiplied the amount of reduction by the cost per kg of NH_3 reduction per year to obtain the total cost of reduction for all categories of a given species.

Table 9.22: *SWOT analysis of the Agri-model*

Strengths	Opportunities
Compatibility with emission model for emission inventories Detailed data break down National database used is compatible with EU data	Incorporate to the model new technologies Versatile use of time-series
Treats	**Weakness**
Easy data entry Basic software is free	Disconnected from macroeconomic models Too much pre-calculations needed Missing measurable indicators in national policies and strategies Data consistencies in the projection estimation process

Most implemented measures have a measurable effect on the emission inventory. List of policies and measures taken into account in emissions by individual scenarios and their effect (antagonistic, synergic). The limiting factor during the preparation of projections was the lack of details of the measures and their implementation plans within the Agriculture sector. Lack of information makes it difficult to implement and evaluate their impact. For this reason, an expert estimate of selected parameters was used during the preparation of the projections or European goals were used. It is therefore necessary to supplement the further specification of measures in the future for a more correct setting of models:

- Mechanism of implementation.
- Supporting resources requirements.
- Monitoring of implemented measures at the farm level, respectively business entity.

9.5.3. Scenarios, Parameters and PAMs

A review of actual and planned policies and measures was done. The forthcoming EU food strategy aims to reduce the use of pesticides, fertilizers and antibiotics in agriculture. By 2030, the consumption of hazardous pesticides should be reduced by 50% and the consumption of inorganic fertilizers should decrease by 20%. Targets were set for the entire European Union, the Slovak Republic has not set binding reduction resulting from the Farm to Fork strategy.

The Low Carbon Strategy of the Slovak Republic aims to identify measures, including achieving climate neutrality in the Slovak Republic in 2050 and achieving a 55% emission reduction in 2030 compared to

1990. This ambitious goal was formally defined in the last stage of the Low Carbon Strategy. Other less ambitious emission reduction scenarios were analysed in detail.

In preparing projections, measures were selected and analysed to detectable impact on the estimated emissions and their quantified impact on the greenhouse gas inventory and inventory of pollutants as possible. All other measures proposed in the Low Carbon Strategy are not implemented in the projections due to a lack of measurable effect on inventory but have an impact on the whole concerning the environment.

Based on the qualification of the probable impact of mitigation measures on emission inventories, we distinguish:

1. Measures having an identifiable impact on emissions. This impact can be specifically attributed to the implementation of mitigation measures. They are measurable and effective, this type of measure has been used in the preparation of emission projections.

2. Measures that have an impact on emissions are reported in inventories, but this impact cannot be specifically attributed to a specific mitigation measure. This includes measures that are difficult to measure and often have different synergistic or antagonistic effects.

3. Measures whose impact on emissions reported in inventories is possible because emission reductions are visible. The effect of these measures depends on other factors.

4. Measures that do not have a direct impact on emissions but which may have a positive impact on farmers' behaviour or the environment in the sector.

In the context of this document were prepared two scenarios:

The **WEM** scenario is a measures scenario that includes projections of anthropogenic emissions from agricultural sources, taking into account the effects of policies and measures adopted by the end of 2022. The measures considered in the **WEM** scenario prevent NH_3 emissions by storing manure and manure more efficiently by isolating them from the environment. This measure can be found in several strategic documents, especially in the Decree of the Ministry of the Environment of the Slovak Republic no. 248/2023 Coll., which implements certain provisions of the Air Act. The implementation of this measure has an impact on NH_3 and NOx from category 3B Manure and slurry management.

The **WEM** scenario takes into account the estimated consumption trend of nitrogenous organic and inorganic fertilizers based on exponential equalization by analysing previous emission trends. The **WEM** scenario has an increasing trend of nitrogen oxide emission projections, mainly due to Slovakia's expected continued revival of crop production. After 2020, the consumption of inorganic fertilizers is expected to increase by 50% compared to 2005. We assume that the consumption of inorganic fertilizers will increase, which will be necessary to compensate for the lack of organic nitrogen due to the decrease in the number of farm animals until 2050. The increase will be caused mainly by the growth in the number of grazing animals (meat species of cattle, sheep and goats). The increase in emissions projections in the **WEM** scenario is also visible in the category of applied other organic waste, namely compost and digestate. The amount of applied matter from cultivated plants to the soil will also increase.

The measure, taken from the Farm to Fork strategy, is to limit the use of pesticides, fertilizers and antibiotics in agriculture. This strategy was developed in synergy with the European Green Deal, which set itself the goal of reducing the environmental and climate footprint of the European food system. Within the **WAM** scenario, a target of reducing nitrogen fertilizer consumption by 20% by 2030 was implemented. The **WAM** scenario is a scenario with additional measures containing projections of emissions from agricultural sources, which include the effects of policies and measures adopted and implemented after 2020. The **WAM** scenario was modelled on strategic documents prepared by the Ministry of Environment of the Slovak Republic in cooperation with the Ministry of Agriculture and Rural Development of the Slovak Republic. A transition period was implemented in the emission projections, which aligns with the transition period for limiting urea (2020-2025) – ***Table 9.24.*** It is likely that the Slovak Republic will negotiate its own percentage reduction in fertilizer consumption and will claim a transitional period that will be legislated at the national level. After the legislative process, it will be necessary to adjust the emission projections in accordance with the future valid state strategy. Even though planned mitigation measures have been implemented, emissions are projected to increase by 2030 and 2050, creating pressure for much more ambitious measures. The urea reduction had a gradual trend, shown in the ***Table 5.3***. Limiting urea also affects CO_2 emissions from agriculture and especially on NH_3 emissions.

The **WAM** scenario includes mitigation measures that have a synergistic effect. The measure adopted from NUS SR recommends a legislative restriction on the application of urea-based nitrogen fertilizers. The implementation of this measure has an impact on the reduction of ammonia emissions, mainly due to the high volatility of ammonia from urea fertilizers. By limiting the consumption of urea, nitrogen oxide emissions will also be prevented based on the reduction of the total consumption of inorganic fertilizers in the resulting sum of consumption. The information on the validity of the legislation was unavailable. Therefore, an expert judgement was used.

The potential for reducing ammonia emission, NMVOC emissions in agriculture is mainly related to the efficiency of manure management, in particular the handling and storage of manure and slurry and their application to the soil in a low-emission manner. Some measures are included in Decree No. 248/2023 Coll. of the Ministry of the Environment of the Slovak Republic and are also valid for farms classified under Act No. 39/2013 Coll. on Integrated Pollution Prevention and Control. Mitigation measures included in the current legislation have been included in the WEM scenario. Currently, a revision of the Decree of the MŽP SR No. 248/2023 Coll. is underway, as well as an amendment to the Air Act No. 146/2023 Coll., in order to introduce the obligation to comply with the principles of Good Agricultural Practice. Measures to reduce ammonia (NH_3) emissions from livestock farming were applied to the key sources of these emissions, namely cattle, pig, and poultry farms. In selecting the measures, the "BAT" (Best Available Techniques) approach was followed, meaning that the most effective, accessible, and economically feasible options were used. The measures themselves were categorized into three groups: those related to the composition of feed mixtures, and those concerning the storage and application of manure and slurry. Financial capital of €29 440 465 (Pigs 7 392 790, Cattle 6 678 726, Poultry 15 368 949) is needed to implement measures to reduce ammonia emissions from livestock, which are the key producers. The measures consist of the addition of additives (reducing ammonia emissions) to the feed mixtures, covering the manure stores with plastic sheeting, ploughing in the manure and incorporating the manure within 4 hours of application, band application of the manure by means of a trailing hose with a foot and subsurface application of the manure in the form of an open slit.

The WAM scenario also contains measures of increased processing of animal waste in biogas plants to produce biogas, which can be used as a local energy source. This measure included in the Low Carbon Strategy of the Slovak Republic does not contain details such as animal species, percentages of recovered waste and others that would provide measurable indicators potentially usable in the calculation of emission projections. As part of the preparation of emission projections, this information was additionally expertly estimated. For this analysis, it was considered that 10% of organic manure from cattle and 23.2% of organic manure from pigs would be recovered in biogas plants. Cattle and pigs are key categories of animals with the highest emission recovery potential, the potentials were chosen as expert judgement. Biogas from stations is a promising source of renewable electricity and heat, which can be used at the local level. Information was included based of Recommendation number ***SK-3B-2019- 0002***

Table 9.23: *Efficiency of used abatements*

Abatement efficiency of measures	Reduction potential	References
Storage of Manure or Slurries		
Fixed hatch or roof	80%	**Code Good Agricultural Practice***
Covering the surface of the tank with straw	40%	
Covering the surface of the tanks with foil	60%	
Slurry/liquid with natural crust cover	40%	
Application of manure Or Slurries		
Furrow injection	40%	**Code Good Agricultural Practice***
Deep injection	90%	
Incorporation within 12 hours	50%	
Incorporation within 24 hours	30%	
Incorporation within 4 hours	65%	

*In Slovak

The **WAM** scenario contains measures that are in synergy and can be implemented in the calculation model. This is the use of amino acids in the ration reducing the nitrogen excretion of animals, it was implemented in the model through a more precise optimization of nitrogen substances in the ration. The measure was used in the estimation of nitrogen excretion per 1 animal per year in cattle. Based on the meta-analysis, the estimate of the mitigation potential compared to the reference value was in the range of 17±6% N_{EX}.

Emissions of NH_3 from manure and manure storage in the WAM scenario were modelled by taking into account the measure of introducing requirements to reduce emissions from livestock farms.

Another implemented measure, which has an impact on NH_3 and NOx emissions in category 3.B Manure and manure management, was the use of manure as a feedstock into biogas plants. The impact on reducing emissions in two main ways - reducing carbon emissions from fossil fuels through the production of energy sources and reducing direct emissions of methane and nitrous oxide from manure and sludge storage. Although anaerobic digestion does produce methane, it is captured and used in energy production, which has a positive impact on increasing the share of energy from renewable sources.

Emissions of NH_3 and NOx from the application of inorganic nitrogen fertilizers (category 3.D Agricultural soils) were modelled in the **WAM** scenario based on a measure implemented from the Low Carbon Strategy of the Slovak Republic. This measure recommends the transition or legislative restriction on the application of nitrogen fertilizers to urea bases. This measure's implementation impacts the reduction of NH_3 and NOx emissions, mainly due to the high volatility of ammonia from urea fertilizers. At the same time, limiting urea consumption will prevent carbon dioxide emissions. Nitrous oxide emissions are limited based on reducing the total consumption of inorganic fertilizers in the resulting consumption summary.

The last implemented measure was taken from the European Green Deal and mentioned in the Farm to Fork strategy. This measure recommended a 20% reduction in inorganic fertilizers consumption by 2030. This measure has an impact on NH_3 and NOx.

The implemented measure taken from the Low Carbon Strategy recommends the transition or legislative restriction on the application of urea-based nitrogen fertilizers. The implementation of this measure has an impact on the reduction of ammonia emissions, mainly due to the high volatility of ammonia from urea fertilizers. Limiting the consumption of urea also avoids NOx emissions by reducing the total consumption of inorganic fertilizers in the resulting consumption summary. The information on the validity of the legislation was unavailable. Therefore, an expert judgement was used. The reduction of urea had a gradual course, which is shown in ***Table 9.24*.**

Table 9.24: *Limitation of urea consumption from 2025 to 2050 according to the WAM scenario*

YEAR OF IMPLEMENTATION	PERCENT OF UREA CONSUMPTION REDUCTION
2020-2025	The transition period, time to implement legislation
2026-2030	10 %
2031-2035	20 %
2036-2040	30 %
2041-2045	50 %
2046-2050	70 %

The list of policies and measures that have been taken into account in the emission projections according to the individual scenarios and their effect is given in ***Table 9.25***.

Table 9.25: *List of implemented policies and measures into projections according to the scenarios*

STRATEGIC DOCUMENT LEGISLATION	SCENARIO	GAS / CATEGORY	MEASURE	EFFECT OF THE MEASURE
Code of good agricultural practice National Air Pollution Control Programme Low carbon strategy Decree of the Ministry of the Environment of the Slovak Republic No. 248/2023 Coll.	WEM	NH_3, NMVOC - 3.B Manure management	Efficient storage of animal waste, specifically storage of liquids in isolated tanks from the environment or in tanks with access to oxygen and storage of manure in plastic bags without or with minimal addition of water	synergistic
Code of good agricultural practice	WAM	NH_3, NMVOC – Manure management	Application of amino acids into feeding doses	synergistic

STRATEGIC DOCUMENT LEGISLATION	SCENARIO	GAS / CATEGORY	MEASURE	EFFECT OF THE MEASURE
Low carbon strategy	WAM	NH_3 - storage of manure and manure	Effectively process animal waste and use biogas, especially as a local energy source	synergistic
	WAM	NH_3,NOx - agricultural land	Intensification of the use of nitrogen fertilizers with stabilized nitrogen at the expense of the use of urea	synergistic
Farm to fork strategy	WAM	NH_3,NOx, HCB agricultural land	Reduction of inorganic nitrogen fertilizers by 20 % compared to 2030	synergistic

9.5.4. Emission Projections in the Agriculture Sector

NMVOC emissions

NMVOC emission projections were prepared using the WEM and WAM scenarios. The emission projections decreased mainly due to a decrease in the projected number of livestock and intensive feeding with active substances in dairy cattle, sheep and swine categories. Projection by the WEM scenario followed the Ordinance of the Government of the Slovak Republic No. 248/2023 Coll.

Figure 9.50: *Emission projections trends for pollutant NMVOC in sector Agriculture*

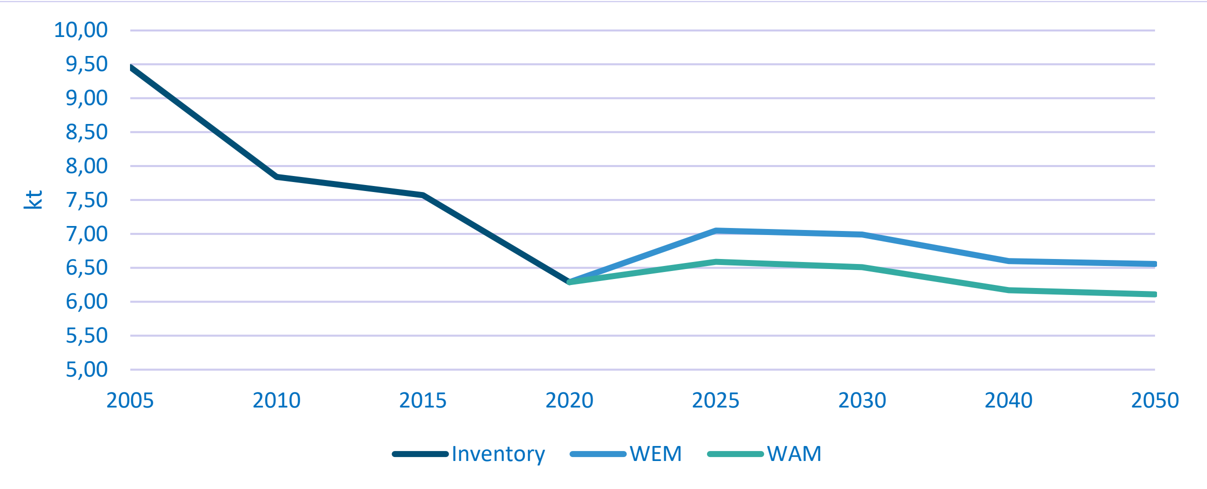


Table 9.26*: NMVOC emissions in sector Agriculture in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	9.30	7.68	7.41	6.13	5.79	7.18	7.13	6.74	6.70
3.D	0.16	0.16	0.16	0.16	0.13	0.14	0.14	0.14	0.14
3 Agriculture	**9.46**	**7.84**	**7.57**	**6.29**	**5.92**	**7.05**	**6.99**	**6.60**	**6.56**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	9.30	7.68	7.41	6.13	5.79	6.45	6.372	6.03	5.97
3.D	0.16	0.16	0.16	0.16	0.13	0.14	0.14	0.14	0.14
3 Agriculture	**9.46**	**7.84**	**7.57**	**6.29**	**5.92**	**6.59**	**6.51**	**6.17**	**6.11**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NH_3 and NOx emissions

Sector agriculture is a dominant contributor to NH_3 emissions, approximately 90% share of the national total. The largest share of ammonia emissions was generated by 3.D Agricultural soils, which produced approximately 70% of NH_3 within the sector. The key source in Agricultural Soils in the Animal manure applied to soils where were implemented abatements (Incorporation within 12 and 24 hours, deep injection of manure), followed by the category Inorganic N-fertilizers representing approximately 20% of the total NH_3 emissions, there are no abatements were implemented, due to missing policies. Emissions from 3.B.1 Cattle, 3.B.3 Swine and 3.B.2 Sheep are key emission sources of NH_3.

Projections of NH_3 and NOx emissions from manure and manure management and agricultural soils were prepared in the WEM and WAM scenarios.

The WEM scenario is conservative and does not envisage further measures to reduce emissions. The emission trend in WEM scenario has stable increasing trend (***Figure 9.51***) of NOx emissions. In the WEM scenario, higher consumption of inorganic nitrogen fertilizers is included compared to the recorded values in historical years. The year 2020 and 2021 was particularly affected by the pandemic, which led to higher prices of natural gas and subsequently increased prices of inorganic N-fertilizers. As a result, farmers reduced their consumption of these fertilizers.

For the projection, the impact of the pandemic year was avoided, and the projection was prepared without considering the influence of the pandemic. Similar trends were observed in animal production, where there was a decrease in the number of pigs, goats, and poultry. If this negative trend continues beyond the after-pandemic years, the projections will be adjusted accordingly in future submissions.

Figure 9.51: *Emission projections trends for pollutant NH_3 in sector Agriculture*

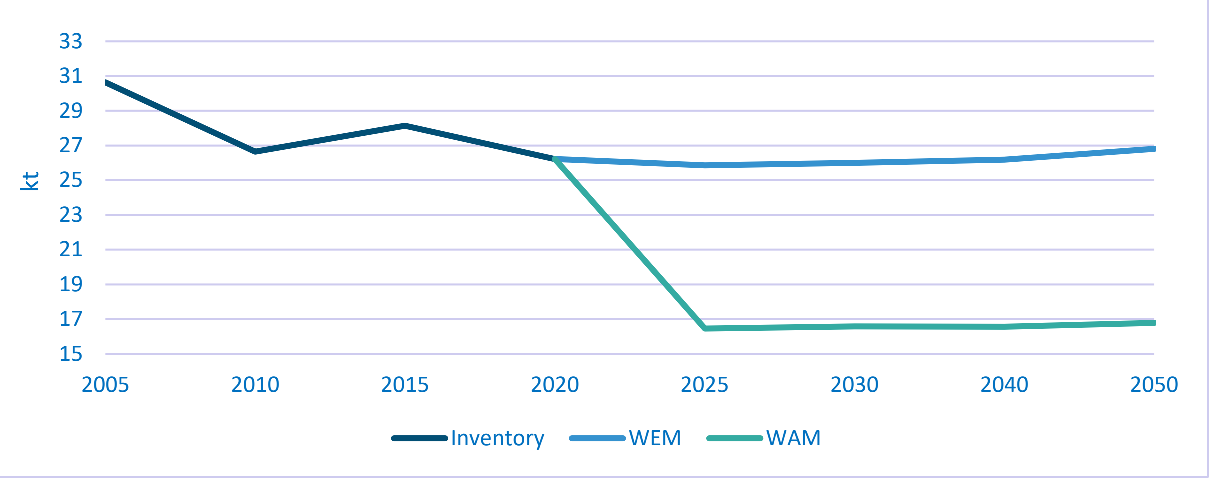


Table 9.27: *NH_3 emissions in sector Agriculture in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	9.14	7.71	7.48	6.26	5.72	6.73	6.64	6.55	6.55
3.D	21.50	18.93	20.67	19.96	17.35	19.13	19.37	19.64	20.26
3 Agriculture	**30.64**	**26.64**	**28.15**	**26.22**	**23.07**	**25.86**	**26.00**	**26.19**	**26.81**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	9.14	7.71	7.48	6.26	5.72	4.89	4.90	4.87	4.90
3.D	21.50	18.93	20.67	19.96	17.35	11.57	11.70	11.69	11.88
3 Agriculture	**30.64**	**26.64**	**28.15**	**26.22**	**23.07**	**16.46**	**16.59**	**16.56**	**16.78**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Agricultural NOx emissions have increased. The NOx emissions from agricultural soils especially Inorganic N-fertilizers application is a key source of emission. The emission projections increased due to the increasing consumption of nitrogen N-fertilizers, which will be needed to replace the lack of organic nitrogen in soils due to livestock decreasing. Agriculture is an insignificant source of NOx emissions and no policies and measures are available.

***Figure 9.52:** Emission projections trends for pollutant NOx in sector Agriculture*

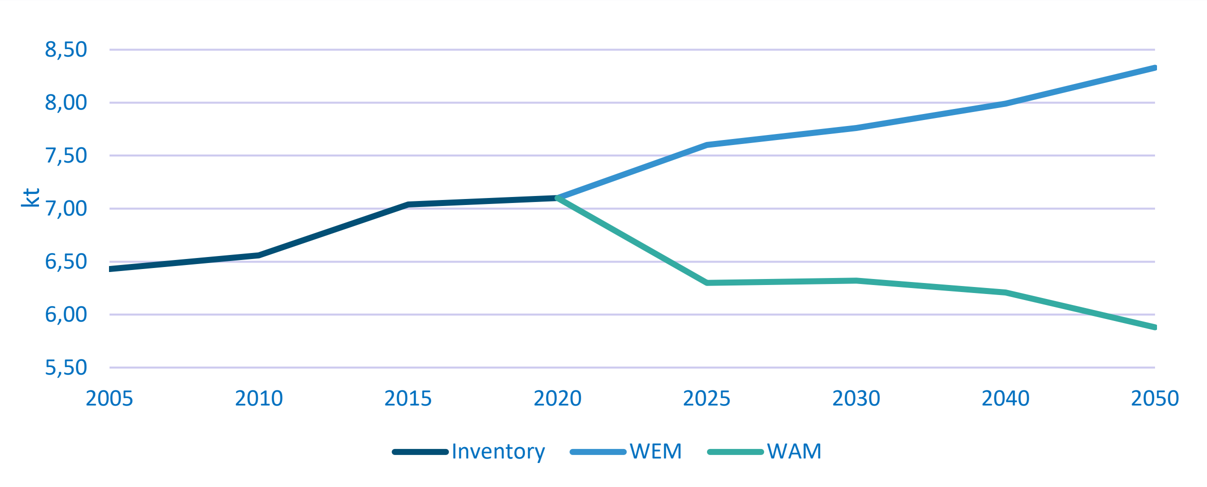


***Table 9.28:** NOx emissions in sector Agriculture in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	0.18	0.14	0.14	0.14	0.12	0.12	0.12	0.12	0.12
3.D	6.26	6.42	6.90	6.97	6.43	7.48	7.64	7.86	8.21
3 Agriculture	**6.43**	**6.56**	**7.04**	**7.10**	**6.55**	**7.60**	**7.76**	**7.99**	**8.33**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	0.18	0.14	0.14	0.14	0.12	0.12	0.12	0.12	0.12
3.D	6.26	6.42	6.90	6.97	6.43	6.18	6.20	6.09	5.76
3 Agriculture	**6.43**	**6.56**	**7.04**	**7.10**	**6.55**	**6.30**	**6.32**	**6.21**	**5.88**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

The decrease in emissions by 2040 in the WEM scenario compared to 1990 is at the level of -51.6% and compared to 2005 at the level of -7%.

$PM_{2.5}$, PM_{10}, TSP emissions

The $PM_{2.5}$, PM_{10} and TSP emissions were calculated in one scenario due to missing strategical documents and mitigation measures for emissions emitted in Manure management and Agricultural soils. The agricultural $PM_{2.5}$, PM_{10} and TSP emissions from Agricultural Soils have decreased trend from 2005 to 2020 and the decrease will continue until 2050 due to a decrease in cropped areas of oat, barley and rye. Agriculture is an insignificant source of $PM_{2.5}$, PM_{10} and TSP emissions and no policies and measures are available. The decrease in $PM_{2.5}$ emissions by 2050 in the WEM scenario compared to 1990 is at the level of -62% and then decreases by 40% compared to 2005.

The decrease in PM_{10} emissions by 2050 in the WEM scenario compared to 1990 is at the level of -41% and then decreases by 35% compared to 2005.

The decrease in TSP emissions by 2050 in the WEM scenario compared to 1990 is at the level of -50% and then decreases by 34% compared to 2005.

Figure 9.53: *Emission projections trends for pollutant $PM_{2.5}$ in sector Agriculture*

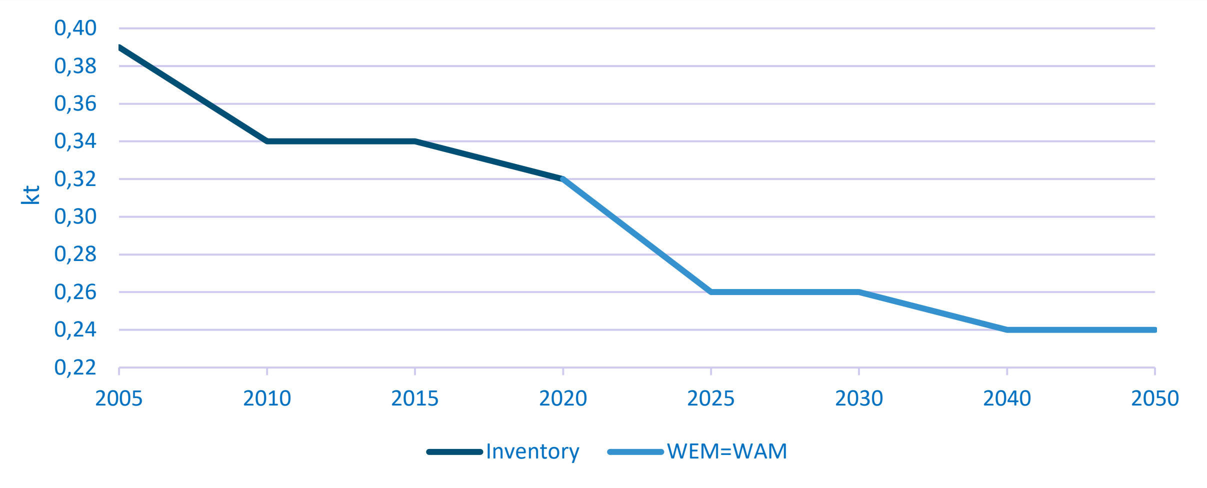


Table 9.29*: $PM_{2.5}$ emissions in sector Agriculture in kt*

WEM=WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	0.19	0.17	0.16	0.14	0.13	0.10	0.10	0.10	0.10
3.D	0.20	0.18	0.18	0.18	0.17	0.16	0.16	0.14	0.14
3 Agriculture	**0.39**	**0.34**	**0.34**	**0.32**	**0.30**	**0.26**	**0.26**	**0.24**	**0.24**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Table 9.30*: PM_{10} emissions in sector Agriculture in kt*

WEM=WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	0.79	0.70	0.67	0.52	0.48	0.50	0.49	0.46	0.43
3.D	3.66	3.23	3.26	3.28	3.02	2.81	2.77	2.52	2.43
3 Agriculture	**4.45**	**3.93**	**3.93**	**3.80**	3.49	**3.31**	**3.26**	**2.98**	**2.87**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Table 9.31*: TSP emissions in sector Agriculture in kt*

WEM=WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.B	2.73	2.47	2.37	1.70	1.56	1.90	1.83	1.72	1.62
3.D	2.73	2.64	2.58	2.60	2.10	2.08	2.10	2.00	1.98
3 Agriculture	**5.46**	**5.11**	**4.95**	**4.31**	**3.66**	**3.98**	**3.93**	**3.72**	**3.59**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

HCB emissions

Historically, hexachlorobenzene (HCB) was widely used as a seed treatment to prevent fungal growth in crops such as wheat, barley, oats and rye. Emission projections were made using two scenarios, WEM and WAM. In the WAM scenario, the objective of the Farm to Fork strategy was implemented (50% reduction in the use and risk of chemical pesticides and a 50% reduction in the use of more hazardous pesticides). The emission of hexachlorbenzene decreases more in the WAM scenario compared to the WEM scenario. Volume of pesticides containing contamination of hexachlorbenzene decrease continuously, this trend is visible in WEM scenario.

The decrease of HCB by 2050 in the WEM scenario compared to 1990 is at the level of -94% and then decreases by 83%. HCH TSP emissions by 2050 in the WEM scenario compared to 1990 is at the level of -97% and then decreases by 91% compared to 2005.

Table 9.32: *HCB emissions in sector Agriculture*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.Df	0.06	0.03	0.05	0.03	0.01	0.06	0.05	0.04	0.03
3 Agriculture	**0.06**	**0.03**	**0.05**	**0.03**	**0.01**	**0.06**	**0.05**	**0.04**	**0.03**

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
3.Df	0.06	0.03	0.05	0.03	0.01	0.03	0.03	0.02	0.01
3 Agriculture	**0.06**	**0.03**	**0.05**	**0.03**	**0.01**	**0.03**	**0.03**	**0.02**	**0.01**

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

9.6 EMISSION PROJECTIONS IN THE WASTE SECTOR

9.6.1. Methodologies and Key Assumptions/Trends

In general, the more waste we produce, the more we have to get rid of. Some waste disposal methods release both pollutants and greenhouse gases into the air. Recycling is one method of reducing the impact of waste disposal on the air and the climate. However, there are also ways of managing waste that are more environmentally friendly.

The waste management sector consists of the following NFR categories:

- 5.A Solid Waste Disposal on Land
- 5.B Biological Treatment of Solid Waste
- 5.C Waste Incineration an Open Burning of Waste
- 5.D Wastewater Handling
- 5.E Other Waste

The most common disposal methods are landfill and, to a lesser extent, incineration. When waste from landfills decomposes, non-methane volatile organic compounds (NMVOCs) and methane are released into the air, and particulate emissions are released when waste is handled (PM).

Incineration is the second most common method of waste disposal in the Slovak Republic. In the past energy from incineration was not often used and waste was only disposed of. Modern plants now use waste as a fuel in the production of energy or heat, and waste is also recovered in this way. In this case, the emissions from incineration are classified in the energy sector. In our country, waste incineration contributes significantly to the number of dioxins and furans (PCDDs/PCDFs) that are emitted into the air. Since dioxins are virtually unbreakable in nature and can persist for hundreds of years, they are deposited in animal tissues and thus enter the human food chain. Dietary intake, especially of meat, fish, eggs, milk and fats, is the most important route of entry of dioxins into the human body. Incineration of waste also releases high levels of heavy metal emissions into the air. Modern waste incineration plants capture these pollutants efficiently, but this was not common practice in the past. Heavy metals are deposited in the soil and subsequently in organisms, from which they are difficult to break down. Through the food chain, contamination of organisms gradually increases. Animals at the end of the food chain, and therefore humans, are particularly at risk from heavy metals. The risk is particularly higher in coastal areas, where seafood consumption is generally higher.

Recycling is not the only sustainable way to recover waste. Composting any organic waste, such as food and garden waste, is one of them. Organic waste decomposes into mulch in a matter of weeks, which can be used as fertilizer for the soil. Many households practise small-scale composting, large-scale composting systems are also being developed with the collection of organic waste from parks and urban amenities. Similar types of organic waste can also be treated in biogas plants. Unlike composting, here the waste is decomposed anaerobically (without air access) and biogas is produced which can be further burned to generate energy that can be used for heating.

This sector also includes cremations of human and animal remains, which are also a source of air pollution through emissions of heavy metals and POPs.

Wastewater treatment also releases pollutants and greenhouse gases (both CH_4 and N_2O). In general, emissions of POPs as well as NMVOCs, CO and NH_3 occur in wastewater treatment plants, but in most cases, these are negligible amounts.

9.6.2. Model Description

Projections of emissions were prepared in accordance with the methodology of EMEP GB 2023, the methodology is consistent with the methodology of estimating emissions in Waste sector. The calculation analysis tool is based on the MS Excel platform and the calculation includes various policies and measures (in numerical formulation) defined according to the WEM and WAM scenarios. Calculations of emissions projections of individual gases were carried out in consistency with the GHG emission projection from waste activities.

There are several specially developed mathematical models for the preparation of emission projections, but due to the need for complex input data including economic and energy indicators, it is currently not possible to use them for the purposes of reporting national projections. The small Slovak economy would need its own model developed exactly for our conditions, or at least specifying the specific national parameters that enter the calculations (ideally up to tier 3 level). We are currently working partly at the level of tier 1 and partly already at the level of tier 2 (national data on production and waste management), as we lack the necessary statistical data specific to Slovakia.

Improving the quality and timely availability of input data as well as further improvements in the preparation of emissions projections from the waste sector should enable the entire calculation process to be automated, which should bring a reduction in calculation time and create space for the creation of a larger number of scenarios and the processing of sensitivity analysis.

Calculating of NMVOC emission projections from landfilling is connected with the methane emissions and it follows that two of parameters used are of an objective nature - the development of the population over the monitored period as well as the total production of waste. These parameters are influenced by social and economic factors, which we still do not know how to regulate or guide significantly. Their future values for the monitored period are therefore relatively difficult to predict and burdened with a relatively high degree of uncertainty. The other three parameters (proportion of landfilled waste, composition of waste, capture and use of landfill gas) are more or less subjective in nature and can be influenced by external interventions and state policies. Some of these parameters may (but may not) act synergistically and increase their impact on overall emissions from landfilling. For example, the construction and operation of additional waste-to-energy facilities ("incinerators" = WtE) will in any case contribute to a decrease in the amount of landfilled waste, for example, in the data from BSK and KSK. More intensive separated collection of waste components will lead to a decrease of DOC in landfilled waste. The construction and operation of new MBU facilities will combine both of these parameters. However, it should be noted that the residue from MBU facilities (ending up in landfills) has a higher DOC > 0 than the residue from WtE (DOC < 0). The resulting impact of the measures on these parameters will depend on the capacity of the new facilities and their operational efficiency. However, from a time point of view, it is necessary to think with a horizon of at least 5-10 years, so that these policies are also reflected at the output. Based on knowledge from European countries, where there has already been a shift away from landfilling, it is clear that the production of landfill gas and thus the amount NMVOC from landfills will subsequently decrease. On the other hand, according to the EEA report from May 2021, Slovakia is among the EU27 countries with the lowest use of landfill gas (only 5%), while the EU average is around 39%. Due to the lack of data, it is not possible to more precisely quantify the total potential of usable methane from landfills and the current efficiency of its capture and processing.

When describing the preparation of emission projections, it should be noted that emissions from landfilling are calculated according to the components of the landfilled waste (food, wood, paper, textiles, sludge...) and not according to the type of landfills in the sense of the Directive on landfills (2018/850 or 1999/31/EC). Considering the different development and production of municipal and industrial waste in Slovakia, as well as the requirement in previous revisions of the national inventory, emission projections were calculated separately with industrial waste = ISW (sk. 01 to 19 EWC) and separately with municipal waste = MSW (sk. 20 EWC). The resulting emission projections from the waste landfill category (5.A) are then the sum of both sub-categories.

Table 9.33: *SWOT analysis of the Waste-model*

Strengths	Opportunities
Compatibility with emission inventories Detailed data break down Database used is compatible with national data Models are free of charge	Incorporate to the model new technologies Versatile use of time-series
Treats	**Weakness**
Bugs can be introduced if data is incorporated manually Lack of input data introduce high uncertainty	Disconnected from macroeconomic models Too much pre-calculations needed Missing measurable indicators in national policies and strategies Data consistencies in the projection estimation process

9.6.3. Scenarios, Parameters and PAMs

Two scenarios have been prepared to model the emission projections for categories 5.A - Landfills and 5.D - Wastewater:

- WEM – scenario with existing measures (realistic)
- WAM – scenario with additional measures (optimistic)

For the modelling of emission projections from categories 5.B - Composting of non-biogenic waste and 5.C - Incineration of waste without energy recovery, only one scenario was prepared, namely WEM = WAM, due to the lack of relevant PAMs.

The scenario with existing measures (realistic) scenario, or also called BAU = Business as Usual, is based on the expectation that developments in solid waste landfill management will continue as observed in other EU countries undergoing economic transition.

Municipal waste production - the WEM scenario presents a projection of methane emissions from MSW with the continuation of current trends and policies in waste management in Slovakia without taking into account more significant externalities or radical economic collapses. The production of municipal waste for the years 2023 – 2050 copies the expected development of GDP with annual growth in the range of 1.48% - 1.03%. At the same time, we assume that the current significant decrease in the share of landfilled waste to the total production of MSW (-3.1% per year or -40 300 t/y) will slow down and stabilize at 1% per year (-20 000 t/y). Methane emissions from landfilling of municipal waste are shown in ***Table 9.34*** below.

Table 9.34: *Trend projections of MSW parameters in WEM scenario up to 2050*

Year	Unit	2022	2025	2030	2035	2040	2045	2050
MSW	*kilo tonnes*	2 597.46	2 592.79	2 750.77	2 943.83	3 137.35	3 196.77	3 524.17
MSW-> SWDS	*kilo tonnes*	2 597.46	2 592.79	2 750.77	2 943.83	3 137.35	3 196.77	3 524.17

Production of industrial waste - the WEM scenario represents a projection with a continuation of the current trends given by the policies and measures in the waste management in Slovakia without taking into account more significant externalities or radical economic collapses. The amount of landfilled industrial waste containing biodegradable carbon stabilises at around 92 000 t/year. Methane emissions from landfilling of industrial waste are shown in ***Table 9.35*** below.

Table 9.35: *Trend projections of ISW parameters in WEM scenario up to 2050*

Year	Unit	2022	2025	2030	2035	2040	2045	2050
ISW -> SWDS	*kilo tonnes*	65.90	90.27	89.40	91.14	92.02	93.61	95.07

The WAM scenario presents a projection of the future development of methane emissions from waste landfills in Slovakia when new policies in waste management are introduced and applied without taking into account significant external influences (economic crisis, war, another pandemic, etc.). The scenario with additional measures (optimistic) is based on the expectation that additional supporting measures will be implemented in the waste management sector in Slovakia to increase the rate of waste recovery and reduce the amount of landfilled waste (MBU, WtE, etc.).

Municipal waste production – in the WAM scenario is expected a decrease of the "FOOD" component in municipal waste due to separate collection of kitchen waste. Similarly, the separate collection of textiles from 1.1.2025 will contribute to the reduction of this component in the MSW landfilled. Further intensification of separate collection, support of composting and aerobic digestion will also bring a decrease in the components of paper and garden waste in landfilled MSW. The deposit system of returnable packaging will probably be reflected in the reduction of the production of mixed packaging, which represents a significant share of landfilled waste. The introduction of mandatory treatment of municipal waste before landfilling and an increase in the share of waste that can be used for energy will also have a significant impact on reducing the amount of landfilled municipal waste. By 2050, there could thus be a substantial decrease in landfilled bio-degradable carbon, which also represents an adequate decrease in the DOC value by about 35% and, ultimately, a decrease in methane production from landfills. This scenario assumes a significant decrease in the amount of landfilled municipal waste, i.e. diversion of mixed MSW to other (new) facilities gradually by approx. 80 000 t per year until 2050. In accordance with goals of European Commission for waste management, the goal for 2035 is set: landfill less than 10% of MSW and recover more than 60% MSW. The 2030 environmental strategy has a set goal for the year 2030 to landfill max. 25% and evaluate min. 60%. The WAM scenario envisages reaching the landfill goal of max. 25% in 2030 and max. 15% of MSW in 2035 with a gradual reduction of landfilled MSW from 2023 by approx. 42 000 tons per year. Methane emissions from landfilling of municipal waste are shown in the following ***Table 9.36***.

Table 9.36*: Trend and projections of parameters and methane emissions from MSW in WAM scenario up to 2050*

Year	Unit	2022	2025	2030	2035	2040	2045	2050
MSW	kilo tonnes	2 597.46	2 592.79	2 750.77	2 943.83	3 137.35	3 196.77	3 524.17
MSW-> SWDS	kilo tonnes	1 021.58	886.22	684.61	482.99	281.38	206.11	146.97

Production of industrial waste - WAM scenario represents a projection of the future development of methane emissions from landfilling of industrial waste in Slovakia with a slight decrease in the amount of landfilled ISW. Methane emissions from landfilling of industrial waste are shown in the following ***Table 9.37***.

Table 9.37: *Trend and projections of ISW parameters in WAM scenario up to 2050*

Year	Unit	2022	2025	2030	2035	2040	2045	2050
ISW -> SWDS	kilo tonnes	65.90	66.55	77.18	72.67	69.66	66.13	62.87

Biological treatment of solid waste (5.B) – Category was calculated in scenario with existing measures (WEM) scenario due to missing strategical documents and mitigation measures after 2021. The WEM scenario with existing measures is based on the expectation that the development of waste composting will continue to increase, as observed in the last decade. This trend was mainly determined by the adopted Strategy for Reducing the Disposal of Biodegradable Waste in Landfills, developed in accordance with Article 5(1) of Directive 1999/31/EC. The goal of this strategy, as per Article 5(1) of the Waste Landfill Directive, is to limit the amount of biodegradable municipal waste disposed of in landfills and propose measures to achieve the goals set out in Article 5(2), primarily through recycling, composting, biogas production, or the use of waste as a source of secondary raw materials and energy.

In Slovakia, basic legal conditions were established to fulfil this requirement in Section 5(1)(d) of the Ministry of Environment of the Slovak Republic Decree No. 283/2001 Coll. This section stipulates that the binding part of the waste management program of the relevant state administration authorities should include measures to reduce the amount of biodegradable municipal waste deposited in landfills. This reduction is expressed in units of weight in the baseline and target years, with the aim of achieving a reduction in the disposal of such waste in landfills in the following manner:

- Within 9 years from the effective date of Decree No. 283/2001 Coll., the amount of biodegradable municipal waste deposited in landfills will be reduced to 75% (-25%) of the Strategy for Reducing the Disposal of Biodegradable Waste in Landfills Ministry of the Environment of the Slovak

Republic 8 total amount (weight) of biodegradable municipal waste generated between 1995-2010.

- Within 12 years from the effective date of Decree No. 283/2001 Coll., the amount of biodegradable municipal waste deposited in landfills will be reduced to 50% (-50%) of the total amount of biodegradable municipal waste generated between 1995-2013.
- Within 19 years from the effective date of Decree No. 283/2001 Coll., the amount of biodegradable municipal waste deposited in landfills will be reduced to 35% (-65%) of the total amount (weight) of biodegradable municipal waste generated between 1995-2020.

Table 9.38: *Projections of activity data on composting in WEM scenario*

Year	Unit	2020	2030	2040	2050
MSW	*kilo tonnes of dm*	265.15	264.10	310.64	357.18
Other SW	*kilo tonnes of dm*	315.78	306.70	322.77	338.84

Waste incineration (5.C) - Currently, no strategy addresses the construction of new incineration plants for non-municipal waste without energy recovery. According to the Environmental Strategy 2030, the recycling rate of municipal waste, including its preparation for reuse, should increase to 60% in Slovakia by 2030, and the rate of landfilling should decrease to less than 25% by 2035. The Waste Management Program for 2020-2025 does not anticipate the construction of new incineration capacities. Increasing the recycling rate and reducing the amount of waste landfilled will not have a significant impact on the amount of waste incinerated without energy recovery. For modelling emission projections, one scenario was prepared only one scenario based on existing measures (realistic), also known as BAU (Business as Usual), is founded on the expectation that the trend in incinerating industrial waste without energy recovery will continue as observed over the past decade.

Wastewater treatment (5.D) – the scenario with existing measures (realistic) or also called BAU = Business as Usual, is based on the expectation that wastewater management developments will continue as observed over the last decade. According to these assumptions, the development of the wastewater sector is characterized by an increase in the share of the population covered by sewerage systems, with the aim of reaching 85% coverage in 2050. This scenario corresponds with the information from the Envirostrategy 2030[2], as well as with the recently adopted document "Concept of water policy of the Slovak Republic until 2030 with a view to 2050”[3]. Similar visions are also declared in the Plan for the Development of Public Sewers for the Slovak Republic[4]. This goal is also indirectly stated in the frequent statements that all agglomerations with population of over 2000 and half of the agglomerations with population of up to 2000 are planned to be part of sewage network, which in total gives the value of about 85% of population connected to sewage system. This development can be characterised by the continuous development of sewerage systems and the modernisation of wastewater treatment plants to meet the requirements of the EU water sector strategies.

The scenario assumes that the number of inhabitants using storage tanks (cesspools) will decrease (from 26% in 2022 to 12% in 2050) due to the expansion of the sewerage network from 71 to 85% and also by increasing the number of domestic wastewater treatment plants from the current 2 to 3%.

[2] https://www.minzp.sk/files/iep/03_vlastny_material_envirostrategia2030_def.pdf

[3] https://www.minzp.sk/files/sekcia-vod/koncepcia-vodnej-politiky/koncepcia-vodnej-politiky.pdf

[4] https://www.minzp.sk/voda/verejne-vodovody-verejne-kanalizacie/

The scenario with additional measures (optimistic) is based on the expectation that developments in the wastewater sector will continue with increased financial support from the Slovak government as well as EU support under the Recovery Plan for Europe. This development is characterised by an accelerated increase in the share of the population connected to sewerage systems, with a target of 90% connection in 2050. This scenario corresponds to the aspiration to achieve a level of sewerage connection as high as in the developed Western European countries (at least 90% connection to sewers and wastewater treatment plants).

The scenario assumes that the number of inhabitants using septic tanks will decrease (from 26% in 2022 to 7% in 2050) as a result of the intensive expansion of sewerage from 71 to 90% and the construction of decentralised domestic wastewater treatment plants from 2 to 3%. This strategy corresponds to the strict requirement of the European Commission, as stated in procedure No 2016/2191, for non-compliance with certain articles of Council Regulation 91/271/EEC of 21 May 1991 concerning urban wastewater treatment. These measures are expected to contribute to a reduction of methane emissions in the municipal sector by almost 70% and in the industrial sector by 76% in 2050 compared to 2005.

9.6.4. Emission Projections in the Waste Sector

Emissions from the Waste sector do not have a key impact on overall emissions. Projection emissions are estimated based on new calculations for AP emissions projections in this sector. A significant share of total emissions is for NMVOC and NH_3, however emission projections of SO_X, NH_3 a $PM_{2,5}$ are also prepared (***Tables 9.39*** – ***9.43***, ***Figur9.54***).

NOx emissions

Table 9.39: *NOx emissions in sector Waste in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	0.427	0.434	0.477	0.383	0.385	0.386	0.387	0.391	0.395

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	0.427	0.434	0.477	0.383	0.385	0.386	0.386	0.390	0.394

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NMVOC emissions

Table 9.40: *NMVOC emissions in sector Waste in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	1.378	0.823	0.798	0.750	0.718	0.685	0.658	0.650	0.643

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	1.378	0.823	0.798	0.750	0.718	0.663	0.612	0.588	0.566

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

SOx emissions

Table 9.41: *SOx emissions in sector Waste in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	0.012	0.012	0.014	0.011	0.012	0.012	0.012	0.012	0.012

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	0.012	0.012	0.014	0.011	0.012	0.011	0.011	0.011	0.011

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

NH_3 emissions

Table 9.42: *NH_3 emissions in sector Waste in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	1.007	0.925	2.548	2.226	2.177	2.162	2.301	2.383	2.394

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	1.007	0.925	2.548	2.226	2.177	2.155	2.287	2.191	2.035

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

$PM_{2.5}$ emissions

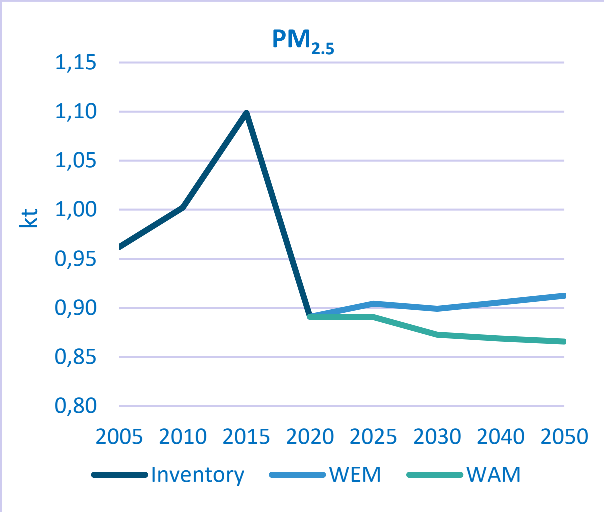
Table 9.43: *$PM_{2.5}$ emissions in sector Waste in kt*

WEM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	0.962	1.002	1.099	0.891	0.898	0.904	0.899	0.906	0.912

WAM	2005	2010	2015	2020	2022*	2025	2030	2040	2050
5 Waste	0.962	1.002	1.099	0.891	0.898	0.891	0.873	0.869	0.866

** Base year 2022; 1990 – 2022 based on the inventory submission 15. 3. 2024*

Figure 9.54: *Air pollutants emissions trends in sector Waste*



PM2.5
kt
1,15
1,10
1,05
1,00
0,95
0,90
0,85
0,80
2005
2010
2015
2020
2025
2030
2040
2050
Inventory
WEM
WAM

CHAPTER 10: LARGE POINT SOURCES

Last update: 15.3.2021

10.1 METHODOLOGICAL ISSUES

After the NECD review in 2020, the old LPS methodology was revised following the recommendations of the TERT in "Final Review Report 2020".

All LPS represent E-PRTR facilities as defined in the EMEP reporting guidelines. Only the facilities reported to the E-PRTR with pollutant releases into the air over threshold values specified in Annex II to the E-PRTR Regulation are included. If the threshold value was exceeded for at least one pollutant, the non-zero emissions of other relevant pollutants were also included in the LPS.

Facilities in E-PRTR which have non-relevant pollutants only (in the view of NECD: GHGs, some heavy metals etc.) are not included in LPS.

Some LPS have more than one GNFR. The reason is that more activities can be performed in the facilities (the main activity and also secondary activities, which have a technical connection). For example, in large farms, in addition to animal husbandry, fuel combustion (breeding hall heating) sometimes occurs - in which case the emissions are divided into GNFR C_OtherStationaryComb and K_AgriLivestock.

Two separate databases were used for LPS processing:

- National PRTR
- NEIS (detailed specification in Annex IV)

The National PRTR contains only the total emissions of the facility, therefore the source of metadata was NEIS. NEIS has much more detailed records than the National PRTR. Detailed information about the NEIS is described in IIR **ANNEX IV, Chapter A4.2 SYSTEM CHARACTERISTICS**.

The allocation of emissions into stack height categories also comes from the NEIS.

The data in the National PRTR (as well as E-PRTR) and the NEIS are consistent because the data reported to the NRZ by the operators are validated according to the NEIS.

Possible discrepancies between LPS (Annex VI) and CLRTAP data (Annex I):

Heavy metals, POPs, PCDD/PCDF, HCB, PCB

- Annex I: specific-sector calculation methodology for the CLRTAP report following the EMEP Guidebook
- Annex VI: various types of applied methodology (the data are based on the reporting obligation of individual operators). More information about applied quantification methodologies is written in IIR **ANNEX IV, Chapter A4.2 SYSTEM CHARACTERISTICS**.

Possible discrepancies between LPS (Annex VI) and E-PRTR data:

PM_{10}

- The emissions of PM_{10} are not reported in the E-PRTR. The operators are obliged to monitor only TSP emissions and not the individual fractions of PM.

Annex VI: Emissions are estimated by an internal algorithm considering the amount of TSP and the type of combustion plant or technology in the NEIS central database.

CHAPTER 11: NATIONAL GRIDDED DATA

Last update: 15.3.2021

11.1 OVERVIEW

Convention on Long-Range Transboundary Air Pollution obliges countries to report gridded emissions and large point sources (LPS) data. Both datasets shall be reported every four years from 2017 onwards for the year x-2. This chapter includes basic information on data reported in the year 2017 for the year 2015.
Only data for the year 2015 is available in increased spatial resolution of the EMEP grid 0.1° x 0.1°. The data for previous years 1990, 1995, 2000, 2005 and 2010 was reported in submission in the year 2012.
In order to improve the quality of reporting Slovakia planned to report all milestone years in higher spatial resolution in the next report in May 2021.

11.2 METHODOLOGY AND DATA SOURCES FOR GRIDDED EMISSIONS

Gridded data were reported in line with the EMEP/EEA GB_{2016}, part Spatial mapping of emissions in GNFR categories. Emissions from inventory were spatially distributed using GIS methods. Gridded emissions for 2015 are consistent with reporting in 2017. LPS data were included within the submission of the gridded data. Gridded data were based on fuel sold methodology.

Table 11.1: *The basic methodology used in each GNFR sector*

GNFR SECTOR	THE PROXY USED FOR DISTRIBUTION OF NON-POINT SOURCES (PLEASE SPECIFY BY NFR CODE WHERE RELEVANT)
A_PublicPower	LPS and point sources are not included in LPS. Data from the National emission information system.
B_Industry	LPS data, Industry areas from Corine landcover.
C_OtherStatComb	Corine landcover - inhabited areas, information from census 2011 - a type of fuel for households, data from National emission information system, LPS
D_Fugitives	Five areas were identified as sources of Fugitive emissions - manually identification, LPS, population density map for distributing of NMVOC emissions from petrol stations
E_Solvents	Population density, Corine landcover
F_RoadTransport	Information about transport intensity
G_Shipping	Information from ports, and distribution to river lines
H_Aviation	Point sources - international and inland airports
I_OtherMobile	Railroads emissions – non-electrify railroads map and information from railway depots. Forest and agricultural offroads - Corine landcover. LPS - compressor stations
J_Waste	Population density, Corine landcover, LPS
K_AgriLivestock	Corine landcover
L_AgriOther	Corine landcover

Additional information based on questions in the NECD review 2020:
GNFR sector C_OtherStationaryComb
The most emissions in sector C_OtherStationaryComb come from combustion in households for heating and hot water. Emissions from national inventory in the households sector were spatially distributed based on data from the census 2011 to inhabited areas from Corine landcover. Census 2011 was the source of information about fuels which is primarily used for heating (gas, solid, electricity, liquid). Spatially we have information on the level of small municipality units. We could calculate the share of fuel used in each unit. Data contain many gaps, but we were able to use it for spatial disaggregation of emissions.

The most significant contribution to $PM_{2.5}$ emissions is from firewood combustion in family houses. In urban areas, people use natural gas or a combination of natural gas and wood to a much greater extent than in rural areas. This caused emissions in rural areas to be significantly higher than in urban areas. It also depends on the region. The share of natural gas (NG) use is higher in the lowlands and in the western part of Slovakia. Also because NG is more expensive. This assumption was also shown by data from the 2011 census, but also by data from the 2018 household survey.

GNFR sectors K_AgriLivestock and L_AgriOther

For the distribution of NH_3 emissions was used tier 1 methodology was recommended in the EMEP guidebook chapter 7 spatial mapping. We used data from Corine land cover for arable land. And base on the area of arable land we distribute emissions to each cell.

11.3 PLANNED IMPROVEMENTS

Slovakia planned to improve the methodology and completeness of reporting in the next submission of gridded data in May 2021, with a focus on the key source categories.

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ANNEXES

ANNEX I: KEY CATEGORY ANALYSIS

Key categories were calculated on a detailed level for HMs and POPs in sectors of Energy, Industry and Waste. Uncertainty analysis was also included in the calculation. The tables below show the result of the analysis for the particular NFR categories.

Table A1.1: *Level assessment of the key categories analysis of air pollutants in the Slovak Republic in 2023 in %(cumulative total at least 80%)*

Nox	3Da1(27)	1A3bi(11)	1A4cii(10)	3Da2a(5)	1A3bii(4)	1A3biii(4)	3Da3(4)	1A3c(3)	1A2gvii(3)	2C1(3)	1A2f(3)	1A3di(ii)(2)	1A4bi(2)
NMVOC	2H2(18)	1B2b (10)	1A4bi(8)	1B2ai(8)	1B2av(7)	1B2d(7)	3B1b(5)	1A3bv(5)	3B1a(4)	2D3d(3)	1B1a(2)	3De(2)	3B4gii(1)
SOx	1B2aiv(40)	2C1(13)	1A1a(10)	1A1b(10)	2B10a(6)	1A2a(3)							
NH_3	3Da1(36)	3Da2a(29)	3Da4(7)	3B4gii(5)	3Da3(4)								
$PM_{2.5}$	1A4bi(44)	5C2(10)	1A3bvi(5)	3Dc(4)	3B1b(4)	3B1a(3)	1A3bi(3)	1A3bvii(3)	1B1b(2)	1A4cii(2)	5E(1)		
PM_{10}	3Dc(32)	1A4bi(19)	5C2(5)	1A3bvi(5)	3B4gii(5)	3B4gi(4)	2A5b(3)	3B1b(3)	3B1a(2)	1B1b(2)	1A3bvii(2)		
TSP	3Dc(17)	3B4gi(12)	1B4bi(9)	3B3(9)	2A5b(6)	3B4gii(6)	1A3bvi(4)	3B1b(4)	1B1b(4)	3B1a(4)	5C2(3)	1A3bvii(3)	5C1bi(3)
BC	1A4bi(31)	1A3bi(15)	5C2(8)	1A3bvi(7)	1A4cii(6)	1A3bii(5)	2G(4)	1A2gvii(2)	1A3biii(2)				
CO	1A4bi(40)	5C2(17)	2C1(9)	1A3bi(4)	1B1b(3)								
Pb	1A3bvi(75)	2C1(10)											
Cd	1A4bi(26)	1A3bvi(13)	2G(9)	1A2a(6)	5C1bii(6)	1A1a(5)	2C1(4)	1B1b(4)	5C2 (4)	1A2f(3)	1A4ai(2)		
Hg	1A2f(22)	2K(18)	5C1bv(11)	1A2a(8)	1A2d(7)	1A1a(6)	1A3bi(5)	1A3biii(2)					
As	1A1a(42)	1A3bvi(13)	2C1(11)	5C2(10)	1B1b(3)	1A2d(3)							
Cr	1A3bvi(81)												
Cu	1A3bvi(94)												
Ni	1A1a(28)	1A3bvi(22)	1A3di(ii)(21)	1A3dii(6)	2C1(5)								
Se	1A1a(34)	2C1(19)	1A3bvi(12)	1B1b(9)	1A2a(8)								
Zn	1A3bvi(44)	2D3i(24)	2C1(19)										
PCDD/F	2C7a(22)	1A4bi(18)	1B1b(11)	1A2f(10)	1A3bi(6)	5C2(4)	1A1c(4)	1A3c(3)	2C1(3)				
PAHs	2C1(55)	1B1b(22)	1A4bi(7)										
HCB	5C1bii(91)												
PCB	5C1bii(63)	2C1(22)											

Note: Different colours used to highlight sectors - 1, 2, 3, 5

Table A1.2: *Trend assessment of the key categories analysis with uncertainty of air pollutants in the Slovak Republic in 2023 in % (cumulative total at least 80%)*

Nox	1A4cii(17)	1A3biii(15)	1A3bi(10)	3Da1(10)	1A1a(6)	1A3bii(3)	1A3c(3)	2C1(3)	1A2gvii(3)	1A2f(2)	5C2(2)	1A4bi(2)	3Da3(1)	1A3di(ii)(1)	1A4bii(1)
NMVOC	1A4bi(18)	2H2(18)	1B2b(11)	1B2av(6)	1A3bi(6)	1B2d(6)	1B2ai(5)	1A3bv(4)	2D3d(2)	3De(2)	1A2gviii(1)	1B1a(1)	3B4gii(1)		
SOx	1B2aiv(33)	1A1a(14)	1A4bi(11)	2C1(9)	2B10a(5)	1A1b(5)	1A2d(4)								
NH_3	3Da2a(31)	3Da1(29)	3B3(10)	3B1b(8)	3Da4(5)										
$PM_{2.5}$	1A4bi(57)	5C2(8)	1A3bvi(4)	3Dc(3)	1A3bvii(2)	1A3bi(2)	3B1b(2)	3B1a(2)	1A1a(1)						
PM_{10}	1A4bi(33)	3Dc(27)	5C2(5)	1A3bvi(5)	3B4gii(4)	2A5b(2)	1A3bvii(2)	3B4gi(2)	1B1b(2)						
TSP	1A4bi(25)	3Dc(16)	3B4gi(7)	2A5b(6)	3B4gii(5)	5C1bi(5)	1A3bvi(4)	5C2(3)	1A3bvii(3)	1B1b(3)	5C1bii(3)	3B4h(2)			
BC	1A4bi(45)	1A3bi(9)	1A3biii(7)	1A3bvi(7)	5C2(7)	2G(4)	1A3bii(2)	1A2gvii(2)							
CO	1A4bi(48)	5C2(10)	1A3bi(8)	2C1(5)	1A4cii(5)	1A4bii(5)	1B1b(2)								
Pb	1A3bvi(47)	1A3bi(21)	1A1a(10)	2C1(4)											
Cd	1A1a(27)	1A4bi(15)	1A3bvi(8)	2G(6)	2C7a(6)	1A2a(4)	1A2d(4)	5C1bii(3)	1B1b(1)	5C2(2)	2C1(2)	1B1b(1)	1A4ai(1)		
Hg	1A1a(15)	1A2f(15)	2K(13)	1A2a(11)	5C1bv(10)	1A2d(6)	1A3bi(4)	2C1(2)	5C1biii(2)	1A4ai(2)					
As	1A1a(34)	1A5a(25)	1A3bvi(8)	5C2(5)	1A4bi(4)	2C1(4)	2C7a(3)								
Cr	1A3bvi(78)	2C7a(3)													
Cu	1A3bvi(59)	2C1(10)	1A3biii(9)	1A3bi(7)											
Ni	1A3bvi(27)	1A1a(20)	1A3di(ii)(14)	1A3dii(8)	1B1b(3)	1A2f(3)	1A2a(2)	2C1(2)							
Se	1A1a(26)	2C1(18)	1A3bvi(13)	1A2a(12)	1B1b(6)	1A2a(4)	1A2f(3)	2A3(2)							
Zn	1A3bvi(51)	2D3i(10)	2C1(9)	1A3biii(4)	1A3bi(3)	1A1a(2)	5C2(2)								
PCDD/F	1A1a(20)	2C7a(16)	1A4bi(12)	1B1b(8)	1A2f(8)	1A2c(5)	1A3bi(4)	5C2(3)	5C1biii(3)	1A1c(3)					
PAHs	2C1(49)	1A4bi(15)	1B1b(11)	5C2(8)											
HCB	5C1bii(83)														
PCB	5C1bii(48)	5C1bi(33)													

Note: Different colours used to highlight sectors - 1, 2, 3, 5

ANNEX II: INCLUSION/EXCLUSION OF CONDENSABLE COMPONENT OF PARTICULATE MATTER IN EMISSION FACTORS

The table below shows individual NFR categories, which were balanced using emission factors that include/exclude condensable components of particulate matter. Green cells represent emission factors that include condensable components and purple cells that exclude condensable components. Grey cells represent categories with notation keys and blue cell categories are unknown in using the condensable component in emission factors of particulate matter.

***Table A2.1:** Inclusion/exclusion of the condensable component from the PM_{10} and $PM_{2.5}$ emission factors*

	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
1A1a	Public electricity and heat production		X	Measured emissions
1A1b	Petroleum refining		X	Measured emissions
1A1c	Manufacture of solid fuels and other energy industries		X	Measured emissions
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		X	Measured emissions
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		X	Measured emissions
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		X	Measured emissions
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print		X	Measured emissions
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco		X	Measured emissions
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		X	Measured emissions
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)			
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		X	Measured emissions
1A3ai(i)	International aviation LTO (civil)	X		Eurocontrol [1]
1A3aii(i)	Domestic aviation LTO (civil)	X		Eurocontrol
1A3bi	Road transport: Passenger cars			Unkown - Model Copert
1A3bii	Road transport: Light duty vehicles			Unkown - Model Copert
1A3biii	Road transport: Heavy duty vehicles and buses			Unkown - Model Copert
1A3biv	Road transport: Mopeds & motorcycles			Unkown - Model Copert
1A3bv	Road transport: Gasoline evaporation			Unkown - Model Copert
1A3bvi	Road transport: Automobile tyre and brake wear			Unkown - Model Copert
1A3bvii	Road transport: Automobile road abrasion			Unkown - Model Copert
1A3c	Railways		X	Halder (2005) [2]
1A3di(ii)	International inland waterways		X	Entec (2007) [3]
1A3dii	National navigation (shipping)		X	Entec (2007) [3]
1A3ei	Pipeline transport		X	Measured emissions
1A3eii	Other (please specify in the IIR)			
1A4ai	Commercial/institutional: Stationary		X	Measured emissions
1A4aii	Commercial/institutional: Mobile			
1A4bi	Residential: Stationary	X		Life project
1A4bii	Residential: Household and gardening (mobile)			
1A4ci	Agariculture/Forestry/Fishing: Stationary		X	Measured emissions
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	X		EEA/EMEP GB_{2023}
1A4ciii	Agriculture/Forestry/Fishing: National fishing			
1A5a	Other stationary (including military)		X	Measured emissions
1A5b	Other, Mobile (including military, land based and recreational boats)	X		EEA/EMEP GB_{2023}

	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
1B1a	Fugitive emission from solid fuels: Coal mining and handling		X	EPA (1998) [4]
1B1b	Fugitive emission from solid fuels: Solid fuel transformation		X	EPA (1998) [4]
1B1c	Other fugitive emissions from solid fuels			
1B2ai	Fugitive emissions oil: Exploration, production, transport			
1B2aiv	Fugitive emissions oil: Refining / storage			
1B2av	Distribution of oil products			
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)			
1B2c	Venting and flaring (oil, gas, combined oil and gas)			
1B2d	Other fugitive emissions from energy production			
2A1	Cement production		X	Measured emissions
2A2	Lime production		X	Measured emissions
2A3	Glass production		X	Measured emissions
2A5a	Quarrying and mining of minerals other than coal		X	Measured emissions
2A5b	Construction and demolition		X	Wrap (2006) [5]
2A5c	Storage, handling and transport of mineral products			
2A6	Other mineral products (please specify in the IIR)		X	Measured emissions
2B1	Ammonia production			
2B2	Nitric acid production			
2B3	Adipic acid production			
2B5	Carbide production		X	Measured emissions
2B6	Titanium dioxide production			
2B7	Soda ash production			
2B10a	Chemical industry: Other (please specify in the IIR)		X	Measured emissions
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)		X	Measured emissions
2C1	Iron and steel production		X	Measured emissions
2C2	Ferroalloys production		X	Measured emissions
2C3	Aluminium production			
2C4	Magnesium production		X	Measured emissions
2C5	Lead production		X	Measured emissions
2C6	Zinc production			
2C7a	Copper production			
2C7b	Nickel production			
2C7c	Other metal production (please specify in the IIR)		X	Measured emissions
2C7d	Storage, handling and transport of metal products (please specify in the IIR)			
2D3a	Domestic solvent use including fungicides			
2D3b	Road paving with asphalt		X	Measured emissions
2D3c	Asphalt roofing			
2D3d	Coating applications			
2D3e	Degreasing			
2D3f	Dry cleaning			
2D3g	Chemical products			
2D3h	Printing			
2D3i	Other solvent use (please specify in the IIR)			
2G	Other product use (please specify in the IIR)	X*		Schauer et al. (1998)[5]

	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
2H1	Pulp and paper industry		X	Measured emissions
2H2	Food and beverages industry			
2H3	Other industrial processes (please specify in the IIR)		X	Measured emissions
2I	Wood processing		X	Measured emissions
2J	Production of POPs		X	Measured emissions
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)			
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)			
3B1a	Manure management - Dairy cattle		X	
3B1b	Manure management - Non-dairy cattle		X	
3B2	Manure management - Sheep		X	
3B3	Manure management - Swine			
3B4a	Manure management - Buffalo		X	
3B4d	Manure management – Goats		X	
3B4e	Manure management - Horses		X	
3B4f	Manure management - Mules and asses			
3B4gi	Manure management - Laying hens		X	
3B4gii	Manure management - Broilers		X	
3B4giii	Manure management - Turkeys		X	
3B4giv	Manure management - Other poultry		X	
3B4h	Manure management - Other animals (please specify in IIR)			
3Da1	Inorganic N-fertilizers (includes also urea application)			
3Da2a	Animal manure applied to soils			
3Da2b	Sewage sludge applied to soils			
3Da2c	Other organic fertilisers applied to soils (including compost)			
3Da3	Urine and dung deposited by grazing animals			
3Da4	Crop residues applied to soils			
3Db	Indirect emissions from managed soils			
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products		X	EEA/EMEP GB$_{2023}$
3Dd	Off-farm storage, handling and transport of bulk agricultural products			
3De	Cultivated crops			
3Df	Use of pesticides			
3F	Field burning of agricultural residues			
3I	Agriculture other (please specify in the IIR)			
5A	Biological treatment of waste - Solid waste disposal on land		X	
5B1	Biological treatment of waste - Composting		X	
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities			
5C1a	Municipal waste incineration			
5C1bi	Industrial waste incineration		X	US EPA (1996) [6]
5C1bii	Hazardous waste incineration			
5C1biii	Clinical waste incineration			
5C1biv	Sewage sludge incineration			
5C1bv	Cremation			Unknown

	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
5C1bvi	Other waste incineration (please specify in the IIR)			
5C2	Open burning of waste			
5D1	Domestic wastewater handling			
5D2	Industrial wastewater handling			
5D3	Other wastewater handling			
5E	Other waste (please specify in IIR)			
6A	Other (included in national total for entire territory) (please specify in IIR)			

*for tobacco combustion, for fireworks use unknown

Note:

[1] Kugele A., Jelinek F., Gaffal R. (2005): Aircraft Particulate Matter Emission - Estimation through all Phases of Flight

[2] Halder M., Löchter, A. (2005): Status and future development of the diesel fleet'. Rail diesel study, WP1 final report

[3] Entec UK Limited (2007) Ship Emissions Inventory – Mediterranean Sea, Final Report for Concawe

[4] US EPA (1998). AP42, Compilation of air pollutant emission factors, Vol. 1: Stationary point and area sources, fifth edition, Vol. 1, chapter 11.9 Western surface coal mining

[5] Wrap (2006): Fugitive Dust Handbook, Chapter 3. Construction and Demolition, Western Regional Air Partnership (WRAP)

[6] US EPA (1996). Compilation of Air Pollutant Emission Factors Vol.1. Stationary, Point and Area Sources. Report AP-42 (5th ed.).

ANNEX III: ENERGY BALANCE OF THE SLOVAK REPUBLIC

***Table A3.1:** Energy balance of the Slovak Republic in 2023 in TJ*

	Anthra-cite	*Coking Coal*	*Other Bituminous Coal*	*Brown Coal and Lignite*	*Hard Coal Coke*	*Brown Coal Briquettes*	*Patent Fuel*	*Coal Tar*	*Coke Oven Gas*	*Blast Furnace Gas*	*Oxygen Steel Furnace Gas*
Primary Production	-	-	-	8 753	-	-	-	-	-	-	-
Import	464	70 548	9 889	4 756	4 561	819	56	-	-	-	-
Export	-	-	-	-	366	-	-	1 842	-	-	-
Stock Changes	283	901	-328	942	338	-	-	-	-	-	-
Gross Inland Consumption	**747**	**71 449**	**9 561**	**14 451**	**4 533**	**819**	**56**	**-1 842**	**-**	**-**	**-**
Transformation Input	**386**	**71 449**	**3 578**	**13 303**	**46 260**	**-**	**-**	**-**	**793**	**1 288**	**306**
Electricity Production - Thermal Equipment	386	-	3 578	13 303	-	-	-	-	793	1 282	291
of which: Public	386	-	2 513	13 280	-	-	-	-	-	-	-
Autoproducers	-	-	1 065	23	-	-	-	-	793	1 282	291
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	58 683	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	12 766	-	-	46 260	-	-	-	-	-	-
Refineries	-	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	6	15
Transformation Output	**-**	**-**	**-**	**-**	**43 613**	**-**	**-**	**1 842**	**10 814**	**20 576**	**3 105**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	43 613	-	-	1 842	10 814	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	20 576	3 105
Refineries	-	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Product Transferred	-	-	-	-	-	-	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-	-
Consumption of the Energy Sector	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3 273**	**11 363**	**-**
Distribution Losses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**118**	**1 624**	**483**

1st continuation

	Anthra-cite	*Coking Coal*	*Other Bituminous Coal*	*Brown Coal and Lignite*	*Hard Coal Coke*	*Brown Coal Briquettes*	*Patent Fuel*	*Coal Tar*	*Coke Oven Gas*	*Blast Furnace Gas*	*Oxygen Steel Furnace Gas*
Final Consumption	**361**	**-**	**5 983**	**1 148**	**1 886**	**819**	**56**	**-**	**6 630**	**6 301**	**2 316**
Final Non - Energy Consumption	**258**	**-**	**-**	**-**	**760**	**-**	**-**	**-**	**-**	**-**	**-**
of which: Chemical Industry	-	-	-	-	-	-	-	-	-	-	-
Final Energy Consumption	**103**	**-**	**5 983**	**1 148**	**1 126**	**819**	**56**	**-**	**6 630**	**6 301**	**2 316**
Industry	**103**	**-**	**4 754**	**528**	**1 098**	**-**	**-**	**-**	**6 630**	**6 301**	**2 316**
of which: Iron and steel	103	-	4 235	-	113	-	-	-	6 626	6 301	2 316
Non - ferrous metals	-	-	-	-	56	-	-	-	-	-	-
Chemical	-	-	-	-	28	-	-	-	-	-	-
Non - metallic minerals	-	-	519	482	845	-	-	-	4	-	-
Mining and quarrying	-	-	-	-	-	-	-	-	-	-	-
Food, beverages and tobacco	-	-	-	-	56	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-	-
Pulp, paper and print	-	-	-	-	-	-	-	-	-	-	-
Mach. and transport equipment	-	-	-	46	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Other Sectors	**-**	**-**	**1 229**	**620**	**28**	**819**	**56**	**-**	**-**	**-**	**-**
of which: Households	-	-	300	402	28	567	-	-	-	-	-
Agriculture	-	-	-	-	-	-	-	-	-	-	-
Commercial and public services	-	-	929	218	-	252	56	-	-	-	-

2nd continuation

	Natural Gas	*Crude Oil and NGL*	*Refinery Feedstock*[1/]	*Refinery Gas*	*LPG*	*Naphta*	*Gasoline*	*Kerosene*
Primary Production	1 752	84	8 553	-	-	-	-	-
Import	159 699	227 561	-	-	2 392	880	9 794	87
Export	-	42	-	-	2 760	4 488	28 372	2 771
Stock Changes	-10 319	-8 022	-	-	-92	704	-615	-87
Gross Inland Consumption	**151 132**	**219 581**	**8 553**	**-**	**-460**	**-2 904**	**-19 193**	**-2 771**
Transformation Input	**30 593**	**219 581**	**30 630**	**167**	**-**	**-**	**-**	**-**
Electricity Production - Thermal Equipment	22 781	-	-	167	-	-	-	-
of which: Public	21 811	-	-	-	-	-	-	-
Autoproducers	970	-	-	167	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-
Refineries	-	219 581	30 630	-	-	-	-	-
Heat Production	7 812	-	-	-	-	-	-	-
Transformation Output	**-**	**-**	**-**	**14 815**	**7 820**	**25 300**	**46 247**	**3 984**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-
Refineries	-	-	-	14 815	7 820	25 300	46 247	3 984
Heat Production	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-6 609**	**-**	**22 077**	**-**	**-2 668**	**-5 632**	**-**	**-**
Product Transferred	-6 609	-	13 777	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	8 300	-	-2 668	-5 632	-	-
Consumption of the Energy Sector	**3 200**	**-**	**-**	**10 993**	**-**	**-**	**-**	**-**
Distribution Losses	**2 849**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3rd continuation

	Natural Gas	*Crude Oil and NGL*	*Refinery Feedstock[1/]*	*Refinery Gas*	*LPG*	*Naphta*	*Gasoline*	*Kerosene*
Final Consumption	**106 460**	**-**	**-**	**3 655**	**4 692**	**16 764**	**27 054**	**1 213**
Final Non - Energy Consumption	**12 553**	**-**	**-**	**-**	**2 208**	**16 764**	**-**	**-**
of which: Chemical Industry	12 553	-	-	-	2 208	16 764	-	-
Final Energy Consumption	**93 907**	**-**	**-**	**3 655**	**2 484**	**-**	**27 054**	**1 213**
Industry	**30 410**	**-**	**-**	**3 655**	**368**	**-**	**44**	**-**
of which: Iron and steel	5 879	-	-	-	-	-	44	-
Non - ferrous metals	1 262	-	-	-	-	-	-	-
Chemical	3 594	-	-	3 655	-	-	-	-
Non - metallic minerals	3 246	-	-	-	92	-	-	-
Mining and quarrying	1 040	-	-	-	-	-	-	-
Food, beverages and tobacco	4 811	-	-	-	92	-	-	-
Textile and leather	319	-	-	-	-	-	-	-
Pulp, paper and print	1 444	-	-	-	-	-	-	-
Mach. and transport equipment	5 666	-	-	-	46	-	-	-
Not elsewhere specified	3 149	-	-	-	138	-	-	-
Transport	**313**	**-**	**-**	**-**	**1 610**	**-**	**27 010**	**1213**
Other Sectors	**63 184**	**-**	**-**	**-**	**506**	**-**	**-**	**-**
of which: Households	43 949	-	-	-	276	-	-	-
Agriculture	1 223	-	-	-	138	-	-	-
Commercial and public services	18 012	-	-	-	92	-	-	-

1/ include Additives, Oxygenates and Other Hydrocarbons

4th continuation

	Diesel Oil	*Light Fuel Oil*	*Heavy Fuel Oil - Low Sulphur (<1%)*	*Heavy Fuel Oil - High Sulphur (>=1%)*	*White Spirit SBP*	*Lubricants*	*Bitumens*	*Paraffin Waxes*	*Petroleum Coke*	*Other Products*
Primary Production	-	-	-	-	-	-	-	-	-	-
Import	55 619	1 261	162	2 666	387	2 459	8 310	173	2 583	5 750
Export	86 584	1 058	4 242	8 685	215	375	3 544	-	-	13 784
Stock Changes	1 346	-81	-81	-566	-	-	-	-	-276	-381
Gross Inland Consumption	**-29 619**	**122**	**-4 161**	**-6 585**	**172**	**2 084**	**4 766**	**173**	**2 307**	**-8 415**
Transformation Input	**-**	-	**81**	**2 909**	**-**	**-**	**-**	**-**	**-**	**-**
Electricity Production - Thermal Equipment	-	-	81	2 909	-	-	-	-	-	-
of which: Public	-	-	81	-	-	-	-	-	-	-
Autoproducers	-	-	-	2 909	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	-
Refineries	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	-
Transformation Output	**111 785**	**1 058**	**4 242**	**16 685**	**-**	**-**	**-**	**-**	**1 619**	**11 712**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	-
Refineries	111 785	1 058	4 242	16 685	-	-	-	-	1 619	11 712
Heat Production	-	-	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Product Transferred	-	-	-	-	-	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-
Consumption of the Energy Sector	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1 618**	**-**
Distribution Losses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

5th continuation

	Diesel Oil	*Light Fuel Oil*	*Heavy Fuel Oil - Low Sulphur (<1%)*	*Heavy Fuel Oil - High Sulphur (>=1%)*	*White Spirit SBP*	*Lubricants*	*Bitumens*	*Paraffin Waxes*	*Petroleum Coke*	*Other Products*
Final Consumption	**82 166**	**1 180**	**-**	**7 191**	**172**	**2 084**	**4 766**	**173**	**2 308**	**3 297**
Final Non - Energy Consumption	**-**	**936**	**-**	**-**	**172**	**2 084**	**4 766**	**173**	**620**	**3 297**
of which: Chemical Industry	-	936	-	-	-	-	-	-	-	3 297
Final Energy Consumption	**82 166**	**244**	**-**	**7 191**	**-**	**-**	**-**	**-**	**1 688**	**-**
Industry	**420**	**163**	**-**	**7 191**	**-**	**-**	**-**	**-**	**1 688**	**-**
of which: Iron and steel	-	-	-	-	-	-	-	-	-	-
Non - ferrous metals	-	-	-	-	-	-	-	-	-	-
Chemical	-	-	-	7 191	-	-	-	-	-	-
Non - metallic minerals	42	-	-	-	-	-	-	-	1 688	-
Mining and quarrying	126	-	-	-	-	-	-	-	-	-
Food, beverages and tobacco	42	122	-	-	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-
Pulp, paper and print	-	-	-	-	-	-	-	-	-	-
Mach. and transport equipment	-	-	-	-	-	-	-	-	-	-
Not elsewhere specified	210	41	-	-	-	-	-	-	-	-
Transport	**79 769**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Other Sectors	**1 977**	**81**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
of which: Households	-	-	-	-	-	-	-	-	-	-
Agriculture	1 977	-	-	-	-	-	-	-	-	-
Commercial and public services	-	81	-	-	-	-	-	-	-	-

6th continuation

	Nuclear Heat	*Solar Heat*	*Geo-thermal Heat*	*Ambient heat*	*Heat*	*Wood and Charcoal*	*Municipal Solid Wastes*	*Biogas*	*Industrial Wastes*	*Wind energy*	*Hydro Energy*	*Solar Electricity*	*Electricity*	*Liquid Biofuels*	*Total*
Primary Production	177 266	405	366	4 721	-	48 857	2 971	4 461	6 683	14	16 870	2 178	-	7 745	291 679
Import	-	-	-	-	61	259	-	-	490	-	-	-	38 336	3 637	613 659
Export	-	-	-	-	-	373	-	-	-	-	-	-	50 656	4 251	214 408
Stock Changes	-	-	-	-	-	-270	-	-	80	-	-	-	-	37	-16 487
Gross Inland Consumption	**177 266**	**405**	**366**	**4 721**	**61**	**48 473**	**2 971**	**4 461**	**7 253**	**14**	16 870	2 178	**-12 320**	**7 168**	**674 443**
Transformation Input	**175 483**	**-**	**334**	**-**	**-**	**16 627**	**1 765**	**3 554**	**536**	**-**	**-**	**-**	**-**	**-**	**619 623**
Electricity Production - Thermal Equipment	-	-	-	-	-	13 674	1 765	3 479	517	-	-	-	-	-	65 006
of which: Public	-	-	-	-	-	7 772	-	968	318	-	-	-	-	-	47 129
Autoproducers	-	-	-	-	-	5 902	1 765	2 511	199	-	-	-	-	-	17 877
Nuclear Plants	175 483	-	-	-	-	-	-	-	-	-	-	-	-	-	175 483
Coke Ovens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58 683
Blast Furnaces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59 026
Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250 211
Heat Production	-	-	334	-	-	2 953	-	75	19	-	-	-	-	-	11 214
Transformation Output	**-**	**-**	**-**	**-**	**24 781**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**87 358**	**-**	**437 356**
Electricity Production - Thermal Equipment	-	-	-	-	15 064	-	-	-	-	-	-	-	21 359	-	36 423
of which: Public	-	-	-	-	12 952	-	-	-	-	-	-	-	13 129	-	26 081
Autoproducers	-	-	-	-	2 112	-	-	-	-	-	-	-	8 230	-	10 342
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-	-	65 999	-	65 999
Coke Ovens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56 269
Blast Furnaces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23 681
Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	245 267
Heat Production	-	-	-	-	9 717	-	-	-	-	-	-	-	-	-	9 717
Exchanges and Transfers, Backflows	**-1 783**	**-2**	**-**	**-4 721**	**6 506**	**-**	**-**	**-**	**-**	**-14**	-16 870	**-2 178**	**19 062**	**-7 168**	**0**
Product Transferred	-1 783	-2	-	-4 721	6 506	-	-	-	-	-14	-16 870	-2 178	19 062	-7 168	0
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Consumption of the Energy Sector	**-**	**2**	**-**	**-**	**2 835**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**13 496**	**-**	**46 780**
Distribution Losses	**-**	**-**	**-**	**-**	**3 923**	**11**	**-**	**-**	**-**	**-**	**-**	**-**	**4 021**	**-**	**13 029**

End of table

	Nuclear Heat	Solar Heat	Geo-thermal Heat	Ambient heat	Heat	Wood and Charcoal	Municipal Solid Wastes	Biogas	Industrial Wastes	Wind energy	Hydro Energy	Solar Electricity	Electricity	Liquid Biofuels	Total
Final Consumption	-	**401**	**32**	-	**24 590**	**31 835**	**1 206**	**907**	**6 717**	-	-	-	**76 583**	-	**430 946**
Final Non - Energy Consumption	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**44 591**
of which: Chemical Industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35 758
Final Energy Consumption	-	**401**	**32**	-	**24 590**	**31 835**	**1 206**	**907**	**6 717**	-	-	-	**76 583**	-	**386 355**
Industry	-	-	-	-	**2 244**	**12 812**	-	**38**	**6 704**	-	-	-	**31 871**	-	**119 338**
of which: Iron and steel	-	-	-	-	25	39	-	-	-	-	-	-	5 980	-	31 661
Non - ferrous metals	-	-	-	-	74	-	-	-	-	-	-	-	749	-	2 141
Chemical	-	-	-	-	320	3	-	-	950	-	-	-	3 373	-	19 114
Non - metallic minerals	-	-	-	-	201	95	-	-	5 724	-	-	-	2 376	-	15 314
Mining and quarrying	-	-	-	-	2	-	-	-	-	-	-	-	212	-	1 380
Food, beverages and tobacco	-	-	-	-	72	208	-	11	-	-	-	-	2 203	-	7 617
Textile and leather	-	-	-	-	26	1	-	-	-	-	-	-	497	-	843
Pulp, paper and print	-	-	-	-	974	9 876	-	3	-	-	-	-	3 064	-	15 361
Mach. and transport equipment	-	-	-	-	361	213	-	24	30	-	-	-	9 320	-	15 706
Not elsewhere specified	-	-	-	-	189	2 377	-	-	-	-	-	-	4 097	-	10 201
Transport	-	-	-	-	-	-	-	-	-	-	-	-	**2 542**	-	**112 457**
Other Sectors	-	**401**	**32**	-	**22 346**	**19 023**	**1206**	**869**	**13**	-	-	-	**42 170**	-	**154 560**
of which: Households	-	321	-	-	15 987	18 666	-	-	-	-	-	-	21 053	-	101 549
Agriculture	-	-	32	-	68	278	-	554	-	-	-	-	727	-	4 997
Commercial and public services	-	80	-	-	6 291	79	1206	315	13	-	-	-	20 390	-	48 014

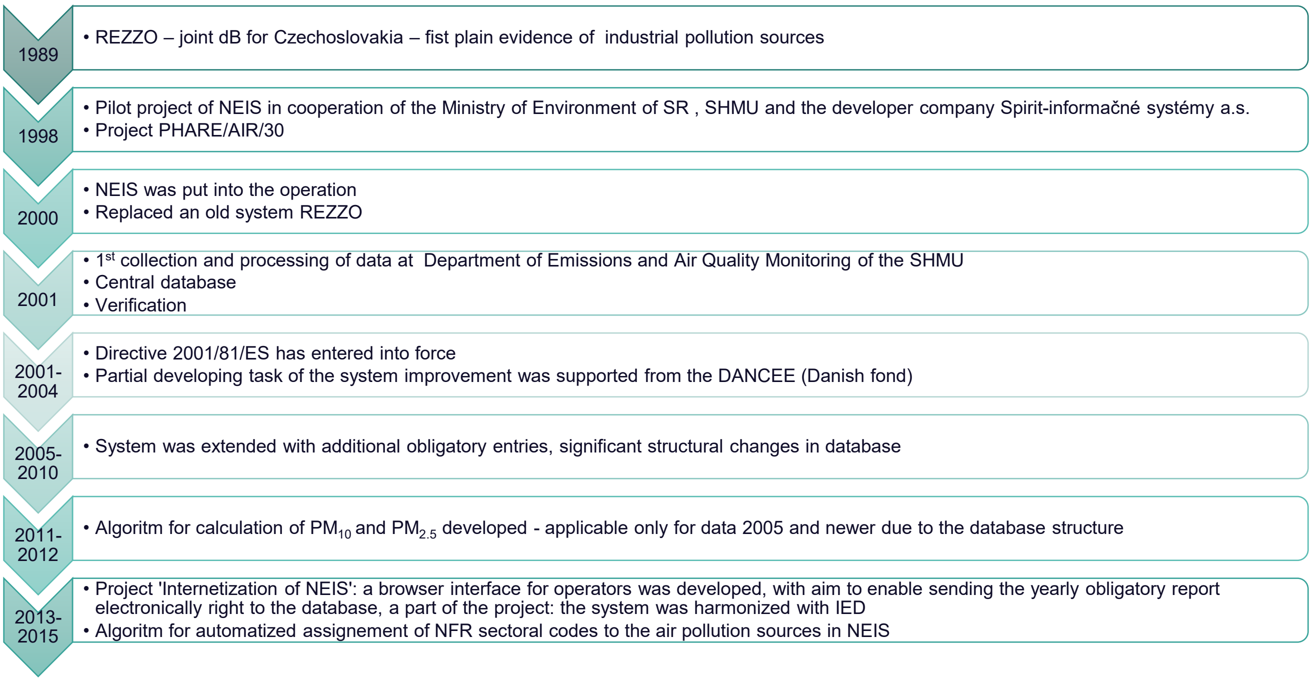
ANNEX IV: ADDITIONAL INFORMATION ON METHODOLOGY

ANNEX IV includes additional information on the methodology used in the NEIS database.

NEIS database is the National Emission Information System for air pollutants (NO_X, SOX, NMVOC, NH3, HM and TSP). Information System NEIS was established in 1998. The database was developed to fulfil the national legislation in air quality and the requirements for pollutant fees decisions (Act No 401/1998 on air pollution charges as amended). Since 2000, when the NEIS was set into operation, the emissions are directly collected consistently and verified on more levels. This database replaced an old system REZZO (Emission and Air Pollution Source Inventory). The first collection and processing of data by NEIS were realized in 2001. The Department of Emissions and Biofuels of the SHMÚ is in charge of the processing of final data in the central database. The following scheme represents the formation of the database in time with important dates.

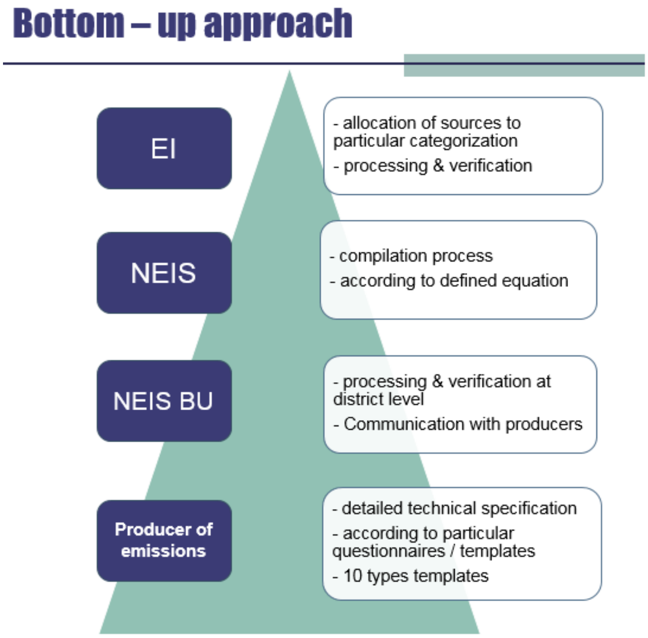
The last changes within the improvement of the NEIS were carried out from December 2013 until August 2015. Within the scope of the recent Project 'Internetization of NEIS, a browser interface was developed. The aim was to enable sending the yearly obligatory report electronically right to the database NEIS PZ WEB. The module NEIS BU on district offices is connected to this database and data is synchronized.

Figure A4.1: *Milestones in the development NEIS database*



The emissions of air pollutants (NOx, SOx, NMVOC, NH_3, TSP, PMs and HM) are recorded and calculated on a yearly basis in the NEIS database. The data collection of air pollutants and emission inventory preparation is performed by a standardized procedure. For the international emission inventory requirements, the bottom-up approach has been introduced for the basic pollutants

Figure A4.2: *Scheme of bottom-up approach built-in database NEIS*



A4.1 DATA COLLECTION

Annual data is collected from energy and industry sources following Act on Air Protection No 137/2010 Coll. as amended and related regulations. The collection of annual activity data is performed through the 10 types of questionnaires (forms), where specific data is required from operators and recorded in the NEIS. In the following table is presented the complete list of forms with the name and content of surveyed data. Forms 1-5 require identification data of operators, a sum of emissions and fees for the operator and individual sources of an operator in each district, data on calculation of fees and data on quality and parameters of combusted fuels and waste. The data has to be updated annually. Forms 6–10 require relatively steady data. Data is updated if the change has been made (for instance reconstruction of source, change of technology, change in source categorization and the size of source etc.).

All annual sets of input data involving fuel amounts (according to the types, and quality marks) necessary for the emission balance are obtained from the district offices using the NEIS BU module. Activity data collected in the NEIS central database are allocated according to the NFR categorization for solid, liquid, gaseous fuels, biomass and other fuels. The emissions balances of air pollutants in the range from 2000–2022 were processed in the NEIS CU module by the same way of calculation.

Table A4.1: *Overview of data forms required from operators of air pollution sources*

FORM TYPE	NAME	CONTENT
T1	Operator of the air pollution sources	Annual data on emissions and fees
T2	Air pollution source (APS)	Annual data on source - parameters
T3	Combustion parts of APS combusting fuels/waste	Annual data on emissions and fee calculation
T3a	Technological parts of APS combusting fuels/waste - direct process heating	Annual data on emissions and fee calculation
T4	Technological parts of source including surface and fugitive emissions	Annual data on emissions and conditions of fee calculation
T4a	Technological parts of source	Calculations of ammonia in livestock farming
T4b	Technological parts of source	Calculations for storage and handling of organic liquids
T4c	Balance sheet of organic solvents	Annual data on emissions and conditions of fee calculation
T5	Fuels and combusted waste	Annual data on amounts and parameters of fuels
T5a	Fuels in LCP	Annual data on amounts and parameters of fuels

FORM TYPE	NAME	CONTENT
T6	Source of air pollution	Steady data about the source
T7	Location of discharge and release of AP	Base data on stacks, exhausts and defined area
T8	Energy facility - combustion unit	Technical parameters
T9	Technological parts of APS	Base data on technological lines except the direct contact of flue gas with heating medium
T9a	Technological parts of APS	Facility using the organic solvents
T9b	Technological parts of APS	Refuelling gas station
T9c	Technological parts of APS	Distribution storages of gasoline
T9d	Technological parts of APS	Waste incinerations and co-incineration plants
T9e	Technological parts of APS combusting fuels/waste - direct process heating	Technological parts where flue gas is used for direct process heating and drying - technical parameters
T10	Abatement technologies	Base data for energy and technological parts of air pollution sources
-	Fuel sellers	data on fuel sold

A4.2 SYSTEM CHARACTERISTICS

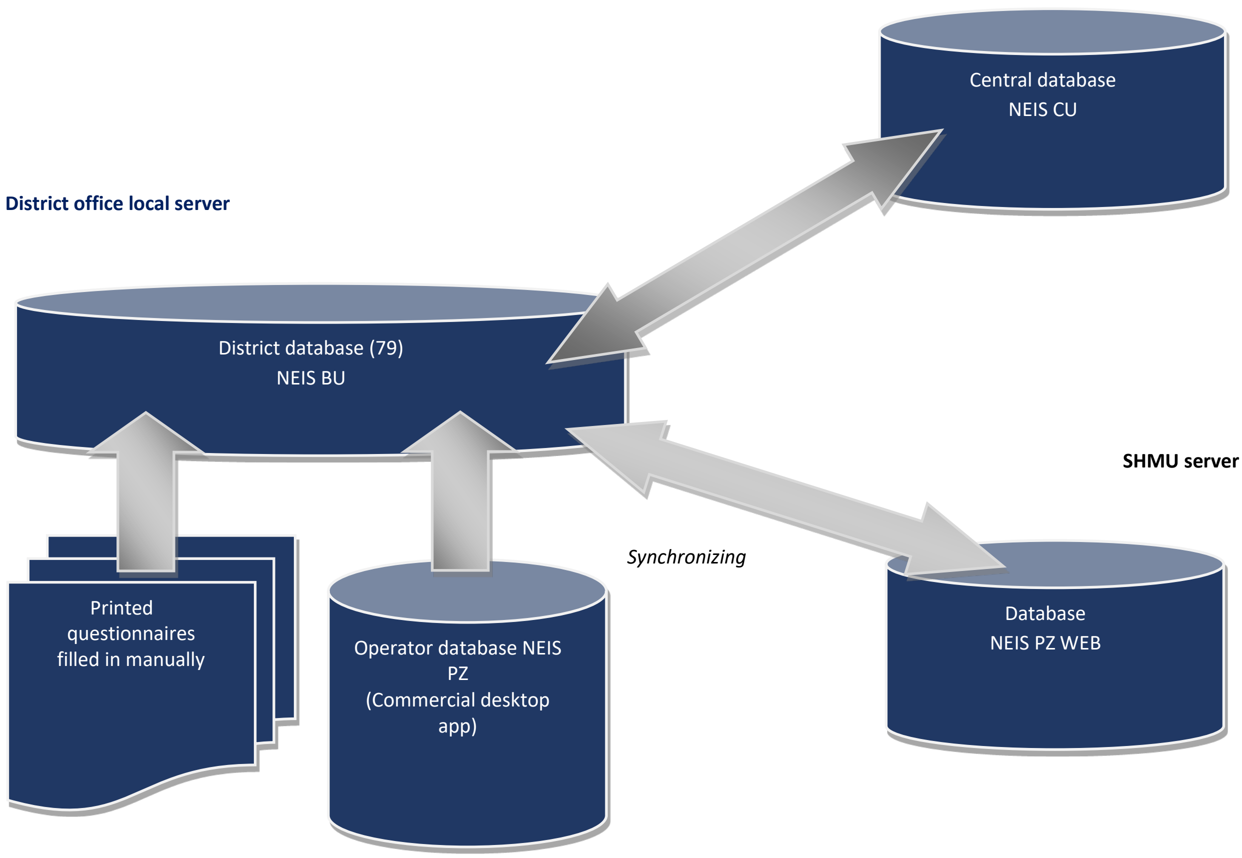
Database NEIS includes about 13000 sources of air pollution per year. The sources are categorized by activity and projected capacity as large or medium (Decree No 410/2012 Coll.) as follow:

- Large sources:
  - Technological units containing combustion plants having a total rated thermal input of more than 50 MW and other technological units with a capacity above the defined limit
- Medium sources:
  - Technological units containing combustion plants having total rated thermal input between 0.3 – 50 MW and other technological units with a capacity under the defined limit for the large sources but over the defined limit for the medium sources

Operators of large and medium sources are obliged to annually report specific datasets about the operation (e.g. quantity of emissions and calculation of the air pollution fee). The reported data is gathered in NEIS. Sources below the relevant projected capacity are defined as small and these are not included individually in this system. However, the emission balance of small sources is being processed at the district level.

Emissions are summarized on the level of the sources releasing pollutants into the air. The term 'source' is defined in the National Act No 146/2023 as a stationary technological unit (including storage of fuels, raw materials or products, quarries and other areas or objects), plant or activity, which is polluting or can pollute the air; delimited is as a functional and spatial complexity of all plants and activities. In some cases, this definition overlaps the definition of the 'installation' in IED, but mainly 'source' is a part of the 'installation'. Another IED term 'plant' is also mainly a part of the 'source' or identical to it.

Figure A4.3: The scheme of the connection of individual databased in NEIS



Each source can contain one or more combustion plants and/or one or more technologies. The quantifying of the yearly emissions is executed on the plant/technology level. The applicable methods for the quantifying are enacted in Decree No 411/2012 on emission monitoring in stationary sources of air pollution:

- prescribed technical balance approach,
- explicit emission-dependence approach,
- continuous measurement,
- calculation using representative individual emission factor or representative individual mass flow,
- calculation using emission factor evaluated by periodic measurement,
- calculation using mass flow or mass concentration evaluated by periodic measurement,
- general emission-dependence approach,
- default emission factor approach[5],
- calculation using an emission-dependence approach or EF published in technical standards, directives, guidelines or another official document of a competent authority, EU and related organizations,
- other suitable approaches to filling given requirements,
- combination of previous approaches.

Possibly activity data is the operation hours, fuel consumption, volume of the waste gases, amount of produced energy or other relevant product.

Due to the NFR sectoral code changes, it was necessary to recalculate the accessible timeline. Revision of all sources expected the development of the methodology for automatized re-assignment of sectoral codes to the individual sources. The accessible timeline in NEIS (2000-2022) was revised: emissions from individual air pollution sources were reallocated according to revised sectoral codes.

[5] General relations, as well as default EF, are published in Bulletin of the Ministry of the Environment No 410/2012 Coll.

The methodology for automatized re-assignment is based on the following key data:

- Air pollution source category (Decree No 410/2012 Coll.)
- SK NACE rev.2 code of the operator

The developed algorithm checks the key data, compares this with the assignment rules and due to the result executes the assignment of the relevant NFR sectoral code. The procedure is iterated for every source record in the chosen year. It is also possible to add an exception.

- Small sources:
  - Stationary equipment – domestic heating equipment for the combustion of solid fuels and natural gas with a total rated thermal input of less than 0.3 MW

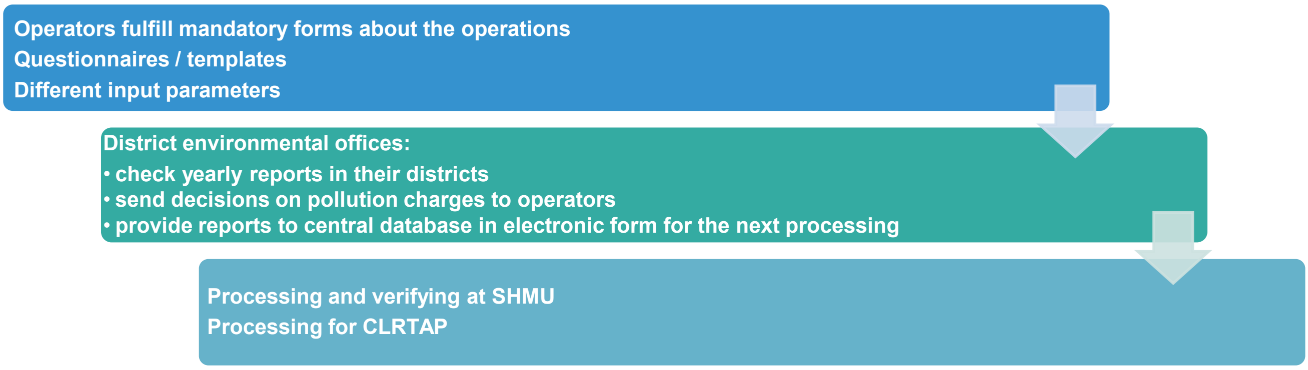
The sources below 0.3 MW (category **1A4bi** – Residential: Stationary plants) are defined as small sources. These are not registered as individual point sources. The emission balance is being processed centrally (NEIS CU - central unit) and it is based on:

- Solid fossil fuels sold (data on district level) for the operator of fuel combustion plants with RTI up to 0,3 MW (households)
  - in 2001–2003 according to Decree No 144/2000
  - in 2004–2009 according to Decree No 53/2004
  - since 2010 according to Decree No 362/2010
  - Consumption of natural gas for the inhabitants and the annual market share on the gas sale in SR
  - Consumption of electric energy in the households
  - Annually specified emission factor

A4.3 DATAFLOW AND PROCESSING

According to Act No 137/2010 Coll. as amended by Act No 318/2012 Coll. operators of large and medium sources are obliged to annually report specific datasets about the operation. The main data is the amount of released emissions, the pollutant fee and fuel consumption. The dataset contains also the amount of various metadata. This reporting obligation since 1/2016 can be fulfilled by using the browser-interfaced tool NEIS PZ WEB, which was developed for the operators as a result of the project 'Internetization of the National Emission Information System'. Data from operators are collected and verified by the district offices using the SW module NEIS BU. District environmental offices are obliged to prepare the annual dataset containing operational characteristics of air pollution sources in their districts and provide this to the SHMÚ central database in the specified format (79 district databases) for the next processing.

***Figure A4.4:** Scheme of the process of emissions inventory compilation using the NEIS database*



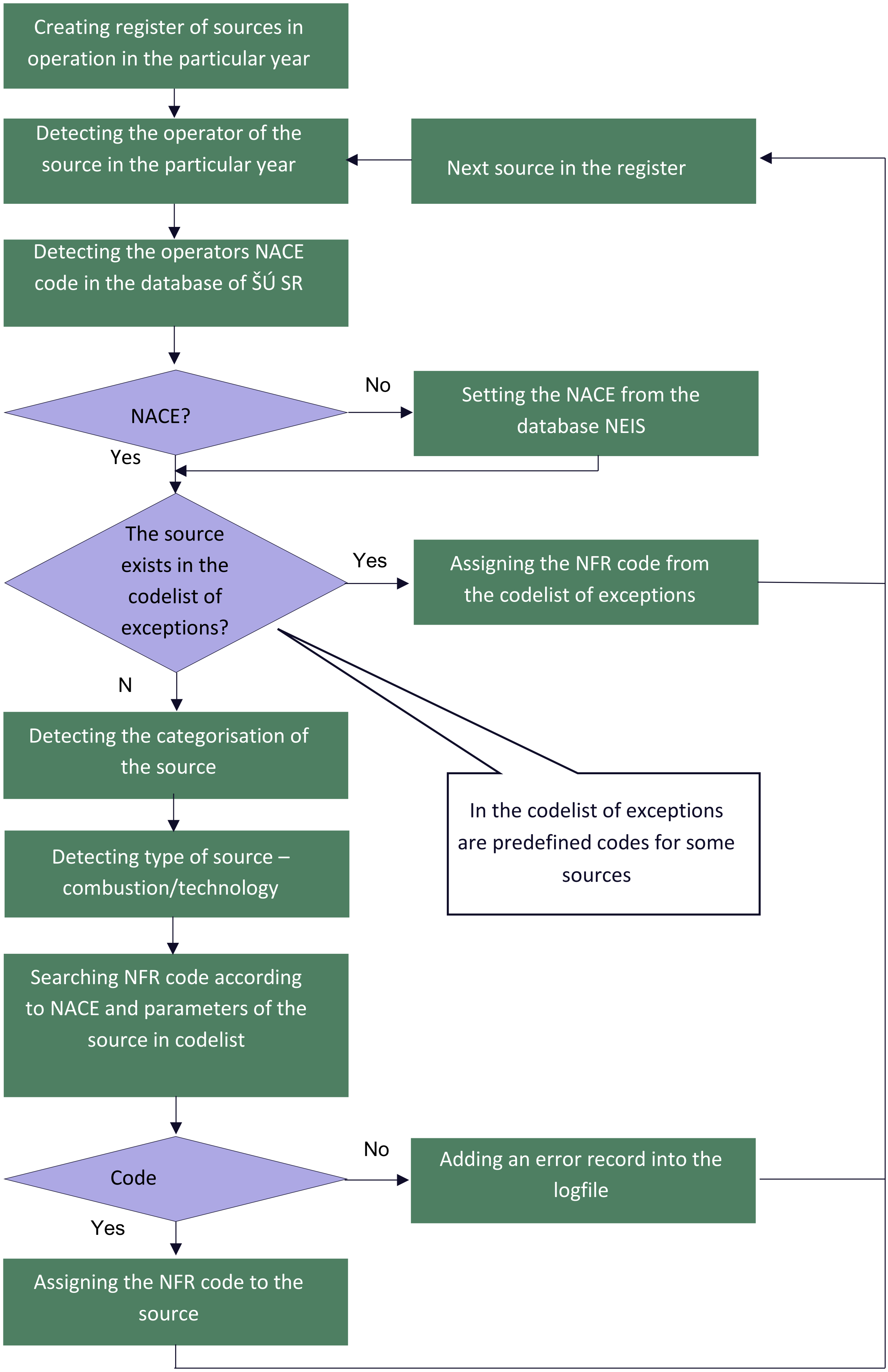
A4.4 VERIFICATION PROCESS OF NEIS DATA

Verification of input data is on a yearly basis. After the legislative deadline for operators to deliver the mandatory questionnaires with data either electronically – direct input to the database or in written form to the district offices, the data are imported and firstly verified on the level of districts (79 district offices responsible for the related pollution sources in the territory of individual districts). Verification is performed partly by automatized inbuilt check-up mechanisms for illogical and missing key data, and partly by the specialist for environmental issues at the district environmental offices. In cases when the data are not clear, the operator or responsible contact persons are contacted for the verification and explanation of their input data.

The second verification level is in a central database in SHMÚ, there is performed also the automatized verification inbuilt check-up mechanisms for illogical and missing key data, and partly by the specialist for environmental issues. In cases when the data are not clear, the operator or responsible district offices are contacted or directly the operators.

A4.5 PROCESS OF CODE MATCHING IN NEIS DATABASE

Figure A4.5: *Flowchart of code matching process*



The sources, having the national categorization, included in the Energy sector are linked to NFR according to the system of NFR code assignment:
However, this definition of energy units is wider and insufficient. For distinguishing into individual NFRs is used also the specification according to NACE.
The collected data are processed to calculate definite emissions for a particular year for each source in a registry. NEIS is highly variable for the determination of emissions according to approved permission on the operation and technical condition of the installation. There are several manners for the compilation of combustion emissions.
Emission compilations for energy in NEIS:

1.	Continuous measurement
2.	Calculation using representative concentration and volume of flue gas

$$Em[t] = (1 - \eta/100) \times c[mg/m^3] \times V[th.m^{-3}] \times 10^{-6}$$

Where
η = Effectiveness of abatement technology or separator
c = concentration of air pollutant

V = quantity/volume of released waste gas3.	Calculation using representative individual mass flow and number of operating hours

$$Em[t] = (1 - \eta/100) \times q[kg/hour] \times 10^{-3}$$

Where
η = Effectiveness of abatement technology or separator
q = mass flow
t = number of operational hours for the related year

4.	Calculation using emission factor and amount of fuel

$$Em[t] = (1 - \eta/100) \times EF[kg/t] \times AD[t] \times 10^{-3}$$
$$Em[t] = (1 - \eta/100) \times EF[kg/mil.m^3] \times AD[th.m^3] \times 10^{-6}$$

Where
η = Effectiveness of abatement technology or separator
EF = Emission Factor
AD = Quantity of fuel

5.	Calculation using emission factor and amount of related quantity other than fuel

$$Em[t] = (1 - \eta/100) \times EF[kg/GJ] \times AD[GJ] \times 10^{-3}$$
$$Em[t] = (1 - \eta/100) \times EF[kg/kWh] \times AD[kWh] \times 10^{-3}$$

Where
η = Effectiveness of abatement technology or separator
EF = Emission Factor
AD = Activity Data (Quantity of related Activity Data)

6.	Calculation using emission factor related to the content of AP in fuel and amount of fuel

$$Em[t] = (1 - \eta/100) \times EF[kg/t] \times AP[\%] \times AD[t] \times 10^{-3}$$
$$Em[t] = (1 - \eta/100) \times EF[kg/mil.m^3] \times AP[\%] \times AD[th.m^3] \times 10^{-6}$$
$$Em[t] = (1 - \eta/100) \times EF[kg/t] \times AP[mg/kg] \times AD[t] \times 10^{-9}$$
$$Em[t] = (1 - \eta/100) \times EF[kg/mil.m^3] \times AP[mg/kg] \times AD[th.m^3] * 10^{-12}$$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of Air Pollutant expressed as a percentage

AD = Activity Data (Quantity of related Activity Data)7.	Calculation using content of ash, sulphur or other compound in dry matter and emission factor related to content of AP in fuel and amount of fuel

$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/t] \times AP\ [\%\ in\ dry\ matter] * 1 - W/100 \times AD\ [t] * 10^{-3}$$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of ash, sulphur or other compound in dry matter expressed as a percentage

W = humidity of the material

AD = Quantity of fuel

8.	Calculation using emission factor related to calorific value

$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/GJ] \times NCV\ [GJ/t] \times AD\ [t] * 10^{-3}$$
$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/GJ] \times NCV\ [GJ/th.m^3] \times AD\ [th.m^3] \times 10^{-3}$$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

NCV = Net Calorific Value

AD = Activity Data (Quantity of related Activity Data)

9.	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel

$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/GJ] \times AP\ [\%] \times NCV\ [GJ/t] \times AD\ [t] \times 10^{-3}$$
$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/GJ] \times AP\ [\%] \times NCV\ [GJ/th.m^3 \times AD\ [th.m^3] \times 10^{-6}$$
$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/GJ] \times AP\ [mg/kg] \times NCV\ [GJ/t] \times AD\ [t] \times 10^{-9}$$
$$Em\ [t] = (1 - \eta/100) \times EF\ [kg/GJ] \times AP\ [mg/kg] \times NCV\ [GJ/th.m^3] \times AD\ [th.m^3] \times 10^{-12}$$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of Air Pollutant expressed as a percentage

AD = Activity Data (Quantity of related Activity Data)

10.	Calculation using content of ash and sulphur in dry matter and emission factor related to content of AP in fuel and related to calorific value and amount of fuel

$$Em\ [t] = \left(1 - \frac{\eta}{100}\right) \times EF\ \left[\frac{kg}{GJ}\right] \times AP\ [\%] \times 1 - W/100 \times NCV\ [GJ/t] \times AD\ [t] \times 10^{-3}$$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of ash and sulphur in dry matter expressed as a percentage

W = humidity of the material

AD = Quantity of fuel

99.	Other manner of determination

In data processing, is taken specific information on abatement technologies and their effectiveness in a compilation of final emissions. (**ANNEX IV, Chapter A4.7**).

A4.5.1 Calculation of Particulate Matters

Total Suspended Particles (TSP) emissions are provided directly by operators of individual large and medium sources on the base of measurements or more precisely by calculation (in compliance with the air protection legislation of the Slovak Republic). The emission inventory of PM_{10} and $PM_{2.5}$ for the Slovak Republic is elaborated according to the EMEP/EEA GB_{2019} and in compliance with requirements of the respect of a working group for emission inventory (UN ECE Task Force on Emission inventory) and the methodology is based on IIASA's report[6].

Automated calculation of emissions PM_{10} and $PM_{2.5}$ was technically implemented in 2011[7] in db. NEIS according to the study[8]. Emissions PM_{10} and $PM_{2.5}$ were processed with certain sectoral default indicators. In respect of that on the EU level was defined emission ceiling for 2020 based on the GAINS model (from IIASA) so we resolved to the methodology of calculation inventory of PM_{10} and $PM_{2.5}$. National inventory is based on the modelling of national projections

The NEIS database contains a special program that automatically calculates emissions of PM_{10} and $PM_{2.5}$. The outputs from the NEIS database are verified and performed in Excel sheets. The efficiency of the installed separation of fractions is defined and then emissions of PM_{10} and $PM_{2.5}$ behind the separator were calculated. After calculations behind the separator, the calculation of total emissions of PM_{10} and $PM_{2.5}$ is taken to NFR tables

Emissions are distinguished into three fractions: fine ($PM_{2.5}$), coarse (PM_{10} -$PM_{2.5}$) and big (PM>10 µm)

Final emissions are calculated: $PM_{10} = PM_{fine} + PM_{coars.}$

A4.6 ENERGY – GENERAL EMISSION FACTORS

The general emission factors are valid for emissions from combustion before the use of abatement technologies or additives. The final amount of released air pollutants demands the effectiveness of abatement or degree of DESOX after the addition of additives.

Emission factors used in the NEIS Database were updated in 2018 in the final report of the Study Drafting of emission factors for combustion plants for MŽP SR. Updated emission factors are available in ANNEX I and ANNEX II of this study (only in Slovak).

A4.7 ABATEMENT TECHNOLOGIES

Table A4.3: *List Abatement technologies reported to the NEIS database*

TYPE OF SEPARATOR	NAME
F - textile	F - Textile hose
F - textile	F - Textile pocket
F - textile	F - Textile sleeve
F - textile	F - Textile chamber-cassette
F - textile	F - Textile wedge
F - textile	F - Textile non-woven felt
F - textile	F - Textile-woven with woven reinforcement
F - textile	F - Textile other
F - textile	F - Not Specified
E - electric	E - Horizontal
E - electric	E - Vertical

[6] hhttp://www.iiasa.ac.at/web/home/research/researchPrograms/air/ir-02-076.pdf
[7] Správa k riešeniu úlohy „Systém pre prepočet emisií TZL na emisie PM10 a PM2.5, SPIRIT informačné systémy
[8] Návrh výpočtu tuhých znečisťujúcich látok s aerodynamickým priemerom menším ako 10 a 2.5 µm (PM_{10} a $PM_{2.5}$), Slovenský hydrometeorologický ústav v spolupráci s ECOSYS, 2008

TYPE OF SEPARATOR	NAME
E - electric	E - Wet
E - electric	E - Wet with pre-wash
E - electric	E - with EFB bedding
E - electric	E - electric other
E - electric	E - Not Specified
S - dry aeromechanic	S - settling chamber
S - dry aeromechanic	S - anther
S - dry aeromechanic	S - jalousie
S - dry aeromechanic	S - single cyclone
S - dry aeromechanic	S - group of cyclones (parallel)
S - dry aeromechanic	S - group of cyclones (serial)
S - dry aeromechanic	S – multi-cyclone
S - dry aeromechanic	S - unspecified
S - dry aeromechanic	S - swirl counter-current
S - dry aeromechanic	S - grained layer
S - dry aeromechanic	S - rotating
S - dry aeromechanic	S - Drop separators
S - dry aeromechanic	S - Separation of dust unspecified
S - dry aeromechanic	S - other
S - dry aeromechanic	S - unspecified
M - wet	M - spraying without filling
M - wet	M - spraying with refill
M - wet	M - foam without filling
M - wet	M - foam with refill
M - wet	M - combines
M - wet	M - single cyclone
M - wet	M – multi-cyclone
M - wet	M - surge with EO
M - wet	M – Counter-current with gas washer
M - wet	M - other
M - wet absorption	M - level
M - wet absorption	M - current-Venturi
M - wet absorption	M - grained layer
M - wet absorption	M - rotating
M - wet absorption	M - condensing
M - wet absorption	M - with chemical reaction
M - wet absorption	M - with organic solvents
M - wet absorption	M - with recirculation of liquid
M - wet absorption	M - other
AD,SP - absorption and combustion	AD - adsorption of gas-solids bed, instable adsorbent
AD,SP - absorption and combustion	AD - adsorption of gas-fluid. Adsorbent bed
AD,SP - absorption and combustion	AD - gas-continuous adsorption moving bed ad
AD,SP - absorption and combustion	SP - Gas combustion - thermal three-stage (burner, mixer, aggravation), linear. Burner
AD,SP - absorption and combustion	SP - Combustion of gases - thermal three-stage, tunnel incinerator
AD,SP - absorption and combustion	SP - Gas Combustion - thermal three-stage, jet incinerator
AD,SP - absorption and combustion	SP - Combustion of gases - thermal in the sand bed
AD,SP - absorption and combustion	SP - Gas-catalytic combustion - solid bed (tapes, rods, bricks, pellets ...)
AD,SP - absorption and combustion	SP - Combustion of gas-catalytic-fluid bed (metals and their compounds on carriers)
DS - DESOX	DS - DESOX-lime-limestone wet scrubbing-WS
DS - DESOX	DS - DESOX - injection of lime milk into the flue gas-SDA

TYPE OF SEPARATOR	NAME
DS - DESOX	DS - DESOX injection of dry sorbent-DSI, additional
DS - DESOX	DS - DESOX-Wellmann-Lord with Na-WL sulphite
DS - DESOX	DS - DESOX-Walter process with ammonia-WAP
DN - DENOX	DN - DENOX-selective non-catalytic reduction - SNCR
DN - DENOX	DN - DENOX-selective catalytic reduction - SCR
DN - DENOX	RD - Reduction of gas catalytic-solid bed
DN - DENOX	RD - Reduction of catalytic-fluid gas
KMB - combine	KMB - combine-SNOX with separate cathodes, catalytic reduction of NOx, catal.ox.SO_2
KMB - combine	KMB - combine-DESONOX catalysing 1 chamber, NOx catalytic reduction, catal.ox.SO_3
KMB - combine	KMB - combine-AC-dry simultaneous adsorption on moving the activated carbon (coke) to H_2SO_4 and N_2
KMB - combine	KMB - Gas capture by condensation (also cryogenic)
KMB - combine	KMB - Gas capture and disposal not specified
BIO - biological separators	BIO - dry-biofilters
BIO - biological separators	Bio - semi-dry biofilters, with reinforcement
BIO - biological separators	BIO - wet-bioscrubbers, bioskrub

A4.8 VOC CONTENT

Table A4.4: *VOC content - scheme*

SPECIFIC CONTENT OF VOC [W%]*	WHITE SPIRIT	PETROLEUM SPIRIT	XYLENE	TOLUENE	STYRENE	ETHYL ACETATE	BUTYL ACETATE	ACETONE	METHYL ACETATE	ETHYL ALCOHOL	BUTYL ALCOHOL	IZOBUTYL	CYCLOHEXANE	KRESOL	MPA	SOLVESO 100	METHYLENE CHLORID	DOWANOL
LACQUERS AND VARNISH																		
oil and varnish	X																	
synthetic airborne	X		X															
synthetic burning			X								XX							
epoxid			X								XX							
polyurethane			X				X								XX			
polymerate				X			X	X							XX			
cellulose			X	X		X	X		X	X		XX						X
asphalt	X		X															
estermid			X											X		X		
resole			X								XX							
PAINTS																		
oil and varnish	X																	
synthetic airborne	X		X															
synthetic burning			X	X							XX							
polyurethane 2 K			X				X								X			
polyurethane 1 K			X				X								X			
acrylic			X				X				XX							
cellulose		XX	X	X		X	X			X		X						
resole			X			X	X				XX							
epoxide			X								XX							
high solid paints	X		X															
chlorine rubber paints			X				X											
for print				X		X	X	X		X								
THINNERS																		
synthetic	X		X															

polyurethane			X				X								X			
cellulose				X		X	X		XX	X		X						
other			X	X		X	X		XX	X	XX	X			X			
solvent adhesives		XX		X		X							X					X
RESINS																		
unsaturated polyester					X													
alkyde resins	X		X															
akryl resins			X				X				XX							
other resins											XX	X						
COATING REMOVERS																		
old cover removers				X				X	XX	X							X	

XX-Confidential data

ANNEX V: NECD RECOMMENDATIONS

The Slovak Republic has prioritised its effort to implement the recommendations of the Review of National Air Pollutant Emission Inventory Data 2024 under Directive (EU) 2016/2284 that might have an impact on the emission estimates as far as possible in the 2025 submission. The implementation of the recommendations is shown in ***Table A5.1***.

Table A5.1: Status of implementation of the NECD recommendations

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA[1]	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-1A1a-2024-0001		T	No	Yes	**High**	1A1a Public electricity and heat production, PM2.5, 2005: The TERT recommends that Slovakia include emission data reported by the operator to explain the relatively high reported emissions in category 1A1a in 2005 in the IIR at the next submission. **Implemented in chapter 3.4.2.**
SK-1A2gviii-2024-0001	Final review Report 2024, Chapter V., p. 13	T	No	Yes	**High**	1A2gviii Stationary combustion in manufacturing industries and construction: Other, SO_2, 2022: The TERT recommends that Slovakia include details to explain the change in emissions in the IIR for the 2025 submission. **Implemented in chapter 3.5.9.**
SK-1A4bi-2024-0001	Final review Report 2024, Chapter V., p. 14	Transparency	Yes	Yes	**High**	1A4bi Residential: Stationary, NMVOC, 2005, 2022: The TERT recommends that Slovakia reviews emission factors for NMVOC (and other pollutants) for category 1A4bi and considers how country-specific data on boiler operation might be obtained to improve uncertainty of emission estimates. **Implemented in chapter 3.7.4.**

Serial No.	**Review report/ Chapter/Page**	**Priority criteria** TCCCA[1]	**Priority criteria** Key category	**Priority criteria** over emission 2%	**Priority level** (Very high, High, Low)	**Review Recommendation**
SK-1A4ci-2022-0001	Final review Report 2024, Chapter V., p. 14	Completeness	No	No	**High**	1A4ci Agriculture/Forestry/Fishing: Stationary, NH_3, 1990-2022: For category 1A4ci Agriculture, Forestry, Fishing: Stationary, NH3, all years, The TERT notes that the issue is below the threshold of significance for a technical correction.The TERT recommends that Slovakia report the NH_3 emissions following the methodology presented during the review week in the 2025 submission, both in the IIR and Annex IV template. **Implemented in chapter 3.7.6.**
SK-1A3b-2024-0001	Final Review Report 2024, Chapter V	Accuracy	No	No	**High**	For category 1A3b Road Transport, NO_X, NMVOC, $PM_{2.5}$, PM_{10}, CO, TSP, all years, The TERT recommends that Slovakia use the latest version of COPERT in the next submission. **Implemented in chapter 3.6.3.**
SK-3De-2023-0001	Final review report 2024, Chapter V., p. 12	Accuracy	NO	NO	**Very high**	**3De Cultivated Crops category**: the TERT observed that Slovakia applied a Tier 2 methodology along with the default NMVOC emission factor developed for several crop categories to estimate NMVOC emissions for the entire reporting period.The TERT recommends that Slovakia include a revised estimate in the next submission**. Implemented in chapter 5.10.3**

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA[1]	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-3Da2a-2023-0001	Final review report 2024 Chapter V., p. 15	T	Yes	Yes	**High**	**3Da2a Animal Manure applied to Soils, NH3:** For the 3Da2a Animal Manure applied to Soils Category, NH3, 2021, The TERT reiterates the recommendation made in the previous review that Slovakia includes a summary of information on mitigation measures used in Slovakia and detailed explanations for the decrease in emissions in the IIR of their next submission. **Implemented Chapter 5.8**
SK-5C2-2024-0001	Final review Report 2024, Chapter V., p. 15	Transparency	Yes	Yes	**High**	**5C2 Open burning of waste, PM2.5, 2005:** The TERT recommends that Slovakia adds this relevant explanation to the IIR. **Implemented in chapter 6.6.5.**

ANNEX VI: IMPLEMENTATION OF MITIGATION MEASURES FOR AMMONIA EMISSIONS REDUCTION IN AGRICULTURE

Revision of the provided information was done according to the NECD **Recommendation No A8/SK-3Da2a-2023-0001** of the SVK NECD Final Review Report 2023. Mitigation measures were defined as any anthropogenic interventions that can either reduce the sources of GHG emissions to achieve the reduction targets. In the context of the United Nations Framework Convention on Climate Change, a mitigation measure is a national-level analysis of the various technologies and practices that can mitigate climate change or polluted air. The mitigation measures were divided into groups according to the place and time of their application:

- During feeding of the livestock;
- During housing of animals;
- During storage of organic waste;
- During spreading of organic waste into the agricultural soils

A6.1 ANALYSIS OF MITIGATION MEASURES IN THE SLOVAK REPUBLIC

At present, abatements are very difficult to estimate in the condition of the Slovak Republic, due to a lack of official statistical information. The SHMÚ administers the NEIS. NEIS has information about the mitigation measures used by farmers. These data are confidential. The SHMÚ conducts the NEIS under the Act of the Ministry of the Environment of the Slovak Republic No 137/2010[9] Coll. on Air and Decree of the Ministry of the Environment of the Slovak Republic No 410/2012 Coll[10]. The farmers, the operators of the source of air pollution, provide "emission confession" of the Environmental District Office. Emission confession contains detailed information about pollution sources, emitted pollution and pollution charges into the relevant district in the prescribed forms, or a portable electronic medium. NEIS has information on livestock numbers of animals, manure management systems and used abatements as well.

The emission from the NEIS database is not possible to fully implement into the national emission inventories due to the validity of the legislation. In addition, ammonia emissions from goats missing entirely in the database due to a lack of law. The best practice for the NH_3 estimation is analysing nitrogen flux in agriculture. Estimation of nitrogen flux is a more complex approach, which was used during NH_3 calculation. During it, nitrogen losses are formed as nitrogen emissions (NH_3, NO, N_2O). Emissions are estimated from each breeding phase. The NEIS calculates only NH_3 emissions. The Slovak Republic shall also report other nitrogen emissions (NO, N_2O). The NH_3 emissions are calculated with a default emissions factor, which is constant during all time-series in the NEIS system. Nevertheless, NEIS is a good source of additional data for the emissions inventory for quality control purposes.

A6.2 METHODOLOGY ISSUE-METHOD

The SHMÚ compiles annually NH_3 balance according to the EMEP/EEA GB_{2019} using country-specific parameters and national input data from the ŠU SR[11]. The ŠU SR does not dispose of official information about abatements. Therefore, in the NEIS, as mentioned above, the abatement information from farms is available from 2006 to the present.

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[9] Act of the Ministry of the Environment of the Slovak Republic no.137/2010 Coll. Of 3 March 2010

[10] Decree of the Ministry of the Environment of the Slovak Republic no. 410/2012 Coll. of 30 November 2012 Implementing certain provisions of the Air

Table A6.1: *Efficiency of abatements*

ABATEMENT EFFICIENCY OF MEASURE I	EFFICIENCY OF ABATEMENTS	SOURCE OF EFFICIENT
	STORAGE OF MANURE OR SLURRIES	
Fixed hatch or roof	80%	Code Good Agricultural Practice*
Covering the surface of the tank with straw	40%	
Covering the surface of the tanks with foil	60%	
Slurry/liquid with natural crust cover	40%	
	APPLICATION OF MANURE OR SLURRIES	
Furrow injection	40%	Code Good Agricultural Practice*
Deep injection	90%	
Incorporation within 12 hours	50%	
Incorporation within 24 hours	30%	

***In Slovak**

The farms from the NEIS were examined analogically in the NEIS and abatements were investigated, for example spreading after 12 and 24 hours and storage for liquid and solid manure from the different livestock species. The results of the research were a list of abatements applied to the emission balance. ***Table A6.2*** and ***A6.3*** provide a share of the abatements per farm. They were calculated for a better interpretation and usability in the NH_3 calculations. NH_3 emissions from Sector 3 Agriculture are estimated according to the EMEP/EEA GB_{2019} as a Tier 3 approach for cattle, sheep, goats, swine, horses and poultry. The nitrogen excretion rate is calculated based on the nitrogen content of the feed according to the IPCC 2006 GL methodology. For the calculation of the tier 3 approach was accepted philosophy for ammonia reduction. Ammonia reduction at the various stages of livestock manure production and handling are interdependent and combinations of measures are not simply additive in terms of their combined emission reduction. Implementation of abatements was done according to Approach 2 presented in the 2021 Task Force on Emission Inventories and Projections as called Approach 2. A single well-mixed system, due to missing detailed information on the number of animals breed cross the systems. Approach 2 model is put together as a single well-mixed system with weighted-average emission factors. Abated emission factors were calculated separately and implemented into the N flow tool in the system python.

$$EF_{average} = \left(EF_{ref}x \sum_i P_i x(1 - AE_i)\right) + \left(EF_{ref}x\left(1 - \sum_i P_i\right)\right)$$

Where:

$Ef_{average}$ = Abated emission factors, EF_{ref} = unabated/reference emission factors, P_i= Penetration of measure I, AE_i Abatement efficiency of measure i, I type of measure per farm.

Figure A6.1: *Development of abatements since 2006*

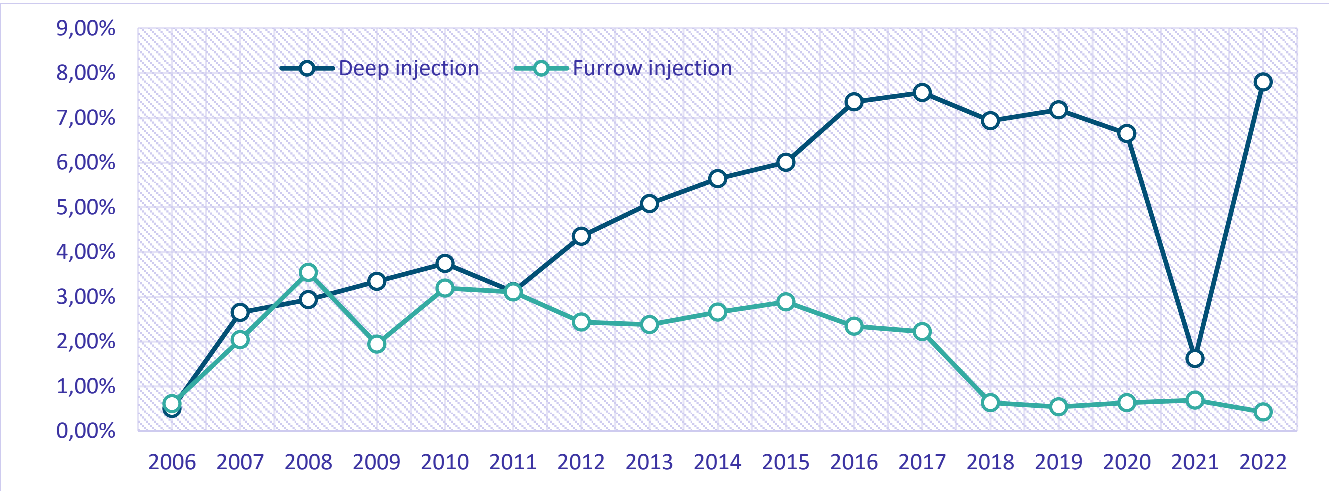


Figure A6.2: *Development of abatements since 2006*

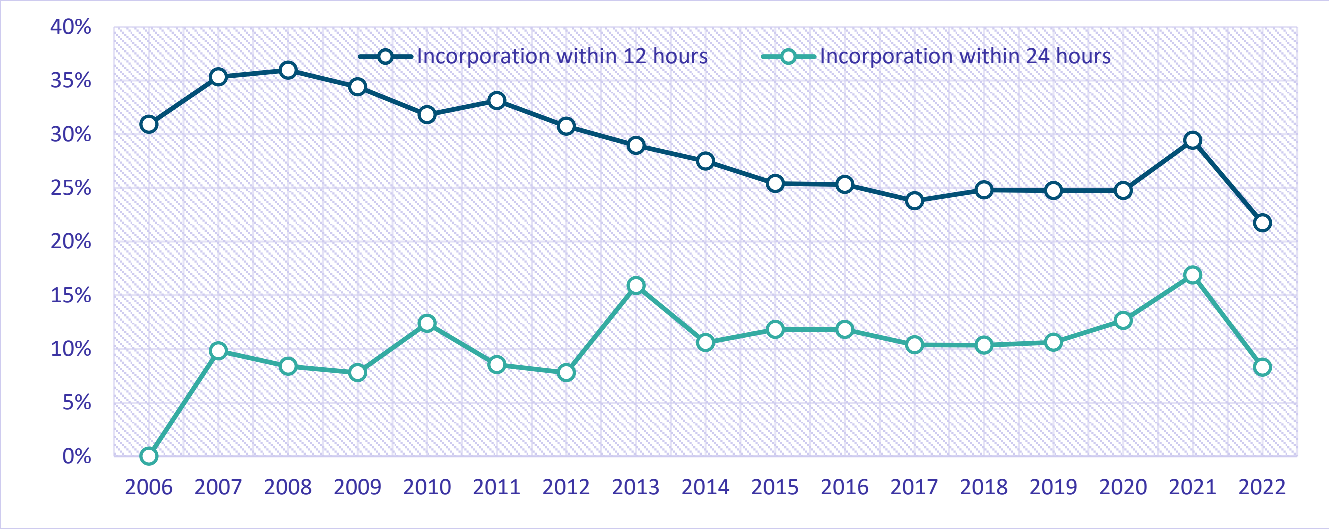
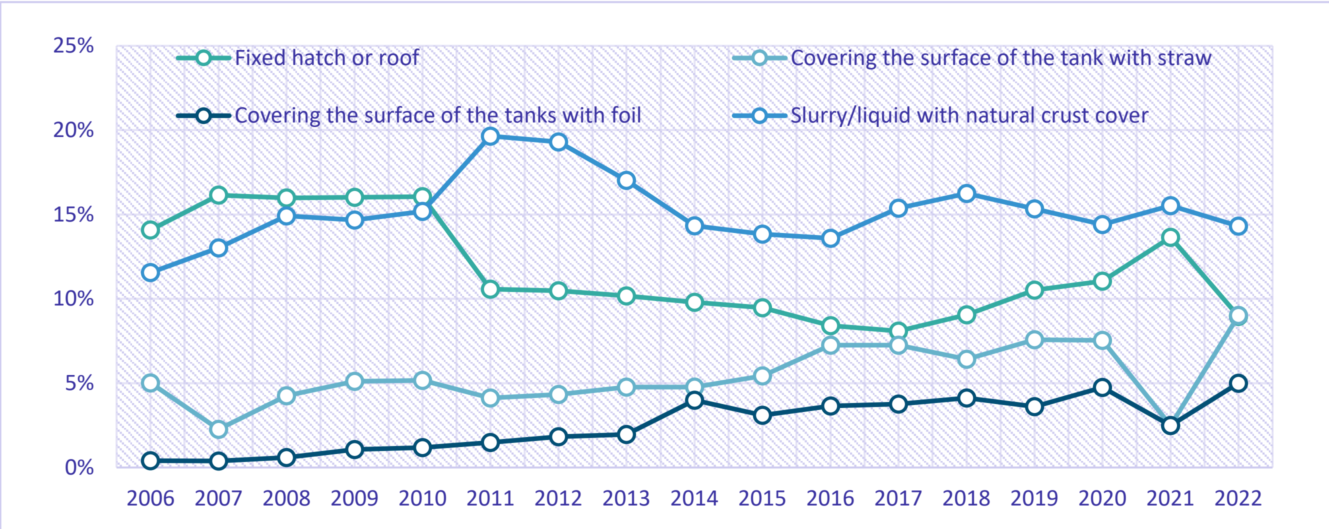


Figure A6.3: *Development of abatements since 2006*



This chapter was included according to the NECD **Recommendation No A1/SK-3B-2023-0001** of the SVK NECD Final Review Report 2023 and **No. A3/SK-3B1a-2023-0001**: Trend of abatements**:** The penetration factors mentioned in the Slovak IIR do not originate from estimated values of future law effectiveness. It is worth noting that in the previous programming period of the common agricultural policy, funding was allocated for ammonia reduction techniques. Additionally, the older version of the Air Act proposed measures to decrease ammonia levels in the air. The SHMÚ is responsible for monitoring and calculating emissions via the National Emission Information System (NEIS). This system collects data on mitigation measures implemented to reduce ammonia emissions, covering the period from 2006 to the present. The national emission factors used in the calculations incorporate some of these measures aimed at reducing emissions. ***Figures A6.1***, ***A6.2*** and ***A6.3*** show a visible increasing trend in 2021 and decreasing in 2022 mainly in fixed hatch or roof and incorporation within 12 and 24 hours. The explanation for this trend may have two reasons, the number of operators may decrease and this may decrease of penetration factor of the storage abatement measure. The second reason for the increase and decrease are very unpredictable trends due to economic issues in the sector.

Table A6.2: *Penetration of storage abatement measure – fixed hatch or roof*

					FIXED HATCH OR ROOF				
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2006	20%	20%	2%	0%	14%	0%	38%	46%	0%
2007	18%	20%	5%	24%	0%	0%	35%	42%	19%
2008	18%	19%	4%	22%	0%	0%	36%	42%	17%
2009	18%	19%	2%	22%	0%	0%	21%	33%	43%
2010	17%	17%	1%	26%	0%	0%	18%	34%	48%
2011	16%	17%	1%	23%	0%	0%	14%	35%	0%
2012	17%	16%	4%	21%	0%	0%	14%	34%	0%
2013	16%	15%	4%	27%	0%	0%	10%	30%	0%
2014	16%	14%	5%	27%	0%	0%	10%	26%	0%
2015	16%	15%	4%	24%	0%	0%	9%	26%	0%
2016	16%	15%	2%	24%	0%	0%	8%	20%	0%
2017	15%	15%	2%	21%	0%	0%	9%	18%	0%
2018	15%	15%	2%	23%	0%	13%	9%	13%	0%
2019	15%	16%	2%	22%	0%	17%	8%	16%	9%
2020	16%	15%	2%	24%	0%	18%	17%	14%	6%
2021	16%	15%	1%	4%	0%	20%	31%	38%	11%
2022	16%	14%	2%	23%	0%	2%	17%	10%	5%

Table A6.3: *Penetration of storage abatement measure – covering the surface of the tank with straw*

				COVERING THE SURFACE OF THE TANK WITH STRAW					
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2006	4%	4%	2%	5%	29%	0%	3%	3%	0%
2007	4%	3%	4%	4%	5%	0%	1%	1%	0%
2008	5%	5%	3%	4%	8%	0%	11%	7%	0%
2009	5%	6%	5%	4%	12%	0%	10%	9%	0%
2010	5%	6%	2%	4%	11%	0%	12%	11%	0%
2011	5%	5%	2%	3%	2%	0%	13%	11%	0%
2012	4%	5%	2%	3%	1%	0%	17%	11%	0%
2013	4%	5%	2%	3%	0%	0%	22%	11%	0%
2014	4%	5%	2%	3%	1%	0%	23%	10%	0%
2015	3%	4%	2%	3%	1%	0%	25%	16%	0%
2016	3%	4%	2%	3%	4%	0%	22%	35%	0%
2017	3%	4%	2%	3%	4%	0%	26%	31%	0%
2018	3%	4%	2%	3%	4%	0%	26%	23%	0%
2019	3%	4%	2%	3%	7%	0%	24%	34%	0%
2020	3%	4%	2%	3%	9%	0%	22%	33%	0%
2021	3%	4%	4%	1%	5%	0%	3%	5%	0%
2022	3%	4%	1%	3%	7%	0%	32%	40%	0%

Table A6.4: *Penetration of storage abatement measure -covering the surface of the tanks with foil*

				COVERING THE SURFACE OF THE TANKS WITH FOIL					
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2006	1%	1%	1%	0%	0%	0%	1%	1%	0%
2007	1%	1%	0%	0%	0%	0%	1%	1%	0%
2008	1%	1%	0%	0%	0%	0%	1%	3%	0%

COVERING THE SURFACE OF THE TANKS WITH FOIL									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2009	2%	1%	0%	0%	0%	0%	1%	6%	0%
2010	2%	1%	0%	0%	0%	0%	4%	5%	0%
2011	4%	2%	0%	0%	0%	0%	5%	5%	0%
2012	5%	2%	0%	0%	0%	0%	5%	7%	0%
2013	4%	2%	1%	0%	0%	0%	4%	7%	0%
2014	4%	2%	0%	0%	0%	0%	13%	21%	0%
2015	4%	1%	0%	0%	0%	0%	11%	15%	0%
2016	4%	3%	0%	0%	0%	0%	16%	14%	0%
2017	4%	3%	0%	0%	0%	0%	14%	17%	0%
2018	4%	3%	0%	0%	0%	0%	13%	22%	0%
2019	4%	3%	0%	0%	0%	0%	15%	15%	0%
2020	5%	2%	0%	0%	0%	0%	19%	21%	0%
2021	3%	4%	4%	1%	5%	0%	3%	5%	0%
2022	5%	3%	0%	0%	0%	0%	21%	21%	0%

Table A6.5: *Penetration of storage abatement measure - Slurry/liquid with natural crust cover*

SLURRY/LIQUID WITH NATURAL CRUST COVER									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2009	33%	32%	0%	4%	0%	0%	45%	32%	0%
2010	36%	35%	4%	3%	0%	0%	44%	31%	0%
2011	37%	36%	3%	3%	6%	0%	48%	31%	33%
2012	36%	35%	3%	4%	3%	0%	47%	34%	31%
2013	36%	36%	2%	4%	2%	0%	41%	34%	16%
2014	37%	35%	1%	0%	4%	0%	36%	30%	0%
2015	37%	36%	1%	0%	1%	0%	35%	27%	0%
2016	38%	36%	1%	0%	2%	0%	37%	22%	0%
2017	39%	36%	2%	0%	3%	0%	34%	22%	20%
2018	38%	36%	1%	0%	2%	0%	35%	27%	23%
2019	40%	37%	1%	0%	2%	0%	36%	20%	16%
2020	39%	37%	1%	1%	3%	0%	27%	17%	19%
2021	35%	38%	8%	2%	5%	0%	31%	20%	16%
2022	40%	37%	1%	1%	0%	0%	26%	17%	22%

Table A6.6: *Penetration of application abatement measure – furrow injection*

FURROW INJECTION									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2006	1%	1%	0%	0%	0%	0%	1%	2%	0%
2007	1%	1%	0%	0%	0%	0%	13%	4%	0%
2008	1%	1%	0%	0%	0%	0%	14%	16%	0%
2009	1%	1%	0%	0%	0%	0%	3%	13%	0%
2010	1%	1%	0%	0%	0%	0%	8%	19%	0%
2011	1%	1%	0%	0%	0%	0%	10%	16%	0%
2012	1%	1%	0%	0%	0%	0%	11%	10%	0%
2013	1%	1%	0%	0%	0%	0%	10%	10%	0%
2014	1%	1%	0%	0%	0%	0%	10%	13%	0%
2015	1%	1%	0%	0%	0%	0%	11%	13%	0%

FURROW INJECTION									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2016	1%	1%	0%	0%	0%	0%	11%	8%	0%
2017	1%	1%	0%	0%	0%	0%	11%	8%	0%
2018	0%	1%	0%	0%	0%	0%	4%	1%	0%
2019	0%	1%	0%	0%	0%	0%	3%	1%	0%
2020	1%	1%	0%	0%	0%	0%	3%	2%	0%
2021	1%	0%	0%	0%	0%	0%	3%	2%	0%
2022	1%	0%	0%	0%	0%	2%	1%	0%	0%

Table A6.7: *Penetration of application abatement – deep injection*

DEEP INJECTION									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2006	1%	0%	0%	0%	0%	0%	2%	2%	0%
2007	2%	0%	0%	0%	0%	0%	11%	11%	0%
2008	2%	0%	0%	0%	0%	0%	16%	8%	0%
2009	2%	1%	0%	0%	0%	0%	15%	12%	0%
2010	3%	0%	0%	0%	0%	0%	18%	13%	0%
2011	5%	1%	0%	0%	0%	0%	13%	9%	0%
2012	6%	2%	0%	0%	0%	0%	16%	16%	0%
2013	6%	2%	0%	0%	0%	0%	21%	18%	0%
2014	5%	1%	0%	0%	0%	0%	25%	20%	0%
2015	5%	1%	0%	0%	0%	0%	24%	24%	0%
2016	6%	2%	0%	0%	0%	0%	24%	35%	0%
2017	6%	2%	0%	0%	0%	0%	27%	33%	0%
2018	6%	2%	0%	0%	0%	0%	26%	28%	0%
2019	6%	2%	0%	0%	0%	0%	26%	30%	0%
2020	7%	2%	0%	0%	0%	0%	24%	28%	0%
2021	4%	1%	0%	0%	0%	0%	4%	5%	0%
2022	7%	1%	0%	0%	0%	30%	32%	0%	0%

Table A6.8: *Penetration of application abatement - incorporation within 12 hours*

INCORPORATION WITHIN 12 HOURS									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2006	50%	51%	24%	13%	43%	0%	49%	49%	0%
2007	48%	51%	20%	10%	30%	55%	34%	39%	30%
2008	53%	54%	19%	9%	38%	61%	29%	34%	27%
2009	54%	54%	18%	9%	12%	66%	41%	34%	22%
2010	52%	53%	14%	12%	11%	63%	30%	28%	23%
2011	51%	52%	14%	12%	8%	68%	38%	29%	26%
2012	51%	52%	6%	11%	4%	60%	35%	25%	32%
2013	52%	52%	6%	12%	3%	59%	28%	22%	28%
2014	51%	50%	6%	12%	5%	56%	18%	23%	27%
2015	49%	50%	6%	11%	2%	51%	16%	18%	26%
2016	48%	48%	4%	11%	6%	66%	11%	10%	25%
2017	46%	46%	4%	11%	7%	54%	11%	10%	25%
2018	45%	45%	4%	9%	6%	59%	19%	11%	24%
2019	43%	44%	4%	12%	22%	43%	14%	13%	27%

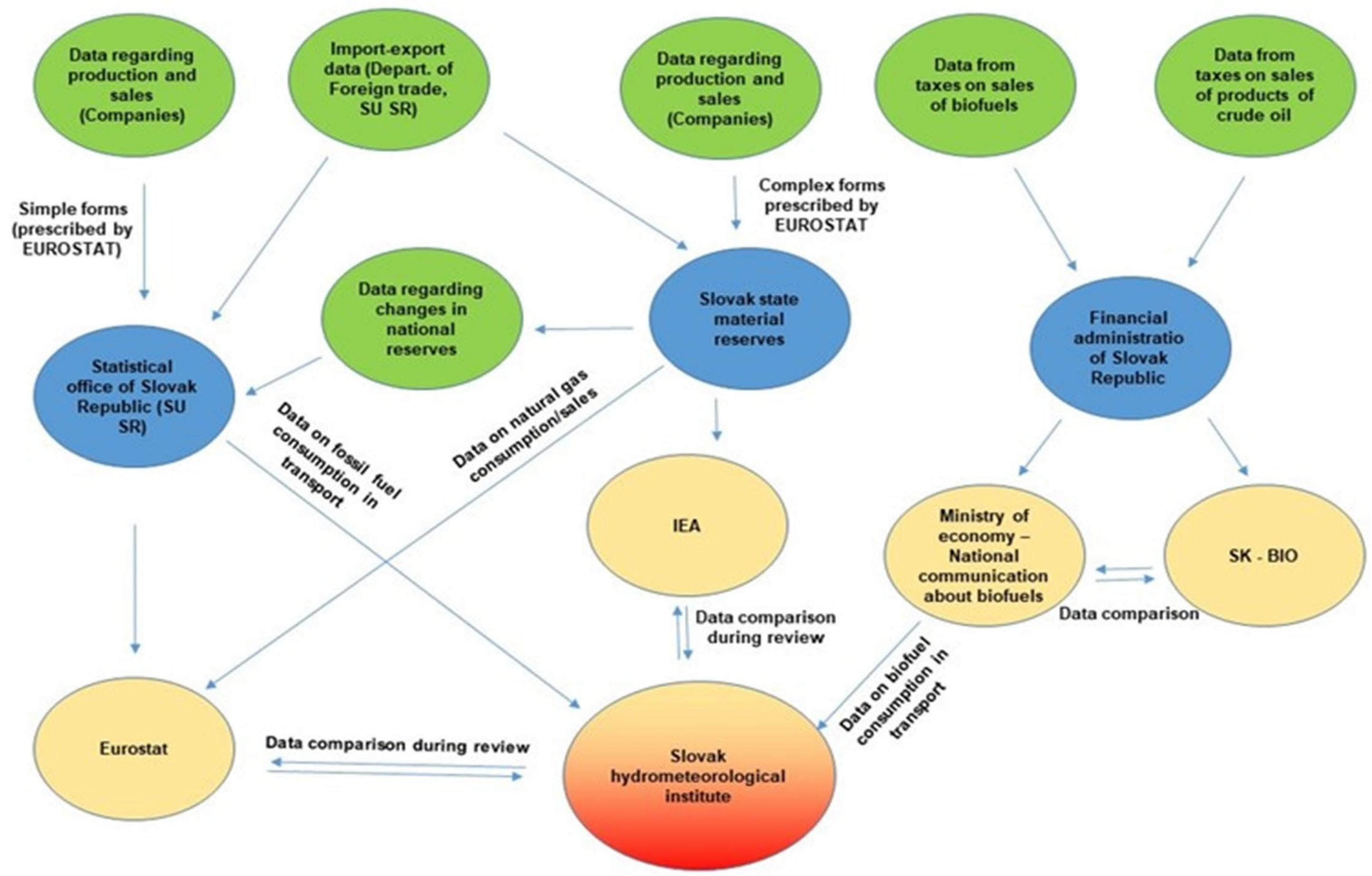
INCORPORATION WITHIN 12 HOURS									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2020	43%	44%	4%	12%	22%	43%	14%	13%	27%
2021	41%	42%	14%	9%	21%	18%	42%	42%	35%
2022	44%	45%	3%	10%	38%	11%	11%	26%	8%

***Table A6.9:** Penetration of application abatement - incorporation within 24 hours*

INCORPORATION WITHIN 24 HOURS									
CATEGORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
2009	13%	13%	2%	5%	0%	6%	6%	4%	21%
2010	14%	14%	4%	6%	7%	20%	13%	10%	24%
2011	15%	15%	4%	3%	0%	10%	6%	5%	19%
2012	14%	14%	4%	5%	0%	7%	6%	5%	17%
2013	13%	14%	5%	9%	54%	13%	10%	5%	20%
2014	14%	16%	3%	4%	0%	18%	10%	6%	23%
2015	15%	15%	3%	3%	0%	36%	9%	5%	20%
2016	15%	15%	3%	3%	0%	36%	9%	5%	20%
2017	17%	17%	3%	1%	0%	25%	8%	4%	19%
2018	17%	18%	3%	1%	0%	20%	8%	4%	22%
2019	17%	19%	3%	1%	0%	19%	8%	6%	23%
2020	18%	19%	3%	1%	0%	40%	6%	5%	20%
2021	22%	23%	8%	2%	0%	45%	13%	14%	25%
2022	18%	20%	2%	1%	0%	0%	4%	22%	7%

ANNEX VII: DATA FLOW OF FUEL

Figure A7.1: *Flowchart of data reporting and utilisation (green – original data, blue – primary users, yellow – secondary users, red – tertiary users)*



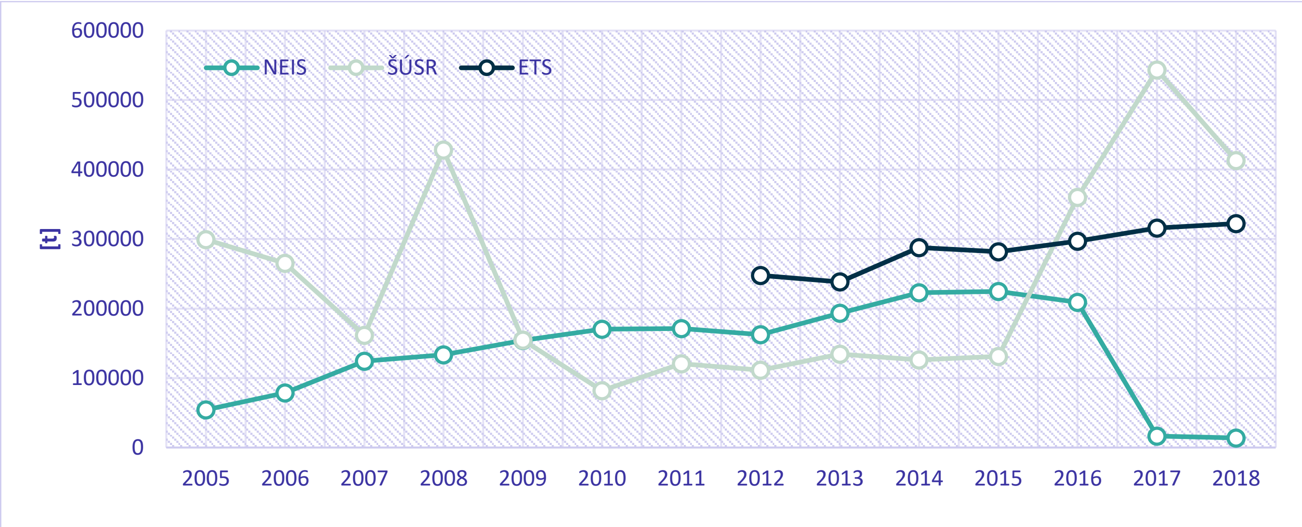
ANNEX VIII: JUSTIFICATION OF THE ACTIVITY DATA SOURCE FOR WASTE INCINERATION

In the previous submission, activity data for industrial and clinical waste incineration were used from the yearbook Waste in the Slovak Republic. These data are collected by the Slovak Ministry of Environment MŽP SR) on a yearly basis. According to information provided by MŽP SR, these data are based only on waste production and also only the first take-over of waste is recorded. Further flows of the waste are unknown.

Operators of waste incineration and waste co-incineration plants are also obligated to provide information on the waste burned to the NEIS database as part of reporting for air pollution taxes. Detailed information on the type of waste incinerated is available in the database from the year 2005.

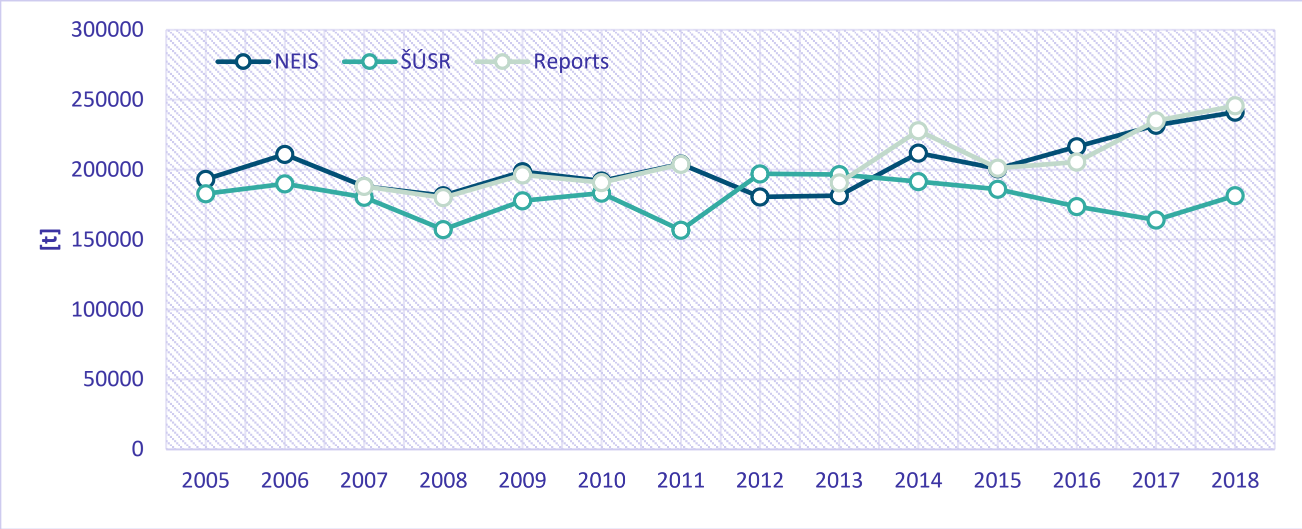
By comparison of the statistical, NEIS and ETS data for the incineration of waste with energy recovery (co-incineration in cement and lime production plants), significant differences were recorded. The amounts of industrial waste incinerated according to statistical data are much higher compared to ETS or waste data. ETS (available since 2012) and NEIS data are similar in trend and absolute amounts (see ***Figure A8.1***). This can be caused by a different definition of waste in national legislation or the same waste can be recorded more than once after some sort of pre-treatment (for example sterilisation) under another waste catalogue number. The NEIS database also contains sources that are not obliged to report to ETS which can cause slight differences between the data.

Figure A8.1: *Comparison of data of industrial waste incinerated (with energy recovery) from ŠÚ SR, NEIS database and ETS*



There are two Municipal waste incineration plants – OLO in Bratislava and KOSIT in Košice. These plants report data about burned waste to the Statistical Office of the Slovak Republic, the NEIS database and also in their yearly reports of operation. Comparing these three sources, data from reports and NEIS shows more similarity than the data from national statistics (see ***Figure A8.2***).

Figure A8.2: Comparison of data of municipal waste incinerated (with energy recovery) from ŠÚ SR and NEIS database



A comparison of the data from the NEIS database and national statistics for IWI (without energy recovery) and CWI (without energy recovery) is shown in the following *Figures A8.3 and A8.4.*

The figures below show a significant difference in amounts of incinerated clinical and industrial waste. For clinical waste, in national statistics also veterinary waste is included.

Figure A8.3: Comparison of data of industrial waste incinerated (without energy recovery) from ŠÚ SR and NEIS database

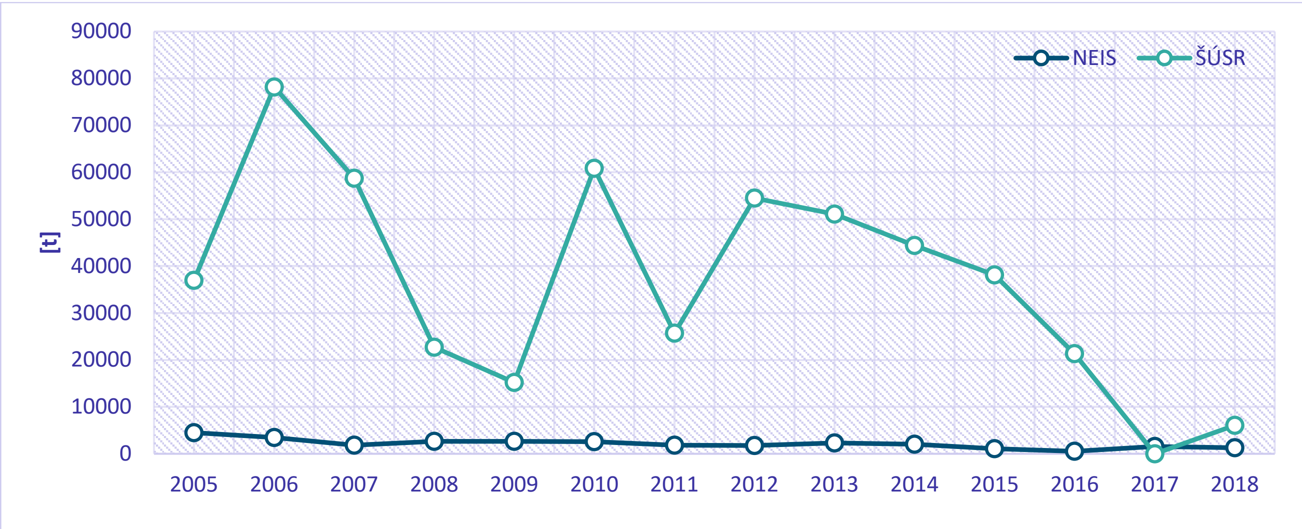
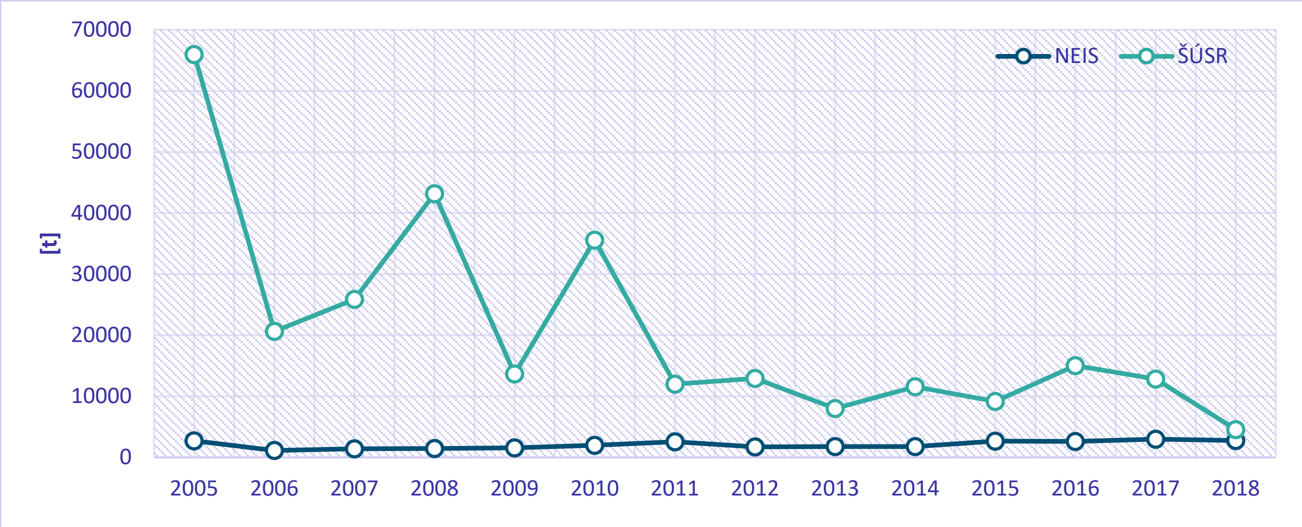


Figure A8.4: *Comparison of data of clinical waste incinerated (without energy recovery) from ŠÚ SR and NEIS database*



For the sake of consistency of using one source of activity data for all waste incineration plants, it was considered to use activity data from the NEIS database, as they are comparable with other sources of data as well as they are regularly checked in.

ANNEX IX: UNCERTAINTY ANALYSIS

Uncertainty assessment is an important part of compiling an emissions inventory and assessing how uncertainties evolve over time. It is considered best practice that emissions inventories contain neither over- nor under-estimates as far as can be judged, and for which uncertainties are reduced as far as practicable.
Uncertainty in emission estimates is a function of the uncertainty of input data i.e. activity or emission factors, used to compile the inventory. Hence, data collection and uncertainty evaluation are strongly linked, and all data contributing to the estimation of emissions should have an associated uncertainty assessment.

A9.1 UNCERTAINTY OF ACTIVITY DATA

Activity data are usually derived from (economic) statistics, including energy statistics and balances, economic production rates, population data, etc. These agencies may have already assessed the uncertainties associated with their data as part of their data collection procedures. These uncertainties can be used to construct probability density functions.
In some cases, uncertainty data for activity rates are not easily available. Since any uncertainty analysis needs quantitative input, quantitative uncertainty ranges are needed.
For activity data uncertainty analysis, uncertainty values from GHG uncertainty analysis were used. When the value was not available, default values from Table 2-1 from the Chapter Uncertainty analysis of EMEP/EEA GB_{2019} were used.

A9.2 UNCERTAINTY OF EMISSION FACTORS

For the purpose of analysis of the uncertainty of emission factors, the data from the CEIP's Uncertainty analysis tool were used for sectors energy, industry, solvents and waste.
For sectors transport and agriculture, the arithmetic means values of the proposed upper and lower emission factor uncertainty from Table 2-2 from the Chapter Uncertainty analysis of EMEP/EEA GB_{2023} were calculated and used for the calculation.
For the sector of residential heating, the value of uncertainty was obtained from the VEC VŠB[12].
Emission factors and measurement uncertainty for emissions from the NEIS database (main pollutants) were established by Decree 410/2012 Coll[13].
The table below represents an example of the uncertainty analysis calculation.

[12] https://powietrze.malopolska.pl/en/life-project/

[13] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2012/410/#prilohy

Table A9.1: *Example of the uncertainty analysis of NOx*

A	B	TECHNOLOGY	FUEL/IDEN.	C	D	E	F	G	H	I	J	K	L	M
				kt	kt	%	%	%	%	%	%	%	%	%
1A1a	NOx	NEIS	NA	20.87	2.63	4	20	20.30	0.84	-0.05	0.02	-0.93	0.10	0.88
1A1b	NOx	NEIS	NA	3.80	1.82	5	20	20.62	0.41	0.00	0.01	0.03	0.09	0.01
1A1c	NOx	NEIS	NA	0.43	0.70	5	20	20.62	0.06	0.00	0.01	0.08	0.04	0.01
1A2a	NOx	NEIS	NA	5.13	2.09	4	20	20.43	0.54	0.00	0.02	-0.02	0.09	0.01
1A2b	NOx	NEIS	NA	0.00	0.01	4	20	20.43	0.00	0.00	0.00	0.00	0.00	0.00
1A2c	NOx	NEIS	NA	0.72	0.21	4	20	20.42	0.01	0.00	0.00	-0.01	0.01	0.00
1A2d	NOx	NEIS	NA	3.30	1.31	4	20	20.37	0.21	0.00	0.01	-0.02	0.05	0.00
1A2f	NOx	NEIS	NA	5.67	4.29	2	20	20.10	2.19	0.01	0.03	0.27	0.09	0.08
1A2gvii	NOx	NA	NA	0.50	0.89	5	200	200.06	9.31	0.00	0.01	0.99	0.05	0.99
1A2gviii	NOx	NEIS	NA	2.58	1.15	3	20	20.26	0.16	0.00	0.01	0.01	0.04	0.00
1A3ai(i)	NOx	Please Select	Jet Gasoline and Aviation Gasoline	0.10	0.04	1	40	40.01	0.00	0.00	0.00	0.00	0.00	0.00
1A3aii(i)	NOx	Please Select	Jet Gasoline and Aviation Gasoline	0.08	0.00	1	40	40.01	0.00	0.00	0.00	-0.01	0.00	0.00
1A3bi	NOx	Passenger cars	Petrol	11.01	9.83	1	40	40.01	45.64	0.04	0.07	1.50	0.10	2.27
1A3bii	NOx	Light commercial vehicles	Diesel	4.45	3.28	1	40	40.01	5.08	0.01	0.02	0.40	0.03	0.16
1A3biii	NOx	Please Select	Please Select	28.26	4.30	1	40	40.01	8.72	-0.06	0.03	-2.31	0.04	5.33
1A3biv	NOx	Please Select	Please Select	0.09	0.02	1	40	40.01	0.00	0.00	0.00	-0.01	0.00	0.00
1A3c	NOx	Rail Cars	Gas Oil/Diesel	1.79	0.44	1	89	88.75	0.45	0.00	0.00	-0.22	0.00	0.05
1A3c	NOx	Line-haul locomotives	Gas Oil/Diesel	4.40	1.08	1	98	97.75	3.29	-0.01	0.01	-0.58	0.01	0.34
1A3di(ii)	NOx	NA	Marine diesel oil/marine gas oil (MDO/MGO)	0.00	0.43	1	200	200.00	2.21	0.00	0.00	0.64	0.00	0.41
1A3dii	NOx	Please Select	Please Select	1.63	0.15	1	200	200.00	0.26	0.00	0.00	-0.81	0.00	0.66
1A3ei	NOx	NEIS	NA	3.11	0.13	1	20	20.02	0.00	-0.01	0.00	-0.18	0.00	0.03
1A4ai	NOx	NEIS	NA	2.75	2.72	4	20	20.36	0.90	0.01	0.02	0.23	0.11	0.06
1A4aii	NOx	Please Select	Please Select	0.11	0.10	5	200	200.06	0.11	0.00	0.00	0.07	0.01	0.01
1A4bi	NOx	Overfire boilers-low heat input	biomass dry	0.08	0.35	3	30	30.15	0.03	0.00	0.00	0.07	0.01	0.00
1A4bi	NOx	Overfire boilers-normal heat input	biomass dry	0.02	0.15	3	30	30.15	0.01	0.00	0.00	0.03	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	biomass wet	0.02	0.08	3	30	30.15	0.00	0.00	0.00	0.02	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	biomass wet	0.00	0.03	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	wood briquettes	0.00	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	wood briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00

A	B	TECHNOLOGY	FUEL/IDEN.	C	D	E	F	G	H	I	J	K	L	M
				kt	kt	%	%	%	%	%	%	%	%	%
1A4bi	NOx	Overfire boilers-low heat input	hard coal	0.12	0.04	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	hard coal	0.03	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	brown coal	1.39	0.01	3	30	30.15	0.00	0.00	0.00	-0.13	0.00	0.02
1A4bi	NOx	Overfire boilers-normal heat input	brown coal	0.38	0.01	3	30	30.15	0.00	0.00	0.00	-0.03	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	Coal briquettes	0.00	0.03	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	Coal briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	Coke	0.20	0.00	3	30	30.15	0.00	0.00	0.00	-0.02	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	Coke	0.05	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	biomass dry	0.03	0.08	3	30	30.15	0.00	0.00	0.00	0.02	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	biomass dry	0.01	0.04	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	biomass wet	0.01	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	biomass wet	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	wood briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	wood briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	hard coal	0.05	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	hard coal	0.01	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	brown coal	0.83	0.01	3	30	30.15	0.00	0.00	0.00	-0.08	0.00	0.01
1A4bi	NOx	Underfire boilers-normal heat input	brown coal	0.19	0.00	3	30	30.15	0.00	0.00	0.00	-0.02	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	Coal briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	Coal briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	Coke	0.08	0.00	3	30	30.15	0.00	0.00	0.00	-0.01	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	Coke	0.02	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	hard coal	0.12	0.04	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	hard coal	0.03	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	brown coal	1.39	0.01	3	30	30.15	0.00	0.00	0.00	-0.13	0.00	0.02
1A4bi	NOx	Overfire boilers-normal heat input	brown coal	0.38	0.01	3	30	30.15	0.00	0.00	0.00	-0.03	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	Coal briquettes	0.00	0.03	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	Coal briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Overfire boilers-low heat input	Coke	0.20	0.00	3	30	30.15	0.00	0.00	0.00	-0.02	0.00	0.00
1A4bi	NOx	Overfire boilers-normal heat input	Coke	0.05	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	biomass dry	0.03	0.08	3	30	30.15	0.00	0.00	0.00	0.02	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	biomass dry	0.01	0.04	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00

A	B	TECHNOLOGY	FUEL/IDEN.	C	D	E	F	G	H	I	J	K	L	M
				kt	kt	%	%	%	%	%	%	%	%	%
1A4bi	NOx	Underfire boilers-low heat input	biomass wet	0.01	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	biomass wet	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	wood briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	wood briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	hard coal	0.05	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	hard coal	0.01	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	brown coal	0.83	0.01	3	30	30.15	0.00	0.00	0.00	-0.08	0.00	0.01
1A4bi	NOx	Underfire boilers-normal heat input	brown coal	0.19	0.00	3	30	30.15	0.00	0.00	0.00	-0.02	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	Coal briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	Coal briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Underfire boilers-low heat input	Coke	0.08	0.00	3	30	30.15	0.00	0.00	0.00	-0.01	0.00	0.00
1A4bi	NOx	Underfire boilers-normal heat input	Coke	0.02	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	biomass dry	0.00	0.06	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	biomass dry	0.00	0.04	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	biomass wet	0.00	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	biomass wet	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	wood briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	wood briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	hard coal	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	hard coal	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	brown coal	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	brown coal	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	Coal briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	Coal briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-low heat input	Coke	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Gasification boilers-normal heat input	Coke	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-low heat input	biomass dry	0.00	0.06	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	biomass dry	0.00	0.02	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-low heat input	biomass wet	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	biomass wet	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-low heat input	wood briquettes	0.00	0.03	3	30	30.15	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	wood briquettes	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00

A	B	TECHNOLOGY	FUEL/IDEN.	C	D	E	F	G	H	I	J	K	L	M
				kt	kt	%	%	%	%	%	%	%	%	%
1A4bi	NOx	Automatic boilers-low heat input	hard coal	0.00	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	hard coal	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-low heat input	brown coal	0.12	0.00	3	30	30.15	0.00	0.00	0.00	-0.01	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	brown coal	0.02	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-low heat input	Coal briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	Coal briquettes	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-low heat input	Coke	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Automatic boilers-normal heat input	Coke	0.00	0.00	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-low heat input	biomass dry	0.05	0.21	3	150	150.03	0.30	0.00	0.00	0.21	0.01	0.05
1A4bi	NOx	Fireplaces-normal heat input	biomass dry	0.01	0.08	3	150	150.03	0.04	0.00	0.00	0.08	0.00	0.01
1A4bi	NOx	Fireplaces-low heat input	biomass wet	0.01	0.05	3	150	150.03	0.02	0.00	0.00	0.05	0.00	0.00
1A4bi	NOx	Fireplaces-normal heat input	biomass wet	0.00	0.02	3	150	150.03	0.00	0.00	0.00	0.02	0.00	0.00
1A4bi	NOx	Fireplaces-low heat input	wood briquettes	0.00	0.01	3	150	150.03	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Fireplaces-normal heat input	wood briquettes	0.00	0.00	3	150	150.03	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-low heat input	hard coal	0.02	0.01	3	75	75.06	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-normal heat input	hard coal	0.00	0.00	3	75	75.06	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-low heat input	brown coal	0.21	0.00	3	75	75.06	0.00	0.00	0.00	-0.05	0.00	0.00
1A4bi	NOx	Fireplaces-normal heat input	brown coal	0.04	0.00	3	75	75.06	0.00	0.00	0.00	-0.01	0.00	0.00
1A4bi	NOx	Fireplaces-low heat input	Coal briquettes	0.00	0.01	3	75	75.06	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-normal heat input	Coal briquettes	0.00	0.00	3	75	75.06	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-low heat input	Coke	0.02	0.00	3	75	75.06	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Fireplaces-normal heat input	Coke	0.00	0.00	3	75	75.06	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Modern stoves-low heat input	biomass dry	0.00	0.06	3	125	125.04	0.02	0.00	0.00	0.06	0.00	0.00
1A4bi	NOx	Modern stoves-normal heat input	biomass dry	0.00	0.02	3	125	125.04	0.00	0.00	0.00	0.02	0.00	0.00
1A4bi	NOx	Modern stoves-low heat input	biomass wet	0.00	0.01	3	125	125.04	0.00	0.00	0.00	0.01	0.00	0.00
1A4bi	NOx	Modern stoves-normal heat input	biomass wet	0.00	0.00	3	125	125.04	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Modern stoves-low heat input	wood briquettes	0.00	0.00	3	125	125.04	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	Modern stoves-normal heat input	wood briquettes	0.00	0.00	3	125	125.04	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	NOx	NA	Natural Gas	1.09	1.97	3	30	30.15	1.04	0.01	0.01	0.33	0.06	0.11
1A4bi	NOx	Please Select	Fuel oil	0.07	0.01	3	30	30.15	0.00	0.00	0.00	0.00	0.00	0.00
1A4bii	NOx	Please Select	Please Select	0.06	0.17	5	200	200.06	0.35	0.00	0.00	0.22	0.01	0.05

A	B	TECHNOLOGY	FUEL/IDEN.	C	D	E	F	G	H	I	J	K	L	M
				kt	kt	%	%	%	%	%	%	%	%	%
1A4ci	NOx	NEIS	NA	0.11	0.25	4	63	62.62	0.07	0.00	0.00	0.10	0.01	0.01
1A4cii	NOx	Please Select	Please Select	8.55	1.79	5	200	200.06	37.89	-0.01	0.01	-2.77	0.09	7.70
1A5a	NOx	NEIS	NA	0.18	0.38	5	20	20.52	0.02	0.00	0.00	0.04	0.02	0.00
1A5b	NOx	NA	Please Select	0.00	0.05	5	200	200.06	0.03	0.00	0.00	0.07	0.00	0.01
1B1b	NOx	Please Select	NA	0.00	0.00	5	256	256.05	0.00	0.00	0.00	0.00	0.00	0.00
2A5a	NOx	Please Select	NA	0.01	0.03	2	20	20.10	0.00	0.00	0.00	0.00	0.00	0.00
2A6	NOx	NA	NA	0.34	0.29	2	20	20.10	0.01	0.00	0.00	0.02	0.01	0.00
2B1	NOx	NA	NA	0.21	0.16	2	20	20.10	0.00	0.00	0.00	0.01	0.00	0.00
2B2	NOx	Please Select	NA	0.17	0.29	2	20	20.10	0.01	0.00	0.00	0.03	0.01	0.00
2B5	NOx	Please Select	NA	0.00	0.06	2	20	20.10	0.00	0.00	0.00	0.01	0.00	0.00
2B10a	NOx	NA	NA	0.70	0.51	2	20	20.10	0.03	0.00	0.00	0.03	0.01	0.00
2B10b	NOx	NA	NA	0.00	0.00	2	20	20.10	0.00	0.00	0.00	0.00	0.00	0.00
2C1	NOx	NEIS	NA	3.27	3.83	7	20	21.36	1.97	0.02	0.03	0.36	0.30	0.22
2C2	NOx	NA	NA	0.43	0.00	3	20	20.22	0.00	0.00	0.00	-0.03	0.00	0.00
2C3	NOx	NEIS	NA	0.23	0.49	2	20	20.10	0.03	0.00	0.00	0.06	0.01	0.00
2C5	NOx	NEIS	NA	0.00	0.00	1	20	20.02	0.00	0.00	0.00	0.00	0.00	0.00
2C7a	NOx	NEIS	NA	0.02	0.06	2	20	20.10	0.00	0.00	0.00	0.01	0.00	0.00
2C7c	NOx	0	NA	1.41	1.06	2	20	20.10	0.13	0.00	0.01	0.07	0.02	0.00
2G	NOx	Other, Tobacco combustion	NA	0.00	0.02	2	53	52.82	0.00	0.00	0.00	0.01	0.00	0.00
2G	NOx	Other, Use of Fireworks	NA	0.00	0.00	2	100	100.02	0.00	0.00	0.00	0.00	0.00	0.00
2H3	NOx	NA	NA	0.00	0.00	2	20	20.10	0.00	0.00	0.00	0.00	0.00	0.00
2I	NOx	NA	NA	0.31	0.27	2	20	20.10	0.01	0.00	0.00	0.02	0.01	0.00
3B1a	NOx	Dairy cattle	Slurry	0.09	0.04	25	200	201.56	0.02	0.00	0.00	0.00	0.01	0.00
3B1b	NOx	Please Select	Please Select	0.16	0.04	25	200	201.56	0.02	0.00	0.00	-0.05	0.01	0.00
3B2	NOx	Sheep	Please Select	0.02	0.01	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3B3	NOx	Please Select	Please Select	0.02	0.00	25	200	201.56	0.00	0.00	0.00	-0.01	0.00	0.00
3B4d	NOx	Goats	Please Select	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3B4e	NOx	Horses	Please Select	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi	NOx	Laying hens (laying hens and parents)	Please Select	0.01	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3B4gii	NOx	Please Select	Please Select	0.03	0.03	25	200	201.56	0.01	0.00	0.00	0.02	0.01	0.00
3B4giii	NOx	Turkeys	Please Select	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00

A	B	TECHNOLOGY	FUEL/IDEN.	C	D	E	F	G	H	I	J	K	L	M
				kt	kt	%	%	%	%	%	%	%	%	%
3B4giv	NOx	Please Select	Please Select	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3Da1	NOx	Please Select	Please Select	8.89	5.10	25	200	201.56	311.55	0.01	0.04	1.89	1.33	5.33
3Da2a	NOx	Please Select	Please Select	2.73	0.95	25	200	201.56	10.71	0.00	0.01	-0.33	0.25	0.17
3Da2b	NOx	NA	NA	0.01	0.00	25	200	201.56	0.00	0.00	0.00	-0.01	0.00	0.00
3Da2c	NOx	NA	NA	0.03	0.15	25	200	201.56	0.27	0.00	0.00	0.21	0.04	0.04
3Da3	NOx	Please Select	Please Select	1.56	0.77	25	200	201.56	7.12	0.00	0.01	0.15	0.20	0.06
3Da4	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3Db	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3Dc	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3Dd	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3De	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3Df	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3F	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
3I	NOx	NA	NA	0.00	0.00	25	200	201.56	0.00	0.00	0.00	0.00	0.00	0.00
5C1bi	NOx	NA	NA	0.01	0.00	5	500	500.02	0.00	0.00	0.00	-0.01	0.00	0.00
5C1bii	NOx	NA	NA	0.00	0.00	5	500	500.02	0.00	0.00	0.00	0.01	0.00	0.00
5C1biii	NOx	Controlled air incineration	NA	0.00	0.00	5	58	58.55	0.00	0.00	0.00	0.00	0.00	0.00
5C1bv	NOx	NA	NA	0.00	0.03	5	500	500.02	0.05	0.00	0.00	0.09	0.00	0.01
5D1	NOx	NEIS	NA	0.00	0.01	4	20	20.49	0.00	0.00	0.00	0.00	0.00	0.00
5D2	NOx	NEIS	NA	0.00	0.00	4	20	20.49	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**135.56**	**58.24**					**452.17**					**25.13**
		Total Uncertainties		**-57.04**				**Uncertainty in total inventory %:**	**21.26**				**Trend uncertainty %:**	**5.01**

A-NFR category, **B**-Pollutant, **C**-Base year emissions, **D**-Year T emissions, **E**-Activity data uncertainty, **F**-Emission factor uncertainty, **G**-Combined uncertainty, **H**-Combined uncertainty as % of total national emissions in year t, **I**-Type A sensitivity, **J**-Type B sensitivity, **K**-Uncertainty in trend in national emissions introduced by emission factor uncertainty, **L**-Uncertainty in trend in national emissions introduced by activity data uncertainty, **M**-Uncertainty introduced into the trend in total national emissions

ANNEX X: TIMETABLE FOR METHODOLOGY IMPROVEMENT OF REPORTING OF HEAVY METALS AND PERSISTENT ORGANIC POLLUTANTS IN SECTORS INDUSTRY AND ENERGY

Due to the implementation of uncertainty analysis into the key category analysis, the list of priority key categories was changed. New methodologies need to be developed for the categories which were not key until now. Also, uncertainty analysis will be further developed and improved. The plan to improve the key categories and uncertainties for the next 3 years is listed in ***Table A10.1***.

Table A10.1: *Plan of improvements*

TASK	OUTCOME	TIME SCHEDULE	STATUS OF IMPLEMENTATION
Uncertainty analysis with detailed data for sectors energy, industry and waste	Uncertainty analysis on tier 1	Submission 2022	**Implemented**
Key category analysis with uncertainties	Identification of key categories with uncertainty	Submission 2022	**Implemented**
Analysis of available methodology and emission data for key categories	List of categories possible to improve	Submission 2026	**To be implemented**
Uncertainty analysis with detailed data for sectors agriculture, transport and residential heating	Uncertainty analysis on tier 1	Submission 2026/2027	**To be implemented**
Improvement of priority categories to Tier 2	Emissions of priority key categories reported using Tier 2	Submission 2026/2027	**To be implemented**
Further analysis of available sources of methodology/Activity data	Emissions of non-priority key categories using Tier 2	Submission 2026/2027	**To be implemented**

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