INFORMATIVE INVENTORY REPORT 2023

SLOVAK REPUBLIC

INFORMATIVE INVENTORY REPORT 2023

Submission under the CLRTAP and NECD

Slovak Hydrometeorological Institute

Department of Emissions and Biofuels

Bratislava, March 15, 2023

PREFACE

TITLE OF REPORT	INFORMATIVE INVENTORY REPORT 2023 SLOVAK REPUBLIC. AIR POLLUTANT EMISSIONS 1990-2021.
EDITOR	Zuzana Jonáček
LEGAL GUARANTOR OF THE REPORT	Ing. Zuzana Kocunová Tel: +421 2 5956 2271 Mail: zuzana.kocunova@enviro.gov.sk Ministry of Environment of the Slovak Republic Air Protection Department (National Focal Point) Námestie Ľ. Štúra 1, 812 35 Bratislava 1 Slovak Republic
EXPERT GUARANTOR OF THE REPORT	Ing. Zuzana Jonáček Tel: +421-2-59415 383 Mail: zuzana.jonacek@shmu.sk Slovak Hydrometeorological Institute Department of Emissions and Biofuels (CLRTAP inventory coordinator) Jeséniova 17, 833 15 Bratislava Slovak Republic
VERSION	**1**
DATE OF SUBMISSION	March 15th, 2023 – FIRST VERSION

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
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
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
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
VÚVZ	Výskumný ústav výživy zvierat Research Institute for Animal Production
WI	Waste incineration

EXECUTIVE SUMMARY

Last update: 15.3.2023

ES.1 BACKGROUND INFORMATION ON INVENTORY OF AIR POLLUTANTS

Informative Inventory Report of the Slovak Republic (IIR SR) 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 IIR SR contains information on the inventory of air pollutants of the Slovak Republic for all years from 1990 to 2021, 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 analysis of emission trends.

ES.2 MAJOR GENERAL CHANGES

All changes were done to achieve improvement in the data quality, data completeness and transparency of the results, in line with the legal requirements and with the SK Review 2022 Recommendations.

In the Energy sector, emissions from the category 1A4bi were recalculated because of the update of the AD for fuels. A new methodology on the tier 2 level for categories 1A2a, 1A2d and 1A2gviii was applied.

In the IPPU sector, emissions for the historical years 1990-1999 from the categories 2C1 and 2C3 were recalculated due to an update of the calculation of these years. In category 2H2, activity data were updated for the years 2005-2009 and 2017-2020 which resulted in recalculations of emissions of NMVOC.

In the Agriculture sector, emissions of NMVOC in 1994 in category 3B3, in 2016 in category 3B1b and in 1994 in category 3De were recalculated due to correction of the transcription between the NFR template and calculation sheets.

In the Waste sector, emissions in the category 5C1bi were recalculated because the wet weight of incinerated industrial sludge was used instead of dry weight. Activity data were updated and resulted in a change in emissions in 2020 (hazardous waste) and 2004, 2005 and 2019 (clinical waste). Also, emissions from sewage sludge incineration without energy recovery were removed from the inventory, as there is no such activity in Slovakia (emissions already reported in the Energy sector).

In category 5D2, the conversion factor for the calculation of NMVOC was corrected. The document structure of the SR 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 provide 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 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.

Since the submission in 2018, emission estimations in sector waste are calculated using EMEP/EEA Guidebook 2019 (EMEP/EEA GB_{2019}) methodology, instead of using emissions value reported to the NEIS database by operators.

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*

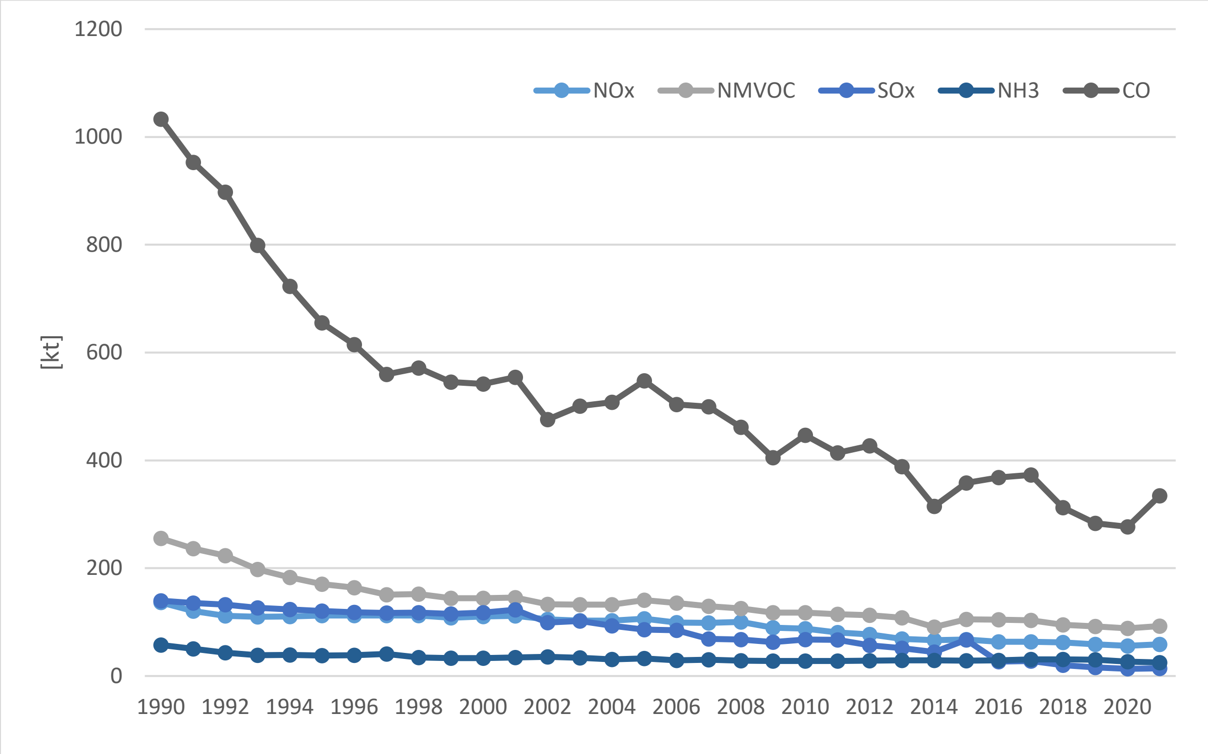


Figure ES.2: *Overall emission trends of the Particulate matter*

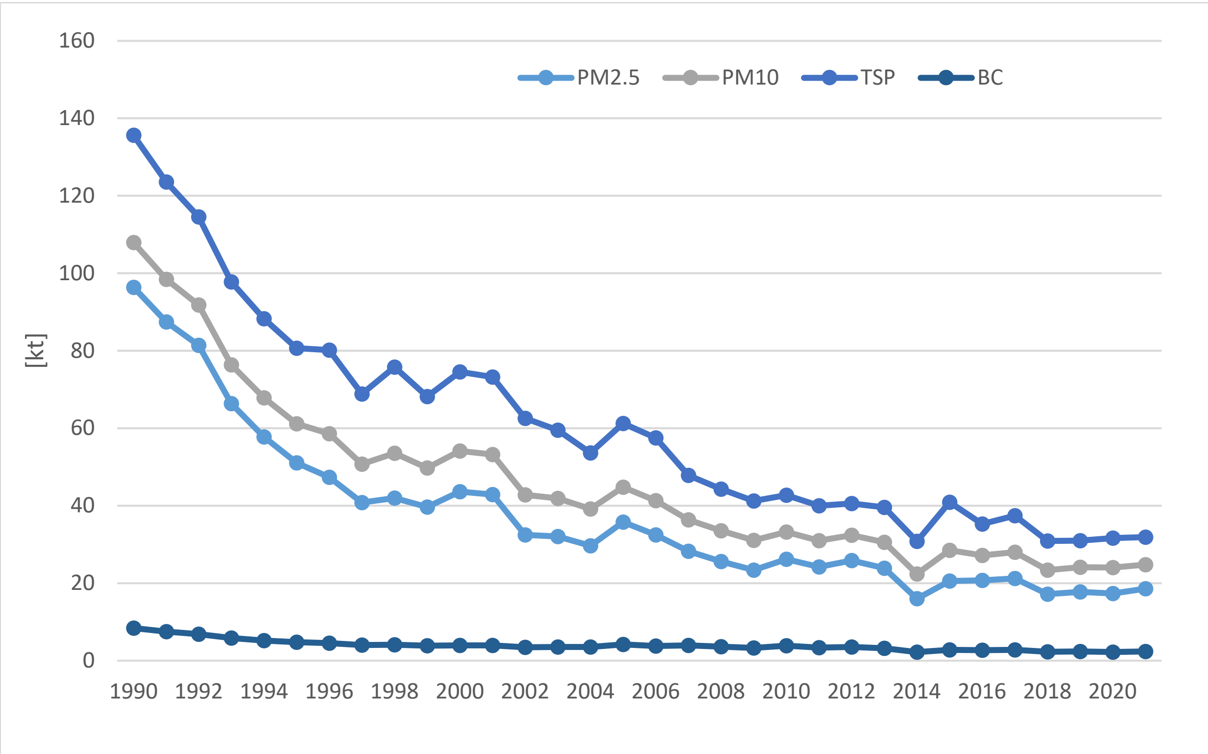


Figure ES.3: *Overall emission trends of the Priority heavy metals*

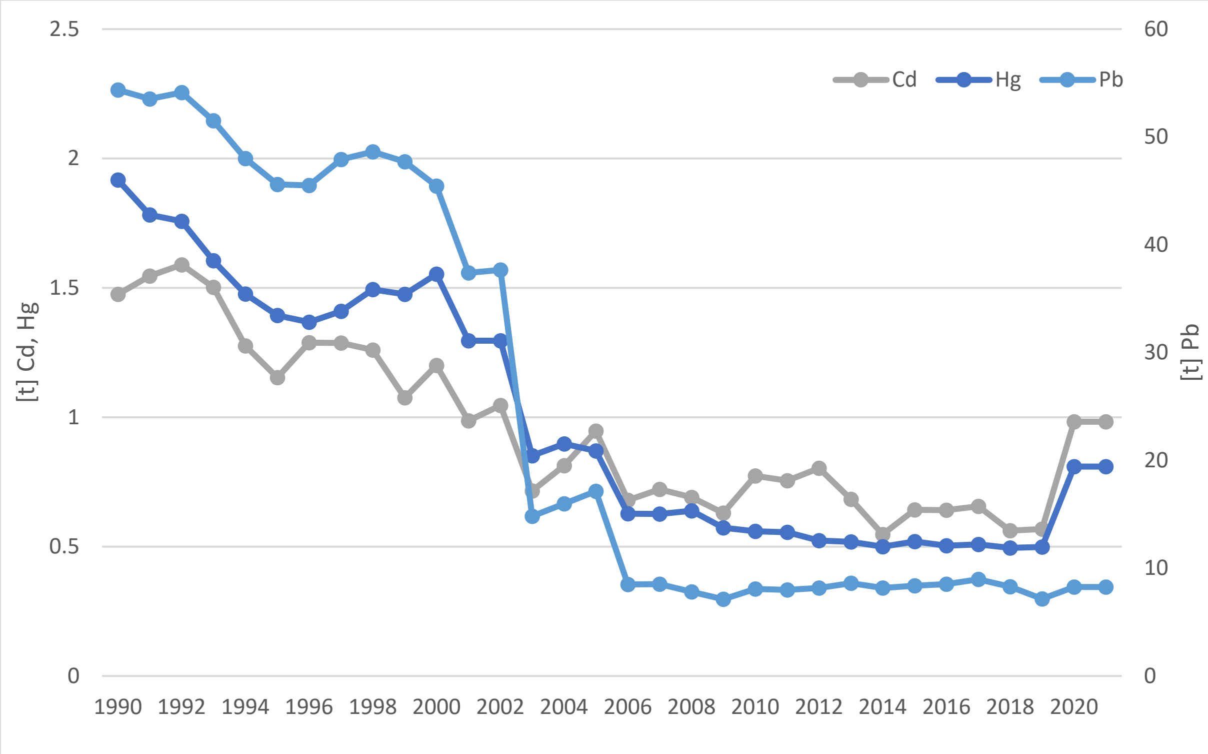
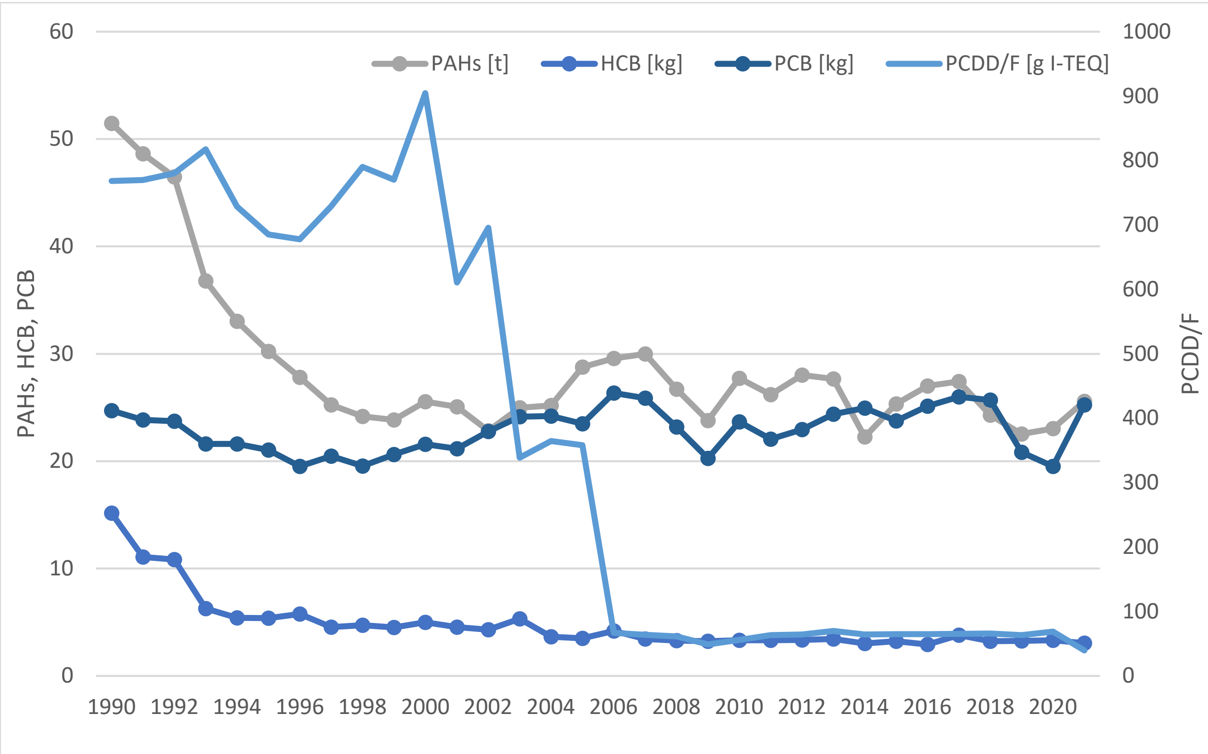


Figure ES.4: *Overall emission trend of the Persistent organic pollutants*



ES.5 OVERVIEW OF RECALCULATIONS

Most of the recalculations realized in the 2023 submission were connected with the improvement of the methodology for energy and improvements in data quality. Also, new data for household heating was collected and improvement in methodology was made. Several errors and units were corrected in this submission.

Table ES.1 provide an overview of recalculations in the 2022 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 2021 and 2022 Final Submissions*

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%	0%	0%	kt	Minor changes in the period 1990-1999 were caused by the update of IEF calculation for historical years for category 2C1 and in the period 2014-2020 by activity data recalculation in category 1A4bi.
NMVOC	-1%	-2%	-2%	-3%	-3%	-4%	kt	The decrease was caused by the correction of the conversion factor for the calculation of NMVOC from industrial wastewater treatment.
SOx (as SO_2)	0%	0%	0%	0%	0%	0%	kt	Minor changes in the period 1990-1999 were caused by the update of IEF calculation for historical years for category 2C1 and in the period 2014-2020 by activity data recalculation in category 1A4bi.
NH_3	0%	0%	0%	0%	0%	1%	kt	Emissions increased slightly as a result of recalculation in category 5B1. The wet weight of composted waste instead of the dry weight was used as activity data.
$PM_{2.5}$	0%	0%	-1%	0%	-2%	-1%	kt	A slight increase in emissions in the whole time series was caused by the implementation of the Tier 2 methodology for category 5A. The decrease in 2005 and 2007 is the result of the correction of AD in the category 2G. Slight changes in activity data for 1A4bi resulted in decreases in 2015 and 2020.
PM_{10}	0%	1%	0%	1%	0%	0%	kt	A slight increase in emissions in the whole time series was caused by the implementation of the Tier 2 methodology for category 5A. The decrease in 2005 and 2007 is the result of the correction of AD in the category 2G. Slight changes in activity data for 1A4bi resulted in decreases in 2015 and 2020.
TSP	0%	0%	0%	1%	-1%	0%	kt	A slight increase in emissions in the whole time series was caused by the implementation of the Tier 2 methodology for category 5A. The decrease in 2005 and 2007 is the result of the correction of AD in the category 2G. Slight changes in activity data for 1A4bi resulted in decreases in 2015 and 2020.
BC	0%	0%	-5%	0%	-1%	-1%	kt	Decrease in 2005 and 2007 is result of correction of AD in the category 2G. Slight changes in actvity data for 1A4bi resulted in dereases in 2015 and 2020.
CO	0%	0%	0%	0%	-1%	-1%	kt	Minor changes in the period 1990-1999 were caused by the update of IEF calculation for historical years for category 2C1 and in the period 2014-2020 by activity data recalculation in the category 1A4bi.
Pb	-5%	-6%	-17%	-25%	-26%	-30%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.

Table ES.1: *Main recalculations and their explanation, % difference for the years 2019, 2015, 2010, 2005, 2000 and 1990 between the 2021 and 2022 Final Submissions*

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
Cd	-9%	-15%	-31%	-35%	-38%	-44%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
Hg	-15%	-18%	-30%	-36%	-43%	-38%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
As	-4%	-7%	-8%	-21%	-41%	-50%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
Cr	-6%	-15%	-18%	-20%	-21%	-23%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
Cu	-4%	-7%	-7%	-5%	-8%	-8%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
Ni	2%	-4%	-14%	-18%	-33%	-37%	t	Emissions changed due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
Se	6%	13%	15%	-19%	-47%	-58%	t	Emissions changed due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
Zn	-20%	-31%	-36%	-38%	-28%	-38%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
PCDD/PCDF	0%	0%	-5%	-3%	-37%	-23%	g I TEQ	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
PAHs	-6%	-12%	-12%	-9%	-9%	-9%	t	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
HCB	1%	2%	3%	-2%	-8%	-6%	kg	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.
PCBs	-11%	-13%	-13%	-7%	-7%	-7%	kg	Emissions decreased due to the improvement of methodology to the tier 2 level for the categories 1A2a, 1A2d and 1A2gviii, changes in activity data and correction of abatement efficiency in the category 1A1a.

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.

Last year 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. This 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 in compliance with GHG inventory at this moment. Several sources from ETS are still allocated in different categories. Tight cooperation with the GHG inventory experts was initiated, but due to a lack of capacity, a complex solution was not yet achieved.

One 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}

This section was added to IIR for the first time in this submission. In 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 into PMs emission factors: Aviation (**1A3a**), Off-road vehicles and other machinery (**1A4cii**) and Other mobile sources (**1A5b**), other categories are estimated using model COPERT and inclusion of condensable compound in EF is unknown. In the sector of Agriculture and Waste, estimations were provided using EEA/EMEP GB_{2019} 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: 15.3.2023

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]

---
[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

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 ($PM_{2.5}$)

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 the 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.

EU context - After joining the EU (1st May 2004), a set of new environmental legislative requirements has been adopted including climate change and air protection. The EU considers climate change as one of the four environmental priorities.

According to Regulation (EU) No 525/2013 (the MMR) the reporting of information on annual emission inventories is required and among others, the evaluation of the effects of the measures and planning of new measures as well as monitoring related to legislation under the EU CARE, namely the EU Effort Sharing Decision (406/2009/EC). The decision sets legally binding targets for the sectors not included in the EU Emissions Trading Scheme, and the EU LULUCF Decision from 17 October 2015 (529/2013/EU), which provides the requirement for accounting of emissions/removals from LULUCF activities but does not include any targets for these in the period 2013 to 2020. The Slovak Republic shall submit the preliminary data on GHG emission inventory for the year X-2 in the required scope by January 15th of each year (Annual Report) and the National Inventory report by the 15th of March each year.

More information on the UNFCCC GHG inventory of The Slovak Republic and National Inventory report 2020 is available at http://ghg-inventory.shmu.sk/documents.php and UNFCCC website.

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, culminating 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)
- Directive 84/360/EEC of the European Parliament and of the Council on combating of air pollution from industrial plants

[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 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]

[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

- 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.

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: Vestnik, 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 within 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 into the Emission Inventory under CLRTAP*

SECTOR/SUBSECTOR	CONTRIBUTOR	INSTITUTION	E-MAIL
CLRTAP coordinator	Zuzana Jonáček	SHMÚ	zuzana.jonacek@shmu.sk
Energy	Monika Jalšovská	SHMÚ	monika.jalsovska@shmu.sk

[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
[19] Vestnik" (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
	Michaela Câmpian Ján Horváth Zuzana Jonáček	SHMÚ SHMÚ SHMÚ	michaela.campian@shmu.sk jan.horvath@shmu.sk zuzana.jonacek@shmu.sk
Transport	Ján Horváth	SHMÚ	jan.horvath@shmu.sk
IPPU	Zuzana Jonáček Vladimír Danielik	SHMÚ STU BA	zuzana.jonacek@shmu.sk
Agriculture	Kristína Tonhauzer Zuzana Palkovičová Vojtech Brestenský	SHMÚ NPPC NPPC	kristina.tonhauzer@shmu.sk
Waste	Zuzana Jonáček	SHMÚ	zuzana.jonacek@shmu.sk
Projections	Marcel Zemko Kristína Tonhauzer Ján Horváth Jiří Balajka	SHMÚ SHMÚ SHMÚ Senior consultant	marcel.zemko@shmu.sk kristina.tonhauzer@shmu.sk jan.horvath@shmu.sk
Gridded emissions	Marcel Zemko	SHMÚ	marcel.zemko@shmu.sk
LPS	Monika Jalšovská	SHMÚ	monika.jalsovska@shmu.sk
QA/QC	Lenka Zetochová	SHMÚ	lenka.zetochova@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, 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 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

[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/

- 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 inventory first approach for air pollutants and energy first approach for the GHGs.

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

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 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 the updated EMEP/EEA GB_{2019} and implements the NFR (reporting nomenclature) and the category. Data are provided between 1990 and 2019[24]. 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, the emissions are directly collected consistently and verified on more levels. This database replaced an 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 2000–2021 were processed in the NEIS CU module by the same way of calculation.

Detailed methodology of the NEIS database is available in **ANNEX IV**.

[23] under the Regulation (EU) No 691/2011 of the EP and of the Council on European environmental economic accounts
[24]https://www.eea.europa.eu//publications/emep-eea-guidebook-2019

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.

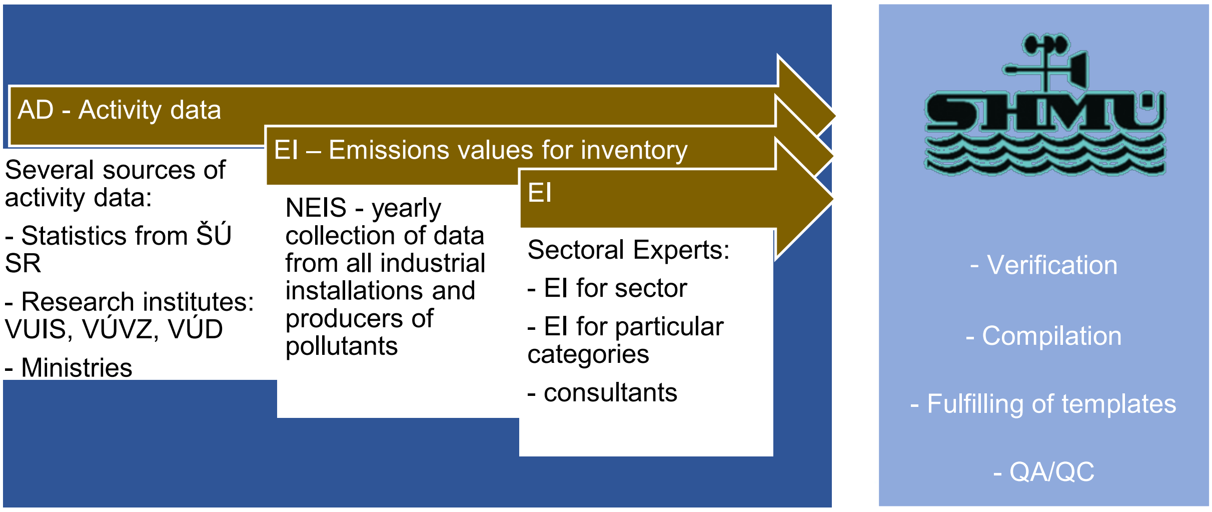
The MŽP SR has mandated the SHMÚ to ensure communication with the producers to collect the necessary data, which they are not obliged to provide to the NEIS.

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_{2019}, following the requirements of the relevant UNECE Working Group on Inventory of Emissions and the methodology based on the IIASA report[25].

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_{2019}. 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.

[25] hhttp://www.iiasa.ac.at/web/home/research/researchPrograms/air/ir-02-076.pdf

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

<u>The methodology used for identification of key categories: Approach 1</u>

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.

<u>Level assessment:</u> 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:

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

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

$\Sigma Ei,$ and $\Sigma Ei,0i$ = 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 2020 to the UNECE/LRTAP. For all gases a level assessment for all years 1990 (base year) and 2018 (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 bellows represent 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		5	11	22						2		2								14		24		14	2	21		8				12	7	33		4					56	51	7	3	170
1A1b			7																																		8	6							9
1A1c															2																														36
1A2a			4							1											6	4	11	14	3	2						4	15	11											31
1A2c																																												4	26
1A2d				6																		3	7	6	8	6						3													113
1A2f	2	2	3	2																			25	17	8	5					6	5	7	4			79	75							139
1A2gvii	5	6	2												2		3	3																											6
1A2gviii								2																																					12
1A3bi	11	9						6	3	1					4	9	14	7		29			5	4						8						5									179
1A3bii	4	2															5	2																											20
1A3biii	5	13								1							2	7										2		11						6									38
1A3biv																																				2									98
1A3bv							2																																						14
1A3bvi									3	3	3	3	3	3			2	2	46	21	2				8	6	44	31	91	54	11	9	6	4	17	15									4
1A3bvii									2	1	2	2	2	2																															3
1A3c	3	3																																									8	51	29
1A3di(ii)	2	4																							3	2					36	32													353
1A3dii		5																													12	8													24
1A4ai			2																		26	16			5	3	7	6								4						2			62
1A4bi		2	4	20			10	24	59	69	26	44	15	33	56	57	44	54			26	18			3	9	4	13								3			8	24	13	14			35
1A4bii															8	5																													37
1A4cii	10	16							2							5	6	2																		2									11
1A5a																					3	2																							3
1B1a							10	2	2		6	2	8	2																															45
1B1b									2		2	2	3	3					7		3				9	4	5				7	5	14	7					22	10					103
1B2ai							6	2																																					8

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	
1B2aiv																					3				4	2																			10
1B2av							26	28																																					53
1B2b							11	2																																					12
2A5b											9	8	16	17																															50
2A6			2	2																																									4
2B10a			7	5																																									12
2C1	2	2	21	13											9	4			25	15	3	1			30	16	5	1		10	10	3	34	23	25	7			55	49	12	9	71	22	478
2C3			13	10																																									23
2C7a																						5				4	18	19																	46
2C7c			4	3																																									6
2D3d							2	1																																					4
2D3i																																			41	34									75
2G																	4	4	6		8	6																							28
2H2							8	9																																					17
2K																							18	12																					29
3B1a					6		3	1	2																																				13
3B1b					6	9	3	3	2		2																																		26
3B3					6	19					2		8	3																															38
3B4gi											4		11	5																															20
3B4gii					9	7					4	3	5	5																															33
3Da1	28	11																																											39
3Da2a	5	2			49	46																																							102
3Da3	4				7																																								11
3Dc									2	2	22	17	10	9																															61
5C1biii																																										5			5
5C1bv																							16	13																					29
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 inside of 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 EEA/EMEP GB_{2016}, collect data from providers and process emission inventory for a given sector – they provide partial reports with information on 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

In November 2019, a Bilateral QAQC meeting between Slovak and Czech inventory compilers took place. The meeting was focused on the methodology for households heating, model COPERT and the exchange of knowledge and experience in the other sectors. These meetings are planned to take place regularly to ensure close cooperation and improvement of our inventories as both countries have a common history and political and socio-economical settings.

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 sector. In this submission, several emissions sources were reallocated and the methodology for calculation of heavy metals and POPs in these sectors was changed to comply with EMEP/EEA GB_{2019}, 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 first time in this submission for the main pollutants (SO_2, NOx, NMVOC, NH_3 and $PM_{2.5}$, CO), priority heavy metals and PAHS. 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: SO_2, 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_{2019}.

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_{2019}.

Table 1.5: *Qualitative uncertainty analysis*

NFR	DESCRIBTION	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD/F	PAHs	HCB	PCB
1A1a	Public electricity and heat production	A	A	A	A	A	A	A	A	A	C	C	D	C	C	C	D
1A1b	Petroleum refining	A	A	A	A	A	A	A	A	A	C	C	C	E	C	E	
1A1c	Manufacture of solid fuels and other energy industries	A	A	A	A	A	A	A	A	A	D	D	D	D	D		
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	A	A	A	A	A	A	A	A	A	E	E	E	E	E	E	E
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	A	A	A	A	A	A	A	A	A	C	C	C	E	C	E	C
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	A	A	A	A	A	A	A	A	A	E	E	E	E	E	E	E
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	A	A	A	A	A	A	A	A	A	C	C	C	E	E	D	C
1A2gvii	Stationary combustion in manufacturing industries and construction: Other	D	D	B	E	E	E	E	C	C		E			E		
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	A	A	A	A	A	A	A	A	A	E	E	E	E	E	E	E
1A3a	Aviation LTO	B	B	A	C	C	C	C	C	**B**	B	B	B				
1A3b	Road transport	B	B	A	C	C	C	C	C	B	E	E	E	E	E	E	E
1A3c	Railways	C	C	B	C	C	C	C		C		C		E	E	E	E
1A3d	Navigation	D	D	B	E	C	C	C	C	C	E	E	E	E	E	E	E
1A3ei	Pipeline transport	A	A	A	A	A	A	A	A	A							
1A4ai	Commercial/institutional: Stationary	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	D
1A4aii, bii, cii, 1A5b	Non-road transport	D	D	B	E	E	E	E	C	C		E			E		
1A4bi	Residential: Stationary	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
1A4ci	Agriculture/Forestry/Fishing: Stationary	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	D
1A5a	Other stationary (including military)	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	D

NFR	DESCRIBTION	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD/F	PAHs	HCB	PCB
1B1a	Fugitive emission from solid fuels: Coal mining and handling		E			E	E	E									
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	D	E	D	C	D	D	D	C	D	C	E	C	C	E		
1B2ai	Fugitive emissions oil: Exploration, production, transport		E														
1B2aiv	Fugitive emissions oil: Refining / storage										C	C	C	C			
1B2av	Distribution of oil products		E														
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)		E														
2A1	Cement production					A	A	A	A								
2A2	Lime production					A	A	A	A								
2A3	Glass production					A	A	A	A		C	C	E				
2A5a	Quarrying and mining of minerals other than coal	A	A	A	A	A	A	A	A								
2A5b	Construction and demolition					C	C	C									
2A6	Other mineral products (please specify in the IIR)	A	A	A	A	A	A	A		A							
2B1	Ammonia production	A	A	A	A	A	A	A		A							
2B2	Nitric acid production	A															
2B5	Carbide production	A	A	A	A	A	A	A		A							
2B10a	Chemical industry: Other (please specify in the IIR)	A	A	A	A	A	A	A	A	A							
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)	A	A	A	A	A	A	A		A							
2C1	Iron and steel production	A	A	A	A	A	A	A	A	A	C	C	C	C	C	E	C
2C2	Ferroalloys production	A	A	A	A	A	A	A	A	A							
2C3	Aluminium production	A	A	A	A	A	A	A	A	A					E		
2C5	Lead production	A	A	A	A	A	A	A		A	C	C	D	C			C
2C7a	Copper production	A	A	A	A	A	A	A	A	A	C	C	C	E			C
2C7c	Other metal production (please specify in the IIR)	A	A	A	A	A	A	A	A	A							
2D3a	Domestic solvent use including fungicides		B										C				
2D3b	Road paving with asphalt		A			A	A	A	A					E			
2D3c	Asphalt roofing		A			A	A	A	A								
2D3d	Coating applications		A														
2D3e	Degreasing		A														
2D3f	Dry cleaning		A														

NFR	DESCRIBTION	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD/F	PAHs	HCB	PCB
2D3g	Chemical products		A									C			C		
2D3h	Printing		A														
2D3i	Other solvent use (please specify in the IIR)		A	A							E	E	E				
2G	Other product use (please specify in the IIR)	B	C	C	B	C	C	C	C	A	C	E	E	C	C		
2H1	Pulp and paper industry					A	A	A	A								
2H2	Food and beverages industry		E														
2H3	Other industrial processes (please specify in the IIR)	A	A	A	A	A	A	A		A							
2I	Wood processing	A	A	A	A	A	A	A		A							
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)												E				D
3B	Manure management	C	C		C	E	E	E									
3D	Inorganic N-fertilizers (includes also urea application)	C	C		C	E	E	E									
5A	Biological treatment of waste - Solid waste disposal on land		A			D	D	D									
5B1	Biological treatment of waste - Composting				C												
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities				A												
5C1bi	Industrial waste incineration	E	E	E		B	B	B	C	E	C	C	C	B	C	B	
5C1bii	Hazardous waste incineration	E	E	E		B	B	B	C	E	C	C	C	B	C	B	
5C1biii	Clinical waste incineration	B	B	C				C	C	B	C	C	C	C	C	E	E
5C1biv	Sewage sludge incineration	E	E	B						E	E	E	E	E	E	B	
5C1bv	Cremation	E	E	E		E	E	E		E	E	E	E	E	E	E	E
5D1	Domestic wastewater handling	A	C	A	C	A	A	A		A							
5D2	Industrial wastewater handling	A	C	A	A	A	A	A		A							
5E	Other waste (please specify in IIR)					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_{2019} for the air pollutants NOx, NMVOC, SO_2, NH_3, PMs, CO, Pb, Cd, Hg, As, Cr. Cu, Ni, Se, Zn, PAH, PCDD/F, HCB, PCBs and BC in the year 2021 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 2021 [%]	TREND ANALYSIS IN 2021 [%]
NOx	21.18	4.98
NMVOC	44.93	12.46
SOx	6.95	0.91
NH3	89.90	24.56
PM2.5	22.01	4.97
PM10	30.88	6.43
TSP	32.97	6.05
BC	26.67	7.69
CO	9.85	5.35
Pb	95.71	21.44
Cd	132.29	54.78
Hg	107.37	26.98
As	43.32	9.77
Cr	78.46	35.69
Cu	612.96	279.17
Ni	129.32	20.59
Se	45.16	8.63
Zn	238.49	109.53
PCDD/F	1267.33	64.15
PAHs	213.54	57.57
HCB	80.75	13.80
PCBs	54.35	30.67

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 (2022). The list of categories reported by the notation keys NE and IE is provided in ***Table 1.7.***

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_{2019}, the notation key not applicable (NA) was used. The lists of notation keys NA and NO are available in ***Table 1.8***.

Several NE key categories have been reported in the 2023 submission for 1990–2021.

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	1990-2021	Cr, Cu, Se, Zn	1990-2021
1A2b	HCB, PCBs	1990-2002, 2008-2021		
1A2gvii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2021		
A3ai(i)	NH_3, Pb, Hg, Cd, AHMs, PCDD/F, PAHs	1990-2021		
1A3aii(i)	NH_3, Pb, Hg, Cd, AHMs, PCDD/F, PAHs	1990-2021		
1A3bv	Zn, PCDD/F, B(a)P, B(b)F, B(k)F, PAHs, PCB	1990-2021		
1A3bvi	Pb, PCDD/F, PAHs, PCB	1990-2021		
1A3bvii	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, PCDD/F, PAHs, PCB	1990-2021		
1A3c	Pb, Hg, As	1990-2021		
1A3di(ii)			All pollutants	1990-2015

NFR	NOT ESTIMATED	YEARS	INCLUDED ELSEWHERE	YEARS
1A4aii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2021		
1A4bii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2021		
1A4ci	NH_3	1990-2021		
1A4cii	Pb, Hg, As, PCDD/F, B(k)F, I()P, HCB, PCBs	1990-2021		
1A5b	Cd, Hg, AHMs, POPs	1990-2021	All pollutants	1990-2014
1B1a	BC, HMs	1990-2021		
1B1b	HCB, PCB	1990-2021		
1B2ai	SOx, PCDD/F	1990-2021		
1B2aiv			MPs, $PM_{2.5}$, PM_{10}, TSP	1990-2021
1B2av	SOx, PCDD/F	1990-2021		
1B2b	SOx, PCDD/F	1990-2021		
1B2c	BC, CO, HMs, POPs	1990-2021	MPs, $PM_{2.5}$, PM_{10}, TSP	1990-2021
2A1			MPs, HMs, POPs	1990-2021
2A2	PHMs	1990-2021	MPs	1990-2021
2A3	PCDD/F, PAHs, HCB	1990-2021	MPs	1990-2021
2A5c			$PM_{2.5}$, PM_{10}, TSP	1990-2021
2A6	BC	1990-2021		
2B5	BC, HMs, PCDD/F, PAHs, HCB	1990-2021		
2B10a	HMs, POPs	1990-2021		
2B10b	BC	1990-2021		
2C1	B(a)P, B(b)F, B(k)F, I()P	1990-2021		
2C2	HMs, PCDD/F, PAHS	1990-2021		
2C3	NH_3, HMs, PCDD/F, HCB	1990-2021		
2C5	NH_3, BC, Cr, Cu, Ni, Se, , B(a)P, B(b)F, B(k)F, I()P, HCB	2011-2021		
2C6	NOx, NMVOC, NH_3, BC, CO, Cr, Cu, Ni, Se, PAHs, HCB	1990-2021		
2C7a	NH_3, Se, Zn, PAHs, HCB	1990-2021		
2C7c	BC, HMs, POPs	1990-2021		
2C7d			All Pollutants	1990-2020
2D3a	$PM_{2.5}$	1990-2021		
2D3b	NOx, SOx, CO, PAHs, HCB	1990-2021		
2D3c	NOx, CO, PHMs, PCDD/F, PAHs, HCB	1990-2021		
2D3e	$PM_{2.5}$	1990-2021		
2D3f	$PM_{2.5}$	1990-2021		
2D3g	NOx, SOx, NH_3, PMs, CO, Pb, Hg, Cu, Zn, B(a)P, B(b)F, B(k)F, I()P, HCB, PCB	1990-2021		
	Cd, As, Cr, Ni, Se, PAHs	2015-2021		
2D3h	$PM_{2.5}$, BC	1990-2021		
2D3i	NOx,, NH_3, PMs, CO, POPs	1990-2021		
2G	Se, HCB, PCBs	1990-2021		
2H1	NH_3, PAHs, HCB	1990-2021	NOx, NMVOC, SOx, CO	1990-2021
2H2	BC	1990-2021		
2H3	BC	1990-2021		
2I	BC, As, Cu	1990-2021		
2K	Pb, Cd, AHMs, HCB	1990-2021		
3Da2a			NMVOC	1990-2021

NFR	NOT ESTIMATED	YEARS	INCLUDED ELSEWHERE	YEARS
3Da3			NMVOC	1990-2021
3Da4	NH_3	1990-2021		
5A	NH_3, CO, Hg	1990-2021		
5B1	NOx, NMVOC, SOx, PMs, CO	1990-2021		
5B2	NOx, NMVOC, SOx, PMs, CO, PHMs, Cr, Zn, POPs	2001-2021		
5C1bi	NH_3, Cr, Cu, Se, Zn, B(a)P, B(b)F, B(k)F, I()P	1990-2006		
5C1bii	NH_3, Cr, Cu, Se, Zn, B(a)P, B(b)F, B(k)F, I()P	1990-2021		
5C1biii	NH_3, $PM_{2.5}$, PM_{10}, TSP, Se, Zn, PAHs	1990-2021		
5C1biv	NH_3	2012-2021		
5C1bv	BC	1990-2021		
5D1	BC, HMS	1990-2021		
5D2	BC, HMS	1990-2021		
5E	NOx, NMVOC, SOx, BC, CO, Ni, Se, Zn, PAHs, HCB, PCB	1990-2021		

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

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
1A1b	PCB	1990-2021		
1A1c	HCB, PCBs	1990-2021		
1A2a			NH_3	1990-2015, 2017-2021
1A2b			NH_3	1990-2021
1A2c			NH_3	1990-2021
1A2d			NH_3	1990-2006
1A2f			NH_3	1990-1999,2006-2011
1A2gvii	Hg, As	1990-2021		
1A3ai(i)	HCB, PCBs	1990-2021		
1A3aii(i)	HCB, PCBs	1990-2021		
1A3bv	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2021		
1A3bvi	NOx, NMVOC, SOx, NH_3, BC	1990-2021		
1A3bvii	NOx NMVOC, SOx, NH_3, BC	1990-2021		
1A3ei	NH_3, HMs, POPs	1990-2021		
1A3eii			All pollutants	1990-2021
1A4ai			NH_3	1990-2013
1A4ciii			All pollutants	1990-2021
1B1a	NOx, SOx, NH_3, CO, POPs	1990-2021		
1B1c			All pollutants	1990-2021
1B2ai	NOx, NH_3, CO, HMs, PAHs, HCB, PCB	1990-2021		
1B2aiv	BC, PAHs, HCB, PCB	1990-2021		
1B2av	NOx, NH_3, CO, HMs, PAHs, HCB, PCB	1990-2021		
1B2b	NOx, NH_3, CO, HMs, PAHs, HCB, PCB	1990-2021		

NFR	NOT APPLICABLE	YEARS	NOT OCCURRING	YEARS
1B2d			All pollutants	1990-2020
2A2	AHMs, POPs	1990-2021		
2A3	PCB	1990-2021		
2A5a	NH_3, BC, HMs, POPs	1990-2021		
2A5b	MPs, BC, HMs, POPs	1990-2021		
2A5c	MPs, BC, HMs, POPs	1990-2021		
2A6	HMs, POPs	1990-2021		
2B1	BC, HMs, POPs	1990-2021		
2B2	NMVOC, SOx, PMs, HMs, POPs	1990-2021		
2B3			All pollutants	1990-2021
2B5	NH_3, PCB	1990-2021	All pollutants	1990-1991
2B6			All pollutants	1990-2021
2B7			All pollutants	1990-2021
2B10b	HMs, POPs	1990-2021	NH_3	2006-2021
2C2	HCB, PCBs	1990-2021	NH_3	2004-2009
2C3	PCBs	1990-2021		
2C4			All pollutants	1990-2021
2C5			All Pollutants	1990-2010
2C6			All pollutants	1990-2011, 2015-2021
2C7b			All Pollutants	1990-2021
2D3a	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, Pb, Cd, AHMs, POPs	1990-2021		
2D3b	NH_3, HMs, PCBs	1990-2021		
2D3c	SOx, NH_3, AHMs, PCBs	1990-2021		
2D3d	NOx, SOx, NH_3, PMs, CO, HMs, POPs	1990-2021		
2D3e	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, HMs, POPs	1990-2021		
2D3f	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, HMs, POPs	1990-2021		
2D3h	NOx, SOx, NH_3, PM_{10}, TSP, CO, HMs, POPs	1990-2021		
2H1	HMs, PCDD/F, PCBs	1990-2021		
2H2	NOx, SOx, NH_3, HMs, POPs	1990-2021		
2H3	HMs, POPs	1990-2021	NH_3	2017-2020
2I	PHMs, Cr, Ni, Se, Zn, POPs	1990-2021	NH_3	2011-2013
2J			All Pollutants	1990-2021
2K	MPs, PMs, PCDD/F, PAHs	1990-2021		
2L			All Pollutants	1990-2021
3B1a	SOx, BC, CO, HMs, POPs	1990-2021		
3B1b	SOx, BC, CO, HMs, POPs	1990-2021		
3B2	SOx, BC, CO, HMs, POPs	1990-2021		
3B3	SOx, BC, CO, HMs, POPs	1990-2021		
3B4a			All Pollutants	1990-2021
3B4d	SOx, BC, CO, HMs, POPs	1990-2021		
3B4e	SOx, BC, CO, HMs, POPs	1990-2021		
3B4f			All Pollutants	1990-2021
3B4gi	SOx, BC, CO, HMs, POPs	1990-2021		
3B4gii	SOx, BC, CO, HMs, POPs	1990-2021		
3B4giii	SOx, BC, CO, HMs, POPs	1990-2021		
3B4giv	SOx, BC, CO, HMs, POPs	1990-2021		

NFR	NOT APPLICABLE	YEARS	NOT OCCURRING	YEARS
3B4h	All Pollutants	1990-2021		
3Da1	NMVOC, SOx, TSP, BC, CO, HMs, POPs	1990-2021	$PM_{2.5}$, PM_{10}	1990-2021
3Da2a	SOx, PMs, HMs, POPs	1990-2021		
3Da2b	NMVOC, SOx, TSP, BC, CO, HMs, POPs	1990-2021	NOx, NH_3	2015-2021
3Da2c	NMVOC, SOx, TSP, BC, CO, HMs, POPs	1990-2021		
3Da3	SOx, TSP, BC, CO, HMs, POPs	1990-2021		
3Da4	NOx, NMVOC, SOx, PMs, HMs, POPs	1990-2021		
3Db	NOx, NMVOC, SOx, PMs, HMs, POPs	1990-2021	NH_3	1990-2021
3Dc	MPs, BC, HMs, POPs	1990-2021		
3Dd	All Pollutants	1990-2021		
3De	NOx, SOx, PMs, HMs, POPs	1990-2021	NH_3	1990-2021
3Df	MPs, PMs, HMs, PCDD/F, PAHs, PCBs	1990-2021		
3F			All Pollutants	1990-2021
3I	All Pollutants	1990-2021		
5A	NOx, SOx, BC, Pb, Cd, AHMs, POPs	1990-2021		
5B1	HMs, POPs	1990-2021		
5B2	As, Cu, Ni, Se	2001-2021	All Pollutants	1990-2021
5C1a			All Pollutants	1990-2021
5C1bi	PCBs	1990-2016, 2018-2021	All Pollutants	2017
5C1bii	PCBs	1990-2021		
5C1biii			Pb	2006-2020
5C1biv			All Pollutants	1990-2011, 2017
5C1bv	NH_3	1990-2021		
5C1bvi			All Pollutants	1990-2021
5C2			All Pollutants	1990-2021
5D1	POPs	1990-2021		
5D2	POPs	1990-2021		
5D3			All Pollutants	1990-2021
5E	NH_3	1990-2021		
6A			All Pollutants	1990-2021

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

CHAPTER 2: KEY TRENDS

Last update: 15.3.2023

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.

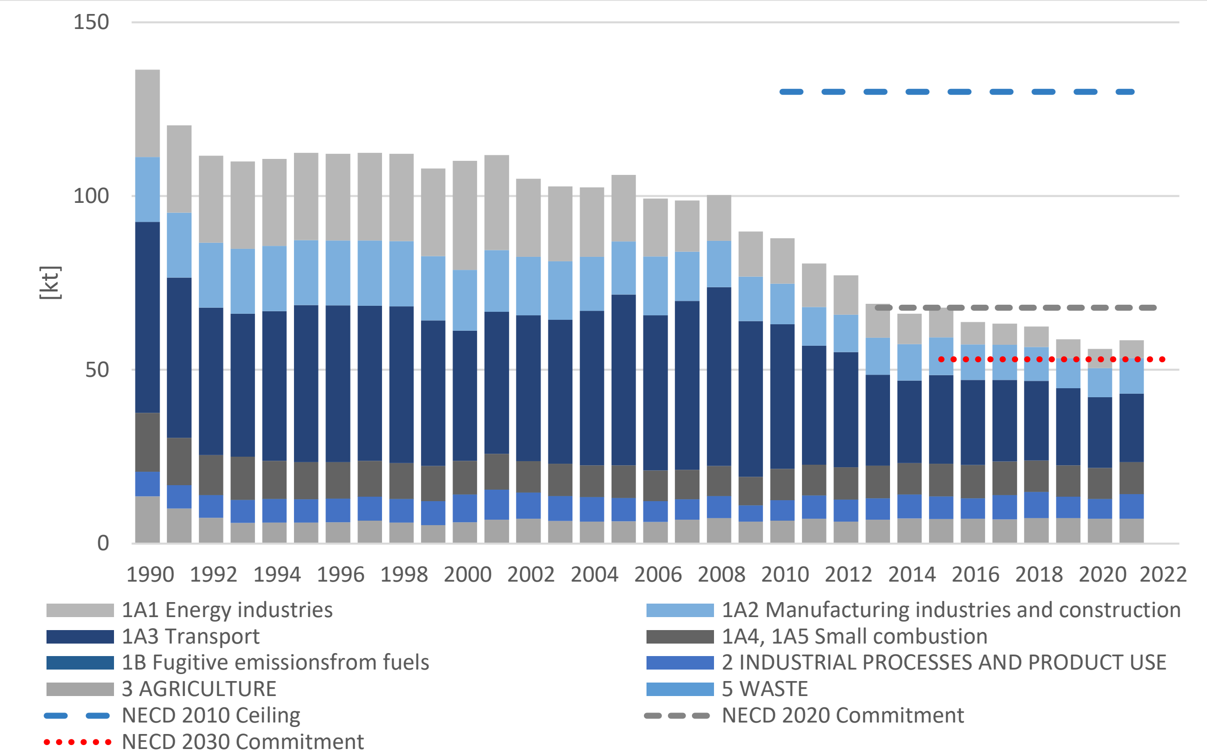
The Directive 2001/81/EC on National emissions ceilings (NEC Directive) sets limit values of emissions of **sulphur dioxide** (SO_2), **nitrogen oxides** (NOx), **volatile organic compounds** (VOCs) and **ammonia** (NH_3).

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 2016/22848/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.

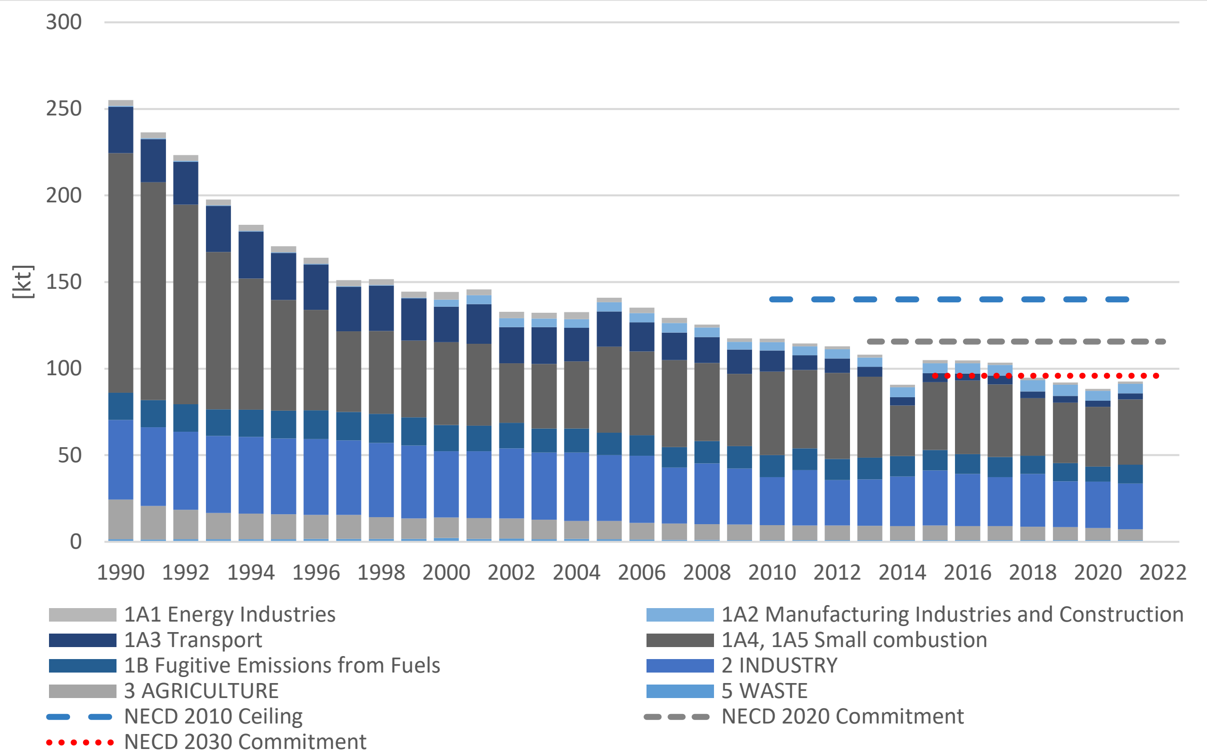
Figure 2.1: *Total NOx Emissions by Sectors*



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 emission in 2021. 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 per cent 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

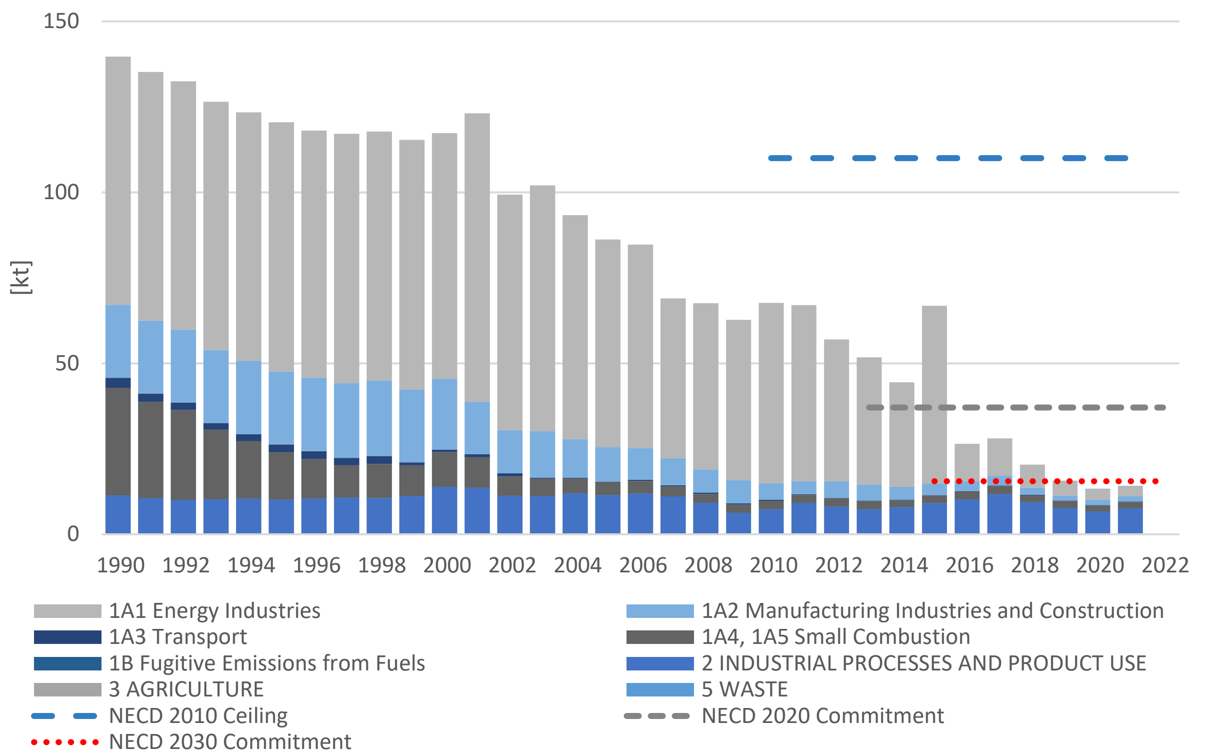
The trends of SOx emissions decreased until 2014 continually. Since 1990 SOx emissions have noticed a significant decrease due to strict air protective legislation. The downward trend relates also to the composition of the fuel used in all sectors and related legislative limitations.

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*



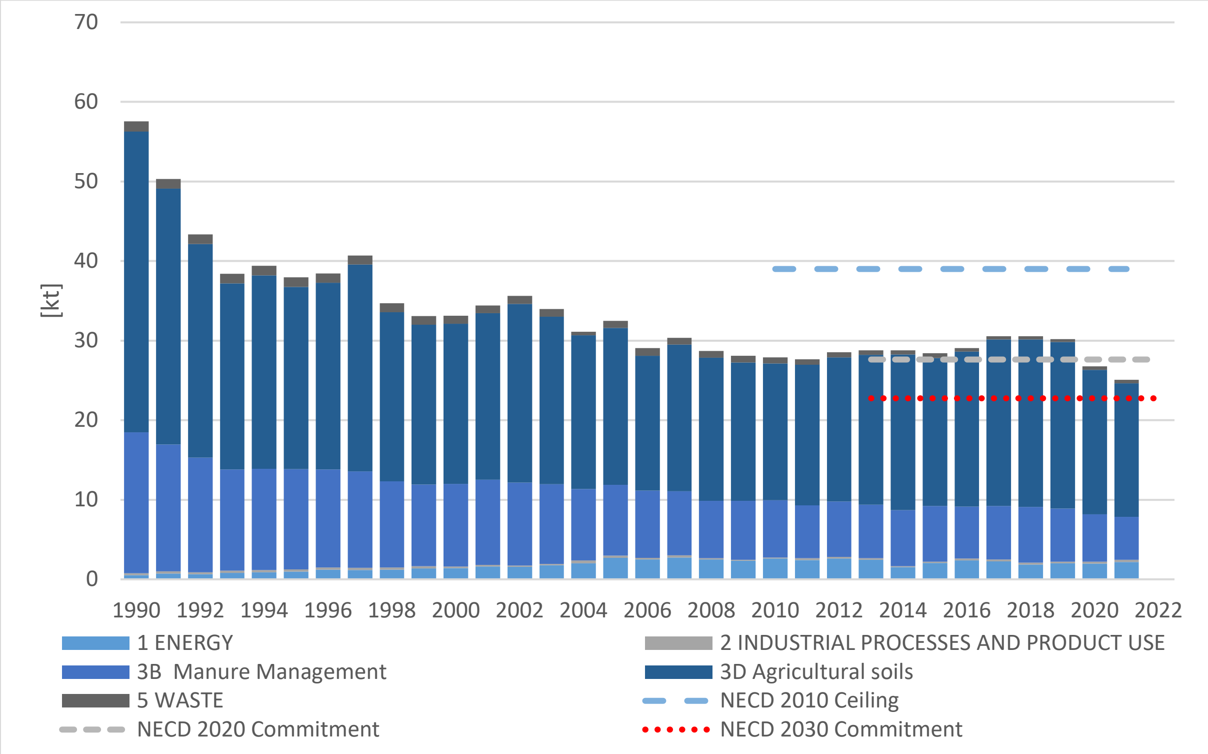
2.1.4 TRENDS IN EMISSIONS OF NH_3

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 **2001/81/EC Directive** and national commitment to emission reduction for the period 2020-2029 set by **2016/2284/EU Directive.**

Figure 2.4: *Total NH_3 Emissions by Sectors*



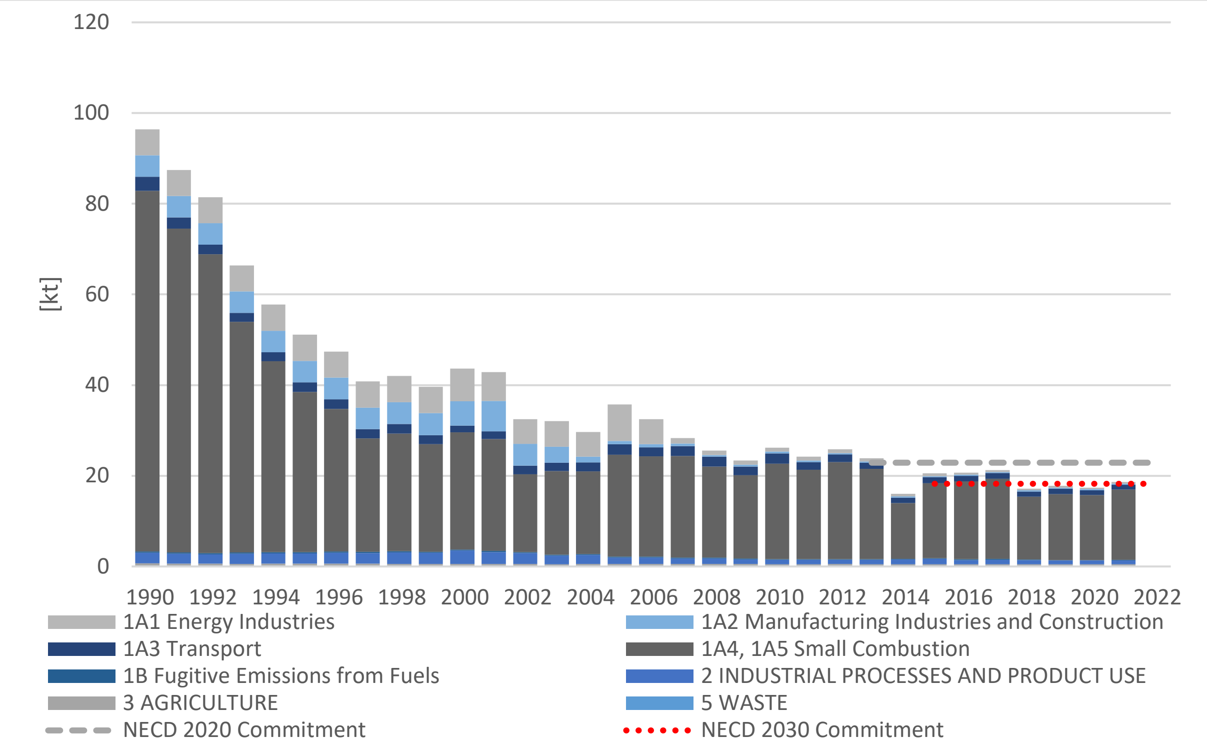
2.1.5 TRENDS IN EMISSIONS OF $PM_{2.5}$

The emission trend of $PM_{2.5}$ is significantly affected by the emission trend of the category of Residential heating. This category produced more than 81% of total $PM_{2.5}$ emissions in the Slovak Republic in the year 2021. 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***).

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

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

Figure 2.6: *Total PM_{10} Emissions by Sectors*

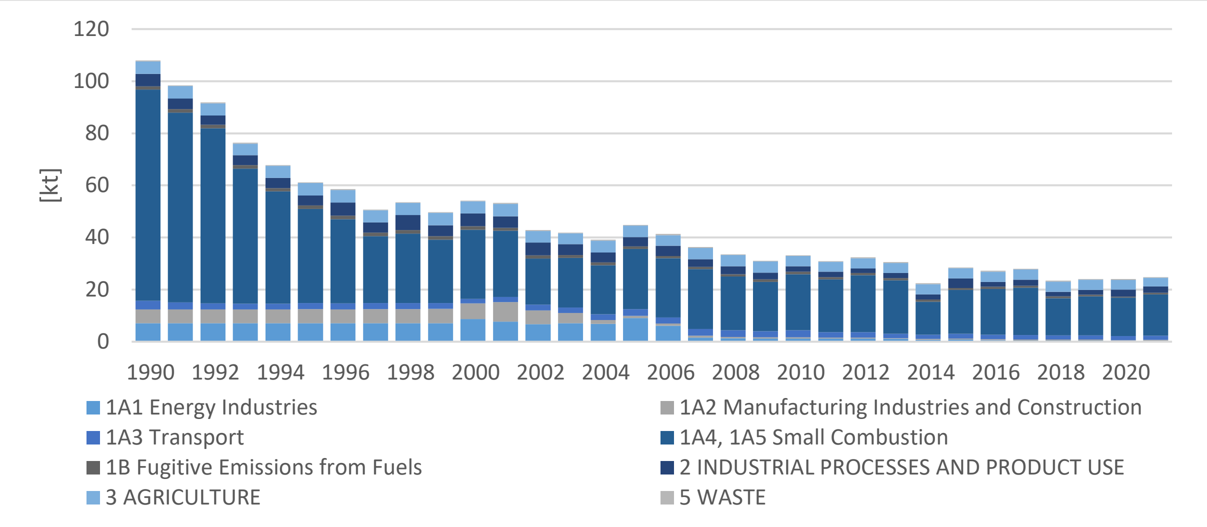


Figure 2.7: *Total BC Emissions by Sectors*

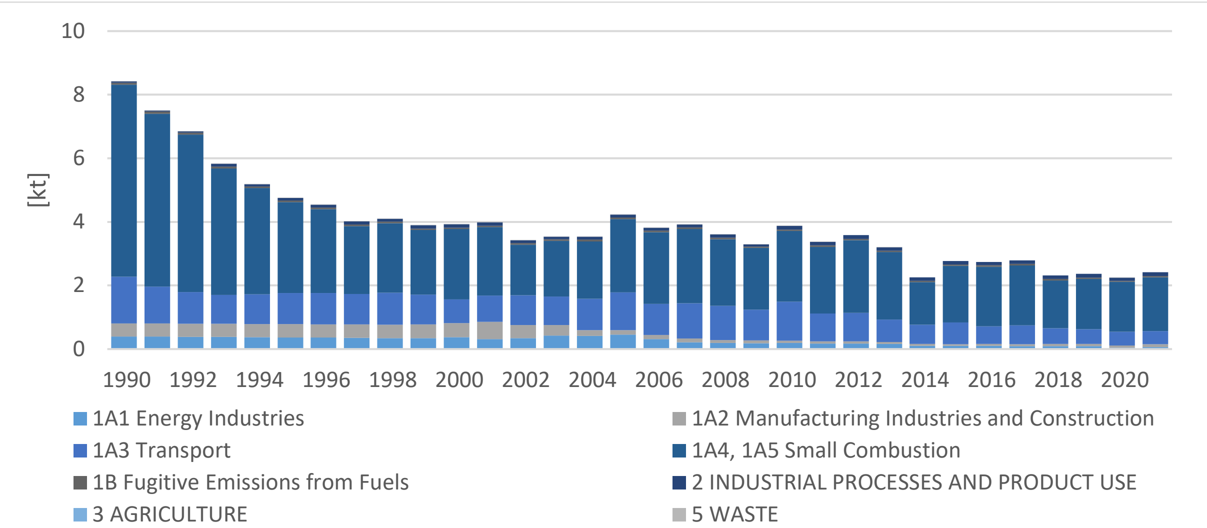
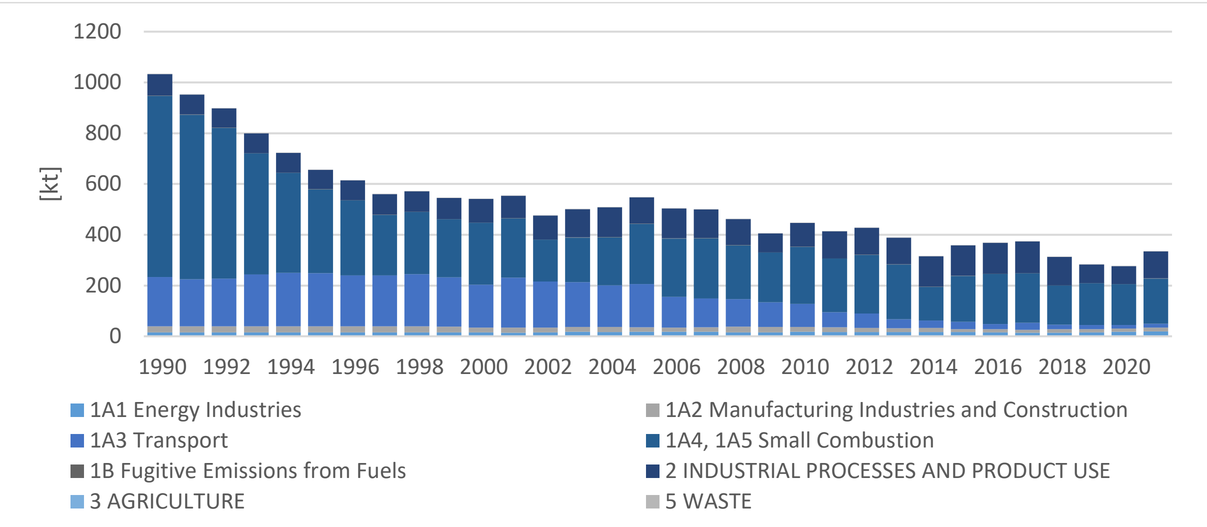


Figure 2.8: *Total CO Emissions by Sectors*



2.3 TRENDS IN EMISSIONS OF HEAVY METALS

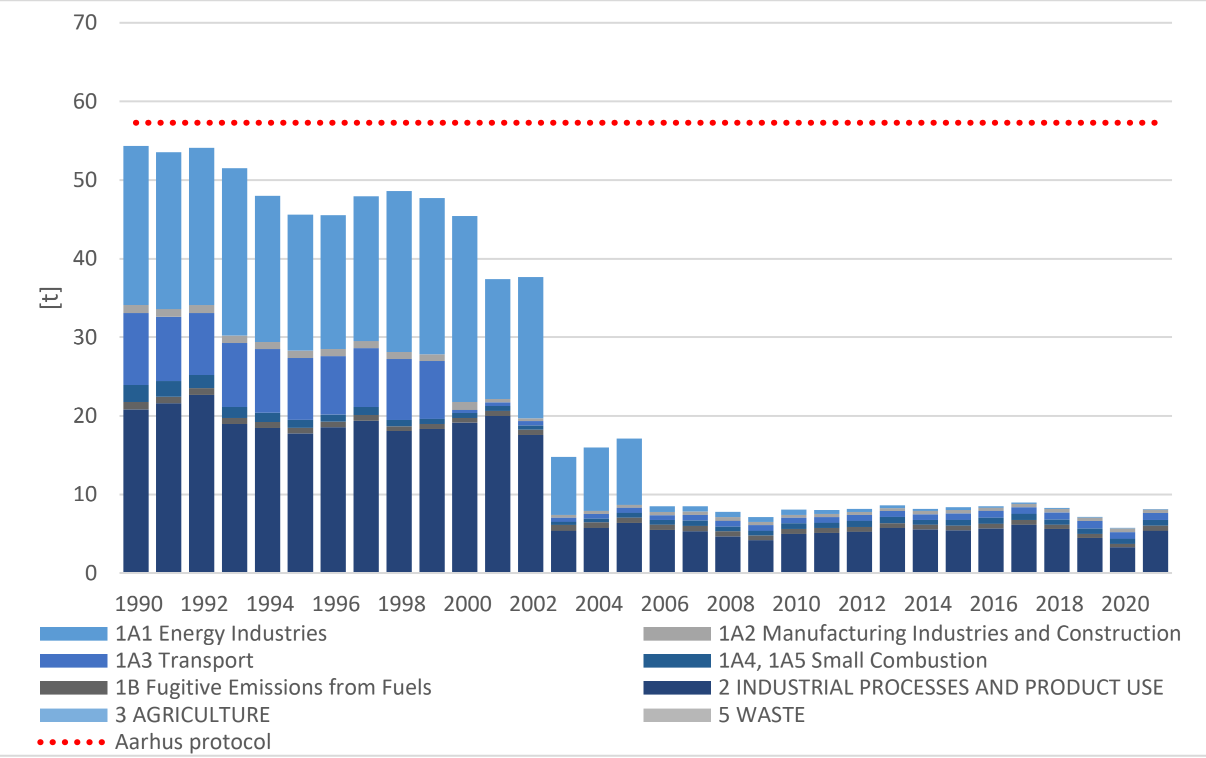
2.3.1 TRENDS IN EMISSIONS OF Pb

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*

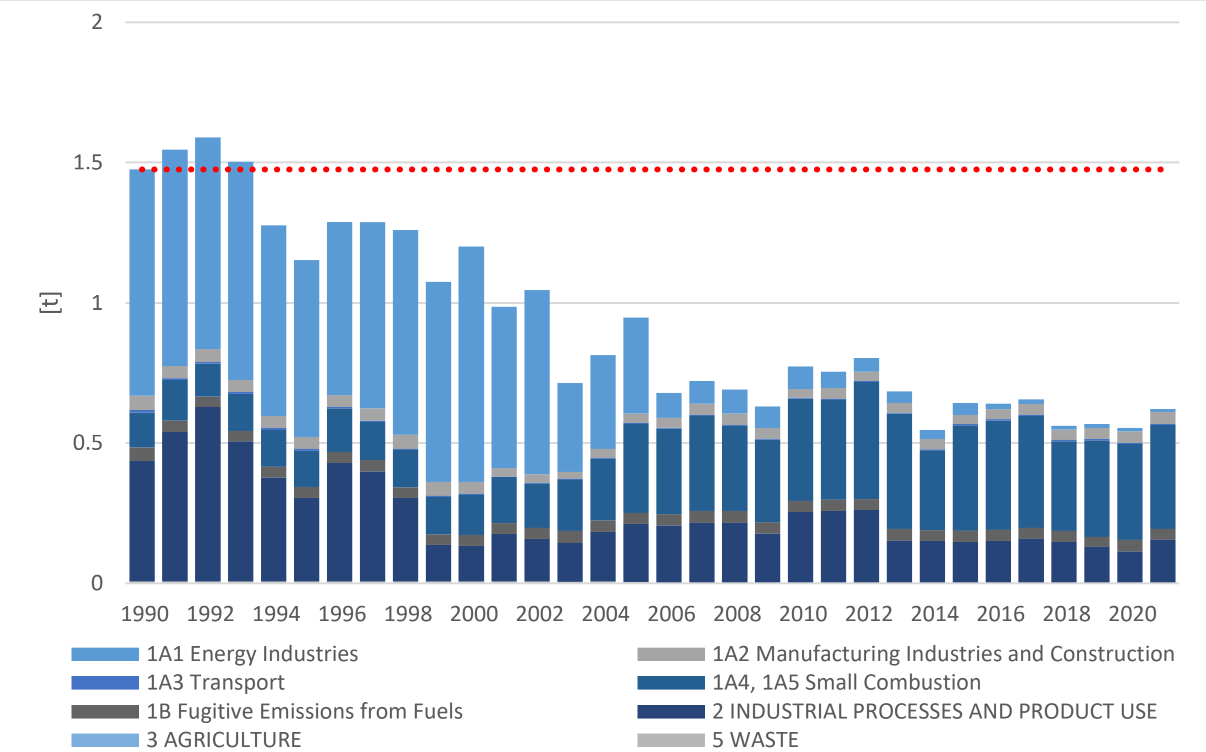


2.3.2 TRENDS IN EMISSIONS OF Cd

As shown in ***Figure 2.10*** emissions of Cd has 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.

There were no exceedances of Aarhus protocols of CLRTAP after the protocol was signed by the Slovak Republic.

Figure 2.10: *Total Cd Emissions by Sources*



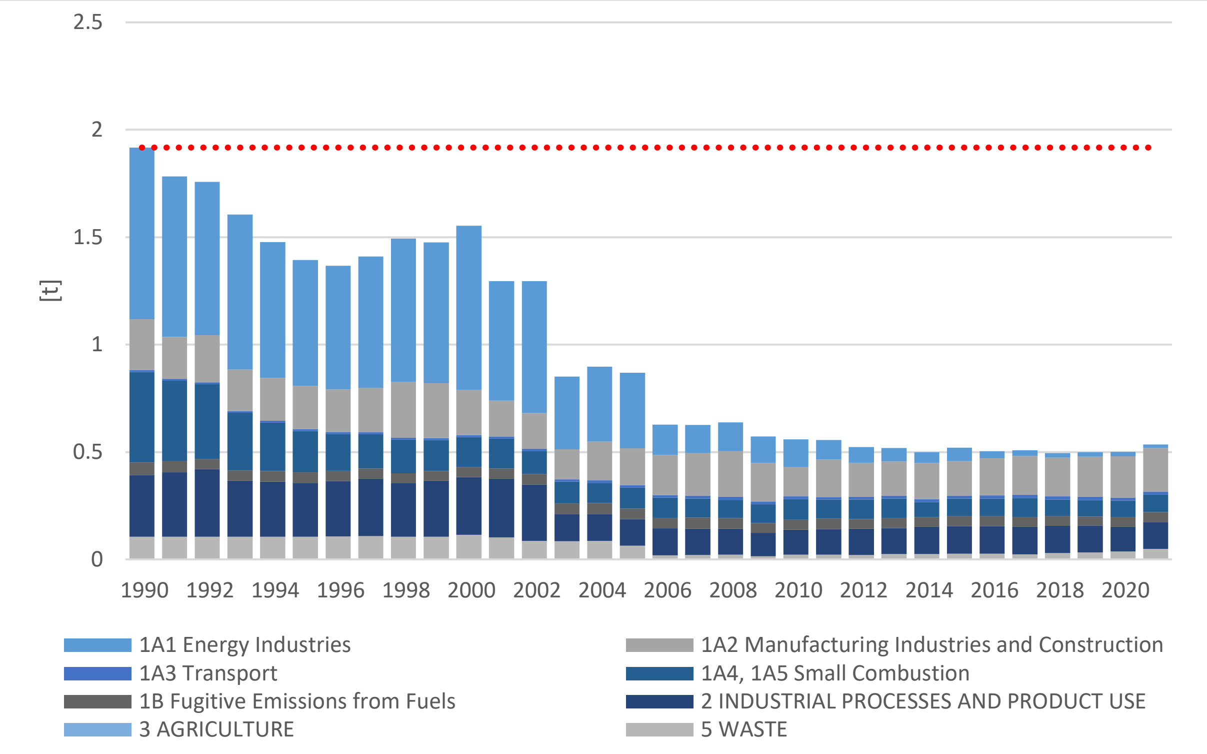
2.3.3 TRENDS IN EMISSIONS OF Hg

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



2.4 TREND IN EMISSION OF POPS

The emission inventory of POPs (PCB, DIOX, PAH - 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).

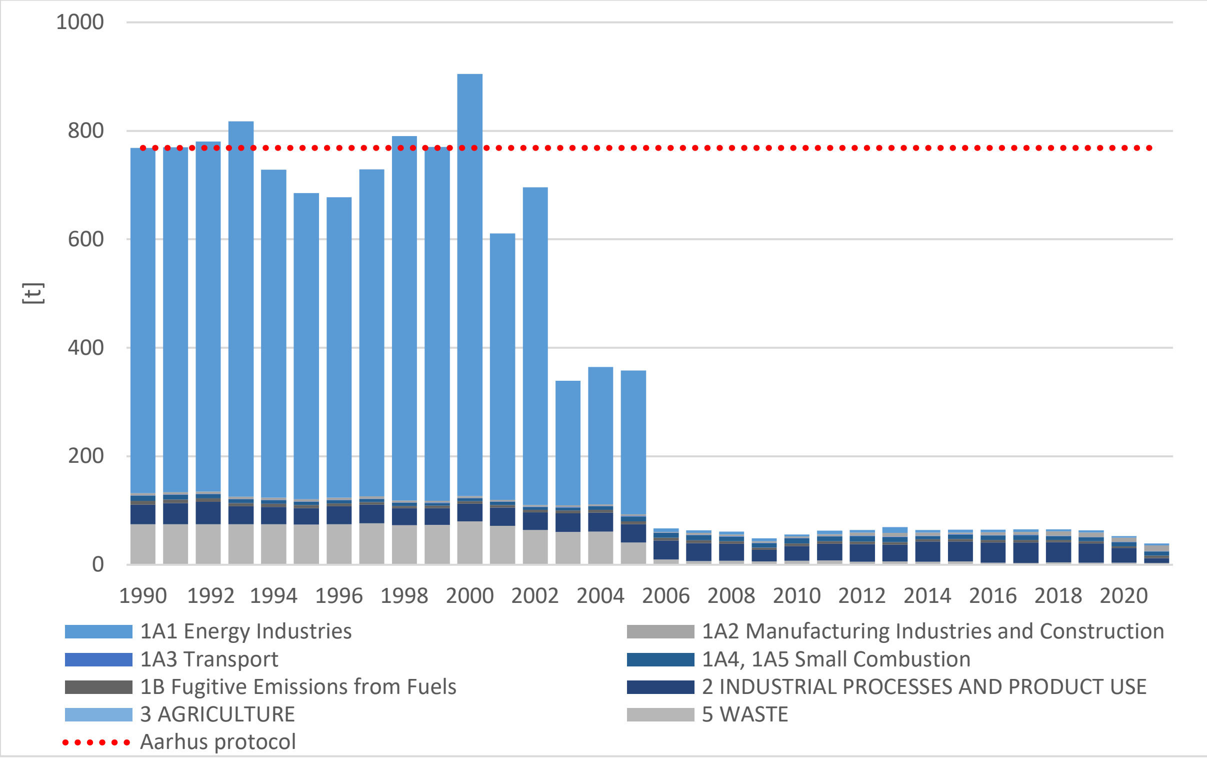
2.4.1 TRENDS IN EMISSIONS OF PCDD/PCDF

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

The main contributors are energy production (includes incineration of municipal waste with energy recovery) and waste incineration without energy recovery, which includes incineration of industrial and clinical waste.

There were no exceedances of Aarhus protocols of CLRTAP after the protocol was signed by the Slovak Republic.

Figure 2.12: *Total PCDD/PCDF Emissions by Sectors*



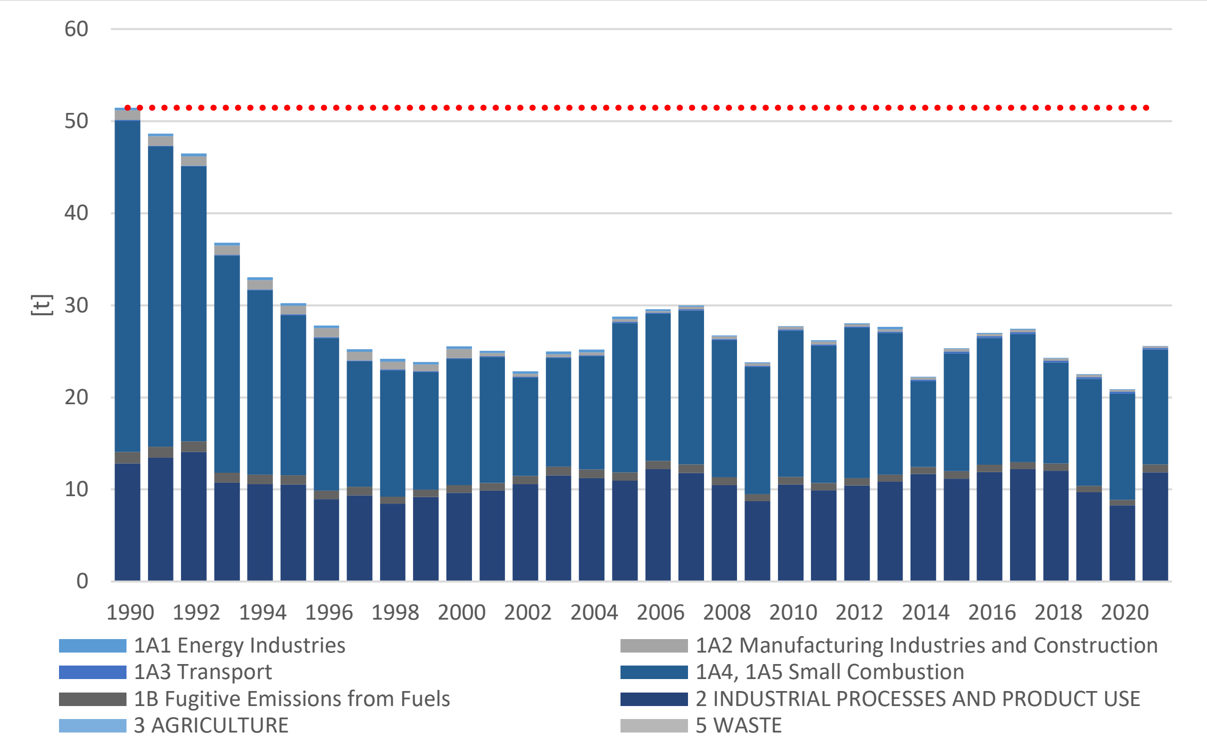
2.4.2 TRENDS IN EMISSIONS OF PAHS

The decreasing trend of PAHS emission 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 households (47%) and metal production (45%) in 2021.

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*

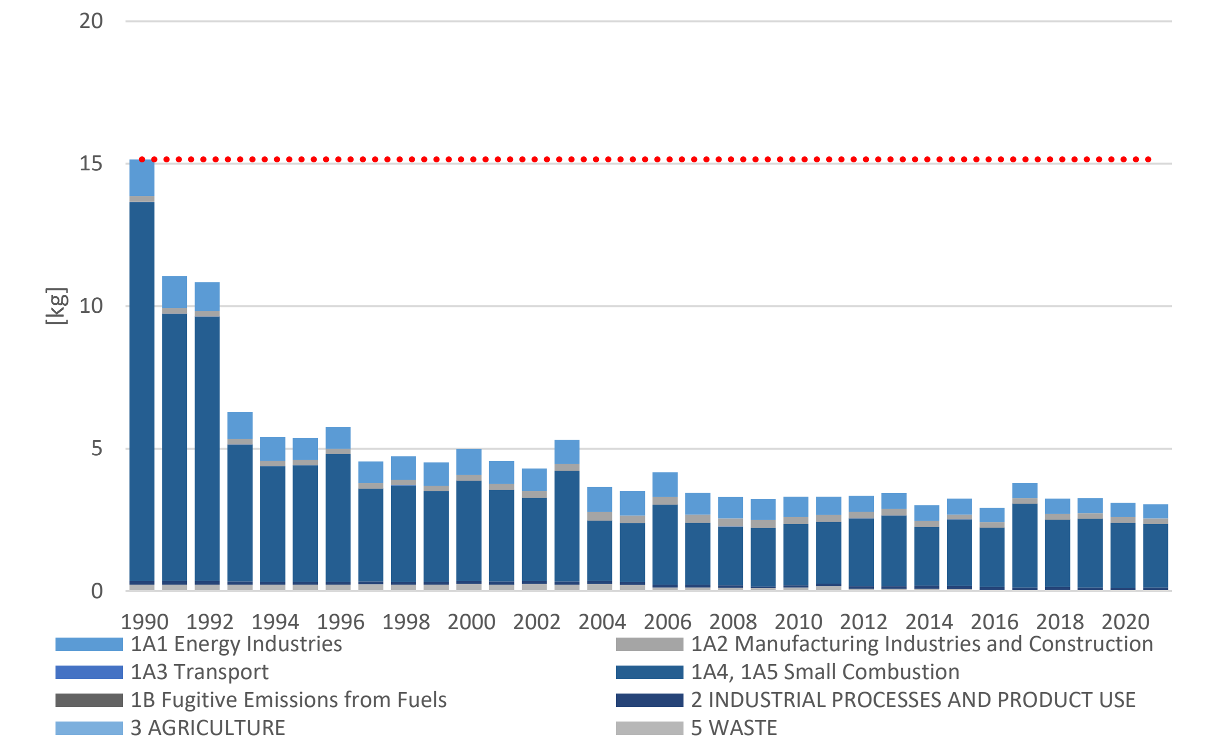


2.4.3 TRENDS IN HCB EMISSIONS

Emissions of HCB are connected to households heating. ***Figure 2.14*** shows a general declining trend since 1990, although since 1995 the trend is 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.

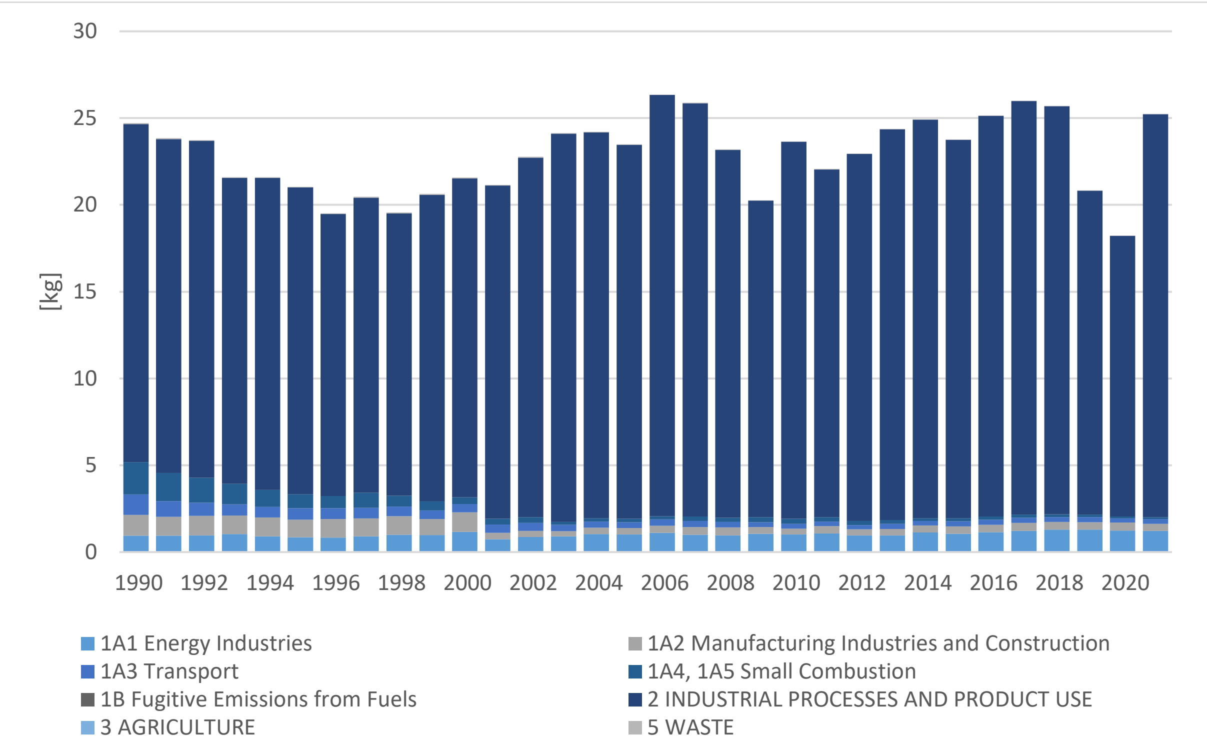
Figure 2.14: *Total HCB Emissions by Sectors*



2.4.4 TRENDS IN PCBs EMISSIONS

Emissions of PCB have 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 2021 was 80%. (***Figure 2.15***).

Figure 2.15: *Total PCBs Emissions by Sectors*



CHAPTER 3: ENERGY (NFR 1)

Last update: 15.3.2023

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 2021, the system contained 13 560 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 3.6.4 Road Transport***.

c/ Estimations 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	T2, NK	T2, 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	T1	T1, NK
1A2c	Chemicals	T3	NK	T3	T3	T1	T1
1A2d	Pulp, Paper and Print	T3	T3, NK	T3	T3	T2	T2
1A2e	Food processing, beverages and tobacco	T3	T3	T3	T3	T1	T1
1A2f	Non-metallic minerals	T3	T3, NK	T3	T3	T1, T2	T1, T2

NFR		METHODOLOGY/TIER					
	LONGNAME OF CATEGORY	NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TSP	BC	HM	POPs
1A2gvii	Mobile Combustion	T1	T1	T1	T1	T1, NK	T1, NK
1A2gviii	Other	T3	T3	T3	T3	T2	T2
	TRANSPORT						
1A3ai(i)	International aviation LTO (civil)	T3	T3	T3	T3	T1, NK	NK
1A3aii(i)	Domestic aviation LTO (civil)	T3	T3	T3	T3	T1, 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 wear	NK	NK	T3	T3	T3	NK
1A3bvii	Road transport: Automobile road abrasion	NK	NK	T3	NK	T3	NK
1A3c	Railways	T1, T2	T2	T2	T2	T1	T1
1A3di(ii)	International inland waterways	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK
1A3dii	National navigation (shipping)	T1	T1	T1	T1	T1	T1
1A3ei	Pipeline transport	T3	NK	T3	T3	NK	NK
1A3eii	Other	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	T1	T1	T1	T1	T1, NK	T1, NK
1A4ci	Agri./Forest./Fish.: Stationary	T3	NK	T3	T3	T2	T2
1A4cii	Agri./Forest./Fish.: Off-road vehicles and other machinery	T1	T1	T1	T1	T1, NK	T1, NK
1A4ciii	Agri./Forest./Fish.: 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	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK	NK
	FUGITIVE EMISSIONS						
1B1a	from solid fuels: Coal mining and handling	T2, NK	NK	T2	NK	NK	NK
1B1b	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	from oil: Exploration, production, transport	T1, NK	NK	NK	NK	NK	NK
1B2aiv	from oil: Refining / storage	NK	NK	NK	NK	T1	T1, NK
1B2av	Distribution of oil products	T1, NK	NK	NK	NK	NK	NK
1B2b	from natural gas	T1, NK	NK	NK	NK	NK	NK
1B2c	Venting and flaring	T1	NK	T1	T1	T1	NK
1B2d	Other fugitive emissions from energy production	NK	NK	NK	NK	NK	NK

3.2 TRENDS IN THE SECTOR ENERGY

In ***Table 3.2*** below is visible 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).

The categories of the energy sector are 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	115.6636	184.7465	128.3135	0.5142	93.3851	98.0758	111.9075	8.3815	948.1925
1995	99.6996	110.9283	110.3461	0.9613	48.2139	52.2641	61.4957	4.6749	579.9693
2000	96.0483	92.0456	103.3794	1.4108	40.1475	44.2713	52.9358	3.8207	448.1912
2005	92.9020	90.9310	74.7581	2.6938	33.7608	36.5840	44.7757	4.1381	443.4311
2010	75.3547	79.8870	60.3784	2.6201	24.7657	26.8360	30.4295	3.7609	352.5760
2011	66.7575	73.1523	57.8090	2.4218	22.7825	24.7796	28.2127	3.2583	306.8300
2012	64.4991	77.1461	48.9462	2.6104	24.3961	26.4493	29.9428	3.4640	321.3906
2013	55.9686	72.0474	44.3613	2.4729	22.4039	24.4039	27.8372	3.0962	283.7023
2014	52.0665	53.1275	36.4031	1.5252	14.4749	16.1618	18.9739	2.1492	195.1534
2015	54.3017	63.6003	57.7000	2.0655	18.8889	20.6743	23.6980	2.6596	238.4522
2016	50.7350	65.5855	16.1358	2.3680	19.2900	21.0487	23.9850	2.6347	246.2610
2017	49.3824	66.0234	16.3242	2.2598	19.7308	21.4305	24.3677	2.6781	249.0327
2018	47.5431	55.6578	10.9316	1.8679	15.8103	17.3640	19.9907	2.2027	200.8891
2019	45.3341	57.0588	7.9800	1.9924	16.4728	18.0041	20.6036	2.2459	209.5740
2020	43.1027	53.5636	6.6467	1.9553	16.0270	17.3286	19.5538	2.1443	206.3195
2021	44.2677	58.7659	6.6342	2.1539	17.2924	18.7463	21.2356	2.3010	228.3567
1990/2021	**-62%**	**-68%**	**-95%**	**319%**	**-81%**	**-81%**	**-81%**	**-73%**	**-76%**
2020/2021	**3%**	**10%**	**0%**	**10%**	**8%**	**8%**	**9%**	**7%**	**11%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	33.5280	1.0393	1.5250	2.7404	4.5626	8.9047	6.0715	5.3972	20.5838
1995	27.8193	0.8486	1.0370	1.4709	2.5160	5.9549	2.7588	2.8147	12.1861
2000	26.3002	1.0682	1.1690	1.5101	2.1461	4.8022	1.4681	2.8839	10.7872
2005	10.7295	0.7357	0.6819	1.0917	2.3052	6.7090	1.3434	2.9006	13.7110
2010	3.0785	0.5177	0.4202	0.8212	2.2176	6.9664	1.5231	2.2805	14.0933
2011	2.8886	0.4969	0.4142	0.6471	2.0700	6.5807	1.3121	1.6974	13.9705
2012	2.8935	0.5409	0.3807	0.5570	2.1547	6.9217	1.0681	1.4619	15.6693
2013	2.8298	0.5303	0.3722	0.5090	2.0759	6.8369	1.0380	1.2817	15.6878
2014	2.6045	0.3956	0.3472	0.4338	1.6678	6.8350	0.9533	1.0624	13.4012
2015	2.9191	0.4950	0.3654	0.5063	2.0099	7.5106	1.1594	1.2530	15.8004
2016	2.8100	0.4894	0.3486	0.3534	1.9637	7.9221	0.9811	0.7316	15.3787
2017	2.8026	0.4958	0.3569	0.3394	1.9699	7.7140	0.9426	0.6703	16.0009
2018	2.6943	0.4132	0.3387	0.2954	1.7628	8.1980	0.9041	0.6046	14.1645
2019	2.6772	0.4360	0.3414	0.2919	1.7970	8.3321	0.8575	0.5769	14.8038
2020	2.4776	0.4401	0.3478	0.2936	1.7224	7.5174	0.8224	0.5578	14.3114
2021	2.7282	0.4662	0.3613	0.2902	1.9052	8.0382	0.9241	0.5150	15.2554
1990/2021	**-92%**	**-55%**	**-76%**	**-89%**	**-58%**	**-10%**	**-85%**	**-90%**	**-26%**
2020/2021	**10%**	**6%**	**4%**	**-1%**	**11%**	**7%**	**12%**	**-8%**	**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]	PCB [kg]
1990	657.4855	14.1090	10.6066	6.1034	7.3751	38.6298	14.8015	5.1860
1995	580.6180	7.0765	5.4130	3.0944	3.6805	19.6863	5.0477	3.3486

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]
2000	792.1340	5.6805	4.4263	2.4455	2.9534	15.9047	4.6289	3.1525
2005	282.9562	6.4586	4.8957	2.6880	3.3802	17.8101	3.1892	1.9143
2010	21.6048	6.2769	4.8265	2.6105	3.2937	17.1717	3.1119	1.9139
2011	24.4326	5.8970	4.5826	2.4548	3.1007	16.2779	3.0625	2.0228
2012	26.0526	6.4043	4.9857	2.6591	3.3749	17.6005	3.1709	1.7980
2013	32.5775	6.0057	4.7671	2.5047	3.1784	16.8033	3.2638	1.8536
2014	21.6005	3.7258	3.1359	1.6004	1.9796	10.5936	2.8255	1.9577
2015	21.9646	5.0492	4.1284	2.1369	2.6948	14.1713	3.0619	1.9592
2016	23.6900	5.3946	4.3771	2.2975	2.8935	15.1213	2.7809	2.0534
2017	24.4063	5.3813	4.4677	2.2816	2.9329	15.2473	3.6607	2.1618
2018	24.1369	4.2770	3.6415	1.8470	2.3546	12.2658	3.0989	2.1742
2019	24.2365	4.4870	3.7959	1.9281	2.4855	12.8262	3.1220	2.1603
2020	22.0699	4.4211	3.7168	1.8853	2.4657	12.6041	2.9998	2.0578
2021	27.5915	4.8303	4.0494	2.0784	2.6817	13.7277	2.9186	2.0222
1990/2021	**-96%**	**-66%**	**-62%**	**-66%**	**-64%**	**-64%**	**-80%**	**-61%**
2020/2021	**25%**	**9%**	**9%**	**10%**	**9%**	**9%**	**-3%**	**-2%**

The share of the categories of emissions of the particular pollutants in the energy sector is shown in ***Figure 3.1*** below.

Transport categories are the main contributor to NOx emissions, especially category **1A3bi** (Passenger cars) with a share of 22% of emissions in the energy sector in 2021 (***Figure 3.1***). Emissions in these categories decrease slowly.

Emissions of NMVOC are emitted mostly by the category **1A4bi** (Residential: Stationary). In 2021, it was 59% of all NMVOC emissions in the energy sector and almost 38% of the total emissions of this pollutant (***Figure 3.1***). Emission is relatively stable, with only slight fluctuation since 2005.

SOx emissions are mainly emitted by category **1A1a** (27% in 2021) 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 2021 this category contributed almost 87% of total emissions of $PM_{2.5}$ (***Figure 3.1***).

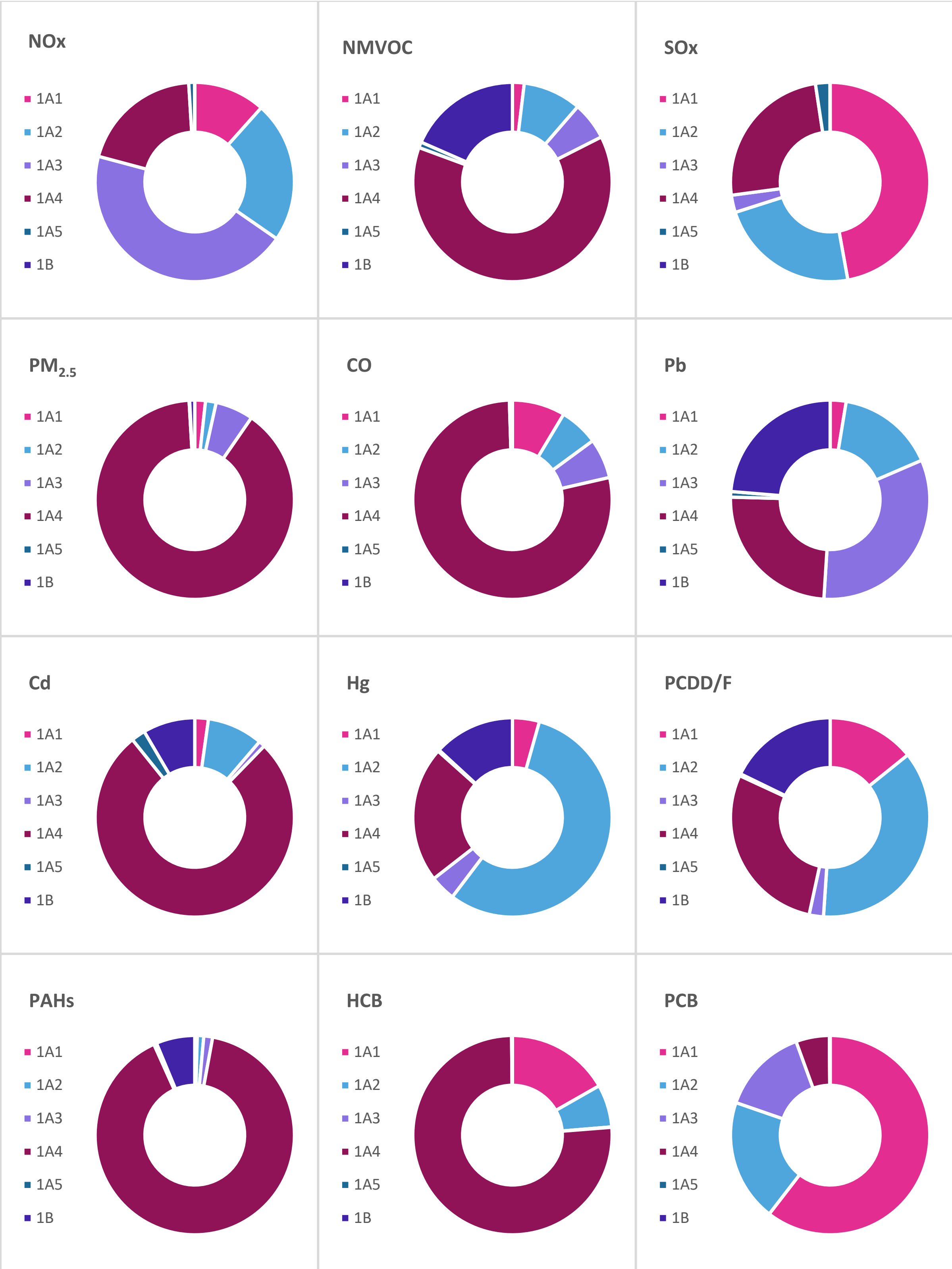
CO emissions are emitted mostly by residential heating and road transport (***Figure 3.1***).

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 2021, 60% 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: *Share of the categories on emissions of the particular pollutants in the energy sector in 2021*



3.3 RECALCULATIONS, IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

The energy sector undertakes continuing improvements. In submission 2023, the emissions of heavy metals and POPs were calculated at the Tier 2 level for categories **1A1c**, **1A2a**, **1A2d** and **1A2gviii**. 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_{2019}, expert estimation and special source (**1A2a**, **1A2d** and **1A2gviii**).

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.

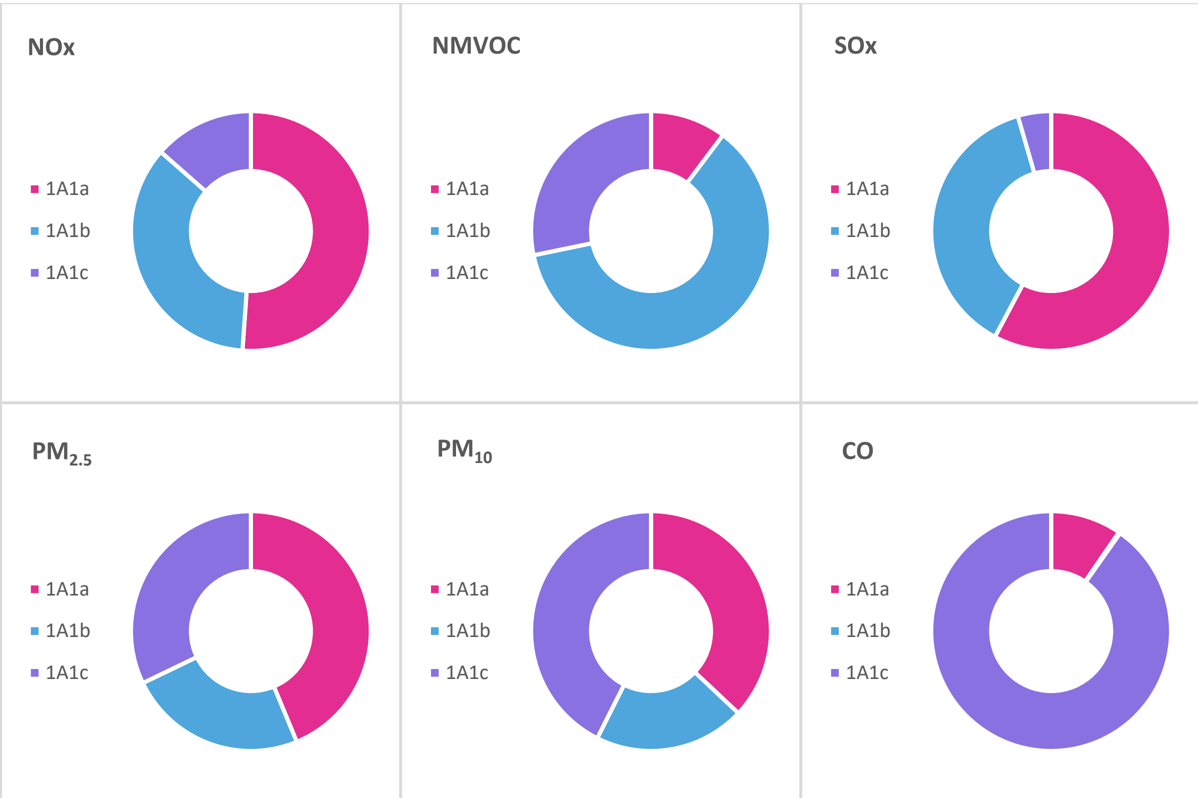
3.4 ENERGY INDUSTRIES (NFR 1A1)

3.4.1 OVERVIEW

The 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. The category **1A1a**, which includes also municipal waste incineration with energy utilization contributes to most main pollutants, heavy metals and POPs. Shares of emissions of main pollutants in particular subcategories are shown in ***Figure 3.2***.

Figure 3.2: *Share of emissions of the main pollutants in 1A1 in 2021*



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 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 SO_X emissions was visible in 2016 emissions. The decline was continuing during 2021.

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 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 the 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	0.1458	2.6616
1995	20.9769	0.1708	60.9819	NO	5.1254	6.1524	8.1609	0.1221	2.6759
2000	26.3778	0.1559	58.8624	NO	6.3197	7.5860	10.0625	0.1167	2.6729
2005	15.2963	0.1529	51.9931	NO	7.2630	7.8104	11.7351	0.1376	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	0.0138	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

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
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
1990/2021	**-87%**	**-33%**	**-97%**	**-**	**-97%**	**-98%**	**-98%**	**-97%**	**-29%**
2020/2021	**-9%**	**-1%**	**-2%**	**-**	**-5%**	**-8%**	**-15%**	**-2%**	**29%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	20.2283	0.8051	0.7982	1.8694	0.9755	0.7200	3.7652	4.5997	6.4920
1995	17.2859	0.6299	0.5854	1.0287	0.4644	0.3311	1.1505	2.1493	2.8929
2000	23.6356	0.8378	0.7612	1.1790	0.4879	0.3380	0.6368	2.2341	2.8657
2005	8.3951	0.3408	0.3521	0.8599	0.4594	0.3455	0.6014	2.2145	3.0403
2010	0.6700	0.0816	0.1290	0.6125	0.3975	0.2142	0.5787	1.8528	1.6634
2011	0.4660	0.0573	0.0906	0.4206	0.2746	0.1480	0.3964	1.2593	1.1252
2012	0.3876	0.0474	0.0739	0.3430	0.2262	0.1406	0.3468	1.0079	1.0820
2013	0.3284	0.0402	0.0622	0.2859	0.1901	0.1217	0.2749	0.8293	0.8960
2014	0.2664	0.0332	0.0510	0.2274	0.1530	0.1048	0.2116	0.6527	0.7836
2015	0.3366	0.0410	0.0629	0.2886	0.1935	0.1225	0.2624	0.8270	0.9611
2016	0.1531	0.0202	0.0314	0.1285	0.0875	0.0593	0.1266	0.3688	0.4705
2017	0.1247	0.0172	0.0269	0.1040	0.0713	0.0508	0.0956	0.3005	0.4123
2018	0.0883	0.0131	0.0206	0.0706	0.0498	0.0402	0.0685	0.2006	0.3379
2019	0.0878	0.0130	0.0204	0.0696	0.0492	0.0363	0.0688	0.1946	0.2949
2020	0.0851	0.0125	0.0197	0.0667	0.0473	0.0328	0.0654	0.1825	0.2624
2021	0.0645	0.0100	0.0157	0.0474	0.0350	0.0333	0.0497	0.1229	0.2864
1990/2021	**-100%**	**-99%**	**-98%**	**-97%**	**-96%**	**-95%**	**-99%**	**-97%**	**-96%**
2020/2021	**-24%**	**-20%**	**-20%**	**-29%**	**-26%**	**2%**	**-24%**	**-33%**	**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	629.9986	0.0009	0.0056	0.0045	0.0004	0.0114	1.2586	0.9524
1995	558.3478	0.0007	0.0029	0.0024	0.0002	0.0062	0.7397	0.8447
2000	771.4119	0.0010	0.0032	0.0026	0.0002	0.0070	0.8788	1.1673
2005	258.9174	0.0009	0.0031	0.0025	0.0002	0.0067	0.8285	1.0241
2010	1.2775	0.0009	0.0024	0.0020	0.0002	0.0055	0.7183	1.0174
2011	1.1418	0.0009	0.0019	0.0016	0.0001	0.0045	0.6347	1.0820
2012	1.0121	0.0008	0.0016	0.0013	0.0001	0.0038	0.5484	0.9570
2013	0.9664	0.0008	0.0014	0.0012	0.0001	0.0035	0.5182	0.9621
2014	1.0167	0.0009	0.0013	0.0012	0.0001	0.0034	0.5478	1.1231
2015	1.0480	0.0009	0.0014	0.0012	0.0001	0.0036	0.5547	1.0641
2016	0.9087	0.0009	0.0010	0.0009	0.0000	0.0030	0.5020	1.1477
2017	0.9314	0.0010	0.0010	0.0010	0.0000	0.0030	0.5206	1.2291
2018	0.9450	0.0010	0.0010	0.0009	0.0000	0.0030	0.5301	1.3018
2019	0.9357	0.0010	0.0010	0.0009	0.0000	0.0029	0.5225	1.2882
2020	0.9048	0.0010	0.0009	0.0009	0.0000	0.0028	0.5022	1.2429
2021	0.8785	0.0010	0.0009	0.0008	0.0000	0.0027	0.4864	1.2228
1990/2021	**-100%**	**8%**	**-85%**	**-82%**	**-94%**	**-77%**	**-61%**	**28%**
2020/2021	**-3%**	**-2%**	**-6%**	**-6%**	**-25%**	**-5%**	**-3%**	**-2%**

An 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 the category 1A1a

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [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	4 050.06	2 265.37
2020	72.16	21 365.92	26 783.40	3 751.43	2 212.09
2021	56.82	20 398.62	32 704.33	4 826.17	2 162.16
1990/2021	**-85%**	**-70%**	**-10%**	**-**	**-**
2020/2021	**-21%**	**-5%**	**22%**	**29%**	**-2%**

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 is 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 2021.

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 calculation of 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	1.64	584.32	78.2	63%	75%	25.64

The emissions of heavy metals and POPs are calculated at the Tier 2 level. The activity data (fuels, types of combustion plants and other 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 heavy metals and POPs are default EF from EMEP/EEA GB_{2019} (***Table 3.7***).

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

$$E_{pollutant} = \sum EF_{technology/pollutant} \times A_{production/technology}$$

Where:

$E_{pollutant}$ = annual emission of pollutant,

$EF_{technology/pollutant}$ = technology-specific emission factor

$A_{production/technology}$ = activity data (country's fuel usage and installed combustion technology).

Table 3.7: *Emission factors for heavy metals and POPs in the category 1A1a*

TYPE OF FUEL		HEAVY FUEL OIL	LIGHT FUEL OIL		HARD COAL	
T2	UNIT	DRY BOTTOM BOILER	GAS TURBINES	STATIONARY ENGINES	DRY BOTTOM BOILER	FLUID BED BOILER
Pb	[mg/GJ]	4.56	0.0069	4.07	7.3	7.3
Cd	[mg/GJ]	1.2	0.0012	1.36	0.9	0.9
Hg	[mg/GJ]	0.341	0.053	1.36	1.4	1.4
As	[mg/GJ]	3.98	0.0023	1.81	7.1	7.1
Cr	[mg/GJ]	2.55	0.28	1.36	4.5	4.5
Cu	[mg/GJ]	5.31	0.17	2.72	7.8	9
Ni	[mg/GJ]	255	0.0023	1.36	7.9	4.9
Se	[mg/GJ]	2.06	0.0023	6.79	23	23
Zn	[mg/GJ]	87.8	0.44	1.81	19	90
PCDD/F	[ng I-TEQ/GJ]	2.5	NE	0.99	10	10
B(a)P	[µg/GJ]	NE	NE	0.116	0.7	0.7
B(b)F	[µg/GJ]	4.5	NE	0.502	37	37
B(k)F	[µg/GJ]	4.5	NE	0.0987	29	29
I()P	[µg/GJ]	6.92	NE	0.187	1.1	1.1
PAHs	[µg/GJ]	15.92	NE	0.9037	67.8	67.8
HCB	[µg/GJ]	NE	NE	0.22	6.7	6.7
PCBs	[ng/GJ]	NE	NE	0.13	3.3	3.3

TYPE OF FUEL		BROWN COAL		GASEOUS FUELS			BIOMASS
T2	UNIT	DRY BOTTOM BOILER	FLUID BED BOILER	DRY BOTTOM BOILER	GAS TURBINES	STATIONARY ENGINES	DRY BOTTOM BOILER
Pb	[mg/GJ]	15	15	0.0015	0.0015	0.04	20.6
Cd	[mg/GJ]	1.8	1.8	0.00025	0.00025	0.003	1.76
Hg	[mg/GJ]	2.9	2.9	0.1	0.1	0.1	1.51
As	[mg/GJ]	14.3	14.3	0.12	0.12	0.05	9.46
Cr	[mg/GJ]	9.1	9.1	0.00076	0.00076	0.05	9.03
Cu	[mg/GJ]	1	1	0.000076	0.000076	0.01	21.1
Ni	[mg/GJ]	9.7	9.7	0.00051	0.0051	0.05	14.2
Se	[mg/GJ]	45	45	0.0112	0.0112	0.2	1.2
Zn	[mg/GJ]	8.8	8.8	0.0015	0.0015	2.91	181
PCDD/F	[ng I-TEQ/GJ]	10	10	0.5	NE	0.57	50
B(a)P	[µg/GJ]	1.3	1.3	0.56	0.56	1.2	1.12
B(b)F	[µg/GJ]	37	37	0.84	1.58	9	0.043
B(k)F	[µg/GJ]	29	29	0.84	1.11	1.7	0.0155
I()P	[µg/GJ]	2.1	2.1	0.84	8.36	1.8	0.0374
PAHs	[µg/GJ]	69.4	69.4	3.08	11.61	13.7	1.2159
HCB	[µg/GJ]	6.7	6.7	NE	NE	NE	5
PCBs	[ng/GJ]	3.3	3.3	NE	NE	NE	3.5

BC emissions were estimated in this submission based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB2019) (***Table 3.8***). The calculated BC emission values are presented in ***Table 3.4***.

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

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 2021.

3.4.2.4 Source-specific recalculations

The recalculations were made based on changes in activity data and correction of abatement efficiency calculation. The results of the recalculations are in ***Table 3.9***.

Table 3.9: *Previous and revised emissions in the category 1A1a*

YEAR	BC [kt]			Pb [t]			Cd [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.1450	0.1458	0%	20.2659	20.2283	0%	0.8097	0.8051	-1%
1991	0.1433	0.1439	0%	19.9837	19.9526	0%	0.7741	0.7703	0%
1992	0.1400	0.1404	0%	20.0388	20.0126	0%	0.7552	0.7520	0%
1993	0.1353	0.1355	0%	21.2767	21.2544	0%	0.7801	0.7774	0%
1994	0.1291	0.1291	0%	18.5732	18.5536	0%	0.6807	0.6783	0%
1995	0.1225	0.1221	0%	17.3038	17.2859	0%	0.6321	0.6299	0%
1996	0.1127	0.1118	-1%	16.9750	16.9573	0%	0.6196	0.6175	0%
1997	0.1075	0.1062	-1%	18.4085	18.3912	0%	0.6641	0.6620	0%
1998	0.1019	0.1002	-2%	20.4546	20.4373	0%	0.7306	0.7285	0%
1999	0.0985	0.0964	-2%	19.8927	19.8746	0%	0.7143	0.7121	0%
2000	0.1172	0.1167	0%	23.6536	23.6356	0%	0.8400	0.8378	0%
2001	0.1111	0.1000	-10%	15.2719	15.2543	0%	0.5760	0.5741	0%
2002	0.0923	0.0817	-11%	17.9828	17.9653	0%	0.6573	0.6554	0%
2003	0.0883	0.0880	0%	7.4029	7.4008	0%	0.3152	0.3150	0%
2004	0.0867	0.0863	-1%	8.0484	8.0494	0%	0.3318	0.3319	0%
2005	0.1379	0.1376	0%	8.4010	8.3951	0%	0.3416	0.3408	0%
2006	0.0989	0.0988	0%	0.7112	0.7050	-1%	0.0888	0.0881	-1%
2007	0.0142	0.0142	0%	0.6476	0.6435	-1%	0.0805	0.0800	-1%
2008	0.0121	0.0121	0%	0.7565	0.6853	-9%	0.0931	0.0845	-9%
2009	0.0112	0.0112	0%	0.7246	0.6258	-14%	0.0891	0.0773	-13%
2010	0.0117	0.0117	0%	0.9589	0.6700	-30%	0.1158	0.0816	-30%
2011	0.0140	0.0140	0%	0.9287	0.4660	-50%	0.1118	0.0573	-49%
2012	0.0134	0.0134	0%	0.9816	0.3876	-61%	0.1167	0.0474	-59%
2013	0.0110	0.0110	0%	1.0120	0.3284	-68%	0.1193	0.0402	-66%
2014	0.0105	0.0105	0%	0.9447	0.2664	-72%	0.1112	0.0332	-70%
2015	0.0138	0.0138	0%	0.9692	0.3366	-65%	0.1136	0.0410	-64%
2016	0.0062	0.0062	0%	1.0038	0.1531	-85%	0.1184	0.0202	-83%
2017	0.0044	0.0044	0%	1.0204	0.1247	-88%	0.1208	0.0172	-86%
2018	0.0035	0.0035	0%	0.9727	0.0883	-91%	0.1149	0.0131	-89%
2019	0.0042	0.0042	0%	0.8317	0.0878	-89%	0.0979	0.0130	-87%

YEAR	BC [kt]			Pb [t]			Cd [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	0.0042	0.0042	0%	0.6711	0.0851	-87%	0.0789	0.0125	-84%

YEAR	Hg [t]			As [t]			Cr [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.8053	0.7982	-1%	1.9056	1.8694	-2%	0.9986	0.9755	-2%
1991	0.7520	0.7461	-1%	1.6355	1.6057	-2%	0.8269	0.8079	-2%
1992	0.7183	0.7134	-1%	1.4314	1.4065	-2%	0.6940	0.6780	-2%
1993	0.7255	0.7213	-1%	1.3036	1.2824	-2%	0.5967	0.5832	-2%
1994	0.6342	0.6305	-1%	1.1400	1.1214	-2%	0.5220	0.5101	-2%
1995	0.5887	0.5854	-1%	1.0457	1.0287	-2%	0.4753	0.4644	-2%
1996	0.5783	0.5749	-1%	1.0272	1.0104	-2%	0.4670	0.4562	-2%
1997	0.6134	0.6102	-1%	1.0354	1.0190	-2%	0.4557	0.4452	-2%
1998	0.6685	0.6652	0%	1.0760	1.0596	-2%	0.4583	0.4478	-2%
1999	0.6577	0.6544	-1%	1.0885	1.0714	-2%	0.4729	0.4619	-2%
2000	0.7647	0.7612	0%	1.1965	1.1790	-1%	0.4990	0.4879	-2%
2001	0.5582	0.5557	0%	1.1318	1.1180	-1%	0.5549	0.5452	-2%
2002	0.6173	0.6147	0%	1.1097	1.0959	-1%	0.5094	0.4998	-2%
2003	0.3389	0.3385	0%	0.9144	0.9123	0%	0.5053	0.5040	0%
2004	0.3477	0.3478	0%	0.8770	0.8777	0%	0.4740	0.4745	0%
2005	0.3533	0.3521	0%	0.8657	0.8599	-1%	0.4631	0.4594	-1%
2006	0.1426	0.1413	-1%	0.6765	0.6704	-1%	0.4314	0.4276	-1%
2007	0.1294	0.1284	-1%	0.6137	0.6094	-1%	0.3919	0.3894	-1%
2008	0.1488	0.1351	-9%	0.7120	0.6443	-10%	0.4562	0.4130	-9%
2009	0.1427	0.1237	-13%	0.6771	0.5839	-14%	0.4350	0.3755	-14%
2010	0.1829	0.1290	-30%	0.8791	0.6125	-30%	0.5695	0.3975	-30%
2011	0.1766	0.0906	-49%	0.8446	0.4206	-50%	0.5489	0.2746	-50%
2012	0.1816	0.0739	-59%	0.8772	0.3430	-61%	0.5750	0.2262	-61%
2013	0.1841	0.0622	-66%	0.8923	0.2859	-68%	0.5888	0.1901	-68%
2014	0.1698	0.0510	-70%	0.8220	0.2274	-72%	0.5465	0.1530	-72%
2015	0.1736	0.0629	-64%	0.8419	0.2886	-66%	0.5600	0.1935	-65%
2016	0.1813	0.0314	-83%	0.8777	0.1285	-85%	0.5820	0.0875	-85%
2017	0.1864	0.0269	-86%	0.8991	0.1040	-88%	0.5942	0.0713	-88%
2018	0.1761	0.0206	-88%	0.8473	0.0706	-92%	0.5631	0.0498	-91%
2019	0.1512	0.0204	-86%	0.7171	0.0696	-90%	0.4783	0.0492	-90%
2020	0.1228	0.0197	-84%	0.5722	0.0667	-88%	0.3831	0.0473	-88%

YEAR	Cu [t]			Ni [t]			Se [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.7557	0.7200	-5%	3.8036	3.7652	-1%	4.7152	4.5997	-2%
1991	0.6231	0.5936	-5%	3.0347	3.0029	-1%	3.8811	3.7860	-2%
1992	0.5197	0.4950	-5%	2.3997	2.3731	-1%	3.2339	3.1547	-2%
1993	0.4429	0.4218	-5%	1.8872	1.8645	-1%	2.7525	2.6850	-2%
1994	0.3852	0.3666	-5%	1.4789	1.4590	-1%	2.4156	2.3563	-2%
1995	0.3481	0.3311	-5%	1.1687	1.1505	-2%	2.2034	2.1493	-2%
1996	0.3396	0.3227	-5%	0.9614	0.9434	-2%	2.1730	2.1196	-2%
1997	0.3288	0.3123	-5%	0.8012	0.7836	-2%	2.1095	2.0577	-2%
1998	0.3285	0.3120	-5%	0.7009	0.6834	-3%	2.1090	2.0572	-2%
1999	0.3386	0.3213	-5%	0.6535	0.6352	-3%	2.1895	2.1356	-2%
2000	0.3550	0.3380	-5%	0.6553	0.6368	-3%	2.2904	2.2341	-2%

YEAR	Cu [t]			Ni [t]			Se [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2001	0.3576	0.3398	-5%	0.6787	0.6627	-2%	2.6290	2.5923	-1%
2002	0.3364	0.3190	-5%	0.6036	0.5876	-3%	2.3787	2.3433	-1%
2003	0.3613	0.3540	-2%	0.6812	0.6772	-1%	2.4552	2.4480	0%
2004	0.3446	0.3384	-2%	0.6303	0.6282	0%	2.2902	2.2920	0%
2005	0.3515	0.3455	-2%	0.6076	0.6014	-1%	2.2330	2.2145	-1%
2006	0.3537	0.3476	-2%	0.6101	0.6036	-1%	2.1299	2.1105	-1%
2007	0.2949	0.2910	-1%	0.5185	0.5142	-1%	1.9261	1.9130	-1%
2008	0.3090	0.2783	-10%	0.5989	0.5419	-10%	2.2197	2.0082	-10%
2009	0.2384	0.2062	-14%	0.6025	0.5205	-14%	2.0930	1.8044	-14%
2010	0.3056	0.2142	-30%	0.8280	0.5787	-30%	2.6609	1.8528	-30%
2011	0.2927	0.1480	-49%	0.7896	0.3964	-50%	2.5322	1.2593	-50%
2012	0.3538	0.1406	-60%	0.8784	0.3468	-61%	2.5823	1.0079	-61%
2013	0.3717	0.1217	-67%	0.8462	0.2749	-68%	2.5953	0.8293	-68%
2014	0.3670	0.1048	-71%	0.7469	0.2116	-72%	2.3685	0.6527	-72%
2015	0.3492	0.1225	-65%	0.7535	0.2624	-65%	2.4192	0.8270	-66%
2016	0.3773	0.0593	-84%	0.8233	0.1266	-85%	2.5391	0.3688	-85%
2017	0.3996	0.0508	-87%	0.7647	0.0956	-87%	2.6258	0.3005	-89%
2018	0.4209	0.0402	-90%	0.7234	0.0685	-91%	2.4447	0.2006	-92%
2019	0.3217	0.0363	-89%	0.6273	0.0688	-89%	2.0355	0.1946	-90%
2020	0.2356	0.0328	-86%	0.4950	0.0654	-87%	1.5944	0.1825	-89%

YEAR	Zn [t]			PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	6.5855	6.4920	-1%	630.0478	629.9986	0%	0.0117	0.0114	-3%
1991	5.4165	5.3381	-1%	629.7962	629.7553	0%	0.0100	0.0097	-3%
1992	4.4992	4.4323	-1%	638.8424	638.8078	0%	0.0087	0.0085	-3%
1993	3.8116	3.7546	-1%	685.8814	685.8520	0%	0.0079	0.0077	-2%
1994	3.2852	3.2347	-2%	598.6788	598.6529	0%	0.0069	0.0067	-2%
1995	2.9394	2.8929	-2%	558.3716	558.3478	0%	0.0064	0.0062	-2%
1996	2.8346	2.7881	-2%	547.7313	547.7076	0%	0.0063	0.0061	-2%
1997	2.7241	2.6781	-2%	596.7296	596.7063	0%	0.0063	0.0061	-2%
1998	2.7065	2.6605	-2%	665.6483	665.6251	0%	0.0065	0.0063	-2%
1999	2.7751	2.7262	-2%	645.9020	645.8775	0%	0.0066	0.0064	-2%
2000	2.9081	2.8657	-1%	771.4350	771.4119	0%	0.0072	0.0070	-2%
2001	3.0951	3.0135	-3%	485.4432	485.4141	0%	0.0068	0.0067	-1%
2002	2.8242	2.7415	-3%	579.4023	579.3721	0%	0.0066	0.0065	-2%
2003	3.1526	3.1371	0%	222.9210	222.9144	0%	0.0070	0.0069	-1%
2004	2.9948	2.9828	0%	246.4379	246.4338	0%	0.0069	0.0069	0%
2005	3.0550	3.0403	0%	258.9256	258.9174	0%	0.0068	0.0067	-1%
2006	3.0394	3.0243	0%	1.4034	1.3950	-1%	0.0068	0.0067	-1%
2007	2.4332	2.4234	0%	1.2534	1.2471	-1%	0.0060	0.0060	-1%
2008	2.5396	2.3046	-9%	1.3192	1.2527	-5%	0.0064	0.0060	-7%
2009	1.8623	1.6126	-13%	1.3219	1.2353	-7%	0.0061	0.0056	-9%
2010	2.3671	1.6634	-30%	1.5421	1.2775	-17%	0.0070	0.0055	-22%
2011	2.2089	1.1252	-49%	1.5746	1.1418	-27%	0.0069	0.0045	-35%
2012	2.6995	1.0820	-60%	1.6073	1.0121	-37%	0.0068	0.0038	-44%
2013	2.7042	0.8960	-67%	1.6731	0.9664	-42%	0.0068	0.0035	-49%
2014	2.7005	0.7836	-71%	1.7430	1.0167	-42%	0.0066	0.0034	-48%
2015	2.7121	0.9611	-65%	1.7148	1.0480	-39%	0.0065	0.0036	-44%

YEAR	Zn [t]			PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2016	2.9122	0.4705	-84%	1.8024	0.9087	-50%	0.0070	0.0030	-58%
2017	3.1422	0.4123	-87%	1.8666	0.9314	-50%	0.0074	0.0030	-60%
2018	3.4197	0.3379	-90%	1.9131	0.9450	-51%	0.0073	0.0030	-60%
2019	2.4960	0.2949	-88%	1.7520	0.9357	-47%	0.0064	0.0029	-54%
2020	1.7873	0.2624	-85%	1.5539	0.9048	-42%	0.0054	0.0028	-48%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	1.2905	1.2586	-2%	0.9524	0.9524	0%
1991	1.1259	1.0996	-2%	0.9523	0.9523	0%
1992	1.0035	0.9815	-2%	0.9662	0.9662	0%
1993	0.9355	0.9168	-2%	1.0376	1.0376	0%
1994	0.8194	0.8030	-2%	0.9057	0.9057	0%
1995	0.7547	0.7397	-2%	0.8447	0.8447	0%
1996	0.7430	0.7281	-2%	0.8286	0.8286	0%
1997	0.7586	0.7442	-2%	0.9029	0.9029	0%
1998	0.7980	0.7836	-2%	1.0072	1.0072	0%
1999	0.8028	0.7878	-2%	0.9773	0.9773	0%
2000	0.8943	0.8788	-2%	1.1674	1.1673	0%
2001	0.7803	0.7685	-2%	0.7342	0.7342	0%
2002	0.7904	0.7791	-1%	0.8765	0.8765	0%
2003	0.8262	0.8220	-1%	0.9102	0.9102	0%
2004	0.8418	0.8393	0%	1.0311	1.0311	0%
2005	0.8338	0.8285	-1%	1.0241	1.0241	0%
2006	0.8569	0.8514	-1%	1.1184	1.1184	0%
2007	0.7601	0.7565	0%	0.9971	0.9971	0%
2008	0.7915	0.7497	-5%	0.9614	0.9614	0%
2009	0.7790	0.7263	-7%	1.0523	1.0523	0%
2010	0.8644	0.7183	-17%	1.0175	1.0174	0%
2011	0.8640	0.6347	-27%	1.0821	1.0820	0%
2012	0.8417	0.5484	-35%	0.9571	0.9570	0%
2013	0.8495	0.5182	-39%	0.9623	0.9621	0%
2014	0.8750	0.5478	-37%	1.1233	1.1231	0%
2015	0.8505	0.5547	-35%	1.0642	1.0641	0%
2016	0.9107	0.5020	-45%	1.1479	1.1477	0%
2017	0.9642	0.5206	-46%	1.2293	1.2291	0%
2018	0.9715	0.5301	-45%	1.3020	1.3018	0%
2019	0.8717	0.5225	-40%	1.2883	1.2882	0%
2020	0.7613	0.5022	-34%	1.2431	1.2429	0%

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 Plc 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 SOx 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 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

The overview of emissions in this category is shown in ***Table 3.11***.

Table 3.11: *Overview of emissions in the 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
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
1990/2021	**-52%**	**-66%**	**-89%**	**-96%**	**-69%**	**-69%**	**-69%**	**-69%**	**-92%**
2020/2021	**6%**	**-10%**	**-2%**	**-1%**	**9%**	**7%**	**7%**	**9%**	**-19%**

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

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990/2021	**-100%**	**-98%**	**-89%**	**-92%**	**-**	**-**	**-96%**	**-**	**-**
2020/2021	**-2%**	**-2%**	**-2%**	**-2%**	**-**	**-**	**-2%**	**-**	**-**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]	HCB [g]	PCBs [kg]
1990	4.5512	NE	NE	NE	NE	0.2601	0.0260	NA
1995	4.5586	NE	NE	NE	NE	0.2605	0.0260	NA
2000	4.5539	NE	NE	NE	NE	0.2602	0.0260	NA
2005	4.1941	NE	NE	NE	NE	0.2397	0.0240	NA
2010	1.0323	NE	NE	NE	NE	0.0295	0.0029	NA
2011	3.7737	NE	NE	NE	NE	0.1078	0.0108	NA
2012	2.3316	NE	NE	NE	NE	0.0666	0.0067	NA
2013	8.7569	NE	NE	NE	NE	0.2502	0.0250	NA
2014	2.6129	NE	NE	NE	NE	0.0747	0.0075	NA
2015	2.4826	NE	NE	NE	NE	0.0709	0.0071	NA
2016	2.2741	NE	NE	NE	NE	0.0650	0.0065	NA
2017	2.6853	NE	NE	NE	NE	0.0767	0.0077	NA
2018	1.5152	NE	NE	NE	NE	0.0433	0.0043	NA
2019	1.6741	NE	NE	NE	NE	0.0478	0.0048	NA
2020	1.0560	NE	NE	NE	NE	0.0302	0.0030	NA
2021	1.0360	NE	NE	NE	NE	0.0296	0.0030	NA
1990/2021	**-77%**	**-**	**-**	**-**	**-**	**-89%**	**-89%**	**-**
2020/2021	**-2%**	**-**	**-**	**-**	**-**	**-2%**	**-2%**	**-**

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

Table 3.12: *Overview of activity data in the 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
1990/2021	**-89%**	**-35%**	**64%**	**-54%**	**-**	**-**
2020/2021	**-2%**	**-1%**	**9%**	**4%**	**-**	**805219900%**

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 is 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 2021.

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 calculation of 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	91.2%	99.6%	18.4%	12.04

*T1 EMEP/EEA GB_{2019} EF

HMs and POPs emissions from the 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_{2019} (***Table 3.14***).

Table 3.14: *Emission factors for HMs and POPs in 1A1b*

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]	350
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

The recalculations were made in 2008 due to the addition of the efficiency of the abatement technology. The results of the recalculations are in ***Table 3.15***.

Table 3.15: *Previous and revised emissions in the category 1A1b*

YEAR	Pb [t]			Cd [t]			As [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2008	0.0051	0.0002	-96%	0.0004	0.0001	-83%	0.0001	0.0000	-26%
2009	0.0052	0.0002	-96%	0.0004	0.0001	-83%	0.0001	0.0000	-26%
2010	0.0019	0.0001	-96%	0.0001	0.0000	-83%	0.0000	0.0000	-26%
2011	0.0070	0.0002	-96%	0.0005	0.0001	-83%	0.0001	0.0001	-26%
2012	0.0043	0.0002	-96%	0.0003	0.0001	-83%	0.0001	0.0000	-26%
2013	0.0163	0.0006	-96%	0.0013	0.0002	-83%	0.0002	0.0001	-26%
2014	0.0049	0.0002	-96%	0.0004	0.0001	-83%	0.0001	0.0000	-26%
2015	0.0046	0.0002	-96%	0.0004	0.0001	-83%	0.0001	0.0000	-26%
2016	0.0042	0.0002	-96%	0.0003	0.0001	-83%	0.0001	0.0000	-26%
2017	0.0050	0.0002	-96%	0.0004	0.0001	-83%	0.0001	0.0000	-26%
2018	0.0028	0.0001	-96%	0.0002	0.0000	-83%	0.0000	0.0000	-26%
2019	0.0031	0.0001	-96%	0.0002	0.0000	-83%	0.0000	0.0000	-26%

YEAR	Pb [t]			Cd [t]			As [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	0.0020	0.0001	-96%	0.0002	0.0000	-83%	0.0000	0.0000	-26%

YEAR	Ni [t]			PCDD/F [g I-TEQ]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2008	0.0005	0.0002	-68%	1.3610	2.7215	100%
2009	0.0006	0.0002	-68%	1.4064	2.8124	100%
2010	0.0002	0.0001	-68%	0.5162	1.0323	100%
2011	0.0008	0.0002	-68%	1.8872	3.7737	100%
2012	0.0005	0.0001	-68%	1.1660	2.3316	100%
2013	0.0018	0.0006	-68%	4.3792	8.7569	100%
2014	0.0005	0.0002	-68%	1.3067	2.6129	100%
2015	0.0005	0.0002	-68%	1.2415	2.4826	100%
2016	0.0005	0.0001	-68%	1.1373	2.2741	100%
2017	0.0005	0.0002	-68%	1.3429	2.6853	100%
2018	0.0003	0.0001	-68%	0.7577	1.5152	100%
2019	0.0003	0.0001	-68%	0.8372	1.6741	100%
2020	0.0002	0.0001	-68%	0.5281	1.0560	100%

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 3.16***.

Table 3.16: *Activities according to national categorization included in 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 3.17***. Increasing in emissions in 2021 is related to the increase in activity data.

Table 3.17: *Overview of emissions in the 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
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

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2021	0.6962	0.3153	0.1404	0.0296	0.0964	0.1625	0.2443	0.0463	17.7035
1990/2021	**62%**	**-75%**	**-80%**	**-67%**	**-77%**	**-77%**	**-77%**	**-77%**	**44%**
2020/2021	**-20%**	**3%**	**-19%**	**77%**	**56%**	**55%**	**54%**	**56%**	**13%**

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	0.0060	0.0003	NA	0.0044	0.0098	0.0046	0.0024	0.0049	0.0207
1990/2021	**20%**	**20%**	**-**	**20%**	**20%**	**20%**	**20%**	**20%**	**20%**
2020/2021	**78%**	**78%**	**-**	**78%**	**78%**	**78%**	**78%**	**78%**	**78%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
1990	1.6671	0.0185	0.0002	0.0001	0.0000	0.0189
1995	1.6693	0.0185	0.0002	0.0001	0.0000	0.0189
2000	1.7411	0.0193	0.0002	0.0001	0.0000	0.0197
2005	1.8243	0.0203	0.0002	0.0001	0.0000	0.0206
2010	1.3114	0.0146	0.0002	0.0001	0.0000	0.0148
2011	1.5365	0.0171	0.0002	0.0001	0.0000	0.0174
2012	1.4893	0.0165	0.0002	0.0001	0.0000	0.0169
2013	1.4642	0.0163	0.0002	0.0001	0.0000	0.0166
2014	1.4959	0.0166	0.0002	0.0001	0.0000	0.0169
2015	1.5727	0.0175	0.0002	0.0001	0.0000	0.0178
2016	1.5734	0.0175	0.0002	0.0001	0.0000	0.0178
2017	1.5144	0.0168	0.0002	0.0001	0.0000	0.0171
2018	1.5328	0.0170	0.0002	0.0001	0.0000	0.0173
2019	1.3402	0.0149	0.0002	0.0001	0.0000	0.0152
2020	1.1291	0.0125	0.0002	0.0000	0.0000	0.0128
2021	2.0066	0.0223	0.0003	0.0001	0.0001	0.0227
1990/2021	**20%**	**20%**	**20%**	**20%**	**20%**	**20%**
2020/2021	**78%**	**78%**	**78%**	**78%**	**78%**	**78%**

An overview of activity data (energy consumption) for this source category is in ***Table 3.18*** below.

Table 3.18: *Overview of activity data in the 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

YEAR	COAL TRANSFORMED [kt]	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
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	2 719.00	0.12	6 038.13	6.37	NO	NO
1990/2021	**20%**	**-**	**-15%**	**-**	**-**	**-**
2020/2021	**78%**	**145%**	**19%**	**29%**	**-**	**-**

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 is 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 2021.

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 3.19***).

Table 3.19: *Emission factors for calculation of 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	40%	67%	48%	1730.01

*T1 EMEP/EEA GB_{2019} EF

HMs and POPs emissions were calculated using Tier 2 emission factors with by-product recovery from EMEP/EEA GB_{2019} (***Table 3.20***).

Table 3.20: *Emission factors for heavy metals and POPs in the category 1A1c*

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

T2	UNIT	COAL
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

The recalculations were made based on a change in methodology from Tier 1 to Tier 2. The results of the recalculations are in ***Table 3.21***.

Table 3.21: *Previous and revised emissions in the category 1A1c*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.1988	0.0050	0.0781	0.0781	0.0781	-98%	0.2130	NA	–
1991	0.1983	0.0050	0.0779	0.0779	0.0779	-98%	0.2125	NA	–
1992	0.1986	0.0050	0.0780	0.0780	0.0780	-98%	0.2128	NA	–
1993	0.1990	0.0050	0.0782	0.0782	0.0782	-98%	0.2132	NA	–
1994	0.1986	0.0050	0.0780	0.0780	0.0780	-98%	0.2128	NA	–
1995	0.1975	0.0050	0.0776	0.0776	0.0776	-98%	0.2116	NA	–
1996	0.2006	0.0050	0.0788	0.0788	0.0788	-98%	0.2149	NA	–
1997	0.1986	0.0050	0.0780	0.0780	0.0780	-98%	0.2128	NA	–
1998	0.1963	0.0050	0.0771	0.0771	0.0771	-98%	0.2103	NA	–
1999	0.1993	0.0051	0.0783	0.0783	0.0783	-98%	0.2135	NA	–
2000	0.2081	0.0052	0.0818	0.0818	0.0818	-98%	0.2230	NA	–
2001	0.1846	0.0050	0.0725	0.0725	0.0725	-98%	0.1978	NA	–
2002	0.2025	0.0054	0.0795	0.0795	0.0795	-98%	0.2169	NA	–
2003	0.2174	0.0056	0.0854	0.0854	0.0854	-98%	0.2329	NA	–
2004	0.1996	0.0056	0.0784	0.0784	0.0784	-98%	0.2139	NA	–
2005	0.2025	0.0054	0.0796	0.0796	0.0796	-98%	0.2170	NA	–
2006	0.1954	0.0055	0.0767	0.0767	0.0767	-98%	0.2093	NA	–
2007	0.1941	0.0052	0.0762	0.0762	0.0762	-98%	0.2079	NA	–
2008	0.1794	0.0049	0.0705	0.0705	0.0705	-98%	0.1923	NA	–
2009	0.1758	0.0044	0.0690	0.0690	0.0690	-98%	0.1883	NA	–
2010	0.1818	0.0039	0.0714	0.0714	0.0714	-98%	0.1948	NA	–
2011	0.1733	0.0046	0.0681	0.0681	0.0681	-98%	0.1857	NA	–
2012	0.1740	0.0044	0.0684	0.0684	0.0684	-98%	0.1864	NA	–
2013	0.1717	0.0044	0.0675	0.0675	0.0675	-98%	0.1840	NA	–
2014	0.1739	0.0045	0.0683	0.0683	0.0683	-98%	0.1863	NA	–
2015	0.1808	0.0047	0.0710	0.0710	0.0710	-98%	0.1937	NA	–
2016	0.1812	0.0047	0.0712	0.0712	0.0712	-98%	0.1942	NA	–
2017	0.1664	0.0045	0.0654	0.0654	0.0654	-98%	0.1783	NA	–
2018	0.1706	0.0046	0.0670	0.0670	0.0670	-98%	0.1828	NA	–
2019	0.1566	0.0040	0.0615	0.0615	0.0615	-98%	0.1678	NA	–
2020	0.1417	0.0034	0.0557	0.0557	0.0557	-98%	0.1519	NA	–

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0781	0.0036	-95%	0.0405	0.0081	-80%	0.0000	0.0286	100%
1991	0.0779	0.0036	-95%	0.0404	0.0081	-80%	0.0000	0.0285	100%
1992	0.0780	0.0036	-95%	0.0404	0.0081	-80%	0.0000	0.0283	100%
1993	0.0782	0.0036	-95%	0.0405	0.0081	-80%	0.0000	0.0282	100%
1994	0.0780	0.0036	-95%	0.0404	0.0081	-80%	0.0000	0.0281	100%
1995	0.0776	0.0036	-95%	0.0402	0.0081	-80%	0.0000	0.0279	100%
1996	0.0788	0.0036	-95%	0.0408	0.0082	-80%	0.0000	0.0278	100%
1997	0.0780	0.0036	-95%	0.0404	0.0082	-80%	0.1775	0.0038	-98%
1998	0.0771	0.0036	-95%	0.0400	0.0082	-79%	0.1771	0.0038	-98%
1999	0.0783	0.0037	-95%	0.0406	0.0083	-80%	0.1773	0.0038	-98%
2000	0.0818	0.0038	-95%	0.0424	0.0085	-80%	0.1777	0.0038	-98%
2001	0.0725	0.0037	-95%	0.0376	0.0082	-78%	0.1773	0.0038	-98%
2002	0.0795	0.0039	-95%	0.0412	0.0088	-79%	0.1763	0.0038	-98%
2003	0.0854	0.0041	-95%	0.0443	0.0091	-79%	0.1791	0.0039	-98%
2004	0.0784	0.0041	-95%	0.0406	0.0092	-77%	0.1773	0.0039	-98%
2005	0.0796	0.0040	-95%	0.0412	0.0089	-78%	0.1753	0.0039	-98%
2006	0.0767	0.0040	-95%	0.0398	0.0090	-77%	0.1780	0.0039	-98%
2007	0.0762	0.0038	-95%	0.0395	0.0086	-78%	0.1858	0.0040	-98%
2008	0.0705	0.0035	-95%	0.0365	0.0080	-78%	0.1649	0.0039	-98%
2009	0.0690	0.0032	-95%	0.0358	0.0072	-80%	0.1808	0.0041	-98%
2010	0.0714	0.0028	-96%	0.0370	0.0064	-83%	0.1941	0.0043	-98%
2011	0.0681	0.0033	-95%	0.0353	0.0075	-79%	0.1782	0.0043	-98%
2012	0.0684	0.0032	-95%	0.0354	0.0073	-79%	0.1808	0.0042	-98%
2013	0.0675	0.0032	-95%	0.0350	0.0071	-80%	0.1744	0.0042	-98%
2014	0.0683	0.0032	-95%	0.0354	0.0073	-79%	0.1733	0.0041	-98%
2015	0.0710	0.0034	-95%	0.0368	0.0077	-79%	0.1602	0.0038	-98%
2016	0.0712	0.0034	-95%	0.0369	0.0077	-79%	0.1569	0.0034	-98%
2017	0.0654	0.0033	-95%	0.0339	0.0074	-78%	0.1624	0.0030	-98%
2018	0.0670	0.0033	-95%	0.0347	0.0075	-78%	0.1547	0.0035	-98%
2019	0.0615	0.0029	-95%	0.0319	0.0065	-79%	0.1554	0.0034	-98%
2020	0.0557	0.0024	-96%	0.0289	0.0055	-81%	0.1533	0.0034	-98%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0369	0.0020	-94%	0.0206	0.0041	-80%	0.3265	0.0172	-95%
1991	0.0368	0.0020	-94%	0.0205	0.0041	-80%	0.3259	0.0172	-95%
1992	0.0369	0.0020	-94%	0.0206	0.0041	-80%	0.3263	0.0172	-95%
1993	0.0370	0.0020	-94%	0.0206	0.0041	-80%	0.3269	0.0172	-95%
1994	0.0369	0.0020	-94%	0.0206	0.0041	-80%	0.3262	0.0172	-95%
1995	0.0367	0.0020	-94%	0.0205	0.0041	-80%	0.3244	0.0172	-95%
1996	0.0373	0.0021	-94%	0.0208	0.0041	-80%	0.3296	0.0173	-95%
1997	0.0369	0.0020	-94%	0.0206	0.0041	-80%	0.3263	0.0173	-95%
1998	0.0365	0.0021	-94%	0.0203	0.0041	-80%	0.3225	0.0173	-95%
1999	0.0370	0.0021	-94%	0.0206	0.0042	-80%	0.3274	0.0175	-95%
2000	0.0387	0.0021	-95%	0.0216	0.0042	-80%	0.3419	0.0179	-95%
2001	0.0343	0.0021	-94%	0.0191	0.0041	-78%	0.3034	0.0174	-94%
2002	0.0376	0.0022	-94%	0.0210	0.0044	-79%	0.3326	0.0185	-94%
2003	0.0404	0.0023	-94%	0.0225	0.0046	-80%	0.3571	0.0193	-95%
2004	0.0371	0.0023	-94%	0.0207	0.0046	-78%	0.3279	0.0194	-94%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.0376	0.0022	-94%	0.0210	0.0044	-79%	0.3327	0.0188	-94%
2006	0.0363	0.0022	-94%	0.0202	0.0045	-78%	0.3209	0.0189	-94%
2007	0.0360	0.0021	-94%	0.0201	0.0043	-79%	0.3188	0.0181	-94%
2008	0.0333	0.0020	-94%	0.0186	0.0040	-79%	0.2948	0.0168	-94%
2009	0.0326	0.0018	-94%	0.0182	0.0036	-80%	0.2887	0.0153	-95%
2010	0.0338	0.0016	-95%	0.0188	0.0032	-83%	0.2988	0.0135	-95%
2011	0.0322	0.0019	-94%	0.0179	0.0037	-79%	0.2847	0.0158	-94%
2012	0.0323	0.0018	-94%	0.0180	0.0036	-80%	0.2859	0.0153	-95%
2013	0.0319	0.0018	-94%	0.0178	0.0036	-80%	0.2821	0.0151	-95%
2014	0.0323	0.0018	-94%	0.0180	0.0036	-80%	0.2857	0.0154	-95%
2015	0.0336	0.0019	-94%	0.0187	0.0038	-80%	0.2971	0.0162	-95%
2016	0.0337	0.0019	-94%	0.0188	0.0038	-80%	0.2978	0.0162	-95%
2017	0.0309	0.0018	-94%	0.0172	0.0037	-79%	0.2733	0.0156	-94%
2018	0.0317	0.0019	-94%	0.0177	0.0037	-79%	0.2803	0.0158	-94%
2019	0.0291	0.0016	-94%	0.0162	0.0033	-80%	0.2572	0.0138	-95%
2020	0.0263	0.0014	-95%	0.0147	0.0028	-81%	0.2328	0.0116	-95%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.1846	1.6671	803%	0.0021	0.0189	801%
1991	0.1842	1.6662	805%	0.0021	0.0189	802%
1992	0.1844	1.6681	805%	0.0021	0.0189	802%
1993	0.1848	1.6700	804%	0.0021	0.0189	801%
1994	0.1844	1.6699	806%	0.0021	0.0189	803%
1995	0.1833	1.6693	810%	0.0021	0.0189	808%
1996	0.1863	1.6829	803%	0.0021	0.0190	801%
1997	0.1844	1.6789	810%	0.0021	0.0190	808%
1998	0.1823	1.6813	822%	0.0021	0.0190	820%
1999	0.1851	1.7030	820%	0.0021	0.0193	818%
2000	0.1933	1.7411	801%	0.0022	0.0197	798%
2001	0.1715	1.6882	885%	0.0019	0.0191	882%
2002	0.1880	1.7964	855%	0.0021	0.0203	853%
2003	0.2019	1.8726	828%	0.0023	0.0212	825%
2004	0.1854	1.8814	915%	0.0021	0.0213	912%
2005	0.1881	1.8243	870%	0.0021	0.0206	867%
2006	0.1814	1.8388	914%	0.0021	0.0208	911%
2007	0.1802	1.7609	877%	0.0020	0.0199	874%
2008	0.1666	1.6317	879%	0.0019	0.0185	876%
2009	0.1632	1.4819	808%	0.0019	0.0168	806%
2010	0.1689	1.3114	677%	0.0019	0.0148	674%
2011	0.1609	1.5365	855%	0.0018	0.0174	852%
2012	0.1616	1.4893	822%	0.0018	0.0169	819%
2013	0.1595	1.4642	818%	0.0018	0.0166	816%
2014	0.1615	1.4959	826%	0.0018	0.0169	824%
2015	0.1679	1.5727	837%	0.0019	0.0178	834%
2016	0.1683	1.5734	835%	0.0019	0.0178	832%
2017	0.1545	1.5144	880%	0.0018	0.0171	878%
2018	0.1584	1.5328	867%	0.0018	0.0173	865%
2019	0.1454	1.3402	822%	0.0016	0.0152	819%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	0.1316	1.1291	758%	0.0015	0.0128	756%

3.5 MANUFACTURING INDUSTRIES AND CONSTRUCTION (NFR 1A2)

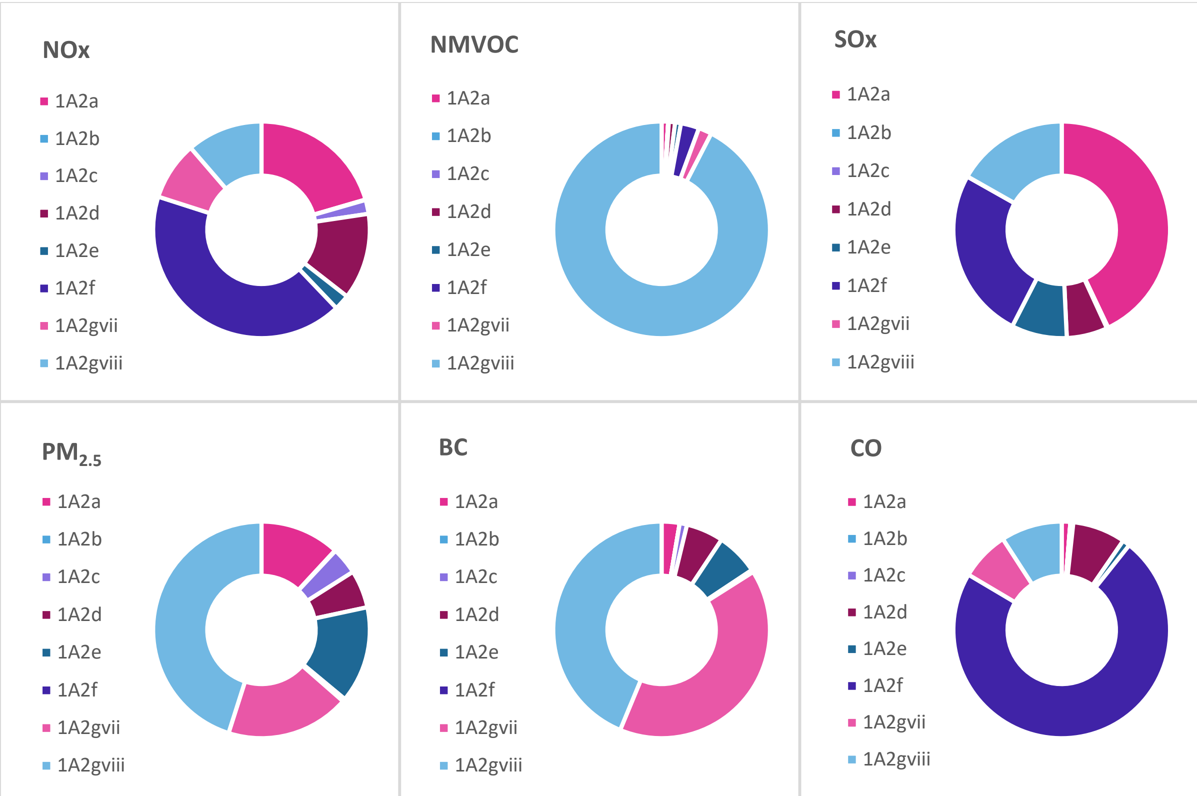
3.5.1 OVERVIEW

The 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). NH_3 emissions from solid biomass combustion are reported as 'NO' because measurements show that NH_3 is not relevant (***Recommendation No 1A2-SK-2022-0001***).

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*: Share of emissions of the main pollutants in 1A2 in 2021*



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 22 971 TJ in 2021. 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. Increasing in emissions in 2021 is related to the increase in activity data.

Activities listed within this category are shown in ***Table 3.22***.

Table 3.22: *Activities according to national categorization included in 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 overview of emissions in this category is shown in ***Table 3.23***.

Table 3.23: *Overview of emissions in the 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	0.0023	0.1848
1990/2021	**-59%**	**49%**	**-84%**	**-**	**-99%**	**-99%**	**-99%**	**-99%**	**-56%**
2020/2021	**114%**	**44%**	**17%**	**-**	**78%**	**72%**	**67%**	**78%**	**86%**

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

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
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
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
1990/2021	**-34%**	**-74%**	**-65%**	**-50%**	**-28%**	**-29%**	**-26%**	**-24%**	**-21%**
2020/2021	**1%**	**2%**	**8%**	**16%**	**1%**	**1%**	**14%**	**0%**	**2%**

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	0.0288	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
1990/2021	**-35%**	**104%**	**91%**	**0%**	**18%**	**53%**	**-24%**	**104%**
2020/2021	**14%**	**4%**	**4%**	**6%**	**7%**	**5%**	**0%**	**1%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.24*** below.

***Table 3.24:** Overview of activity data in the category 1A2a*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [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

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2019	14.44	18 054.40	1 401.57	NO	NO
2020	9.55	16 955.23	1 424.88	8.72	NO
2021	28.80	21 631.33	1 301.52	8.91	NO
1990/2021	**386%**	**16%**	**-10%**	**-**	**-**
2020/2021	**202%**	**28%**	**-9%**	**2%**	**-**

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 is 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 2021.

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 3.25***).

Table 3.25: *Emission factors for calculation of 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	81%	86%	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_{2019}, expert estimation and special source[1] (***Table 3.26***).

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 3.26: *Emission factors for heavy metals and POPs in the category 1A2a*

TYPE OF FUEL		LIQUID FUELS				HARD COAL		
T2	UNIT	ALL TYPE OF BOILERS (≤ 5 MWth)	ALL TYPE OF BOILERS (5 – 50 MWth)	ALL TYPE OF BOILERS (> 100 MWth)	STATIONARY ENGINES	FIXED BED BOILER (≤ 5 MWth)	FIXED BED BOILER (> 100 MWth)	PULVERIZED COAL-FIRED BOILERS (> 100 MWth)
Pb	[mg/GJ]	4.56	4.56	4.56	4.07	13.687	2.656	2.722
Cd	[mg/GJ]	1.2	1.2	1.2	1.36	2.456	0.823	0.268
Hg	[mg/GJ]	0.341	0.341	0.341	1.36	9.051	1.744	0.668
As	[mg/GJ]	3.98	3.98	3.98	1.81	9.402	0.243	0.339
Cr	[mg/GJ]	2.55	2.55	2.55	1.36	15	4.5	4.5

[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 FUEL		LIQUID FUELS				HARD COAL		
Cu	[mg/GJ]	5.31	5.31	5.31	2.72	10	7.8	7.8
Ni	[mg/GJ]	255	255	255	1.36	10	4.9	4.537
Se	[mg/GJ]	2.06	2.06	2.06	6.79	2	23	23
Zn	[mg/GJ]	87.8	87.8	87.8	1.81	150	19	19
PCDD/F	[ng I-TEQ/GJ]	2.5	2.5	2.5	0.99	14.657	2.299	1.314
B(a)P	[mg/GJ]	3.678	3.678	3.678	116	10.975	2.4	2.844
B(b)F	[mg/GJ]	12.673	12.673	12.673	502	18.54	4.768	5.433
B(k)F	[mg/GJ]	3.968	3.968	3.968	98.7	10.966	3.085	3.786
I()P	[mg/GJ]	6.484	6.484	6.484	187	5.956	2.08	3.662
PAHs	[mg/GJ]	26.803	26.803	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	3.334	3.334	0.00013	8.073	0.395	1.176

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

BC emissions were estimated this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2019}) (***Table 3.27***). The calculated BC emission values are presented in ***Table 3.23***.

Table 3.27: *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%

3.5.2.3 Completeness

Emissions are well covered.

3.5.2.4 Source-specific recalculations

The recalculations for HMs and POPs were made due to the change in methodology from Tier 1 to Tier 2. The results of the recalculations are in ***Table 3.28***.

Table 3.28: *Previous and revised emissions in the category 1A2a*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	1.3784	0.0325	-98%	0.0185	0.0085	-54%	0.0865	0.0190	-78%
1991	1.3820	0.0326	-98%	0.0186	0.0085	-54%	0.0868	0.0191	-78%
1992	1.3863	0.0327	-98%	0.0186	0.0086	-54%	0.0870	0.0191	-78%
1993	1.3873	0.0327	-98%	0.0186	0.0086	-54%	0.0871	0.0191	-78%
1994	1.3869	0.0327	-98%	0.0186	0.0086	-54%	0.0871	0.0191	-78%
1995	1.4138	0.0334	-98%	0.0190	0.0087	-54%	0.0887	0.0195	-78%
1996	1.4103	0.0333	-98%	0.0190	0.0087	-54%	0.0885	0.0194	-78%
1997	1.4181	0.0335	-98%	0.0191	0.0088	-54%	0.0890	0.0195	-78%
1998	1.4620	0.0345	-98%	0.0196	0.0090	-54%	0.0916	0.0201	-78%
1999	1.5457	0.0365	-98%	0.0208	0.0096	-54%	0.0966	0.0212	-78%
2000	1.4598	0.0344	-98%	0.0196	0.0090	-54%	0.0918	0.0202	-78%
2001	1.6727	0.0389	-98%	0.0225	0.0035	-85%	0.1043	0.0096	-91%
2002	1.8467	0.0382	-98%	0.0248	0.0037	-85%	0.1149	0.0104	-91%
2003	1.9196	0.0437	-98%	0.0258	0.0039	-85%	0.1198	0.0110	-91%
2004	1.8428	0.0377	-98%	0.0248	0.0037	-85%	0.1158	0.0106	-91%
2005	2.0879	0.0425	-98%	0.0281	0.0042	-85%	0.1300	0.0118	-91%
2006	2.1358	0.0435	-98%	0.0287	0.0043	-85%	0.1338	0.0122	-91%
2007	1.7969	0.0365	-98%	0.0241	0.0036	-85%	0.1128	0.0103	-91%
2008	1.7113	0.0348	-98%	0.0230	0.0034	-85%	0.1081	0.0099	-91%
2009	1.3243	0.0270	-98%	0.0178	0.0027	-85%	0.0851	0.0079	-91%
2010	1.3909	0.0283	-98%	0.0187	0.0028	-85%	0.0905	0.0085	-91%
2011	1.3991	0.0285	-98%	0.0188	0.0028	-85%	0.0909	0.0086	-91%
2012	1.5420	0.0314	-98%	0.0207	0.0031	-85%	0.0989	0.0092	-91%
2013	1.5241	0.0310	-98%	0.0205	0.0031	-85%	0.0977	0.0091	-91%
2014	1.3749	0.0280	-98%	0.0185	0.0028	-85%	0.0894	0.0084	-91%
2015	1.3567	0.0276	-98%	0.0182	0.0027	-85%	0.0880	0.0083	-91%
2016	0.9528	0.0194	-98%	0.0128	0.0019	-85%	0.0642	0.0063	-90%
2017	0.9693	0.0197	-98%	0.0130	0.0020	-85%	0.0650	0.0063	-90%
2018	1.2367	0.0252	-98%	0.0166	0.0025	-85%	0.0817	0.0078	-90%
2019	1.1012	0.0225	-98%	0.0148	0.0022	-85%	0.0710	0.0066	-91%
2020	1.0398	0.0214	-98%	0.0141	0.0022	-84%	0.0670	0.0063	-91%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0421	0.0092	-78%	0.1390	0.0494	-64%	0.1800	0.0858	-52%
1991	0.0422	0.0092	-78%	0.1394	0.0495	-64%	0.1805	0.0861	-52%
1992	0.0424	0.0093	-78%	0.1398	0.0497	-64%	0.1811	0.0863	-52%
1993	0.0424	0.0093	-78%	0.1399	0.0497	-64%	0.1812	0.0864	-52%
1994	0.0424	0.0093	-78%	0.1398	0.0497	-64%	0.1811	0.0864	-52%
1995	0.0432	0.0094	-78%	0.1426	0.0507	-64%	0.1847	0.0880	-52%
1996	0.0431	0.0094	-78%	0.1422	0.0505	-64%	0.1842	0.0878	-52%
1997	0.0433	0.0095	-78%	0.1430	0.0508	-64%	0.1852	0.0883	-52%
1998	0.0446	0.0097	-78%	0.1474	0.0524	-64%	0.1909	0.0910	-52%
1999	0.0472	0.0102	-78%	0.1558	0.0554	-64%	0.2019	0.0963	-52%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2000	0.0446	0.0098	-78%	0.1472	0.0523	-64%	0.1907	0.0909	-52%
2001	0.0510	0.0106	-79%	0.1686	0.0591	-65%	0.2185	0.1024	-53%
2002	0.0562	0.0067	-88%	0.1862	0.0625	-66%	0.2412	0.1080	-55%
2003	0.0585	0.0112	-81%	0.1935	0.0673	-65%	0.2507	0.1165	-54%
2004	0.0563	0.0064	-89%	0.1858	0.0621	-67%	0.2407	0.1072	-55%
2005	0.0636	0.0069	-89%	0.2105	0.0702	-67%	0.2727	0.1215	-55%
2006	0.0652	0.0072	-89%	0.2154	0.0718	-67%	0.2789	0.1243	-55%
2007	0.0549	0.0061	-89%	0.1812	0.0604	-67%	0.2347	0.1046	-55%
2008	0.0524	0.0060	-89%	0.1726	0.0575	-67%	0.2235	0.0996	-55%
2009	0.0408	0.0050	-88%	0.1336	0.0445	-67%	0.1730	0.0771	-55%
2010	0.0431	0.0054	-87%	0.1403	0.0468	-67%	0.1817	0.0810	-55%
2011	0.0433	0.0054	-87%	0.1411	0.0470	-67%	0.1827	0.0814	-55%
2012	0.0475	0.0058	-88%	0.1555	0.0519	-67%	0.2014	0.0898	-55%
2013	0.0469	0.0056	-88%	0.1537	0.0512	-67%	0.1991	0.0887	-55%
2014	0.0426	0.0054	-87%	0.1387	0.0462	-67%	0.1796	0.0800	-55%
2015	0.0420	0.0052	-88%	0.1369	0.0456	-67%	0.1772	0.0790	-55%
2016	0.0299	0.0042	-86%	0.0962	0.0320	-67%	0.1244	0.0555	-55%
2017	0.0304	0.0042	-86%	0.0978	0.0326	-67%	0.1266	0.0564	-55%
2018	0.0385	0.0051	-87%	0.1248	0.0416	-67%	0.1615	0.0720	-55%
2019	0.0340	0.0042	-88%	0.1111	0.0370	-67%	0.1438	0.0642	-55%
2020	0.0321	0.0040	-88%	0.1051	0.0352	-67%	0.1358	0.0606	-55%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.1338	0.0571	-57%	0.0191	0.2350	1132%	2.0645	0.1975	-90%
1991	0.1342	0.0572	-57%	0.0191	0.2356	1132%	2.0699	0.1980	-90%
1992	0.1346	0.0574	-57%	0.0192	0.2364	1132%	2.0762	0.1986	-90%
1993	0.1347	0.0575	-57%	0.0192	0.2365	1132%	2.0778	0.1988	-90%
1994	0.1347	0.0574	-57%	0.0192	0.2365	1132%	2.0772	0.1987	-90%
1995	0.1373	0.0585	-57%	0.0196	0.2410	1132%	2.1174	0.2026	-90%
1996	0.1369	0.0584	-57%	0.0195	0.2404	1132%	2.1121	0.2020	-90%
1997	0.1377	0.0587	-57%	0.0196	0.2418	1132%	2.1239	0.2032	-90%
1998	0.1420	0.0604	-57%	0.0202	0.2493	1133%	2.1894	0.2094	-90%
1999	0.1501	0.0641	-57%	0.0214	0.2635	1134%	2.3145	0.2215	-90%
2000	0.1418	0.0603	-57%	0.0202	0.2489	1130%	2.1866	0.2091	-90%
2001	0.1624	0.0645	-60%	0.0231	0.2860	1139%	2.5043	0.2395	-90%
2002	0.1793	0.0654	-64%	0.0254	0.3171	1146%	2.7645	0.2632	-90%
2003	0.1864	0.0701	-62%	0.0265	0.3286	1140%	2.8738	0.2736	-90%
2004	0.1789	0.0630	-65%	0.0255	0.3167	1141%	2.7599	0.2618	-91%
2005	0.2027	0.0709	-65%	0.0288	0.3586	1146%	3.1254	0.2968	-91%
2006	0.2074	0.0723	-65%	0.0295	0.3666	1141%	3.1983	0.3035	-91%
2007	0.1745	0.0609	-65%	0.0249	0.3085	1140%	2.6910	0.2551	-91%
2008	0.1662	0.0580	-65%	0.0238	0.2938	1137%	2.5638	0.2430	-91%
2009	0.1286	0.0478	-63%	0.0185	0.2274	1126%	1.9863	0.1892	-90%
2010	0.1351	0.0472	-65%	0.0196	0.2388	1119%	2.0873	0.1977	-91%
2011	0.1359	0.0477	-65%	0.0197	0.2402	1120%	2.0994	0.1989	-91%
2012	0.1498	0.0563	-62%	0.0216	0.2648	1127%	2.3126	0.2204	-90%
2013	0.1480	0.0517	-65%	0.0213	0.2617	1128%	2.2852	0.2165	-91%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2014	0.1336	0.0466	-65%	0.0194	0.2361	1119%	2.0631	0.1952	-91%
2015	0.1318	0.0460	-65%	0.0191	0.2330	1121%	2.0356	0.1926	-91%
2016	0.0926	0.0323	-65%	0.0137	0.1636	1098%	1.4327	0.1354	-91%
2017	0.0942	0.0335	-64%	0.0139	0.1665	1101%	1.4571	0.1380	-91%
2018	0.1202	0.0421	-65%	0.0176	0.2124	1110%	1.8574	0.1757	-91%
2019	0.1070	0.0404	-62%	0.0154	0.1891	1124%	1.6520	0.1575	-90%
2020	0.1010	0.0370	-63%	0.0146	0.1785	1124%	1.5639	0.1528	-90%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	2.0931	0.0288	-99%	1.5648	0.0003	-100%
1991	2.0986	0.0289	-99%	1.5687	0.0003	-100%
1992	2.1051	0.0290	-99%	1.5735	0.0003	-100%
1993	2.1066	0.0290	-99%	1.5747	0.0003	-100%
1994	2.1060	0.0290	-99%	1.5744	0.0003	-100%
1995	2.1468	0.0295	-99%	1.6038	0.0003	-100%
1996	2.1415	0.0295	-99%	1.6005	0.0003	-100%
1997	2.1534	0.0296	-99%	1.6094	0.0003	-100%
1998	2.2198	0.0304	-99%	1.6576	0.0003	-100%
1999	2.3468	0.0319	-99%	1.7500	0.0004	-100%
2000	2.2169	0.0307	-99%	1.6590	0.0003	-100%
2001	2.5392	0.0221	-99%	1.8908	0.0004	-100%
2002	2.8032	0.0238	-99%	2.0847	0.0003	-100%
2003	2.9142	0.0254	-99%	2.1709	0.0004	-100%
2004	2.7984	0.0249	-99%	2.0930	0.0003	-100%
2005	3.1694	0.0270	-99%	2.3584	0.0003	-100%
2006	3.2430	0.0283	-99%	2.4215	0.0003	-100%
2007	2.7286	0.0240	-99%	2.0399	0.0003	-100%
2008	2.5993	0.0235	-99%	1.9495	0.0002	-100%
2009	2.0129	0.0196	-99%	1.5247	0.0002	-100%
2010	2.1151	0.0216	-99%	1.6130	0.0002	-100%
2011	2.1274	0.0216	-99%	1.6212	0.0002	-100%
2012	2.3435	0.0226	-99%	1.7736	0.0002	-100%
2013	2.3162	0.0222	-99%	1.7513	0.0002	-100%
2014	2.0906	0.0212	-99%	1.5935	0.0002	-100%
2015	2.0628	0.0208	-99%	1.5707	0.0002	-100%
2016	1.4509	0.0168	-99%	1.1285	0.0002	-100%
2017	1.4757	0.0168	-99%	1.1444	0.0002	-100%
2018	1.8816	0.0203	-99%	1.4472	0.0002	-100%
2019	1.6739	0.0165	-99%	1.2701	0.0002	-100%
2020	1.5812	0.0164	-99%	1.1993	0.0005	-100%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0064	0.0689	981%	1.7486	0.0045	-100%
1991	0.0064	0.0691	981%	1.7532	0.0045	-100%
1992	0.0064	0.0693	981%	1.7586	0.0046	-100%
1993	0.0064	0.0694	981%	1.7599	0.0046	-100%
1994	0.0064	0.0694	981%	1.7593	0.0046	-100%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1995	0.0065	0.0707	981%	1.7935	0.0046	-100%
1996	0.0065	0.0705	981%	1.7890	0.0046	-100%
1997	0.0066	0.0709	981%	1.7989	0.0047	-100%
1998	0.0068	0.0731	981%	1.8546	0.0048	-100%
1999	0.0072	0.0773	981%	1.9609	0.0051	-100%
2000	0.0068	0.0730	981%	1.8518	0.0048	-100%
2001	0.0077	0.0837	981%	2.1219	0.0151	-99%
2002	0.0085	0.0924	981%	2.3427	0.0163	-99%
2003	0.0089	0.0960	981%	2.4351	0.0172	-99%
2004	0.0085	0.0922	981%	2.3377	0.0162	-99%
2005	0.0097	0.1044	981%	2.6486	0.0184	-99%
2006	0.0099	0.1068	981%	2.7094	0.0188	-99%
2007	0.0083	0.0899	981%	2.2794	0.0158	-99%
2008	0.0079	0.0856	981%	2.1709	0.0150	-99%
2009	0.0061	0.0663	981%	1.6800	0.0117	-99%
2010	0.0064	0.0696	981%	1.7644	0.0122	-99%
2011	0.0065	0.0700	981%	1.7747	0.0123	-99%
2012	0.0071	0.0771	981%	1.9560	0.0136	-99%
2013	0.0071	0.0762	981%	1.9334	0.0134	-99%
2014	0.0064	0.0688	981%	1.7441	0.0121	-99%
2015	0.0063	0.0679	981%	1.7210	0.0119	-99%
2016	0.0044	0.0477	982%	1.2085	0.0084	-99%
2017	0.0045	0.0485	982%	1.2295	0.0085	-99%
2018	0.0057	0.0619	982%	1.5687	0.0109	-99%
2019	0.0051	0.0551	981%	1.3969	0.0097	-99%
2020	0.0049	0.0521	973%	1.3188	0.0092	-99%

3.5.3 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: NON-FERROUS METALS (NFR 1A2b)

3.5.3.1 Overview

The category is focused on combustion processes in the production of non-ferrous metals. Activities listed within this category are shown in ***Table 3.29***.

Table 3.29: *Activities according to national categorization included in 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 3.30***.

Table 3.30: *Overview of emissions in the 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

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
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
1990/2021	**56%**	**413%**	**-75%**	**-**	**24%**	**27%**	**13%**	**31%**	**79%**
2020/2021	**8%**	**8%**	**12%**	**-**	**9%**	**9%**	**8%**	**13%**	**8%**

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
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
1990/2021	**76%**	**76%**	**76%**	**76%**	**76%**	**78%**	**76%**	**76%**	**77%**
2020/2021	**8%**	**8%**	**8%**	**8%**	**8%**	**9%**	**8%**	**8%**	**8%**

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	0.0000	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

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]
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
1990/2021	**76%**	**76%**	**76%**	**76%**	**76%**	**76%**	**–**	**–**
2020/2021	**8%**	**8%**	**8%**	**8%**	**8%**	**8%**	**–**	**–**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.31*** below.

Table 3.31: *Overview of activity data in the 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
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
1990/2021	**-**	**-**	**76%**	**-**	**-**
2020/2021	**185%**	**-**	**8%**	**-**	**-**

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 is 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 2021.

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 3.32***).

Table 3.32: *Emission factors for calculation of 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%	85%	16.93

HMs and POPs emissions were calculated using Tier 1 emission factors from EMEP/EEA GB_{2019} (***Table 3.33***).

Table 3.33: Emission factors for heavy metals and POPs in the category 1A2b

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_{2019}) (***Table 3.34***). The calculated BC emission values are presented in ***Table 3.30***.

Table 3.34: 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%

3.5.3.3 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 3.35***. The emissions from the combustion of industrial waste are included in this category because of the energy recovery from the combustion process.

***Table 3.35:** Activities according to national categorization included in 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 3.36***.

***Table 3.36:** Overview of emissions in the 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	0.0007	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	0.0010	0.0614
1990/2021	**-71%**	**-86%**	**-99%**	**-**	**-60%**	**-72%**	**-81%**	**-58%**	**-67%**
2020/2021	**1%**	**-1%**	**-52%**	**-**	**23%**	**23%**	**23%**	**-32%**	**-9%**

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	0.0055	0.0001	0.0041	0.0008	0.0002	0.0000	0.0007	0.0004	0.0073
2020	0.0060	0.0003	0.0026	0.0005	0.0004	0.0001	0.0007	0.0003	0.0116
2021	0.0039	0.0001	0.0026	0.0005	0.0002	0.0000	0.0005	0.0003	0.0056
1990/2021	**-99%**	**-99%**	**-94%**	**-97%**	**-100%**	**-100%**	**-99%**	**-97%**	**-99%**
2020/2021	**-35%**	**-64%**	**0%**	**-2%**	**-63%**	**-65%**	**-31%**	**1%**	**-52%**

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	4.0019	0.2138	0.2989	0.1175	0.0935	0.8992	0.0204	0.7736

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]
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	0.0042	0.0052	0.0207	0.0079	0.0077	0.1229	0.0082	0.0000
2020	0.0039	0.0033	0.0127	0.0048	0.0047	0.1103	0.0086	0.0000
2021	0.0028	0.0032	0.0129	0.0049	0.0048	0.0837	0.0058	0.0000
1990/2021	**-100%**	**-98%**	**-96%**	**-96%**	**-95%**	**-91%**	**-72%**	**-100%**
2020/2021	**-29%**	**-1%**	**2%**	**2%**	**2%**	**-24%**	**-32%**	**-73%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.37*** below.

Table 3.37: *Overview of activity data in the 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	415.16	149.61
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	246.90	105.64
2020	4.24	8.97	0.00	4 133.26	171.55	105.95
2021	2.89	3.39	NO	4 280.55	156.93	69.84
1990/2021	**-67%**	**-99%**	**-**	**-46%**	**-**	**-**
2020/2021	**-32%**	**-62%**	**-**	**4%**	**-9%**	**-34%**

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 is 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 2021.

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 3.38***).

Table 3.38: *Emission factors for calculation of 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%	67%	14.46

HMs and POPs emissions were calculated using Tier 1 emission factors from EMEP/EEA GB_{2019} (***Table 3.39***).

Table 3.39: *Emission factors for heavy metals and POPs in the category 1A2c*

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_{2019}) (***Table 3.40***). The calculated BC emission values are presented in ***Table 3.36***.

Table 3.40: *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%

3.5.4.3 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 3.41***.

Table 3.41: *Activities according to national categorization included in 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 single-source which used in 2004 almost 3x more biomass fuel 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 3.42***. Emissions in this category show an overall increasing trend due to an increase in activity within this category.

Table 3.42: *Overview of emissions in the 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
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
1990/2021	**-60%**	**62%**	**-99%**	**-**	**-91%**	**-92%**	**-94%**	**-88%**	**-79%**
2020/2021	**14%**	**-32%**	**-29%**	**-71%**	**20%**	**18%**	**18%**	**20%**	**85%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0361	0.0041	0.0231	0.0127	0.0431	0.0296	0.1347	0.2115	0.1384
1995	0.0362	0.0041	0.0232	0.0128	0.0425	0.0293	0.1341	0.2087	0.1377
2000	0.0419	0.0047	0.0280	0.0159	0.0422	0.0292	0.1208	0.2078	0.1401
2005	0.0446	0.0044	0.0315	0.0193	0.0272	0.0213	0.0308	0.1370	0.1006

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2010	0.0380	0.0040	0.0297	0.0205	0.0031	0.0059	0.0044	0.0174	0.0542
2011	0.0355	0.0037	0.0284	0.0197	0.0007	0.0023	0.0021	0.0051	0.0440
2012	0.0335	0.0035	0.0268	0.0186	0.0007	0.0022	0.0022	0.0051	0.0416
2013	0.0351	0.0037	0.0278	0.0192	0.0007	0.0023	0.0022	0.0051	0.0441
2014	0.0316	0.0034	0.0250	0.0173	0.0006	0.0021	0.0017	0.0042	0.0407
2015	0.0132	0.0014	0.0106	0.0074	0.0003	0.0009	0.0007	0.0018	0.0184
2016	0.0294	0.0031	0.0233	0.0161	0.0006	0.0020	0.0016	0.0039	0.0379
2017	0.0289	0.0031	0.0228	0.0158	0.0006	0.0019	0.0015	0.0038	0.0381
2018	0.0282	0.0030	0.0223	0.0154	0.0006	0.0019	0.0015	0.0037	0.0370
2019	0.0257	0.0027	0.0204	0.0141	0.0005	0.0017	0.0014	0.0034	0.0334
2020	0.0339	0.0036	0.0268	0.0185	0.0007	0.0023	0.0018	0.0045	0.0442
2021	0.0316	0.0034	0.0251	0.0173	0.0006	0.0021	0.0017	0.0042	0.0410
1990/2021	**-12%**	**-18%**	**8%**	**36%**	**-99%**	**-93%**	**-99%**	**-98%**	**-70%**
2020/2021	**-7%**	**-7%**	**-7%**	**-7%**	**-8%**	**-7%**	**-7%**	**-7%**	**-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]	PCB [kg]
1990	0.1077	0.0004	0.0012	0.0006	0.0003	0.0026	0.0822	0.0244
1995	0.1102	0.0004	0.0013	0.0006	0.0003	0.0026	0.0829	0.0249
2000	0.1533	0.0006	0.0018	0.0009	0.0004	0.0037	0.1016	0.0332
2005	0.2257	0.0009	0.0028	0.0013	0.0007	0.0057	0.1231	0.0467
2010	0.2612	0.0011	0.0033	0.0016	0.0008	0.0067	0.1172	0.0514
2011	0.2522	0.0010	0.0032	0.0015	0.0007	0.0064	0.1103	0.0493
2012	0.2380	0.0010	0.0030	0.0014	0.0007	0.0061	0.1042	0.0465
2013	0.2484	0.0010	0.0032	0.0015	0.0007	0.0064	0.1090	0.0487
2014	0.2234	0.0009	0.0029	0.0013	0.0007	0.0058	0.0980	0.0437
2015	0.0942	0.0004	0.0012	0.0006	0.0003	0.0025	0.0407	0.0182
2016	0.2080	0.0009	0.0027	0.0013	0.0006	0.0054	0.0911	0.0407
2017	0.2043	0.0009	0.0027	0.0012	0.0006	0.0054	0.0895	0.0400
2018	0.1995	0.0009	0.0026	0.0012	0.0006	0.0053	0.0874	0.0390
2019	0.1820	0.0008	0.0024	0.0011	0.0005	0.0048	0.0796	0.0356
2020	0.2397	0.0010	0.0031	0.0015	0.0007	0.0063	0.1050	0.0469
2021	0.2238	0.0010	0.0029	0.0014	0.0007	0.0059	0.0981	0.0438
1990/2021	**108%**	**129%**	**133%**	**128%**	**116%**	**129%**	**19%**	**79%**
2020/2021	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.43*** below.

Table 3.43: *Overview of activity data in the category 1A2d*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [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	22 783.06	NO
2011	13.17	9.27	3 677.97	22 055.32	NO
2012	28.40	14.06	3 274.23	20 817.75	NO
2013	NO	10.93	1 720.44	21 792.68	NO
2014	NO	NO	1 630.09	19 592.17	NO
2015	NO	NO	2 800.74	8 148.13	NO
2016	NO	NO	1 818.05	18 226.09	NO

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2017	33.17	NO	1 513.20	17 900.05	NO
2018	35.04	NO	1 609.60	17 472.21	NO
2019	31.82	NO	2 020.11	15 925.89	NO
2020	1.73	NO	1 843.13	20 973.64	NO
2021	1.72	NO	1 870.16	19 613.63	NO
1990/2021	**-100%**	**-**	**-50%**	**137%**	**-**
2020/2021	**0%**	**-**	**1%**	**-6%**	**-**

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 is 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 2021.

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 3.44***).

Table 3.44: *Emission factors for calculation of 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%	75%	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_{2019}, expert estimation and special source[1] (***Table 3.45***).

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 3.45: *Emission factors for heavy metals and POPs in the category 1A2d*

TYPE OF FUEL		LIQUID FUELS				HARD COAL	
T2	UNIT	ALL TYPE OF BOILERS (≤ 5 MWth)	ALL TYPE OF BOILERS (5–50 MWth)	ALL TYPE OF BOILERS (> 100 MWth)	STATIONARY ENGINES	FIXED BED BOILER (> 100 MWth)	PULVERIZED COAL-FIRED BOILERS (> 100 MWth)
Pb	[mg/GJ]	4.56	4.56	4.56	4.07	2.656	2.722
Cd	[mg/GJ]	1.2	1.2	1.2	1.36	0.823	0.268
Hg	[mg/GJ]	0.341	0.341	0.341	1.36	1.744	0.668
As	[mg/GJ]	3.98	3.98	3.98	1.81	0.243	0.339
Cr	[mg/GJ]	2.55	2.55	2.55	1.36	4.5	4.5
Cu	[mg/GJ]	5.31	5.31	5.31	2.72	7.8	7.8

TYPE OF FUEL		LIQUID FUELS				HARD COAL	
T2	UNIT	ALL TYPE OF BOILERS (≤ 5 MWth)	ALL TYPE OF BOILERS (5–50 MWth)	ALL TYPE OF BOILERS (> 100 MWth)	STATIONARY ENGINES	FIXED BED BOILER (> 100 MWth)	PULVERIZED COAL-FIRED BOILERS (> 100 MWth)
Ni	[mg/GJ]	255	255	255	1.36	4.9	4.537
Se	[mg/GJ]	2.06	2.06	2.06	6.79	23	23
Zn	[mg/GJ]	87.8	87.8	87.8	1.81	19	19
PCDD/F	[ng I-TEQ/GJ]	2.5	2.5	2.5	0.99	2.299	1.314
B(a)P	[mg/GJ]	3.678	3.678	3.678	116	2.4	2.844
B(b)F	[mg/GJ]	12.673	12.673	12.673	502	4.768	5.433
B(k)F	[mg/GJ]	3.968	3.968	3.968	98.7	3.085	3.786
I()P	[mg/GJ]	6.484	6.484	6.484	187	2.08	3.662
PAHs	[mg/GJ]	26.803	26.803	26.803	903.7	12.33	15.725
HCB	[µg/GJ]	-	-	-	0.22	6.7	6.7
PCBs	[µg/GJ]	3.334	3.334	3.334	0.00013	0.395	1.176

TYPE OF FUEL		BROWN COAL		GASEOUS FUELS				
T2	UNIT	FIXED BED BOILER (> 100 MWth)	PULVERIZED COAL-FIRED BOILERS (> 100 MWth)	ALL TYPE OF BOILERS (≤ 5 MWth)	ALL TYPE OF BOILERS (5–50 MWth)	ALL TYPE OF BOILERS (50–100 MWth)	ALL TYPE OF BOILERS (> 100 MWth)	GAS TURBINES
Pb	[mg/GJ]	6.67	4.071	0.0015	0.0015	0.0015	0.0015	0.0015
Cd	[mg/GJ]	0.495	0.292	0.00025	0.00025	0.00025	0.00025	0.00025
Hg	[mg/GJ]	1.924	2.965	0.1	0.1	0.1	0.1	0.1
As	[mg/GJ]	2.102	0.76	0.12	0.12	0.12	0.12	0.12
Cr	[mg/GJ]	9.1	9.1	0.00076	0.00076	0.00076	0.00076	0.00076
Cu	[mg/GJ]	1	1	0.000076	0.000076	0.000076	0.000076	0.000076
Ni	[mg/GJ]	27.67	3.374	0.00051	0.00051	0.00051	0.00051	0.00051
Se	[mg/GJ]	45	45	0.0112	0.0112	0.0112	0.0112	0.0112
Zn	[mg/GJ]	8.8	8.8	0.0015	0.0015	0.0015	0.0015	0.0015
PCDD/F	[ng I-TEQ/GJ]	7.68	1.925	0.5	0.5	0.5	0.5	0.5
B(a)P	[µg/GJ]	3.147	4.653	0.56	0.56	0.56	0.56	0.56
B(b)F	[µg/GJ]	7.973	6.187	0.84	0.84	0.84	0.84	0.84
B(k)F	[µg/GJ]	4.047	4.915	0.84	0.84	0.84	0.84	0.84
I()P	[µg/GJ]	4.203	5.664	0.84	0.84	0.84	0.84	0.84
PAHs	[µg/GJ]	19.37	21.419	3.08	3.08	3.08	3.08	3.08
HCB	[µg/GJ]	6.7	6.7	0.00308	0.00308	0.00308	0.00308	0.00308
PCBs	[ng/GJ]	0.757	0.547	-	-	-	-	-

TYPE OF FUEL		BIOMASS					
T2	UNIT	FIXED BED BOILER (≤ 5 MWth)	FIXED BED BOILER (5 – 50 MWth)	FIXED BED BOILER (> 100 MWth)	FLUIDIZED BED BOILER (50 – 100 MWth)	FLUIDIZED BED BOILER (> 100 MWth)	PULVERIZED COAL-FIRED BOILERS (> 100 MWth)
Pb	[mg/GJ]	27	1.606	4.56	1.606	1.606	1.606
Cd	[mg/GJ]	13	0.169	1.2	0.169	0.169	0.169
Hg	[mg/GJ]	0.56	1.268	0.341	1.268	1.268	1.268
As	[mg/GJ]	0.19	0.871	3.98	0.871	0.871	0.871
Cr	[mg/GJ]	23	0.027	2.55	0.027	0.027	0.027
Cu	[mg/GJ]	6	0.106	5.31	0.106	0.106	0.106

TYPE OF FUEL		BIOMASS					
T2	UNIT	FIXED BED BOILER (≤ 5 MWth)	FIXED BED BOILER (5 – 50 MWth)	FIXED BED BOILER (> 100 MWth)	FLUIDIZED BED BOILER (50 – 100 MWth)	FLUIDIZED BED BOILER (> 100 MWth)	PULVERIZED COAL-FIRED BOILERS (> 100 MWth)
Ni	[mg/GJ]	2	0.085	255	0.085	0.085	0.085
Se	[mg/GJ]	0.5	0.211	2.06	0.211	0.211	0.211
Zn	[mg/GJ]	512	1.991	87.8	1.991	1.991	1.991
PCDD/F	[ng I-TEQ/GJ]	100	11.348	2.5	11.348	11.348	11.348
B(a)P	[mg/GJ]	10000	46.462	3.678	46.462	46.462	46.462
B(b)F	[mg/GJ]	16000	144.329	12.673	144.329	144.329	144.329
B(k)F	[mg/GJ]	5000	67.897	3.968	67.897	67.897	67.897
I()P	[mg/GJ]	4000	33.073	6.484	33.073	33.073	33.073
PAHs	[mg/GJ]	35000	291.761	26.803	291.761	291.761	291.761
HCB	[µg/GJ]	5	5	-	5	5	5
PCBs	[µg/GJ]	0.007	2.233	3.334	2.233	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_{2019}) (***Table 3.46***). The calculated BC emission values are presented in ***Table 3.42***.

Table 3.46: *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%

3.5.5.3 Completeness

Emissions are well covered.

3.5.5.4 Source-specific recalculations

The recalculations for HMs and POPs were made due to the change in methodology from Tier 1 to Tier 2. The results of the recalculations are in ***Table 3.47***.

Table 3.47: *Previous and revised emissions in the category 1A2d*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	1.0410	0.0361	-97%	0.1184	0.0041	-97%	0.0549	0.0231	-58%
1991	1.0396	0.0361	-97%	0.1187	0.0041	-97%	0.0548	0.0231	-58%
1992	1.0406	0.0361	-97%	0.1190	0.0041	-97%	0.0548	0.0231	-58%
1993	1.0417	0.0361	-97%	0.1194	0.0041	-97%	0.0549	0.0232	-58%
1994	1.0460	0.0365	-97%	0.1232	0.0041	-97%	0.0548	0.0235	-57%
1995	1.0367	0.0362	-97%	0.1215	0.0041	-97%	0.0543	0.0232	-57%
1996	1.0532	0.0368	-97%	0.1252	0.0042	-97%	0.0551	0.0237	-57%
1997	1.0506	0.0371	-96%	0.1308	0.0042	-97%	0.0544	0.0241	-56%
1998	1.0558	0.0380	-96%	0.1409	0.0043	-97%	0.0538	0.0248	-54%
1999	1.0373	0.0368	-96%	0.1297	0.0042	-97%	0.0535	0.0238	-56%
2000	1.1330	0.0419	-96%	0.1709	0.0047	-97%	0.0561	0.0280	-50%
2001	1.0347	0.0407	-96%	0.1779	0.0041	-98%	0.0489	0.0274	-44%
2002	1.1223	0.0445	-96%	0.1990	0.0045	-98%	0.0525	0.0299	-43%
2003	1.1334	0.0447	-96%	0.2045	0.0045	-98%	0.0525	0.0303	-42%

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2004	1.4044	0.0654	-95%	0.4188	0.0067	-98%	0.0513	0.0479	-7%
2005	1.0588	0.0446	-96%	0.2573	0.0044	-98%	0.0436	0.0315	-28%
2006	1.1410	0.0492	-96%	0.2828	0.0049	-98%	0.0474	0.0354	-25%
2007	1.1522	0.0502	-96%	0.3013	0.0050	-98%	0.0468	0.0362	-23%
2008	1.1536	0.0509	-96%	0.3045	0.0050	-98%	0.0466	0.0374	-20%
2009	1.3340	0.0561	-96%	0.3189	0.0055	-98%	0.0562	0.0402	-28%
2010	0.6811	0.0380	-94%	0.2971	0.0040	-99%	0.0187	0.0297	59%
2011	0.5968	0.0355	-94%	0.2867	0.0037	-99%	0.0144	0.0284	97%
2012	0.5640	0.0335	-94%	0.2707	0.0035	-99%	0.0135	0.0268	98%
2013	0.5899	0.0351	-94%	0.2833	0.0037	-99%	0.0132	0.0278	110%
2014	0.5281	0.0316	-94%	0.2542	0.0034	-99%	0.0118	0.0250	111%
2015	0.2191	0.0132	-94%	0.1055	0.0014	-99%	0.0061	0.0106	75%
2016	0.4921	0.0294	-94%	0.2369	0.0031	-99%	0.0112	0.0233	108%
2017	0.4828	0.0289	-94%	0.2324	0.0031	-99%	0.0108	0.0228	111%
2018	0.4711	0.0282	-94%	0.2268	0.0030	-99%	0.0106	0.0223	110%
2019	0.4300	0.0257	-94%	0.2070	0.0027	-99%	0.0100	0.0204	104%
2020	0.5663	0.0339	-94%	0.2727	0.0036	-99%	0.0127	0.0268	110%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0264	0.0127	-52%	0.2726	0.0431	-84%	0.1565	0.0296	-81%
1991	0.0263	0.0127	-52%	0.2730	0.0430	-84%	0.1564	0.0295	-81%
1992	0.0263	0.0127	-52%	0.2735	0.0430	-84%	0.1566	0.0296	-81%
1993	0.0263	0.0127	-52%	0.2741	0.0430	-84%	0.1568	0.0296	-81%
1994	0.0263	0.0130	-51%	0.2806	0.0428	-85%	0.1581	0.0294	-81%
1995	0.0261	0.0128	-51%	0.2771	0.0425	-85%	0.1565	0.0293	-81%
1996	0.0264	0.0131	-50%	0.2845	0.0430	-85%	0.1594	0.0296	-81%
1997	0.0260	0.0134	-49%	0.2932	0.0422	-86%	0.1601	0.0291	-82%
1998	0.0257	0.0140	-46%	0.3098	0.0414	-87%	0.1628	0.0286	-82%
1999	0.0256	0.0133	-48%	0.2905	0.0417	-86%	0.1582	0.0288	-82%
2000	0.0266	0.0159	-40%	0.3641	0.0422	-88%	0.1785	0.0292	-84%
2001	0.0231	0.0161	-30%	0.3675	0.0386	-89%	0.1673	0.0219	-87%
2002	0.0248	0.0178	-28%	0.4083	0.0408	-90%	0.1827	0.0242	-87%
2003	0.0248	0.0178	-28%	0.4180	0.0406	-90%	0.1851	0.0238	-87%
2004	0.0226	0.0306	35%	0.7833	0.0293	-96%	0.2617	0.0218	-92%
2005	0.0199	0.0193	-3%	0.4967	0.0272	-95%	0.1859	0.0213	-89%
2006	0.0214	0.0217	2%	0.5443	0.0306	-94%	0.2014	0.0203	-90%
2007	0.0209	0.0226	8%	0.5748	0.0278	-95%	0.2064	0.0212	-90%
2008	0.0208	0.0229	10%	0.5801	0.0294	-95%	0.2073	0.0180	-91%
2009	0.0255	0.0243	-5%	0.6174	0.0363	-94%	0.2332	0.0247	-89%
2010	0.0067	0.0205	207%	0.5307	0.0031	-99%	0.1453	0.0059	-96%
2011	0.0046	0.0197	328%	0.5074	0.0007	-100%	0.1325	0.0023	-98%
2012	0.0043	0.0186	328%	0.4790	0.0007	-100%	0.1252	0.0022	-98%
2013	0.0044	0.0192	341%	0.5014	0.0007	-100%	0.1310	0.0023	-98%
2014	0.0039	0.0173	345%	0.4498	0.0006	-100%	0.1173	0.0021	-98%
2015	0.0018	0.0074	308%	0.1866	0.0003	-100%	0.0487	0.0009	-98%
2016	0.0036	0.0161	341%	0.4192	0.0006	-100%	0.1094	0.0020	-98%
2017	0.0035	0.0158	344%	0.4113	0.0006	-100%	0.1073	0.0019	-98%
2018	0.0035	0.0154	343%	0.4013	0.0006	-100%	0.1047	0.0019	-98%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2019	0.0032	0.0141	337%	0.3663	0.0005	-100%	0.0956	0.0017	-98%
2020	0.0042	0.0185	344%	0.4824	0.0007	-100%	0.1259	0.0023	-98%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0959	0.1347	40%	0.0154	0.2115	1275%	5.4669	0.1384	-97%
1991	0.0958	0.1346	41%	0.0154	0.2109	1273%	5.4772	0.1382	-97%
1992	0.0959	0.1348	41%	0.0154	0.2111	1272%	5.4883	0.1384	-97%
1993	0.0959	0.1344	40%	0.0154	0.2112	1271%	5.5022	0.1384	-97%
1994	0.0962	0.1334	39%	0.0155	0.2103	1257%	5.6489	0.1382	-98%
1995	0.0953	0.1341	41%	0.0153	0.2087	1260%	5.5756	0.1377	-98%
1996	0.0968	0.1337	38%	0.0156	0.2111	1252%	5.7323	0.1389	-98%
1997	0.0962	0.1302	35%	0.0156	0.2074	1227%	5.9385	0.1373	-98%
1998	0.0963	0.1299	35%	0.0158	0.2035	1187%	6.3195	0.1372	-98%
1999	0.0950	0.1333	40%	0.0154	0.2045	1226%	5.8853	0.1371	-98%
2000	0.1023	0.1208	18%	0.0172	0.2078	1110%	7.5152	0.1401	-98%
2001	0.0924	0.1140	23%	0.0159	0.1897	1097%	7.6783	0.1233	-98%
2002	0.0999	0.1251	25%	0.0173	0.2002	1060%	8.5520	0.1355	-98%
2003	0.1007	0.1058	5%	0.0174	0.1999	1047%	8.7669	0.1290	-99%
2004	0.1167	0.0513	-56%	0.0233	0.1474	531%	17.0277	0.1308	-99%
2005	0.0908	0.0308	-66%	0.0170	0.1370	707%	10.6547	0.1006	-99%
2006	0.0976	0.0459	-53%	0.0185	0.1533	730%	11.6933	0.1088	-99%
2007	0.0978	0.0349	-64%	0.0188	0.1400	644%	12.3935	0.1080	-99%
2008	0.0978	0.0262	-73%	0.0189	0.1482	685%	12.5139	0.1008	-99%
2009	0.1147	0.0340	-70%	0.0214	0.1828	753%	13.2294	0.1220	-99%
2010	0.0520	0.0044	-91%	0.0125	0.0174	39%	11.7659	0.0542	-100%
2011	0.0443	0.0021	-95%	0.0113	0.0051	-55%	11.2967	0.0440	-100%
2012	0.0419	0.0022	-95%	0.0106	0.0051	-52%	10.6638	0.0416	-100%
2013	0.0437	0.0022	-95%	0.0110	0.0051	-54%	11.1612	0.0441	-100%
2014	0.0391	0.0017	-96%	0.0099	0.0042	-58%	10.0145	0.0407	-100%
2015	0.0163	0.0007	-96%	0.0042	0.0018	-58%	4.1562	0.0184	-100%
2016	0.0365	0.0016	-96%	0.0092	0.0039	-58%	9.3329	0.0379	-100%
2017	0.0358	0.0015	-96%	0.0090	0.0038	-58%	9.1557	0.0381	-100%
2018	0.0349	0.0015	-96%	0.0088	0.0037	-58%	8.9347	0.0370	-100%
2019	0.0319	0.0014	-96%	0.0081	0.0034	-58%	8.1555	0.0334	-100%
2020	0.0420	0.0018	-96%	0.0106	0.0045	-58%	10.7408	0.0442	-100%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	2.0679	0.1077	-95%	1.2143	0.0026	-100%
1991	2.0673	0.1079	-95%	1.2128	0.0026	-100%
1992	2.0700	0.1082	-95%	1.2140	0.0026	-100%
1993	2.0732	0.1085	-95%	1.2153	0.0026	-100%
1994	2.0972	0.1118	-95%	1.2214	0.0027	-100%
1995	2.0757	0.1102	-95%	1.2100	0.0026	-100%
1996	2.1173	0.1136	-95%	1.2301	0.0027	-100%
1997	2.1396	0.1184	-94%	1.2287	0.0028	-100%
1998	2.1943	0.1270	-94%	1.2379	0.0031	-100%
1999	2.1151	0.1172	-94%	1.2118	0.0028	-100%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2000	2.4468	0.1533	-94%	1.3357	0.0037	-100%
2001	2.3361	0.1581	-93%	1.2232	0.0039	-100%
2002	2.5619	0.1767	-93%	1.3295	0.0044	-100%
2003	2.6035	0.1810	-93%	1.3402	0.0045	-100%
2004	3.9988	0.3672	-91%	1.7242	0.0093	-99%
2005	2.7415	0.2257	-92%	1.2749	0.0057	-100%
2006	2.9814	0.2493	-92%	1.3874	0.0063	-100%
2007	3.0843	0.2654	-91%	1.4095	0.0067	-100%
2008	3.1014	0.2684	-91%	1.4114	0.0068	-100%
2009	3.4304	0.2808	-92%	1.6127	0.0071	-100%
2010	2.3801	0.2612	-89%	0.8916	0.0067	-99%
2011	2.2093	0.2522	-89%	0.7946	0.0064	-99%
2012	2.0863	0.2380	-89%	0.7497	0.0061	-99%
2013	2.1824	0.2484	-89%	0.7743	0.0064	-99%
2014	1.9566	0.2234	-89%	0.6940	0.0058	-99%
2015	0.8128	0.0942	-88%	0.3002	0.0025	-99%
2016	1.8235	0.2080	-89%	0.6484	0.0054	-99%
2017	1.7888	0.2043	-89%	0.6346	0.0054	-99%
2018	1.7457	0.1995	-89%	0.6200	0.0053	-99%
2019	1.5936	0.1820	-89%	0.5691	0.0048	-99%
2020	2.0984	0.2397	-89%	0.7454	0.0063	-99%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0451	0.0822	82%	1.0380	0.0244	-98%
1991	0.0452	0.0822	82%	1.0354	0.0245	-98%
1992	0.0453	0.0824	82%	1.0360	0.0245	-98%
1993	0.0455	0.0825	82%	1.0364	0.0246	-98%
1994	0.0469	0.0838	79%	1.0316	0.0252	-98%
1995	0.0463	0.0829	79%	1.0242	0.0249	-98%
1996	0.0477	0.0847	78%	1.0355	0.0256	-98%
1997	0.0499	0.0862	73%	1.0169	0.0265	-97%
1998	0.0538	0.0894	66%	0.9966	0.0281	-97%
1999	0.0495	0.0853	72%	1.0025	0.0263	-97%
2000	0.0653	0.1016	56%	1.0161	0.0332	-97%
2001	0.0681	0.0991	46%	0.8689	0.0342	-96%
2002	0.0761	0.1092	43%	0.9263	0.0382	-96%
2003	0.0783	0.1113	42%	0.9257	0.0389	-96%
2004	0.1608	0.1857	16%	0.6996	0.0746	-89%
2005	0.0987	0.1231	25%	0.6856	0.0467	-93%
2006	0.1085	0.1343	24%	0.7236	0.0512	-93%
2007	0.1156	0.1402	21%	0.6882	0.0543	-92%
2008	0.1168	0.1412	21%	0.6815	0.0544	-92%
2009	0.1223	0.1536	26%	0.8780	0.0577	-93%
2010	0.1142	0.1172	3%	0.0850	0.0514	-39%
2011	0.1103	0.1103	0%	0.0029	0.0493	1599%
2012	0.1041	0.1042	0%	0.0036	0.0465	1178%
2013	0.1090	0.1090	0%	0.0032	0.0487	1438%
2014	0.0978	0.0980	0%	0.0012	0.0437	3627%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2015	0.0406	0.0407	0%	0.0005	0.0182	3635%
2016	0.0911	0.0911	0%	0.0011	0.0407	3621%
2017	0.0894	0.0895	0%	0.0011	0.0400	3624%
2018	0.0872	0.0874	0%	0.0010	0.0390	3625%
2019	0.0796	0.0796	0%	0.0010	0.0356	3620%
2020	0.1049	0.1050	0%	0.0013	0.0469	3626%

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 3.48*** were included here.

Table 3.48: *Activities according to national categorization included in 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 percent 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

An overview of the emissions is shown in ***Table 3.49***. Emissions of main pollutants in this category show an overall decreasing trend due to stricter emission limits for these pollutants. Emissions of heavy metals and POPs are decreasing due to the decrease of using solid fuels within this category (one source of Slovenské cukrovary changed boiler - they use biogas and natural gas as a source of heating instead of brown coal because the boiler for brown coal already did not hit the emission limits).

Table 3.49: *Overview of emissions in the 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

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
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
1990/2021	**-70%**	**-17%**	**-98%**	**64%**	**-46%**	**-62%**	**-74%**	**-22%**	**-64%**
2020/2021	**-25%**	**-10%**	**-86%**	**-6%**	**-21%**	**-29%**	**-33%**	**32%**	**-6%**

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
1990/2021	**-83%**	**45%**	**-71%**	**-78%**	**-47%**	**-79%**	**-84%**	**-73%**	**-37%**
2020/2021	**-85%**	**-38%**	**-55%**	**-73%**	**-63%**	**-82%**	**-85%**	**-67%**	**-55%**

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	0.0996	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
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

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]
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
1990/2021	**-75%**	**-78%**	**-74%**	**-72%**	**-71%**	**-74%**	**57%**	**-89%**
2020/2021	**-78%**	**-75%**	**-60%**	**-62%**	**-57%**	**-64%**	**-37%**	**-89%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.50*** below.

Table 3.50: *Overview of activity data in the 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
1990/2021	**-97%**	**-89%**	**-59%**	**272%**	**-**
2020/2021	**21%**	**-89%**	**13%**	**-15%**	**-**

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 is 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 2021.

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 3.51***).

Table 3.51: *Emission factors for calculation of historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	NH_3 [g/GJ]	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	38%	60%	41.08

HMs and POPs emissions were calculated using Tier 1 emission factors from EMEP/EEA GB_{2019} (***Table 3.52***).

Table 3.52: *Emission factors for heavy metals and POPs in the category 1A2e*

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_{2019}) (***Table 3.53***). The calculated BC emission values are presented in ***Table 3.49***.

Table 3.53: *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%

3.5.6.3 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 emissions of NOx.

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 3.54***.

Table 3.54: *Activities according to national categorization included in 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 wit projected melting capacity in t/d	

The overview of the emissions is shown in ***Table 3.55***.

Table 3.55: *Overview of emissions in the 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	0.0004	9.3890
2020	4.2351	0.1845	0.2994	0.0415	0.0014	0.0015	0.0015	0.0003	9.9209
2021	4.2879	0.1525	0.4194	0.0484	0.0013	0.0014	0.0014	0.0003	10.5219
1990/2021	**-24%**	**106%**	**-36%**	**-**	**-95%**	**-96%**	**-96%**	**-84%**	**-8%**
2020/2021	**1%**	**-17%**	**40%**	**17%**	**-8%**	**-7%**	**-5%**	**-3%**	**6%**

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	0.1208	0.1906	0.1471	0.0745	1.2488
2021	0.3470	0.0282	0.1569	0.0845	0.1300	0.2051	0.1593	0.0802	1.3442
1990/2021	**25%**	**24%**	**13%**	**12%**	**12%**	**12%**	**15%**	**12%**	**12%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2020/2021	**10%**	**10%**	**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]	I()P [t]	PAHs [t]	HCB [kg]	PCB [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	4.6272	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	7.0336	0.0000	0.0008	0.0002	0.0001	0.0016	0.0136	0.3034
2021	9.7938	0.0000	0.0009	0.0002	0.0001	0.0018	0.0146	0.3265
1990/2021	**84136%**	**12%**	**12%**	**12%**	**12%**	**60%**	**12%**	**12%**
2020/2021	**39%**	**8%**	**8%**	**8%**	**8%**	**16%**	**8%**	**8%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.56*** below.

Table 3.56: *Overview of activity data in the 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
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	5 377.96
2019	2 358.09	3 635.78	4 720.09	6 220.98	337.60
2020	2 409.22	3 776.24	4 401.23	5 981.21	379.41
2021	2 595.59	3 155.22	4 906.93	6 916.78	359.07
1990/2021	**346%**	**-51%**	**-55%**	**7106%**	**2000%**
2020/2021	**8%**	**-16%**	**11%**	**16%**	**-5%**

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 is 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 2021.

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 3.57***).

Table 3.57: *Emission factors for calculation of historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	NH_3 [g/GJ]	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%	89%	635.54

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_{2019} emission factors for the manufacture of cement (**2A1**) and Tier 1 EMEP/EEA GB_{2019} emission factors for industrial waste incineration (**2A2**) were used for the calculation of HMs and POPs emissions (***Table 3.58***).

Table 3.58: *Emission factors for heavy metals and POPs in the category 1A2f*

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	-
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_{2019}) (***Table 3.59***). The calculated BC emission values are presented in ***Table 3.55***.

Table 3.59: *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%

3.5.7.3 Completeness

Emissions are well covered.

3.5.7.4 Source-specific recalculations

The recalculations were made based on changes in activity data in 2020. The results of the recalculations are in ***Table 3.60***.

Table 3.60: *Previous and revised emissions in the category 1A2f*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	0.3079	0.3147	2%	0.0250	0.0256	2%	0.1451	0.1454	0%

YEAR	As [t]			Ni [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	0.0783	0.0784	0%	0.1464	0.1471	1%

YEAR	PCDD/F [g I-TEQ]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	5.1860	7.0336	36%	0.0015	0.0016	7%

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 3.61***. In the year, 2021 was a rise in energy consumption and emissions observed. This is a result of a post-covid recovery of the industry sector.

Table 3.61: *Overview of emissions in the 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
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
1990/2021	**77%**	**29%**	**66%**	**73%**	**79%**	**79%**	**79%**	**80%**	**-32%**
2020/2021	**106%**	**75%**	**100%**	**104%**	**107%**	**107%**	**107%**	**108%**	**17%**

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PAHs [t]
1990	0.0002	0.0008	0.0286	0.0012	0.0002	0.0168	0.0013
1995	0.0002	0.0008	0.0279	0.0011	0.0002	0.0164	0.0013
2000	0.0002	0.0008	0.0272	0.0011	0.0002	0.0160	0.0013

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PAHs [t]
2005	0.0002	0.0008	0.0265	0.0011	0.0002	0.0156	0.0012
2010	0.0002	0.0008	0.0258	0.0011	0.0002	0.0152	0.0012
2011	0.0002	0.0008	0.0257	0.0011	0.0002	0.0151	0.0012
2012	0.0002	0.0008	0.0256	0.0011	0.0002	0.0150	0.0012
2013	0.0002	0.0008	0.0255	0.0011	0.0002	0.0150	0.0012
2014	0.0002	0.0010	0.0340	0.0014	0.0002	0.0200	0.0016
2015	0.0001	0.0007	0.0221	0.0009	0.0001	0.0130	0.0010
2016	0.0001	0.0006	0.0187	0.0008	0.0001	0.0110	0.0009
2017	0.0002	0.0009	0.0289	0.0012	0.0002	0.0170	0.0014
2018	0.0002	0.0012	0.0391	0.0016	0.0002	0.0230	0.0018
2019	0.0002	0.0009	0.0306	0.0013	0.0002	0.0180	0.0014
2020	0.0001	0.0007	0.0238	0.0010	0.0001	0.0140	0.0011
2021	0.0003	0.0014	0.0476	0.0020	0.0003	0.0280	0.0022
1990/2021	**66%**	**66%**	**66%**	**66%**	**66%**	**66%**	**66%**
2020/2021	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.62*** below.

Table 3.62: *Overview of activity data in the 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
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
1990/2021	**52%**	**-**	**-**	**-**	**-**
2020/2021	**100%**	**-**	**-**	**103%**	**-**

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_{2019} Tier 1 emission factors were used.

3.5.8.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2019}.

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

The category covers the sources that cannot be clearly identified to particular activity but generally it is the combustion process. Activities listed within this category are shown in ***Table 3.63***.

Table 3.63: *Activities according to national categorization included in 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

The overview of the emissions is shown in ***Table 3.64***. 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 overall trend of these emissions is connected with the trend of biomass fuels used.

Table 3.64: *Overview of emissions in the 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	0.0408	1.8493
2011	1.1755	4.6571	0.2331	0.0072	0.1360	0.1876	0.2795	0.0368	2.0261
2012	1.1063	4.8403	0.2118	0.0074	0.1529	0.2006	0.2837	0.0420	1.7745
2013	0.9920	5.0664	0.2472	0.0062	0.1183	0.1648	0.2453	0.0324	1.8270
2014	0.9397	5.1977	0.2377	0.0064	0.1141	0.1695	0.2670	0.0311	1.6509
2015	1.1158	5.3408	0.2587	0.0066	0.1190	0.1806	0.2909	0.0325	1.7669
2016	1.1770	5.5870	0.2670	0.0067	0.1271	0.1757	0.2565	0.0350	1.1496
2017	1.4359	5.9146	0.4311	0.0081	0.1362	0.1866	0.2713	0.0343	1.2729
2018	1.1863	6.0538	0.2591	0.0087	0.1310	0.1837	0.2716	0.0361	1.2487
2019	1.1007	6.1370	0.2649	0.0084	0.1345	0.1863	0.2781	0.0371	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	0.0384	1.3213
1990/2021	**-55%**	**4092%**	**-88%**	**-82%**	**-80%**	**-80%**	**-81%**	**-64%**	**-64%**
2020/2021	**7%**	**-3%**	**-4%**	**-38%**	**5%**	**4%**	**4%**	**6%**	**14%**

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	0.0204	0.0063	0.0082	0.0062	0.0107	0.0036	0.0156	0.0075	0.2236
1990/2021	**6%**	**14%**	**25%**	**-37%**	**-12%**	**-60%**	**-94%**	**-55%**	**-7%**
2020/2021	**23%**	**13%**	**44%**	**44%**	**8%**	**18%**	**53%**	**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]	PCB [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	0.0828	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
1990/2021	**42%**	**49%**	**49%**	**49%**	**47%**	**49%**	**46%**	**7%**
2020/2021	**29%**	**8%**	**10%**	**12%**	**10%**	**10%**	**44%**	**49%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.65*** below.

Table 3.65: *Overview of activity data in the 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	5 884.32	9.91
2011	181.78	423.59	7 378.02	6 501.87	NO
2012	197.54	250.28	7 462.88	6 396.84	NO

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2013	142.49	252.31	7 496.96	5 686.90	NO
2014	143.18	276.46	6 432.57	5 570.03	NO
2015	216.29	256.39	7 219.92	5 655.68	NO
2016	182.82	175.15	7 831.62	5 634.13	NO
2017	231.51	2 363.12	8 008.58	6 199.95	NO
2018	185.38	173.66	7 756.01	6 292.75	NO
2019	206.92	172.50	7 779.31	6 247.07	NO
2020	217.54	179.94	7 114.92	3 008.66	NO
2021	364.25	192.74	8 067.25	6 214.20	NO
1990/2021	**-14%**	**-92%**	**-60%**	**455%**	**-**
2020/2021	**67%**	**7%**	**13%**	**107%**	**-**

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 is 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 2021.

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 3.66***).

Table 3.66: *Emission factors for calculation of historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	NH_3 [g/GJ]	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	48%	65%	154.29

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_{2019}, expert estimation and special source[1] (***Table 3.67***).

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 3.67: *Emission factors for heavy metals and POPs in the category 1A2gviii*

TYPE OF FUEL		LIQUID FUELS			HARD COAL	BROWN COAL		
T2	UNIT	ALL TYPE OF BOILERS (≤ 5 MWth)	ALL TYPE OF BOILERS (5–50 MWth)	STATIONARY ENGINES	FIXED BED BOILER (≤ 5 MWth)	FIXED BED BOILER (≤ 5 MWth)	FLUIZED BED BOILER (≤ 5 MWth)	FLUIZED BED BOILER (50–100 MWth)
Pb	[mg/GJ]	4.56	4.56	4.56	13.687	59.471	2.037	2.037

TYPE OF FUEL		LIQUID FUELS			HARD COAL	BROWN COAL		
T2	**UNIT**	**ALL TYPE OF BOILERS** (≤ 5 MWth)	**ALL TYPE OF BOILERS** (5–50 MWth)	**STATIONARY ENGINES**	**FIXED BED BOILER** (≤ 5 MWth)	**FIXED BED BOILER** (≤ 5 MWth)	**FLUIZED BED BOILER** (≤ 5 MWth)	**FLUIZED BED BOILER** (50–100 MWth)
Cd	[mg/GJ]	1.2	1.2	1.2	2.456	1.294	0.282	0.282
Hg	[mg/GJ]	0.341	0.341	0.341	9.051	2.382	1.5	1.5
As	[mg/GJ]	3.98	3.98	3.98	9.402	60.967	0.922	0.922
Cr	[mg/GJ]	2.55	2.55	2.55	15	38.383	9.1	9.1
Cu	[mg/GJ]	5.31	5.31	5.31	10	69.545	1	1
Ni	[mg/GJ]	255	255	255	10	62.104	4.803	4.803
Se	[mg/GJ]	2.06	2.06	2.06	2	5.192	45	45
Zn	[mg/GJ]	87.8	87.8	87.8	150	30.756	8.8	8.8
PCDD/F	[ng I-TEQ/GJ]	2.5	2.5	2.5	14.657	4.986	2.778	2.778
B(a)P	[mg/GJ]	3.678	3.678	3.678	10.975	320.061	5.148	5.148
B(b)F	[mg/GJ]	12.673	12.673	12.673	18.54	518.482	7.621	7.621
B(k)F	[mg/GJ]	3.968	3.968	3.968	10.966	518.482	5.321	5.321
I()P	[mg/GJ]	6.484	6.484	6.484	5.956	400.322	5.559	5.559
PAHs	[mg/GJ]	26.803	26.803	26.803	46.437	1757.347	23.649	23.649
HCB	[µg/GJ]	-	-	-	6.7	6.7	6.7	6.7
PCBs	[µg/GJ]	3.334	3.334	3.334	8.073	5.059	1.449	1.449

TYPE OF FUEL		GASEOUS FUELS				BIOMASS			
T2	**UNIT**	**ALL TYPE OF BOILERS** (≤ 5 MWth)	**ALL TYPE OF BOILERS** (5–50 MWth)	**STATIONARY ENGINES**	**GAS TURBINES**	**FIXED BED BOILER** (≤ 5 MWth)	**FIXED BED BOILER** (5–50 MWth)	**FLUIDIZED BED BOILER** (≤ 5 MWth)	**FLUIDIZED BED BOILER** (5–50 MWth)
Pb	[mg/GJ]	0.0015	0.0015	0.04	0.0015	27	1.606	1.606	1.606
Cd	[mg/GJ]	0.00025	0.00025	0.003	0.00025	13	0.169	0.169	0.169
Hg	[mg/GJ]	0.1	0.1	0.1	0.1	0.56	1.268	1.268	1.268
As	[mg/GJ]	0.12	0.12	0.05	0.12	0.19	0.871	0.871	0.871
Cr	[mg/GJ]	0.00076	0.00076	0.05	0.00076	23	0.027	0.027	0.027
Cu	[mg/GJ]	0.000076	0.000076	0.01	0.000076	6	0.106	0.106	0.106
Ni	[mg/GJ]	0.00051	0.00051	0.05	0.00051	2	0.085	0.085	0.085
Se	[mg/GJ]	0.0112	0.0112	0.2	0.0112	0.5	0.211	0.211	0.211
Zn	[mg/GJ]	0.0015	0.0015	2.91	0.0015	512	1.991	1.991	1.991
PCDD/F	[ng I-TEQ/GJ]	0.5	0.5	0.57	0.5	100	11.348	11.348	11.348
B(a)P	[mg/GJ]	0.56	0.56	1.2	0.56	10000	46.462	46.462	46.462
B(b)F	[mg/GJ]	0.84	0.84	9	0.84	16000	144.329	144.329	144.329
B(k)F	[mg/GJ]	0.84	0.84	1.7	0.84	5000	67.897	67.897	67.897
I()P	[mg/GJ]	0.84	0.84	1.8	0.84	4000	33.073	33.073	33.073
PAHs	[mg/GJ]	3.08	3.08	13.7	3.08	35000	291.761	291.761	291.761
HCB	[µg/GJ]	0.00308	0.00308	-	0.00308	5	5	5	5
PCBs	[µg/GJ]	-	-	-	-	0.007	2.233	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$_{2019}$) (***Table 3.68***). The calculated BC emission values are presented in ***Table 3.64***.

Table 3.68: *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%

3.5.9.3 Completeness

Emissions are well covered.

3.5.9.4 Source-specific recalculations

The recalculations for HMs and POPs were made due change in methodology from Tier 1 to Tier 2. The results of the recalculations are in ***Table 3.69***.

Table 3.69: *Previous and revised emissions in the category 1A2gviii*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	1.3784	0.0325	-98%	0.0185	0.0085	-54%	0.0865	0.0190	-78%
1991	1.3820	0.0326	-98%	0.0186	0.0085	-54%	0.0868	0.0191	-78%
1992	1.3863	0.0327	-98%	0.0186	0.0086	-54%	0.0870	0.0191	-78%
1993	1.3873	0.0327	-98%	0.0186	0.0086	-54%	0.0871	0.0191	-78%
1994	1.3869	0.0327	-98%	0.0186	0.0086	-54%	0.0871	0.0191	-78%
1995	1.4138	0.0334	-98%	0.0190	0.0087	-54%	0.0887	0.0195	-78%
1996	1.4103	0.0333	-98%	0.0190	0.0087	-54%	0.0885	0.0194	-78%
1997	1.4181	0.0335	-98%	0.0191	0.0088	-54%	0.0890	0.0195	-78%
1998	1.4620	0.0345	-98%	0.0196	0.0090	-54%	0.0916	0.0201	-78%
1999	1.5457	0.0365	-98%	0.0208	0.0096	-54%	0.0966	0.0212	-78%
2000	1.4598	0.0344	-98%	0.0196	0.0090	-54%	0.0918	0.0202	-78%
2001	1.6727	0.0389	-98%	0.0225	0.0035	-85%	0.1043	0.0096	-91%
2002	1.8467	0.0382	-98%	0.0248	0.0037	-85%	0.1149	0.0104	-91%
2003	1.9196	0.0437	-98%	0.0258	0.0039	-85%	0.1198	0.0110	-91%
2004	1.8428	0.0377	-98%	0.0248	0.0037	-85%	0.1158	0.0106	-91%
2005	2.0879	0.0425	-98%	0.0281	0.0042	-85%	0.1300	0.0118	-91%
2006	2.1358	0.0435	-98%	0.0287	0.0043	-85%	0.1338	0.0122	-91%
2007	1.7969	0.0365	-98%	0.0241	0.0036	-85%	0.1128	0.0103	-91%
2008	1.7113	0.0348	-98%	0.0230	0.0034	-85%	0.1081	0.0099	-91%
2009	1.3243	0.0270	-98%	0.0178	0.0027	-85%	0.0851	0.0079	-91%
2010	1.3909	0.0283	-98%	0.0187	0.0028	-85%	0.0905	0.0085	-91%
2011	1.3991	0.0285	-98%	0.0188	0.0028	-85%	0.0909	0.0086	-91%
2012	1.5420	0.0314	-98%	0.0207	0.0031	-85%	0.0989	0.0092	-91%
2013	1.5241	0.0310	-98%	0.0205	0.0031	-85%	0.0977	0.0091	-91%
2014	1.3749	0.0280	-98%	0.0185	0.0028	-85%	0.0894	0.0084	-91%
2015	1.3567	0.0276	-98%	0.0182	0.0027	-85%	0.0880	0.0083	-91%
2016	0.9528	0.0194	-98%	0.0128	0.0019	-85%	0.0642	0.0063	-90%
2017	0.9693	0.0197	-98%	0.0130	0.0020	-85%	0.0650	0.0063	-90%
2018	1.2367	0.0252	-98%	0.0166	0.0025	-85%	0.0817	0.0078	-90%
2019	1.1012	0.0225	-98%	0.0148	0.0022	-85%	0.0710	0.0066	-91%
2020	1.0398	0.0214	-98%	0.0141	0.0022	-84%	0.0670	0.0063	-91%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0421	0.0092	-78%	0.1390	0.0494	-64%	0.1800	0.0858	-52%
1991	0.0422	0.0092	-78%	0.1394	0.0495	-64%	0.1805	0.0861	-52%
1992	0.0424	0.0093	-78%	0.1398	0.0497	-64%	0.1811	0.0863	-52%
1993	0.0424	0.0093	-78%	0.1399	0.0497	-64%	0.1812	0.0864	-52%
1994	0.0424	0.0093	-78%	0.1398	0.0497	-64%	0.1811	0.0864	-52%
1995	0.0432	0.0094	-78%	0.1426	0.0507	-64%	0.1847	0.0880	-52%
1996	0.0431	0.0094	-78%	0.1422	0.0505	-64%	0.1842	0.0878	-52%
1997	0.0433	0.0095	-78%	0.1430	0.0508	-64%	0.1852	0.0883	-52%
1998	0.0446	0.0097	-78%	0.1474	0.0524	-64%	0.1909	0.0910	-52%
1999	0.0472	0.0102	-78%	0.1558	0.0554	-64%	0.2019	0.0963	-52%
2000	0.0446	0.0098	-78%	0.1472	0.0523	-64%	0.1907	0.0909	-52%
2001	0.0510	0.0106	-79%	0.1686	0.0591	-65%	0.2185	0.1024	-53%
2002	0.0562	0.0067	-88%	0.1862	0.0625	-66%	0.2412	0.1080	-55%
2003	0.0585	0.0112	-81%	0.1935	0.0673	-65%	0.2507	0.1165	-54%
2004	0.0563	0.0064	-89%	0.1858	0.0621	-67%	0.2407	0.1072	-55%
2005	0.0636	0.0069	-89%	0.2105	0.0702	-67%	0.2727	0.1215	-55%
2006	0.0652	0.0072	-89%	0.2154	0.0718	-67%	0.2789	0.1243	-55%
2007	0.0549	0.0061	-89%	0.1812	0.0604	-67%	0.2347	0.1046	-55%
2008	0.0524	0.0060	-89%	0.1726	0.0575	-67%	0.2235	0.0996	-55%
2009	0.0408	0.0050	-88%	0.1336	0.0445	-67%	0.1730	0.0771	-55%
2010	0.0431	0.0054	-87%	0.1403	0.0468	-67%	0.1817	0.0810	-55%
2011	0.0433	0.0054	-87%	0.1411	0.0470	-67%	0.1827	0.0814	-55%
2012	0.0475	0.0058	-88%	0.1555	0.0519	-67%	0.2014	0.0898	-55%
2013	0.0469	0.0056	-88%	0.1537	0.0512	-67%	0.1991	0.0887	-55%
2014	0.0426	0.0054	-87%	0.1387	0.0462	-67%	0.1796	0.0800	-55%
2015	0.0420	0.0052	-88%	0.1369	0.0456	-67%	0.1772	0.0790	-55%
2016	0.0299	0.0042	-86%	0.0962	0.0320	-67%	0.1244	0.0555	-55%
2017	0.0304	0.0042	-86%	0.0978	0.0326	-67%	0.1266	0.0564	-55%
2018	0.0385	0.0051	-87%	0.1248	0.0416	-67%	0.1615	0.0720	-55%
2019	0.0340	0.0042	-88%	0.1111	0.0370	-67%	0.1438	0.0642	-55%
2020	0.0321	0.0040	-88%	0.1051	0.0352	-67%	0.1358	0.0606	-55%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.1338	0.0571	-57%	0.0191	0.2350	1132%	2.0645	0.1975	-90%
1991	0.1342	0.0572	-57%	0.0191	0.2356	1132%	2.0699	0.1980	-90%
1992	0.1346	0.0574	-57%	0.0192	0.2364	1132%	2.0762	0.1986	-90%
1993	0.1347	0.0575	-57%	0.0192	0.2365	1132%	2.0778	0.1988	-90%
1994	0.1347	0.0574	-57%	0.0192	0.2365	1132%	2.0772	0.1987	-90%
1995	0.1373	0.0585	-57%	0.0196	0.2410	1132%	2.1174	0.2026	-90%
1996	0.1369	0.0584	-57%	0.0195	0.2404	1132%	2.1121	0.2020	-90%
1997	0.1377	0.0587	-57%	0.0196	0.2418	1132%	2.1239	0.2032	-90%
1998	0.1420	0.0604	-57%	0.0202	0.2493	1133%	2.1894	0.2094	-90%
1999	0.1501	0.0641	-57%	0.0214	0.2635	1134%	2.3145	0.2215	-90%
2000	0.1418	0.0603	-57%	0.0202	0.2489	1130%	2.1866	0.2091	-90%
2001	0.1624	0.0645	-60%	0.0231	0.2860	1139%	2.5043	0.2395	-90%
2002	0.1793	0.0654	-64%	0.0254	0.3171	1146%	2.7645	0.2632	-90%
2003	0.1864	0.0701	-62%	0.0265	0.3286	1140%	2.8738	0.2736	-90%
2004	0.1789	0.0630	-65%	0.0255	0.3167	1141%	2.7599	0.2618	-91%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.2027	0.0709	-65%	0.0288	0.3586	1146%	3.1254	0.2968	-91%
2006	0.2074	0.0723	-65%	0.0295	0.3666	1141%	3.1983	0.3035	-91%
2007	0.1745	0.0609	-65%	0.0249	0.3085	1140%	2.6910	0.2551	-91%
2008	0.1662	0.0580	-65%	0.0238	0.2938	1137%	2.5638	0.2430	-91%
2009	0.1286	0.0478	-63%	0.0185	0.2274	1126%	1.9863	0.1892	-90%
2010	0.1351	0.0472	-65%	0.0196	0.2388	1119%	2.0873	0.1977	-91%
2011	0.1359	0.0477	-65%	0.0197	0.2402	1120%	2.0994	0.1989	-91%
2012	0.1498	0.0563	-62%	0.0216	0.2648	1127%	2.3126	0.2204	-90%
2013	0.1480	0.0517	-65%	0.0213	0.2617	1128%	2.2852	0.2165	-91%
2014	0.1336	0.0466	-65%	0.0194	0.2361	1119%	2.0631	0.1952	-91%
2015	0.1318	0.0460	-65%	0.0191	0.2330	1121%	2.0356	0.1926	-91%
2016	0.0926	0.0323	-65%	0.0137	0.1636	1098%	1.4327	0.1354	-91%
2017	0.0942	0.0335	-64%	0.0139	0.1665	1101%	1.4571	0.1380	-91%
2018	0.1202	0.0421	-65%	0.0176	0.2124	1110%	1.8574	0.1757	-91%
2019	0.1070	0.0404	-62%	0.0154	0.1891	1124%	1.6520	0.1575	-90%
2020	0.1010	0.0370	-63%	0.0146	0.1785	1124%	1.5639	0.1528	-90%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	2.0931	0.0288	-99%	1.5648	0.0003	-100%
1991	2.0986	0.0289	-99%	1.5687	0.0003	-100%
1992	2.1051	0.0290	-99%	1.5735	0.0003	-100%
1993	2.1066	0.0290	-99%	1.5747	0.0003	-100%
1994	2.1060	0.0290	-99%	1.5744	0.0003	-100%
1995	2.1468	0.0295	-99%	1.6038	0.0003	-100%
1996	2.1415	0.0295	-99%	1.6005	0.0003	-100%
1997	2.1534	0.0296	-99%	1.6094	0.0003	-100%
1998	2.2198	0.0304	-99%	1.6576	0.0003	-100%
1999	2.3468	0.0319	-99%	1.7500	0.0004	-100%
2000	2.2169	0.0307	-99%	1.6590	0.0003	-100%
2001	2.5392	0.0221	-99%	1.8908	0.0004	-100%
2002	2.8032	0.0238	-99%	2.0847	0.0003	-100%
2003	2.9142	0.0254	-99%	2.1709	0.0004	-100%
2004	2.7984	0.0249	-99%	2.0930	0.0003	-100%
2005	3.1694	0.0270	-99%	2.3584	0.0003	-100%
2006	3.2430	0.0283	-99%	2.4215	0.0003	-100%
2007	2.7286	0.0240	-99%	2.0399	0.0003	-100%
2008	2.5993	0.0235	-99%	1.9495	0.0002	-100%
2009	2.0129	0.0196	-99%	1.5247	0.0002	-100%
2010	2.1151	0.0216	-99%	1.6130	0.0002	-100%
2011	2.1274	0.0216	-99%	1.6212	0.0002	-100%
2012	2.3435	0.0226	-99%	1.7736	0.0002	-100%
2013	2.3162	0.0222	-99%	1.7513	0.0002	-100%
2014	2.0906	0.0212	-99%	1.5935	0.0002	-100%
2015	2.0628	0.0208	-99%	1.5707	0.0002	-100%
2016	1.4509	0.0168	-99%	1.1285	0.0002	-100%
2017	1.4757	0.0168	-99%	1.1444	0.0002	-100%
2018	1.8816	0.0203	-99%	1.4472	0.0002	-100%
2019	1.6739	0.0165	-99%	1.2701	0.0002	-100%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	1.5812	0.0164	-99%	1.1993	0.0005	-100%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0064	0.0689	981%	1.7486	0.0045	-100%
1991	0.0064	0.0691	981%	1.7532	0.0045	-100%
1992	0.0064	0.0693	981%	1.7586	0.0046	-100%
1993	0.0064	0.0694	981%	1.7599	0.0046	-100%
1994	0.0064	0.0694	981%	1.7593	0.0046	-100%
1995	0.0065	0.0707	981%	1.7935	0.0046	-100%
1996	0.0065	0.0705	981%	1.7890	0.0046	-100%
1997	0.0066	0.0709	981%	1.7989	0.0047	-100%
1998	0.0068	0.0731	981%	1.8546	0.0048	-100%
1999	0.0072	0.0773	981%	1.9609	0.0051	-100%
2000	0.0068	0.0730	981%	1.8518	0.0048	-100%
2001	0.0077	0.0837	981%	2.1219	0.0151	-99%
2002	0.0085	0.0924	981%	2.3427	0.0163	-99%
2003	0.0089	0.0960	981%	2.4351	0.0172	-99%
2004	0.0085	0.0922	981%	2.3377	0.0162	-99%
2005	0.0097	0.1044	981%	2.6486	0.0184	-99%
2006	0.0099	0.1068	981%	2.7094	0.0188	-99%
2007	0.0083	0.0899	981%	2.2794	0.0158	-99%
2008	0.0079	0.0856	981%	2.1709	0.0150	-99%
2009	0.0061	0.0663	981%	1.6800	0.0117	-99%
2010	0.0064	0.0696	981%	1.7644	0.0122	-99%
2011	0.0065	0.0700	981%	1.7747	0.0123	-99%
2012	0.0071	0.0771	981%	1.9560	0.0136	-99%
2013	0.0071	0.0762	981%	1.9334	0.0134	-99%
2014	0.0064	0.0688	981%	1.7441	0.0121	-99%
2015	0.0063	0.0679	981%	1.7210	0.0119	-99%
2016	0.0044	0.0477	982%	1.2085	0.0084	-99%
2017	0.0045	0.0485	982%	1.2295	0.0085	-99%
2018	0.0057	0.0619	982%	1.5687	0.0109	-99%
2019	0.0051	0.0551	981%	1.3969	0.0097	-99%
2020	0.0049	0.0521	973%	1.3188	0.0092	-99%

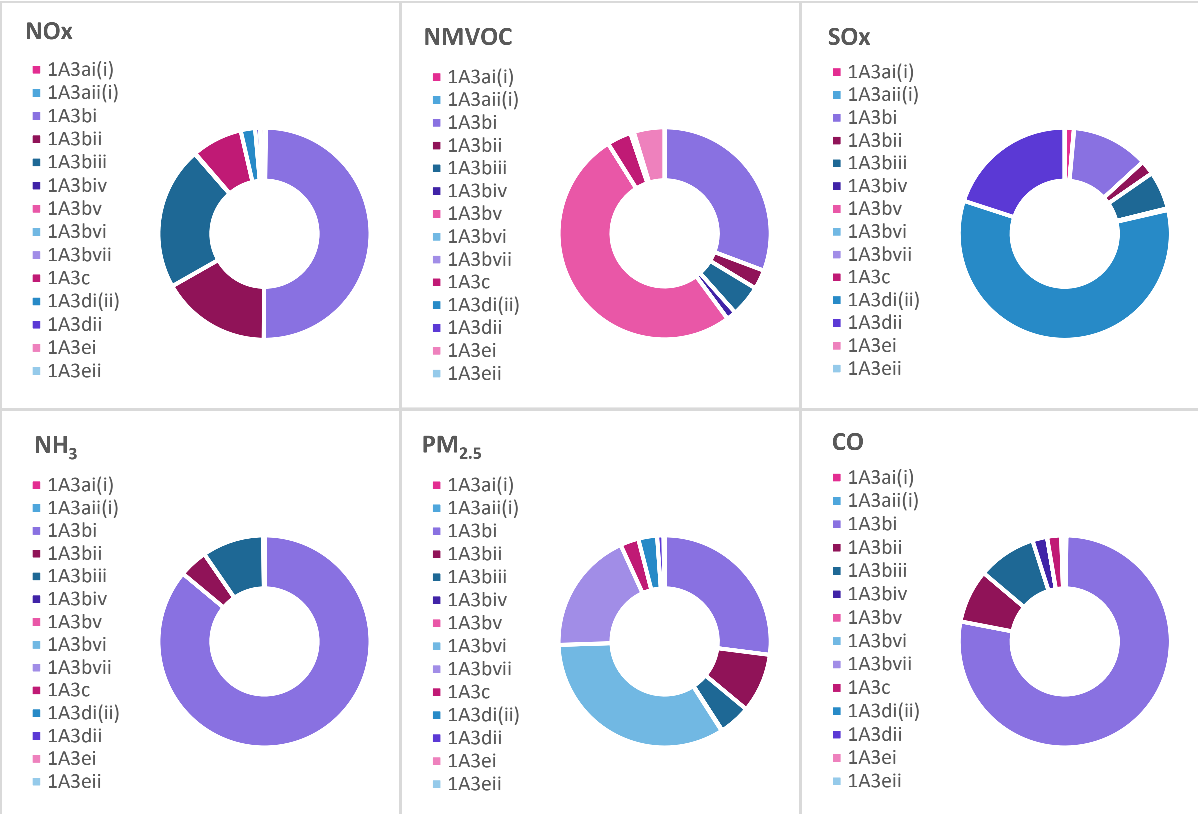
3.6 TRANSPORT (NFR 1A3)

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 observed shift from public transportation to individual passenger cars in Slovakia. After a decrease in fuel consumption and emissions in the pandemic year 2020, there can be observed again a rise. In the 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 64.12% (NO_X) and 93.54% (SO_X), although emission of ammonia has increased by 1 254.65% and PAH increased by

102.93%, 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 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 2021.

Figure 3.4: *Share of emissions of the main pollutants in 1A3 in 2021*



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 were prepared by the sectoral expert. Slovakia has been dealing with data inconsistency from several statistical sources in the last years regarding fuel consumption in transport. Therefore, in agreement with our QA/QC Plan, the extensive analyses of the available statistical information in liquid fuels in transport began in 2017. The results were published in the statistical journal[2] in Slovak.

QA/QC procedures for the transport sector follow basic rules and activities of QA/QC as defined in the EMEP/EEA GB_{2019}. The QC checks were done during the NFR and IIR compilation, general QC questionnaire was filled in and is 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 2014-2021:

- 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);

[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

- Finance Administration of the Slovak Republic (FR SR);
- Ministry of Environment (MŽP SR) (***Table 3.70***).

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 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 (***Figure 3.5***).[3,4]

Table 3.70: *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	Slovak Hydrometeorological Institute	European Environmental Agency
Data on production and sales (companies)	Slovak State Material Reserves	International Energy Agency (data on
		EUROSTAT (natural gas)
Data on fuel sales on gas stations	Ministry of Environment (according to	European Environmental Agency

As shown in ***Table 3.65*** 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 (***Table 3.71*** and **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.

Table 3.71: *Results of fuels consumption comparison according to different sources*

DATA SOURCE	ŠÚ SR			FR SR		
YEAR	PETROL [kt]	DIESEL OIL [kt]	BIOFUELS [kt]	PETROL [kt]	DIESEL OIL [kt]	BIOFUELS [kt]
2014	529.0	1 315.0	167.0	508.6	1 619.7	–
2015	550.0	1 259.0	182.0	516.6	1 743.0	–
2016	581.0	1 442.0	163.0	533.3	1 841.7	–
2017	620.0	1 905.0	176.0	540.0	1 914.0	–
2018	579.0	1 879.0	174.0	544.6	1 978.2	–
2019	562.0	1 952.0	183.0	546.4	2 003.6	–
2020	531.0	1 796.0	187.0	524.5	1 860.0	–
2021	541.0	1889.0	195.0	541.6	1 958.8	–

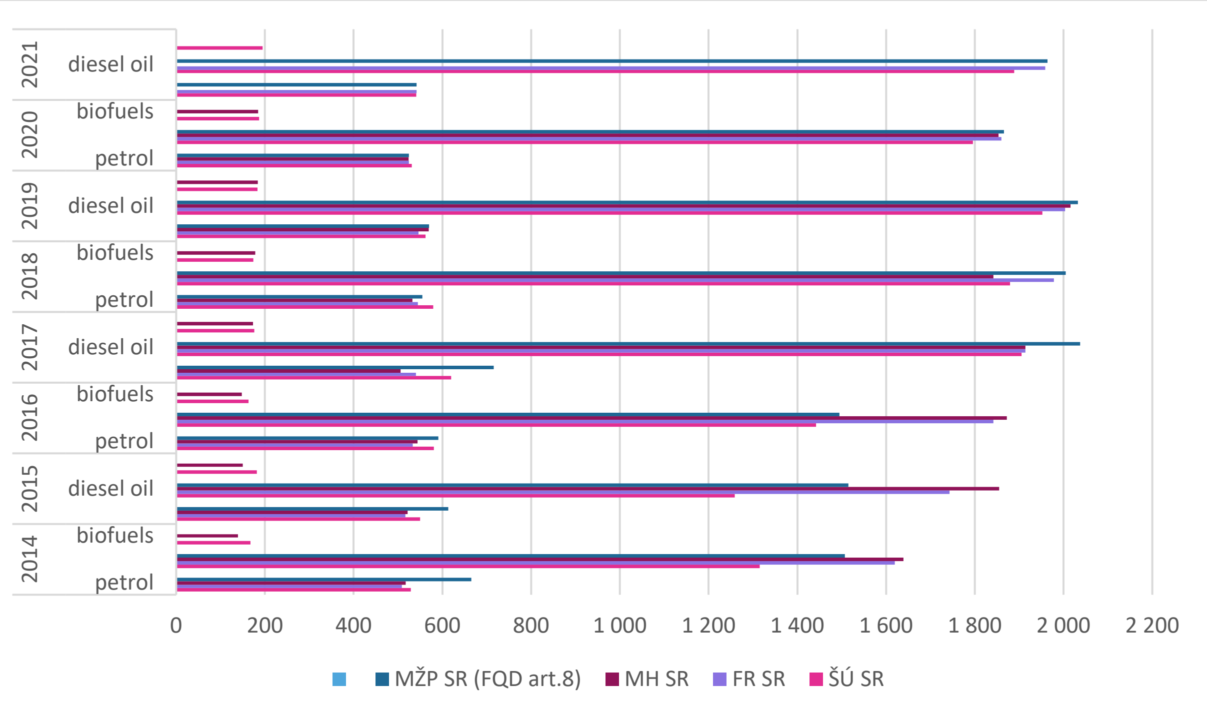
DATA SOURCE	MH SR			MŽP SR (FQD ART.8)		
YEAR	PETROL [kt]	DIESEL OIL [kt]	BIOFUELS [kt]	PETROL [kt]	DIESEL OIL [kt]	BIOFUELS [kt]
2014	517.2	1 639.0	138.9	664.9	1 507.4	–
2015	521.5	1 854.8	149.9	613.1	1 514.8	–
2016	543.8	1 872.3	147.9	591.0	1 494.6	–

[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)

DATA SOURCE	MH SR			MŽP SR (FQD ART.8)		
YEAR	PETROL [kt]	DIESEL OIL [kt]	BIOFUELS [kt]	PETROL [kt]	DIESEL OIL [kt]	BIOFUELS [kt]
2017	506.0	1 914.0	173.0	715.7	2 037.0	–
2018	532.7	1 841.6	178.0	555.0	2 004.6	–
2019	569.0	2 016.0	184.0	532.0	1 893.0	–
2020	524.0	1 853.5	184.9	524.5	1 865.5	–
2021	–	–	–	541.7	1 964.1	–

The main outcomes of this analysis are harmonisation of fuels consumption in the country on the most possible level and lowering the differences in reporting by different subjects to 2.8% for fossil fuels and 2% for biofuels in 2021. Full consistency of data on the 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]

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



3.6.2 DOMESTIC AVIATION LTO (NFR 1A3ai(i)) AND INTERNATIONAL 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 is 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

[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

(without fuel type differentiation). The described approach is maintained for a time series from 1990-2004. For the time series 2005-2021, EUROCONTROL data on the number of flights, fuel consumption and share of domestic and international flights were used. The emissions of NOx, SOx, PMs and CO were taken from the EUROCONTROL file for LTO and Cruise separately and reported in Domestic (***Table 3.72***) and International Aviation LTO cycles (***Table 3.73***). The fuel consumption in category **1A3aii(i)** decreased compared to the base year 1990 by 65.31%. The total consumption of jet kerosene was 4.99 TJ and the consumption of aviation gasoline was 0.14 TJ in the domestic aviation LTO cycle in 2021. Since 2005, domestic aviation emissions are decreasing. This decrease and the whole category is influenced by the fact, that the Slovak Republic has no official national airlines as Slovak Airlines are out of business since 2007, SkyEurope since 2009 and close distance of other big international airports in Vienna and Budapest. The fuel consumption in category **1A3ai(i)** increased compared to the base year 1990 by 6.51%. The total consumption of jet kerosene was 133.38 TJ and the consumption of aviation gasoline was 0.15 TJ allocated in the international aviation LTO cycle in 2021. 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 pandemic. From 2005 until 2019, international aviation emissions were increasing. The increase in fuel consumption and emissions were influenced by the arrival of low-cost airlines (Ryanair – based in Bratislava, WizzAir – based in Košice) and charter flights.

Table 3.72: *Overview of emissions from domestic aviation*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.0809	0.0007	0.0226	0.0004	0.0004	0.0004	0.0002	0.0199
1995	0.0537	0.0004	0.0150	0.0003	0.0003	0.0003	0.0001	0.0132
2000	0.0614	0.0005	0.0172	0.0003	0.0003	0.0003	0.0002	0.0151
2005	0.0079	0.0001	0.0006	0.0002	0.0002	0.0002	0.0001	0.0108
2010	0.0043	0.0002	0.0004	0.0002	0.0002	0.0002	0.0001	0.0121
2011	0.0034	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0112
2012	0.0032	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0127
2013	0.0027	0.0001	0.0002	0.0002	0.0002	0.0002	0.0001	0.0113
2014	0.0030	0.0001	0.0003	0.0002	0.0002	0.0002	0.0001	0.0094
2015	0.0032	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0123
2016	0.0029	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0095
2017	0.0032	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001	0.0097
2018	0.0026	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0086
2019	0.0017	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0044
2020	0.0007	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0030
2021	0.0012	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0047
1990/2021	**-99%**	**-85%**	**-100%**	**-97%**	**-97%**	**-97%**	**-97%**	**-76%**
2020/2021	**73%**	**97%**	**75%**	**-71%**	**-71%**	**-71%**	**-71%**	**59%**

Table 3.73: *Overview of emissions from international aviation*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	0.1020	0.0012	0.0271	0.0007	0.0007	0.0007	0.0003	0.0680
1995	0.0677	0.0008	0.0180	0.0005	0.0005	0.0005	0.0002	0.0458
2000	0.0776	0.0009	0.0205	0.0005	0.0005	0.0005	0.0002	0.0510
2005	0.0698	0.0008	0.0051	0.0011	0.0011	0.0011	0.0005	0.0632
2010	0.0771	0.0011	0.0049	0.0008	0.0008	0.0008	0.0004	0.0541
2011	0.0782	0.0010	0.0050	0.0008	0.0008	0.0008	0.0004	0.0557
2012	0.0722	0.0010	0.0046	0.0007	0.0007	0.0007	0.0004	0.0564
2013	0.0686	0.0011	0.0044	0.0008	0.0008	0.0008	0.0004	0.0560
2014	0.0700	0.0012	0.0043	0.0008	0.0008	0.0008	0.0004	0.0531
2015	0.0834	0.0012	0.0051	0.0009	0.0009	0.0009	0.0005	0.0613
2016	0.0917	0.0016	0.0056	0.0010	0.0010	0.0010	0.0005	0.0693
2017	0.0997	0.0015	0.0060	0.0009	0.0009	0.0009	0.0004	0.0676
2018	0.1113	0.0015	0.0068	0.0011	0.0011	0.0011	0.0005	0.0747

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2019	0.1127	0.0013	0.0069	0.0011	0.0011	0.0011	0.0005	0.0747
2020	0.0364	0.0006	0.0022	0.0005	0.0005	0.0005	0.0002	0.0291
2021	0.0424	0.0009	0.0026	0.0004	0.0004	0.0004	0.0002	0.0348
1990/2021	**-58%**	**-19%**	**-90%**	**-44%**	**-44%**	**-44%**	**-44%**	**-49%**
2020/2021	**16%**	**63%**	**17%**	**-16%**	**-16%**	**-16%**	**-16%**	**20%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.74*** and ***Table 3.75*** below.

Table 3.74: *Overview of activity data from domestic aviation*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	14.80	NA	NA	NO	NO
1995	10.51	NA	NA	NO	NO
2000	10.49	NA	NA	NO	NO
2005	31.99	NA	NA	NO	NO
2010	19.26	NA	NA	NO	NO
2011	15.43	NA	NA	NO	NO
2012	14.51	NA	NA	NO	NO
2013	12.58	NA	NA	NO	NO
2014	13.30	NA	NA	NO	NO
2015	14.02	NA	NA	NO	NO
2016	13.06	NA	NA	NO	NO
2017	13.41	NA	NA	NO	NO
2018	11.01	NA	NA	NO	NO
2019	7.21	NA	NA	NO	NO
2020	2.93	NA	NA	NO	NO
2021	5.13	NA	NA	NO	NO
1990/2021	**-65%**	**–**	**–**	**–**	**–**
2020/2021	**75%**	**–**	**–**	**–**	**–**

Table 3.75: *Overview of activity data from international aviation*

YEAR	LIQUID FUELS [TJ NCV]	SOLID FUELS [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
1990	125.37	NA	NA	NO	NO
1995	89.44	NA	NA	NO	NO
2000	88.48	NA	NA	NO	NO
2005	263.97	NA	NA	NO	NO
2010	251.22	NA	NA	23.53	NO
2011	257.32	NA	NA	27.40	NO
2012	235.74	NA	NA	26.39	NO
2013	226.71	NA	NA	28.96	NO
2014	224.16	NA	NA	49.93	NO
2015	264.49	NA	NA	34.88	NO
2016	289.64	NA	NA	29.49	NO
2017	309.96	NA	NA	49.36	NO
2018	349.00	NA	NA	61.73	NO
2019	354.75	NA	NA	46.74	NO
2020	114.61	NA	NA	40.14	NO
2021	133.53	NA	NA	NO	NO
1990/2021	**7%**	**–**	**–**	**–**	**–**
2020/2021	**17%**	**–**	**–**	**–**	**–**

3.6.2.2 Methodological issues

The airport traffic in Slovakia is determined only by the origin of 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, the only 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 time series 2005-2017. The share is a constant value. The real share of national and international activities for the period 2005-2021 was taken from the EUROCONTROL database directly. Data regarding disaggregation to LTO and cruise phase for the period 1990-2004 (***Table 3.76***) is taken from EUROCONTROL and the share is based on the real data used for time series 2005-2017 (in line with observation and ***Recommendation No SK-1A3aii(ii)-2017-0002***).

Table 3.76: *The share of fuel consumption in domestic and international aviation for the period 1990-2004*

FUELS	DOMESTIC AVIATION	INTERNATIONAL AVIATION
	1990-2004	
Aviation gasoline	30%	70%
Jet kerosene	5%	95%

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 3.77***) 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_{2019}.

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 annual basis.

From the year 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.

Slovakia made in the year 2020 analysis of jet kerosene and aviation gasoline for heavy metals and according to this analysis was able to define a new emission factor for lead (Pb) (***Table 3.77***) for this inventory.

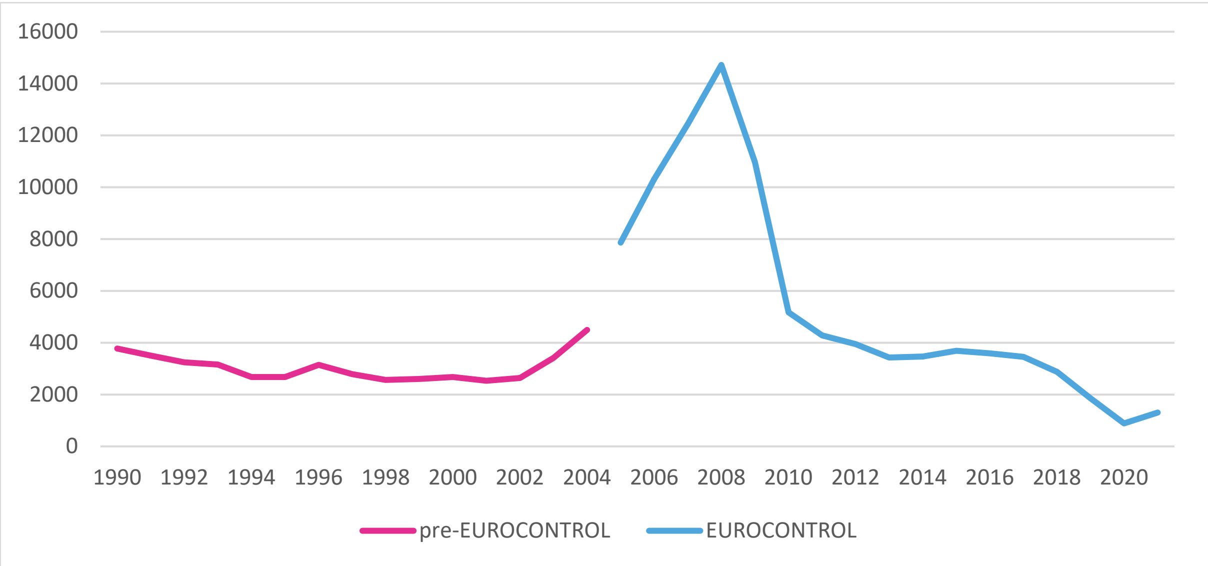
Table 3.77: Average emission factors for the pollutants in civil aviation according to EUROCONTROL

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
	international	13.66	0.04	0.84	0.16	3.08	0.48	0

3.6.2.3 Completeness

Since 2011, the agreement of the European Commission (the EC) and the EUROCONTROL is 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 check, 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

There was a recalculation in the category **1A3ai(i)** domestic aviation due to incorrect input for PM_{10} and TSP for the year 1994. Results of the recalculations are in ***Table 3.78***.

Table 3.78: *Previous and revised emissions in the category 1A3ai(i) domestic aviation*

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]			TSP [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1994	0.0005	0.0005	-	0.0005	0.0005	3 %	0.0005	0.0005	3%

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 2021, the transport network included 545 km of highways, 304 km of motorways and 3 339 km of the category 1st class roads. Total roads network represented 18 152 km of roads in the Slovak Republic in 2021. Road transportation is the most important and key category with the highest share of emissions and continually increasing trend in fuels consumption within transport. There is a huge increase in emission of ammonia compared to base year – 1 306% (***Table 3.79***). 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 3.79: *Overview of emissions in road transport in the years 1990-2021*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	BC [kt]	CO [kt]	Priority HMs [t]	PAHs [t]
1990	43.8129	26.0657	2.4180	0.0249	2.8064	3.0529	1.3470	193.0129	9.1513	0.0860
1995	37.2257	26.6181	1.9042	0.0874	1.9271	2.1443	0.9119	209.2321	7.8600	0.0707
2000	31.5863	20.1830	0.6929	0.3490	1.4436	1.6694	0.7016	168.3104	0.4447	0.0687
2005	43.2728	19.8301	0.1934	0.5261	2.2405	2.5892	1.1622	170.1213	0.6860	0.1121
2010	36.8401	11.7866	0.0285	0.4700	2.1781	2.5618	1.1963	89.2107	0.7471	0.1428
2011	29.5004	8.1419	0.0267	0.4110	1.6056	1.9666	0.8453	58.4767	0.7025	0.1386
2012	30.9457	7.9975	0.0283	0.4179	1.6633	2.0481	0.8758	56.2936	0.7460	0.1500
2013	23.5803	5.3607	0.0274	0.4292	1.2617	1.6455	0.6725	35.5857	0.7387	0.1520
2014	21.6445	4.5491	0.0294	0.3701	1.1361	1.5265	0.5696	29.0237	0.7504	0.1602
2015	22.8935	4.7221	0.0307	0.3458	1.2700	1.6961	0.6497	28.2203	0.8237	0.1817
2016	21.8079	3.6215	0.0314	0.4037	1.1557	1.6166	0.5262	19.0520	0.8847	0.1936
2017	20.8402	4.5952	0.0351	0.3573	1.1858	1.6342	0.5659	26.8405	0.8588	0.1894
2018	20.6112	3.6114	0.0337	0.3852	1.1019	1.5856	0.4651	16.4659	0.9253	0.2039
2019	19.7557	3.6159	0.0361	0.3888	1.0831	1.5772	0.4403	15.8927	0.9435	0.2057
2020	18.2303	3.1477	0.0340	0.3391	0.9807	1.4143	0.4117	13.6974	0.8448	0.1881
2021	17.4287	3.3031	0.0368	0.3505	0.9940	1.4676	0.3863	14.3917	0.9003	0.1943
1990/2021	**-60%**	**-87%**	**-98%**	**1306%**	**-65%**	**-52%**	**-71%**	**-93%**	**-90%**	**126%**
2020/2021	**-4%**	**5%**	**8%**	**3%**	**1%**	**4%**	**-6%**	**5%**	**7%**	**3%**

The major share of emissions belongs to passenger cars (***Table 3.80***). Most of the priority HMs (Pb, Cd and Hg) comes from tyre and brake wear abrasion. The majority of NOx, NMVOC and CO emission is emitted in the cities (***Table 3.81***).

Table 3.80: *Overview of total emissions according to the type of vehicles in 2021*

VEHICLE CATEGORY	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	TSP [kt]	CO [kt]	Priority HMs [t]	PAHs [t]
Passenger cars	9.8319	1.1136	0.0218	0.3018	0.2879	11.5297	0.0111	0.1181
Light duty vehicles	0.1181	0.1181	0.1181	0.1181	0.1181	1.2064	0.0016	0.0215
Heavy duty vehicles and buses	4.2975	0.1727	0.0108	0.0330	0.0513	1.3232	0.0042	0.0545
Mopeds & motorcycles	0.0172	0.0534	0.0001	0.0003	0.0011	0.3325	0.0001	0.0002
Gasoline evaporation	NA	1.8567	NA	NA	NA	NA	NA	NE
Automobile tyre and brake wear abrasion	NA	NA	NA	NA	0.8770	NA	0.8834	NE
Automobile road abrasion	NA	NA	NA	NA	0.7398	NA	NE	NE

***Table 3.81:** Results from COPERT in the distribution for agglomeration mode in 2021*

	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	CO [kt]
Urban	8.2307	2.6126	0.0240	0.0925	0.4459	10.0559
Rural	6.3409	0.4322	0.0249	0.1686	0.3936	2.7596
Highway	2.8571	0.2583	0.0099	0.0894	0.1545	1.5762

3.6.3.2 Methodological issues

COPERT model 5 (v5.5) 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_{2019} methodology. This methodology is balancing fifteen different emissions including greenhouse gases from road transport. 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 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 375 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[7].

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 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, NOx, NH_3, PMs and partially CH_4 can be obtained by the simple formula of driving mode and

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

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 3.82***). 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[8]).

Table 3.82: *Overview of input data used in COPERT 5 model in 2021*

CATEGORY OF ROAD VEHICLE	ACTIVITY DATA		CATEGORY OF ROAD VEHICLE	ACTIVITY DATA	
	NUMBER OF VEHICLE	AVERAGE MILEAGE		NUMBER OF VEHICLES	AVERAGE MILEAGE [KM/VEH]
Passenger Cars	**2 460 567**	**8 745**	Diesel N1-II	73 552	14 028
Petrol Mini	7 837	5 112	Diesel N1-III	138 743	12 840
Petrol Small	820 222	4 438	**Heavy Duty Trucks**	**77 551**	**14 433**
Petrol Medium	382 383	5 424	Petrol >3,5 t	111	544
Petrol Large-SUV-Executive	45 103	6 537	Rigid <=7,5 t	23 947	19 629
2-Stroke	155	1 162	Rigid 7,5 - 12 t	13 487	26 518
Diesel Mini	401	2 399	Rigid 12 - 14 t	3 601	19 627
Diesel Small	25 635	8 114	Rigid 14 - 20 t	4 774	14 982
Diesel Medium	896 500	18 768	Rigid 20 - 26 t	1 211	7 031
Diesel Large-SUV-Executive	202 797	13 306	Rigid 26 - 28 t	51	7 745
Petrol Hybrid Mini	49	5 235	Rigid 28 - 32 t	4 278	27 888
Petrol Hybrid Small	4 302	8 613	Rigid >32 t	146	2 928
Petrol Hybrid Medium	17 518	13 988	Articulated 14 - 20 t	25 925	54 674
Large-SUV-Executive Petrol PHEV	2 230	12 708	Articulated 20 - 28 t	20	22 770
Large-SUV-Executive Small	637	13 509	**Buses**	**7 817**	**21 062**
Large-SUV-Executive Medium	1 129	10 783	Urban Buses Midi <=15 t	1 484	21 674
Large-SUV-Executive Large-SUV-Executive	464	13 832	Urban Buses Standard 15 - 18 t	402	32 416
Diesel PHEV Large-SUV-Executive	53	12 086	Urban Buses Articulated >18 t	53	19 197
LPG Bifuel Mini	24	1 357	Coaches Articulated >18 t	25	22 191
LPG Bifuel Small	22 527	13 050	Coaches Standard <=18 t	5 613	29 141
LPG Bifuel Medium	19 753	11 802	Urban CNG Buses	240	35 104
LPG Bifuel Large-SUV-	5 037	10 433	**L-Category**	**157 092**	**1 034**
CNG Bifuel Small	1 039	10 238	Mopeds 2-stroke <50 cm³	808	597
CNG Bifuel Medium	483	11 021	Mopeds 4-stroke <50 cm³	27 340	717

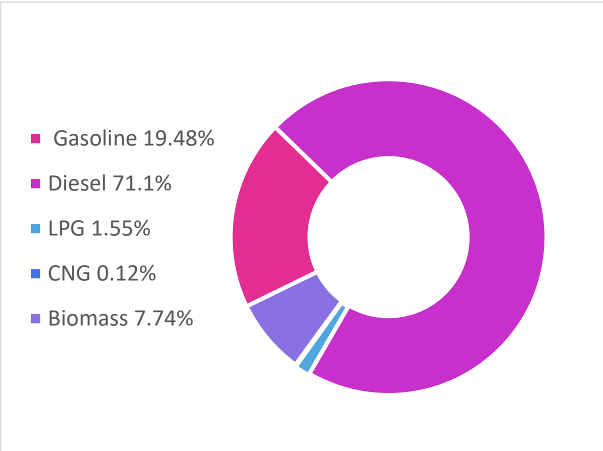
[8] Traffic Census of Slovakia 2015, http://www.ssc.sk/sk/cinnosti/rozvoj-cestnej-siete/dopravne-inzinierstvo.ssc

CATEGORY OF ROAD VEHICLE	ACTIVITY DATA		CATEGORY OF ROAD VEHICLE	ACTIVITY DATA	
	NUMBER OF VEHICLE	AVERAGE MILEAGE		NUMBER OF VEHICLES	AVERAGE MILEAGE [KM/VEH]
CNG Bifuel Large-SUV-Executive	57	3 296	Motorcycles 2-stroke >50 cm³	2 247	867
Light Commercial Vehicles	**267 080**	**10 759**	Motorcycles 4-stroke <250 cm³	44 942	905
Petrol N1-I	25 355	8 638	Motorcycles 4-stroke 250 - 750 cm³	45 873	1 549
Petrol N1-II	9 247	8 679	Motorcycles 4-stroke >750 cm³	35 746	2 010
Petrol N1-III	1 977	6 924	Quad & ATVs	59	541
Diesel N1-I	18 206	13 445	Micro-car	77	992

Input parameters for the CNG buses are 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 fuelled vehicles. All documents available are in the Slovak language and they are official. Share of diesel oil represents 70%, followed by gasoline with 20% share, then LPG (1.40%), CNG (0.13%) and biomass (8%) (***Figure 3.7***).

Figure 3.7: *Fuels balance in road transportation in 2021*



The blending of biomass in liquid fuels was considered and the bio-emissions are calculated since 2007 (the first year of using blended fuels in the transport in Slovakia). The information about fuels 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 3.83***).

Table 3.83: *Estimated activity data and share of biomass for the time series 2007-2021*

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

In ETBE as bio-component is considered only 37% 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 3.84***).

Table 3.84: *National fossil carbon content in FAME in 2021*

FEEDSTOCK	VOLUME [m^3]	C FOSSIL PART	CARBON CONTENT	g FOSSIL CO_2/g FAME
Rapeseed	83 088.9	5.30%	75.50%	0.147
Palm oil	3 697.52	5.50%	71.80%	0.145
Sunflower seed	7 847.78	5.30%	77.20%	0.150
Used cooking oil[9]	46 841.1	5.40%	74.40%	0.147
National average	-	5.34%	75.14%	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 the ***Recommendation No SK-1A3b-2018-0001***, Slovakia managed to distinguish lube oil consumption in 2-stroke vehicles and 4-stroke vehicles (***Table 3.85***). The emissions from lube oil are allocated according to EMEP/EEA GB_{2019} and recommendations:

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

Table 3.85: *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

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

YEAR	2-STROKE LUBE OIL [t]	4-STROKE [t]
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

Lube oil composition, including HMs was analysed and used for emission estimation for the years 2000-2021 (more info in ***Chapter 3.6.4.3***). For the years 1990-1999 were used reconstructed data for fuel composition (***Table 3.86***), vehicle fleet and estimations in line with the ***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 3.86***) 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[10] (Fuel Quality directive) and reported under article 8 (***Recommendation No SK-1A3b-2018-0002***). Lead emissions are allocated according to the previous paragraph.

Table 3.86: *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

[10] 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 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)

YEAR	Ni [ppm]		Se [ppm]		Zn [ppm]		Hg [ppm]		As [ppm]	
	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL	PETROL	DIESEL
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 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***.

In ***Table 3.87*** are presented the fuels from the three greatest sellers in Slovakia. These sellers also represent different refineries that affect the Slovak market.

Table 3.87: *Composition of diesel oil and petrol needed for estimation 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 3.88***. These data were used to estimate heavy metal emissions.

Table 3.88: *Composition of lube oil needed for estimation 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

LUBE OIL BRANDS	[ppm/wt]										
	Pb	Cd	Cu	Cr	Ni	Se	Zn	Hg	As	S	H:C RATIO
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 3.89***), that most of the deregistered cars were in EURO 1 emission category or older categories.

Table 3.89: *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
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 3.90***) 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 3.90**: Yearly change (2008-2009) in the number of passenger cars by emission category (according to the Police statistics)*

TOTAL NUMBER OF PC IN		TOTAL	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 are 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_{2019}, emissions from petrol evaporation are the most important sources:

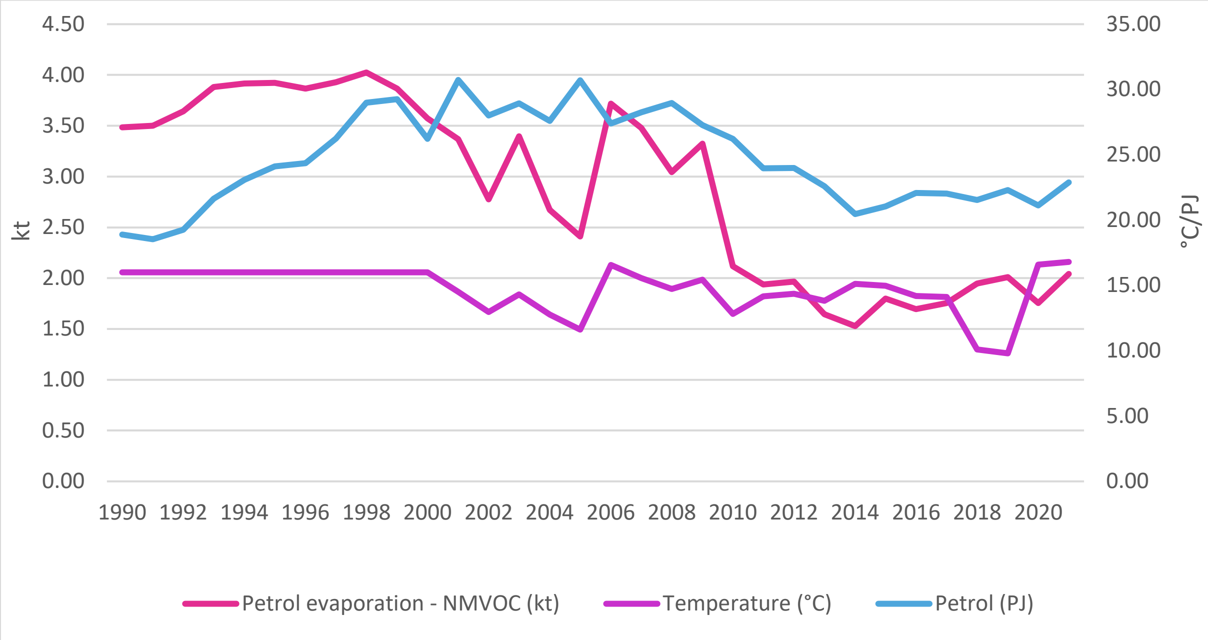
- Breathing losses through the tank vent. Breathing losses are due to the evaporation of fuel in the tank during driving and parking, as a result of normal diurnal temperature variation;
- Fuel permeation/leakage. Various studies (e.g. CRC, 2004; Reuter et al., 1994) indicate that liquid fuel seepage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

This chapter describes the recalculations of emissions. In the IIR 2023 there were no source-specific recalculations made.

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[11] in 2021, the length of managed railways was 3 626 km. The length of the electric railways was 1 585 km. Total NO_x emissions from railways transport increased by 12% compared to the previous year and by 75% compared to the base year (***Table 3.91***).

The increase in fuels consumption was a recovery from the COVID pandemic.

***Table 3.91:** Overview of emissions in railways in the years 1990-2021*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	CO [kt]	PRIORITY HMs [t]	PAHs [t]
1990	6.1928	0.5496	0.0024	0.0008	0.1619	0.1702	1.2646	0.0012	0.0095
1995	3.3542	0.2977	0.0013	0.0004	0.0877	0.0922	0.6849	0.0006	0.0051
2000	2.5600	0.2272	0.0010	0.0003	0.0669	0.0704	0.5228	0.0005	0.0039
2005	1.7520	0.1555	0.0007	0.0002	0.0458	0.0481	0.3578	0.0003	0.0027
2010	1.4432	0.1281	0.0006	0.0002	0.0377	0.0397	0.2947	0.0003	0.0022
2011	1.3928	0.1236	0.0005	0.0002	0.0364	0.0383	0.2844	0.0003	0.0021
2012	1.1791	0.1046	0.0005	0.0002	0.0308	0.0324	0.2408	0.0002	0.0018
2013	1.4511	0.1288	0.0006	0.0002	0.0379	0.0399	0.2963	0.0003	0.0022
2014	1.3789	0.1224	0.0005	0.0002	0.0361	0.0379	0.2816	0.0003	0.0021

[11] Annual Report of Slovak Railway 2021, p. 14.

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	CO [kt]	PRIORITY HMs [t]	PAHs [t]
2015	1.6565	0.1383	0.0006	0.0003	0.0311	0.0340	0.4689	0.0003	0.0023
2016	1.6936	0.1417	0.0004	0.0003	0.0319	0.0349	0.4793	0.0003	0.0024
2017	1.6500	0.1385	0.0004	0.0003	0.0312	0.0341	0.4668	0.0003	0.0023
2018	1.6123	0.1357	0.0004	0.0003	0.0305	0.0333	0.4560	0.0003	0.0022
2019	1.5251	0.1328	0.0004	0.0003	0.0297	0.0325	0.4297	0.0003	0.0022
2020	1.3603	0.1190	0.0003	0.0002	0.0266	0.0291	0.3831	0.0002	0.0020
2021	1.5212	0.1342	0.0004	0.0003	0.0299	0.0327	0.3161	0.0003	0.0023
1990/2021	**-75%**	**-76%**	**-83%**	**-66%**	**-82%**	**-81%**	**-75%**	**-76%**	**-76%**
2020/2021	**12%**	**13%**	**13%**	**13%**	**13%**	**13%**	**-17%**	**13%**	**13%**

3.6.4.2 Methodological issues

Railways transport represents the operation of diesel traction using Tier 2 methodology according to the EMEP/EEA GB_{2019} Higher tier methodology is introduced in 2015 as there are no older data available and as a result of ***Recommendation No SK-1A3c-2020-0001***.

The consumption of each powertrain according to Tier 2 was obtained directly from companies operating these or from calculations based on data provided in the EMEP/EEA GB_{2019}. The consumption of rail cars operated by one of the companies had to be calculated based on data provided by the guidebook and as a result of a field survey. The field survey focused on the average speed of rail cars. Based on the total mileage of rail cars, average consumption (kg/h) and average speed was the total consumption estimated. This estimation was adjusted afterwards according to the total consumption provided by companies (***Table 3.92***).

Table 3.92: *Consumption of each powertrain in particular years (2015-2021) in tonnes*

YEAR	LINE-HAUL LOCOMOTIVES	SHUNTING LOCOMOTIVES	RAIL CARS	TOTAL
2015	21 697.3363	0.0000	7 258.2891	28 955.6254
2016	22 036.8815	0.0000	7 650.5740	29 687.4554
2017	21 303.0055	0.0000	7 717.2538	29 020.2593
2018	20 698.2496	0.0000	7 727.5098	28 425.7594
2019	17 866.4060	0.0000	10 012.9750	27 879.3810
2020	15 717.4992	0.0000	9 276.1755	24 993.6746
2021	17 164.2711	0.0000	11 022.7835	28 187.0546

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 the motor traction in the Slovak Republic was obtained from the railways' companies for all years in time-series and the years 2015-2021 also for each powertrain.

3.6.4.3 Completeness

The verification process is based on cross-checking of 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.

3.6.4.4 Source-specific recalculations

This chapter describes the recalculations of emissions. In the IIR 2023, there were no source-specific recalculations made.

3.6.5 NATIONAL NAVIGATION (NFR 1A3dii) AND INTERNATIONAL INLAND WATERWAYS (NFR 1A3dii(ii))

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 3.93***), despite an increase in touristic 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 3.93: *Overview of emissions in navigation (national and international) in particular years*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	CO [kt]	PRIORITY HMs [t]	PAHs [t]
1990	1.6262	0.0554	0.4101	0.1435	0.1148	0.1271	0.0153	0.1518	0.0045
1995	1.4332	0.0488	0.3615	0.1265	0.1012	0.1120	0.0134	0.1337	0.0040
2000	0.0006	0.0000	0.0002	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000
2005	0.0177	0.0006	0.0045	0.0016	0.0013	0.0014	0.0002	0.0017	0.0000
2010	0.8370	0.0285	0.2111	0.0739	0.0591	0.0654	0.0079	0.0781	0.0023
2011	0.7428	0.0253	0.1873	0.0656	0.0525	0.0581	0.0070	0.0693	0.0021
2012	0.2590	0.0088	0.0653	0.0229	0.0183	0.0202	0.0024	0.0242	0.0007
2013	0.4079	0.0139	0.1029	0.0360	0.0288	0.0319	0.0038	0.0381	0.0011
2014	0.4742	0.0161	0.1196	0.0419	0.0335	0.0371	0.0044	0.0442	0.0013
2015	0.7136	0.0243	0.1800	0.0630	0.0504	0.0558	0.0067	0.0666	0.0020
2016	0.5967	0.0204	0.1505	0.0596	0.0424	0.0469	0.0051	0.0569	0.0017
2017	0.5879	0.0201	0.1483	0.0588	0.0418	0.0462	0.0050	0.0549	0.0016
2018	0.3406	0.0135	0.0996	0.0418	0.0281	0.0311	0.0034	0.0561	0.0016
2019	0.5071	0.0173	0.1279	0.0517	0.0361	0.0399	0.0043	0.0485	0.0014
2020	0.5137	0.0175	0.1296	0.0453	0.0363	0.0402	0.0048	0.0479	0.0014
2021	0.5802	0.0198	0.1463	0.0512	0.0410	0.0454	0.0049	0.0541	0.0016
1990/2021	**-64%**	**-64%**	**-64%**	**13%**	**-64%**	**-64%**	**-68%**	**-64%**	**-65%**
2020/2021	**13%**	**13%**	**13%**	**-64%**	**13%**	**13%**	**2%**	**13%**	**12%**

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. 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$_{2019}$. Activity data for domestic navigation are shown in ***Table 3.94***.

Table 3.94: *The amount of diesel oil sold by shipping companies and allocation to the categories 1A3dii and 1A3di(ii) in selected years 2005-2021*

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

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL [t]		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1D1b	1A3d + 1D1b
	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
	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**

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL [t]		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1D1b	1A3d + 1D1b
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[12] (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**

In 2020 there did not occur shipping on lakes 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

This chapter describes the recalculations of emissions. In the IIR 2023, there were no source-specific recalculations made.

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. An overview of emissions in this category is shown in ***Table 3.95***.

Table 3.95: *Overview of emissions in the 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	NA	0.0001	0.0001	0.0001	0.0000
1995	3.0858	0.1211	0.0008	NA	0.0001	0.0001	0.0001	0.0000
2000	3.1252	0.0871	0.0010	NA	0.0001	0.0001	0.0001	0.0000
2005	3.9738	0.2380	0.0010	NA	0.0000	0.0000	0.0000	0.0000
2010	2.3498	0.1996	0.0039	NA	0.0000	0.0000	0.0000	0.0000
2011	2.4936	0.2109	0.0143	NA	0.0000	0.0000	0.0000	0.0000
2012	0.6886	0.1318	0.0000	NA	0.0000	0.0000	0.0000	0.0000
2013	0.6576	0.1489	0.0000	NA	0.0000	0.0000	0.0000	0.0000
2014	0.1859	0.2599	0.0000	NA	0.0000	0.0000	0.0000	0.0000
2015	0.2273	0.2333	0.0000	NA	0.0001	0.0001	0.0001	0.0000
2016	0.2893	0.2634	0.0000	NA	0.0000	0.0000	0.0000	0.0000
2017	0.2520	0.2149	0.0000	NA	0.0001	0.0001	0.0001	0.0000
2018	0.2089	0.1487	0.0000	NA	0.0036	0.0036	0.0036	0.0001
2019	0.2880	0.1268	0.0000	NA	0.0046	0.0046	0.0046	0.0002
2020	0.1492	0.2162	0.0000	NA	0.0026	0.0026	0.0026	0.0001
2021	0.1314	0.1702	0.0000	NA	0.0016	0.0016	0.0016	0.0001
1990/2021	**-96%**	**40%**	**-99%**	**-**	**1401%**	**1401%**	**1401%**	**1456%**
2020/2021	**-12%**	**-21%**	**14%**	**-**	**-37%**	**-37%**	**-37%**	**-36%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.96*** below.

[12] Previous name Morsevo

***Table 3.96:** Overview of activity data in the 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
1990/2021	**-**	**-**	**-89%**	**-**	**-**
2020/2021	**22%**	**-**	**-32%**	**-**	**-**

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 is 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 2021.

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 3.97***).

***Table 3.97:** Emission factors for calculation of historical years*

	NOx [kg/tGJ]	NMVOC [kg/tGJ]	SOx [kg/tGJ]	TSP [kg/tGJ]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [kg/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_{2019}) (***Table 3.98***). The calculated BC emission values are presented in ***Table 3.95***.

***Table 3.98:** 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%

3.6.6.3 Completeness

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

3.6.6.4 Source-specific recalculations

No recalculations in this submission.

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.

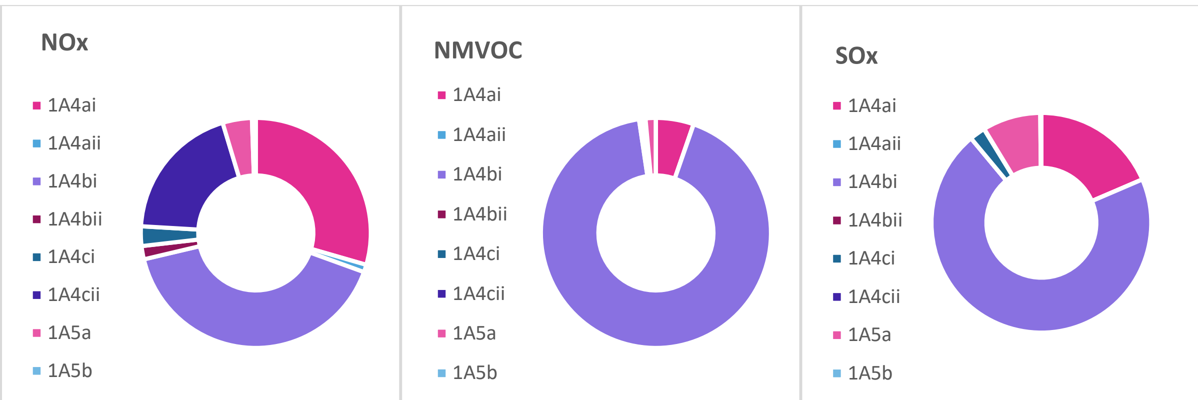
Relevant pollutants are SOx, NOx, CO, NMVOC, particulate matter (PM), black carbon (BC), heavy metals, PAH, polychlorinated dibenzo-dioxins and furans (PCDD/F) and hexachlorobenzene (HCB). For solid fuels, generally, the emissions due to incomplete combustion are many times greater in small appliances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

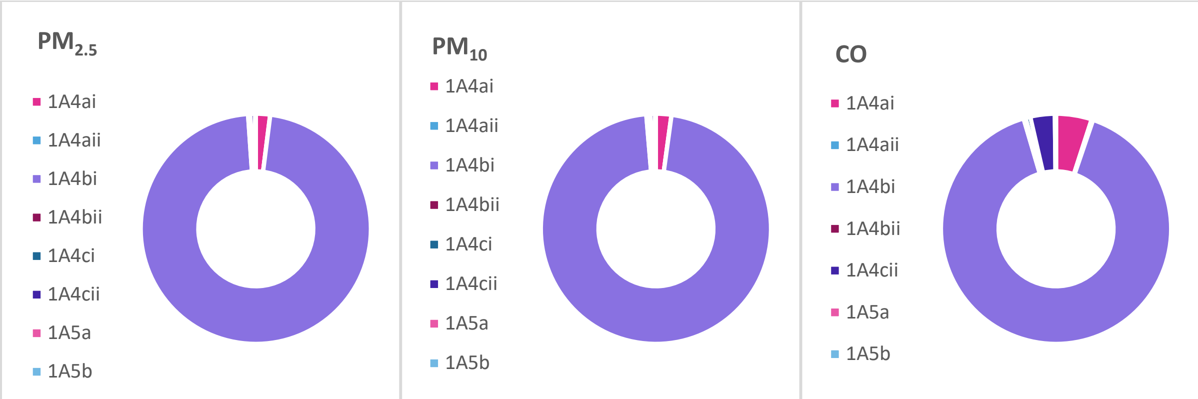
This chapter is focused on emission data from stationary sources with total nominal heat consumption from 0.3 MW to 50 MW (Technological units containing combustion plants having total rated thermal input between 0.3-50 MW and other technological units with a capacity under the defined limit for the 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: *Share of emissions of main pollutants in 1A4 and 1A5 in 2021*





3.7.2 COMMERCIAL/INSTITUTIONAL: STATIONARY (NFR 1A4ai)

3.7.2.1 Overview

The category covers the sources that cannot be clearly identified to particular activity but generally it is the combustion process. Activities listed within this category are shown in ***Table 3.99***.

Table 3.99: *Activities according to national categorization included in 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

An overview of the emissions is shown in ***Table 3.100***. 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 of biomass fuels as a renewable source and political support of this fuel.

Table 3.100: *Overview of emissions in the 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	2.7454	0.2273	2.1823	NO	0.8339	1.0077	1.4833	0.0710	4.3293
1995	2.7469	0.2275	2.1835	NO	0.8344	1.0082	1.4841	0.0708	4.3317
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
1990/2021	**-1%**	**778%**	**-85%**	**-**	**-63%**	**-66%**	**-74%**	**19%**	**-43%**
2020/2021	**3%**	**2%**	**-8%**	**-3%**	**10%**	**10%**	**9%**	**10%**	**2%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.7522	0.0494	0.0374	0.0235	0.1376	0.1117	0.1299	0.0103	2.5886
1995	0.3156	0.0135	0.0171	0.0113	0.0461	0.0456	0.0561	0.0043	0.8170
2000	0.1184	0.0044	0.0075	0.0055	0.0161	0.0169	0.0185	0.0017	0.2824
2005	0.0613	0.0108	0.0054	0.0050	0.0231	0.0107	0.0241	0.0013	0.4656
2010	0.2422	0.0535	0.0137	0.0086	0.1073	0.0408	0.0250	0.0045	2.2515
2011	0.2464	0.0643	0.0128	0.0078	0.1250	0.0434	0.0244	0.0047	2.6581
2012	0.2657	0.0803	0.0127	0.0075	0.1520	0.0489	0.0247	0.0052	3.2720
2013	0.2869	0.0927	0.0129	0.0075	0.1733	0.0542	0.0258	0.0059	3.7585
2014	0.2578	0.0938	0.0107	0.0062	0.1724	0.0509	0.0227	0.0056	3.7731
2015	0.2722	0.1015	0.0110	0.0064	0.1859	0.0543	0.0238	0.0060	4.0752
2016	0.2503	0.0946	0.0102	0.0060	0.1728	0.0503	0.0218	0.0056	3.7951
2017	0.2645	0.1001	0.0108	0.0063	0.1830	0.0530	0.0225	0.0059	4.0157
2018	0.2568	0.0993	0.0102	0.0059	0.1810	0.0519	0.0214	0.0059	3.9808
2019	0.2649	0.1063	0.0100	0.0056	0.1928	0.0544	0.0221	0.0061	4.2524
2020	0.2352	0.1031	0.0079	0.0046	0.1843	0.0504	0.0188	0.0056	4.0982
2021	0.2249	0.0994	0.0077	0.0046	0.1774	0.0484	0.0181	0.0054	3.9485
1990/2021	**-70%**	**101%**	**-79%**	**-80%**	**29%**	**-57%**	**-86%**	**-47%**	**53%**
2020/2021	**-4%**	**-4%**	**-3%**	**0%**	**-4%**	**-4%**	**-4%**	**-3%**	**-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	1.4851	0.3187	0.4296	0.1807	0.1472	1.0762	0.0181	0.7102
1995	0.5975	0.1396	0.1877	0.0842	0.0701	0.4816	0.0048	0.3144
2000	0.2267	0.0581	0.0792	0.0401	0.0348	0.2123	0.0015	0.1196
2005	0.1622	0.0412	0.0611	0.0381	0.0354	0.1758	0.0041	0.0413
2010	0.6129	0.0985	0.1496	0.0679	0.0586	0.3745	0.0206	0.1730
2011	0.6654	0.0983	0.1529	0.0659	0.0566	0.3738	0.0248	0.1516
2012	0.7661	0.1055	0.1689	0.0692	0.0593	0.4028	0.0309	0.1349
2013	0.8575	0.1163	0.2002	0.0763	0.0658	0.4587	0.0356	0.1272
2014	0.8211	0.1072	0.1943	0.0707	0.0615	0.4336	0.0361	0.0853
2015	0.8785	0.1133	0.2064	0.0744	0.0647	0.4588	0.0390	0.0831
2016	0.8170	0.1065	0.1947	0.0709	0.0619	0.4340	0.0364	0.0713
2017	0.8614	0.1114	0.2056	0.0741	0.0647	0.4558	0.0385	0.0768
2018	0.8466	0.1089	0.2070	0.0725	0.0634	0.4517	0.0382	0.0684
2019	0.8909	0.1121	0.2160	0.0737	0.0644	0.4662	0.0409	0.0598
2020	0.8398	0.1047	0.2050	0.0691	0.0608	0.4395	0.0396	0.0235
2021	0.8077	0.1015	0.2001	0.0680	0.0601	0.4298	0.0382	0.0203
1990/2021	**-46%**	**-68%**	**-53%**	**-62%**	**-59%**	**-60%**	**111%**	**-97%**
2020/2021	**-4%**	**-3%**	**-2%**	**-1%**	**-1%**	**-2%**	**-4%**	**-14%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.101*** below.

Table 3.101: *Overview of activity data in the 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	43 053.56	225.84	NO
1995	361.45	3 664.15	43 217.31	216.44	NO
2000	404.13	3 326.20	41 220.69	225.84	NO
2005	164.99	1 176.35	37 589.84	332.87	NO
2010	138.98	1 306.13	28 860.16	3 917.21	NO

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
2011	115.82	1 011.43	25 399.22	5 151.81	NO
2012	87.79	911.25	24 388.98	6 639.92	NO
2013	60.40	892.57	24 507.10	8 078.16	NO
2014	51.64	615.17	22 211.10	10 867.04	NO
2015	49.81	489.84	23 292.66	11 325.35	NO
2016	40.06	418.85	24 016.88	10 877.96	NO
2017	41.44	450.99	24 660.76	11 105.85	NO
2018	29.51	402.26	22 711.85	9 373.46	NO
2019	71.43	351.29	22 524.90	9 842.97	NO
2020	38.85	137.65	21 982.57	10 333.35	NO
2021	30.19	118.83	23 369.43	10 075.90	NO
1990/2021	**-92%**	**-97%**	**-46%**	**4361%**	**-**
2020/2021	**-22%**	**-14%**	**6%**	**-2%**	**-**

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 is 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 2021. 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 3.102***).

Table 3.102: *Emission factors for calculation of 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%	68%	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_{2019} (***Table 3.103***).

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 3.103: Emission factors for heavy metals and POPs in the category 1A4ai

TYPE OF FUEL		LIQUID FUELS				HARD COAL/BROWN COAL	
T2	UNIT	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (> 1 MWth ≤ 50 MWth)	GAS TURBINES (50 kWth – 50 MWth)	STATIONARY RECIPROCATING ENGINES (50 kWth – 50 MWth)	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (>1 MWth ≤ 50 MWth)
Pb	[mg/GJ]	20	10	0.012	0.15	200	100
Cd	[mg/GJ]	0.3	0.3	0.001	0.01	3	1
Hg	[mg/GJ]	0.1	0.1	0.12	0.11	7	9
As	[mg/GJ]	1	1	0.002	0.06	5	4
Cr	[mg/GJ]	20	20	0.2	0.2	15	15
Cu	[mg/GJ]	10	3	0.13	0.3	17.5	10
Ni	[mg/GJ]	300	200	0.005	0.01	13	10
Se	[mg/GJ]	NA	0.5	0.002	0.22	1.8	2
Zn	[mg/GJ]	10	5	0.42	58	200	150
PCDD/F	[ng I-TEQ/GJ]	10	10	1.8	0.99	203	100
B(a)P	[mg/GJ]	8	1	NE	1.9	45.5	13
B(b)F	[mg/GJ]	9	2	NE	15	58.9	17
B(k)F	[mg/GJ]	6	1	NE	1.7	23.7	9
I()P	[mg/GJ]	3	1	NE	1.5	18.5	6
PAHs	[mg/GJ]	26	5	NE	20.1	146.6	45
HCB	[µg/GJ]	NE	NE	NE	0.22	0.62	0.62
PCBs	[µg/GJ]	NE	NE	NE	0.13	170	170

TYPE OF FUEL		GASEOUS FUELS				BIOMASS	
T2	UNIT	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (> 1 MWth ≤ 50 MWth)	GAS TURBINES (50 kWth – 50 MWth)	STATIONARY RECIPROCATING ENGINES (50 kWth – 50 MWth)	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (>1 MWth ≤ 50 MWth)
Pb	[mg/GJ]	0.0015	0.0015	0.0015	0.04	27	27
Cd	[mg/GJ]	0.00025	0.00025	0.00025	0.003	13	13
Hg	[mg/GJ]	0.1	0.1	0.1	0.1	0.56	0.56
As	[mg/GJ]	0.12	0.12	0.12	0.05	0.19	0.19
Cr	[mg/GJ]	0.00076	0.00076	0.00076	0.05	23	23
Cu	[mg/GJ]	0.000076	0.000076	0.000076	0.01	6	6
Ni	[mg/GJ]	0.00051	0.00051	0.00051	0.05	2	2
Se	[mg/GJ]	0.011	0.011	0.011	0.2	0.5	0.5
Zn	[mg/GJ]	0.0015	0.0015	0.0015	2.9	512	512
PCDD/F	[ng I-TEQ/GJ]	0.5	0.5	0.5	0.57	100	100
B(a)P	[mg/GJ]	0.56	0.56	0.56	1.2	10	10
B(b)F	[mg/GJ]	0.84	0.84	0.84	9	16	16
B(k)F	[mg/GJ]	0.84	0.84	0.84	1.7	5	5
I()P	[mg/GJ]	0.84	0.84	0.84	1.8	4	4
PAHs	[mg/GJ]	3.08	3.08	3.08	13.7	35	35
HCB	[µg/GJ]	NA	NA	NA	NA	5	5
PCBs	[µg/GJ]	NA	NA	NA	NA	0.03	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_{2019}) (***Table 3.104***). The calculated BC emission values are presented in ***Table 3.100***.

Table 3.104: *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

The recalculations were made based on changes in activity data. The results of the recalculations are in ***Table 3.105***.

Table 3.105: *Previous and revised emissions in the category 1A4ai*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.7524	0.7522	0%	0.0419	0.0494	18%	0.0385	0.0374	-3%
1991	0.6438	0.6424	0%	0.0335	0.0394	17%	0.0333	0.0323	-3%
1992	0.5467	0.5444	0%	0.0264	0.0309	17%	0.0287	0.0278	-3%
1993	0.4606	0.4577	-1%	0.0205	0.0239	16%	0.0246	0.0238	-3%
1994	0.3850	0.3817	-1%	0.0156	0.0181	16%	0.0209	0.0202	-3%
1995	0.3190	0.3156	-1%	0.0118	0.0135	15%	0.0176	0.0171	-3%
1996	0.2617	0.2585	-1%	0.0088	0.0100	14%	0.0148	0.0143	-3%
1997	0.5029	0.4931	-2%	0.0106	0.0114	7%	0.0269	0.0259	-4%
1998	0.2950	0.2896	-2%	0.0069	0.0075	9%	0.0165	0.0160	-3%
1999	0.2108	0.2073	-2%	0.0055	0.0060	11%	0.0123	0.0119	-3%
2000	0.1200	0.1184	-1%	0.0039	0.0044	13%	0.0077	0.0075	-3%
2001	0.1048	0.1046	0%	0.0055	0.0065	18%	0.0069	0.0068	-2%
2002	0.1718	0.1697	-1%	0.0058	0.0066	14%	0.0102	0.0099	-3%
2003	0.0192	0.0216	13%	0.0054	0.0067	23%	0.0024	0.0024	2%
2004	0.0947	0.0957	1%	0.0071	0.0084	20%	0.0061	0.0060	-2%
2005	0.0581	0.0613	5%	0.0089	0.0108	22%	0.0054	0.0054	0%
2006	0.0761	0.0790	4%	0.0095	0.0115	21%	0.0066	0.0065	0%
2007	0.1535	0.1553	1%	0.0120	0.0143	20%	0.0101	0.0100	-2%
2008	0.1419	0.1434	1%	0.0170	0.0170	0%	0.0088	0.0089	2%
2009	0.1987	0.2022	2%	0.0265	0.0282	6%	0.0129	0.0130	1%
2010	0.2384	0.2422	2%	0.0517	0.0535	4%	0.0136	0.0137	1%
2011	0.2419	0.2464	2%	0.0622	0.0643	3%	0.0127	0.0128	1%
2012	0.2632	0.2657	1%	0.0791	0.0803	1%	0.0126	0.0127	1%
2013	0.2846	0.2869	1%	0.0916	0.0927	1%	0.0127	0.0129	2%
2014	0.2533	0.2578	2%	0.0916	0.0938	2%	0.0106	0.0107	1%
2015	0.2702	0.2722	1%	0.1005	0.1015	1%	0.0110	0.0110	0%
2016	0.2503	0.2503	0%	0.0946	0.0946	0%	0.0102	0.0102	0%
2017	0.2645	0.2645	0%	0.1001	0.1001	0%	0.0108	0.0108	0%
2018	0.2406	0.2568	7%	0.0915	0.0993	9%	0.0098	0.0102	4%
2019	0.2477	0.2649	7%	0.0980	0.1063	8%	0.0096	0.0100	4%
2020	0.2178	0.2352	8%	0.0419	0.0494	18%	0.0076	0.0079	5%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0240	0.0235	-2%	0.1264	0.1376	9%	0.1097	0.1117	2%
1991	0.0209	0.0205	-2%	0.1044	0.1130	8%	0.0934	0.0948	1%
1992	0.0182	0.0178	-2%	0.0853	0.0917	8%	0.0790	0.0799	1%
1993	0.0158	0.0155	-2%	0.0689	0.0735	7%	0.0662	0.0667	1%
1994	0.0135	0.0132	-2%	0.0553	0.0585	6%	0.0551	0.0554	1%
1995	0.0116	0.0113	-2%	0.0440	0.0461	5%	0.0455	0.0456	0%
1996	0.0099	0.0097	-2%	0.0346	0.0360	4%	0.0371	0.0371	0%
1997	0.0169	0.0164	-3%	0.0550	0.0548	0%	0.0696	0.0688	-1%
1998	0.0108	0.0106	-2%	0.0335	0.0338	1%	0.0410	0.0406	-1%
1999	0.0083	0.0082	-2%	0.0249	0.0253	2%	0.0294	0.0292	-1%
2000	0.0056	0.0055	-2%	0.0155	0.0161	4%	0.0169	0.0169	0%
2001	0.0052	0.0051	-1%	0.0173	0.0187	8%	0.0153	0.0155	2%
2002	0.0071	0.0070	-2%	0.0231	0.0240	4%	0.0245	0.0245	0%
2003	0.0025	0.0025	1%	0.0115	0.0137	19%	0.0041	0.0046	14%
2004	0.0046	0.0046	-1%	0.0197	0.0220	11%	0.0145	0.0150	3%
2005	0.0049	0.0050	0%	0.0197	0.0231	17%	0.0099	0.0107	8%
2006	0.0058	0.0058	0%	0.0219	0.0254	16%	0.0123	0.0131	7%
2007	0.0077	0.0076	-1%	0.0309	0.0347	12%	0.0228	0.0236	3%
2008	0.0070	0.0071	1%	0.0377	0.0379	1%	0.0226	0.0228	1%
2009	0.0085	0.0085	0%	0.0601	0.0631	5%	0.0301	0.0309	3%
2010	0.0086	0.0086	1%	0.1041	0.1073	3%	0.0399	0.0408	2%
2011	0.0078	0.0078	1%	0.1211	0.1250	3%	0.0423	0.0434	2%
2012	0.0075	0.0075	0%	0.1499	0.1520	1%	0.0484	0.0489	1%
2013	0.0074	0.0075	1%	0.1714	0.1733	1%	0.0537	0.0542	1%
2014	0.0062	0.0062	1%	0.1685	0.1724	2%	0.0499	0.0509	2%
2015	0.0063	0.0064	0%	0.1842	0.1859	1%	0.0538	0.0543	1%
2016	0.0060	0.0060	0%	0.1728	0.1728	0%	0.0503	0.0503	0%
2017	0.0063	0.0063	0%	0.1830	0.1830	0%	0.0530	0.0530	0%
2018	0.0057	0.0059	3%	0.1671	0.1810	8%	0.0483	0.0519	7%
2019	0.0055	0.0056	2%	0.1780	0.1928	8%	0.0506	0.0544	8%
2020	0.0045	0.0046	3%	0.1695	0.1843	9%	0.0466	0.0504	8%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.12942	0.12994	0%	0.0103	0.0103	0%	2.3110	2.5886	12%
1991	0.10947	0.10979	0%	0.0088	0.0088	0%	1.8921	2.1076	11%
1992	0.09172	0.09188	0%	0.0075	0.0074	-1%	1.5309	1.6943	11%
1993	0.07604	0.07608	0%	0.0063	0.0063	-1%	1.2236	1.3443	10%
1994	0.06590	0.06591	0%	0.0053	0.0052	-1%	0.9671	1.0536	9%
1995	0.05607	0.05605	0%	0.0044	0.0043	-2%	0.7568	0.8170	8%
1996	0.04438	0.04430	0%	0.0036	0.0036	-2%	0.5888	0.6298	7%
1997	0.06381	0.06302	-1%	0.0067	0.0065	-3%	0.8948	0.9130	2%
1998	0.04007	0.03968	-1%	0.0040	0.0039	-3%	0.5509	0.5682	3%
1999	0.02989	0.02966	-1%	0.0029	0.0029	-2%	0.4135	0.4310	4%
2000	0.01855	0.01848	0%	0.0018	0.0017	-2%	0.2649	0.2824	7%
2001	0.02097	0.02108	1%	0.0016	0.0016	0%	0.3110	0.3468	12%
2002	0.03589	0.03595	0%	0.0024	0.0024	-2%	0.3869	0.4138	7%
2003	0.02223	0.02276	2%	0.0005	0.0006	10%	0.2233	0.2725	22%
2004	0.03146	0.03186	1%	0.0015	0.0015	1%	0.3587	0.4109	15%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.02361	0.02413	2%	0.0012	0.0013	5%	0.3899	0.4656	19%
2006	0.02328	0.02374	2%	0.0015	0.0015	4%	0.4306	0.5093	18%
2007	0.01947	0.01961	1%	0.0024	0.0025	2%	0.5989	0.6884	15%
2008	0.01902	0.01917	1%	0.0023	0.0023	2%	0.7749	0.7774	0%
2009	0.02216	0.02242	1%	0.0035	0.0036	2%	1.1925	1.2586	6%
2010	0.02468	0.02498	1%	0.0044	0.0045	3%	2.1790	2.2515	3%
2011	0.02401	0.02437	1%	0.0045	0.0047	3%	2.5715	2.6581	3%
2012	0.02453	0.02472	1%	0.0051	0.0052	2%	3.2248	3.2720	1%
2013	0.02554	0.02578	1%	0.0056	0.0059	7%	3.7128	3.7585	1%
2014	0.02238	0.02271	2%	0.0056	0.0056	2%	3.6868	3.7731	2%
2015	0.02359	0.02379	1%	0.0059	0.0060	1%	4.0368	4.0752	1%
2016	0.02178	0.02178	0%	0.0056	0.0056	0%	3.7951	3.7951	0%
2017	0.02249	0.02249	0%	0.0059	0.0059	0%	4.0157	4.0157	0%
2018	0.02021	0.02144	6%	0.0055	0.0059	7%	3.6714	3.9808	8%
2019	0.0208	0.0221	6%	0.0058	0.0061	6%	3.9246	4.2524	8%
2020	0.0175	0.0188	7%	0.0053	0.0056	6%	3.7684	4.0982	9%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	1.4422	1.4851	3%	1.0620	1.0762	1%
1991	1.2256	1.2579	3%	0.9156	0.9262	1%
1992	1.0336	1.0572	2%	0.7851	0.7929	1%
1993	0.8651	0.8816	2%	0.6721	0.6776	1%
1994	0.7176	0.7286	2%	0.5683	0.5718	1%
1995	0.5907	0.5975	1%	0.4793	0.4816	0%
1996	0.4826	0.4865	1%	0.4023	0.4036	0%
1997	0.8927	0.8880	-1%	0.7098	0.7075	0%
1998	0.5303	0.5289	0%	0.4415	0.4409	0%
1999	0.3836	0.3837	0%	0.3317	0.3317	0%
2000	0.2252	0.2267	1%	0.2115	0.2123	0%
2001	0.2070	0.2124	3%	0.1963	0.1985	1%
2002	0.3188	0.3214	1%	0.2807	0.2817	0%
2003	0.0623	0.0719	15%	0.0823	0.0861	5%
2004	0.1947	0.2036	5%	0.1773	0.1807	2%
2005	0.1480	0.1622	10%	0.1701	0.1758	3%
2006	0.1823	0.1968	8%	0.2030	0.2089	3%
2007	0.3216	0.3369	5%	0.2944	0.3003	2%
2008	0.3311	0.3326	0%	0.2894	0.2911	1%
2009	0.4283	0.4412	3%	0.3142	0.3196	2%
2010	0.5987	0.6129	2%	0.3641	0.3745	3%
2011	0.6484	0.6654	3%	0.3630	0.3738	3%
2012	0.7568	0.7661	1%	0.3951	0.4028	2%
2013	0.8486	0.8575	1%	0.4335	0.4587	6%
2014	0.8042	0.8211	2%	0.4277	0.4336	1%
2015	0.8710	0.8785	1%	0.4552	0.4588	1%
2016	0.8170	0.8170	0%	0.4340	0.4340	0%
2017	0.8614	0.8614	0%	0.4558	0.4558	0%
2018	0.7860	0.8466	8%	0.4244	0.4517	6%
2019	0.8269	0.8909	8%	0.4413	0.4662	6%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2020	0.7756	0.8398	8%	0.4167	0.4395	5%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0152	0.0181	19%	0.7376	0.7102	-4%
1991	0.0121	0.0144	18%	0.6365	0.6129	-4%
1992	0.0095	0.0112	18%	0.5454	0.5251	-4%
1993	0.0073	0.0086	17%	0.4637	0.4465	-4%
1994	0.0056	0.0065	16%	0.3909	0.3764	-4%
1995	0.0041	0.0048	16%	0.3265	0.3144	-4%
1996	0.0031	0.0035	15%	0.2700	0.2600	-4%
1997	0.0034	0.0037	8%	0.5350	0.5151	-4%
1998	0.0023	0.0025	10%	0.3120	0.3004	-4%
1999	0.0018	0.0020	12%	0.2216	0.2134	-4%
2000	0.0013	0.0015	14%	0.1242	0.1196	-4%
2001	0.0020	0.0024	18%	0.1032	0.0993	-4%
2002	0.0020	0.0023	15%	0.1767	0.1702	-4%
2003	0.0021	0.0026	23%	0.0073	0.0070	-4%
2004	0.0026	0.0031	20%	0.0876	0.0843	-4%
2005	0.0034	0.0041	22%	0.0429	0.0413	-4%
2006	0.0036	0.0044	22%	0.0617	0.0594	-4%
2007	0.0044	0.0053	20%	0.1430	0.1377	-4%
2008	0.0064	0.0064	0%	0.1119	0.1144	2%
2009	0.0101	0.0108	6%	0.1846	0.1846	0%
2010	0.0199	0.0206	4%	0.1730	0.1730	0%
2011	0.0239	0.0248	3%	0.1516	0.1516	0%
2012	0.0304	0.0309	1%	0.1349	0.1349	0%
2013	0.0352	0.0356	1%	0.1272	0.1272	0%
2014	0.0352	0.0361	2%	0.0853	0.0853	0%
2015	0.0387	0.0390	1%	0.0831	0.0831	0%
2016	0.0364	0.0364	0%	0.0713	0.0713	0%
2017	0.0385	0.0385	0%	0.0768	0.0768	0%
2018	0.0352	0.0382	9%	0.0684	0.0684	0%
2019	0.0377	0.0409	8%	0.0598	0.0598	0%
2020	0.0364	0.0396	9%	0.0235	0.0235	0%

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**). Results of the separation are shown in ***Table 3.106***.

Table 3.106: *Overview of emissions in the 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

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2010	0.1550	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
1990/2021	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**
2020/2021	**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	0.0000	0.0002	0.0060	0.0002	0.0000	0.0035	0.0001	0.0002	0.0003
1995	0.0000	0.0002	0.0065	0.0003	0.0000	0.0038	0.0001	0.0002	0.0003
2000	0.0000	0.0002	0.0070	0.0003	0.0000	0.0041	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	0.0048	0.0001	0.0002	0.0004
2011	0.0000	0.0002	0.0082	0.0003	0.0000	0.0048	0.0001	0.0002	0.0004
2012	0.0000	0.0002	0.0083	0.0003	0.0000	0.0049	0.0001	0.0002	0.0004
2013	NO	NO	NO	NO	NO	NO	NO	NO	NO
2014	0.0001	0.0003	0.0085	0.0004	0.0001	0.0050	0.0002	0.0003	0.0004
2015	0.0001	0.0003	0.0102	0.0004	0.0001	0.0060	0.0002	0.0003	0.0005
2016	0.0000	0.0002	0.0068	0.0003	0.0000	0.0040	0.0001	0.0002	0.0003
2017	0.0000	0.0002	0.0051	0.0002	0.0000	0.0030	0.0001	0.0002	0.0002
2018	0.0000	0.0001	0.0034	0.0001	0.0000	0.0020	0.0001	0.0001	0.0002
2019	0.0001	0.0003	0.0085	0.0004	0.0001	0.0050	0.0002	0.0003	0.0004
2020	0.0000	0.0002	0.0051	0.0002	0.0000	0.0030	0.0001	0.0002	0.0002
2021	0.0000	0.0002	0.0051	0.0002	0.0000	0.0030	0.0001	0.0002	0.0002
1990/2021	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**
2020/2021	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.107*** below.

Table 3.107: *Overview of activity data in the category 1A4aii*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [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

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
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
1990/2021	**-21%**	**-**	**-**	**-**	**-**
2020/2021	**0%**	**-**	**-**	**-1%**	**-**

3.7.3.2 Methodological issues

Slovakia was able to receive statistical data about fuel combustion from the year 2012. Years 1990-2011 were estimated using expert judgment and 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_{2019} Tier 1 emission factors were used.

3.7.3.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2019}.

3.7.3.4 Source-specific recalculations

This chapter describes the recalculations of emissions. In the IIR 2023, there were no source-specific recalculations made.

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 emission, as well as fuel consumption, are relatively stable with a slight downward trend. A small increase in emissions and fuel consumption in the year 2021 was driven by the cold winter and pandemic crisis.

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 3.108***.

Table 3.108: *Overview of emissions in the 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	0.3259	78.1729	79.3979	87.1231	5.6817	690.2921
1995	3.6223	63.0227	11.1223	0.7147	34.1807	34.7633	37.9143	2.6490	315.4333
2000	3.8857	47.1180	6.7151	0.9072	24.5206	24.9708	27.0765	2.0141	229.6318
2005	4.1456	48.6813	2.3431	2.0635	21.9844	22.4908	23.8950	2.1639	226.4921
2010	4.0201	46.3647	1.7528	2.0910	20.5575	21.0422	22.2990	2.0660	215.1242
2011	3.6592	43.4006	1.6277	1.9526	19.1940	19.6460	20.8239	1.9278	201.6142
2012	3.7751	47.3901	1.7450	2.1430	20.8628	21.3551	22.6300	2.1004	220.3918
2013	3.6917	44.1582	1.6218	1.9855	19.3900	19.8464	21.0368	1.9497	205.2521
2014	2.7537	26.2323	1.2132	1.1010	11.7489	12.0168	12.7773	1.1529	121.6985
2015	3.2537	36.2392	1.4173	1.6285	15.9562	16.3291	17.3203	1.5975	169.8696

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2016	3.4790	39.5439	1.4421	1.8327	16.6725	17.0698	18.0706	1.6926	187.4071
2017	3.6702	38.7664	1.6167	1.7598	17.1646	17.5625	18.6391	1.7131	184.6048
2018	3.1746	30.1586	1.3016	1.3773	13.3804	13.6895	14.5317	1.3339	145.0451
2019	3.3002	31.8227	1.2831	1.5017	14.0751	14.4030	15.2749	1.4133	154.1601
2020	3.3476	31.6204	1.1888	1.5200	13.8994	14.2255	15.0762	1.4040	153.9179
2021	3.7626	34.7288	1.2655	1.6966	15.0022	15.3561	16.2653	1.5240	170.3840
1990/2021	**-28%**	**-75%**	**-96%**	**421%**	**-81%**	**-81%**	**-81%**	**-73%**	**-75%**
2020/2021	**12%**	**10%**	**6%**	**12%**	**8%**	**8%**	**8%**	**9%**	**11%**

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	0.4969	0.3172	0.0763	0.0626	1.0034	0.2607	0.1349	0.0533	6.1297
2013	0.4673	0.2942	0.0748	0.0594	0.9351	0.2438	0.1261	0.0505	5.7062
2014	0.2793	0.1640	0.0576	0.0421	0.5458	0.1420	0.0744	0.0316	3.2360
2015	0.3975	0.2426	0.0661	0.0523	0.7797	0.2054	0.1057	0.0431	4.7668
2016	0.4373	0.2668	0.0685	0.0517	0.8477	0.2278	0.1168	0.0466	5.0692
2017	0.4452	0.2624	0.0752	0.0603	0.8577	0.2275	0.1167	0.0486	5.2238
2018	0.3538	0.2055	0.0646	0.0498	0.6787	0.1804	0.0924	0.0386	4.1176
2019	0.3800	0.2239	0.0659	0.0507	0.7281	0.1946	0.0991	0.0410	4.4740
2020	0.3796	0.2263	0.0661	0.0497	0.7315	0.1953	0.0993	0.0407	4.5026
2021	0.4362	0.2567	0.0718	0.0547	0.8187	0.2229	0.1111	0.0445	5.2387
1990/2021	**-58%**	**275%**	**-80%**	**-91%**	**-66%**	**-49%**	**-66%**	**-71%**	**32%**
2020/2021	**15%**	**13%**	**9%**	**10%**	**12%**	**14%**	**12%**	**9%**	**16%**

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	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	8.8678	5.9609	4.3626	2.3611	3.1507	15.8353	2.3405	0.1060
2013	8.2384	5.5494	4.0977	2.1970	2.9449	14.7890	2.4393	0.1015
2014	4.7695	3.2658	2.4572	1.2916	1.7454	8.7600	2.0084	0.0681
2015	6.8563	4.5574	3.4065	1.8088	2.4437	12.2164	2.2895	0.0886
2016	7.4696	4.9155	3.6705	1.9723	2.6454	13.2036	2.0360	0.1041
2017	7.5682	4.8952	3.7421	1.9527	2.6816	13.2715	2.8869	0.1033
2018	5.9795	3.8090	2.9393	1.5252	2.1091	10.3826	2.3167	0.0832
2019	6.4483	4.0488	3.1210	1.6231	2.2503	11.0431	2.3599	0.0866
2020	6.4751	4.0305	3.1157	1.6197	2.2530	11.0189	2.2473	0.0853
2021	7.0358	4.3717	3.3690	1.7645	2.4423	11.9475	2.1826	0.0891
1990/2021	**-3%**	**-66%**	**-63%**	**-68%**	**-65%**	**-65%**	**-84%**	**-86%**
2020/2021	**9%**	**8%**	**8%**	**9%**	**8%**	**8%**	**-3%**	**4%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.109*** below. This table represents fuels allocated to the fuel type for calculations. Fuels in the template are allocated following principles from IPCC 2006 Guidelines.

Table 3.109: *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	NO	28 588.64	1 472.00	4 786.82	NO
1995	776.15	1 124.53	16 578.16	NO	42 360.63	1 058.00	10 554.05	NO
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	32 182.72	785.81
2013	942.90	230.19	1 177.86	506.85	48 200.08	368.00	29 772.52	944.59
2014	828.07	170.77	913.26	414.61	43 395.60	184.00	16 687.61	430.61
2015	982.83	147.10	955.40	570.61	43 903.00	184.00	24 654.61	884.13
2016	1 025.72	204.57	804.37	641.48	44 697.43	368.00	27 800.63	1 125.80
2017	1 252.68	217.24	863.90	936.44	49 339.18	368.00	26 665.16	1 256.38
2018	1 056.04	131.98	652.26	862.55	45 735.20	322.00	20 869.03	1 123.24
2019	1 100.86	106.96	556.82	899.92	45 951.45	368.00	22 668.76	1 374.10
2020	1 084.83	63.95	412.97	958.40	47 205.23	276.00	22 939.01	1 390.48
2021	1 055.43	53.72	453.17	1 082.14	51 715.57	276.00	27 042.32	1 639.21
1990/2021	**-56%**	**-99%**	**-99%**	**-**	**81%**	**-81%**	**465%**	**-**
2020/2021	**-3%**	**-16%**	**10%**	**13%**	**10%**	**0%**	**18%**	**18%**

HC – Hard coal
BC – Brown coal
CB – Coal briquettes
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 is not fully covered by the ŠÚ SR. Direct statistics is 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 inconstancies 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[13] 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, and the results are currently being processed.

Boiler structure

Data on the household's equipment structure are one of the most important outputs of the statistical survey. The results of the survey included data such as age, type, power, fuel consumption for each device. Based on data from the second survey, we obtained the improved structure of combustion equipment in Households. ***Table 3.110*** shows the boiler structure for 2021.

Table 3.110: *Households share by type of fuels and type of equipment for the year 2021*

2021	TYPE OF EQUIPMENT	BC	HC & COKE	CB	PELETS & WOOD BRIQUETTES	FIREWOOD	OTHER
1	Over-fire boilers	54.5%	66.3%	76.7%	33.5%	44.4%	47.6%
2	Under-fire boilers	28.4%	13.2%	10.0%	9.7%	10.8%	30.5%
3	Gasification boilers	3.7%	4.5%	2.3%	16.1%	8.8%	0.0%
4	Automatic boilers	7.4%	6.7%	3.3%	27.2%	4.3%	8.6%
5	Fireplaces, stoves, masonry stoves	4.7%	8.3%	7.5%	10.1%	26.9%	9.5%
6	Modern masonry stoves and pellets stoves	1.2%	1.0%	0.2%	3.4%	4.8%	3.8%
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 gasification boilers and automatic boilers 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 3.111*** shows the share of plants in 2005 and ***Table 3.112*** in 1990.

Table 3.111: *Households share by type of fuels and type of equipment for the year 2005*

2005	TYPE OF EQUIPMENT	BC	HC & COKE	CB	PELETS & 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%

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

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

1990	TYPE OF EQUIPMENT	BC	HC & COKE	CB	PELETS & 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[14] 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 3-39 and 3-42) modern masonry/built-in tile stoves and pellets stoves (Table 3-44) were obtained from the EMEP/EEA GB_{2019} (Tier 2). The GHGs emission factors for relevant fuel types were taken from IPCC Guidelines, Tier 1 methodology. For category Modern masonry/built-in tile stoves and pellets stoves, emission factors only for combustion of wood, wooden pellets and briquettes were available.

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

The very small recalculations were made based on changes in degree days data. The results of the recalculations affect biomass consumption in the years 2018-2020. The difference was less than 1%.

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 3.113***. Data for

[14] https://powietrze.malopolska.pl/en/life-project/

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 3.113:** Overview of emissions in the 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
1990/2021	**206%**	**357%**	**274%**	**238%**	**185%**	**185%**	**185%**	**173%**	**394%**
2020/2021	**4%**	**18%**	**11%**	**8%**	**2%**	**2%**	**2%**	**0%**	**20%**

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
1990/2021	**274%**	**274%**	**274%**	**274%**	**274%**	**274%**	**290%**	**261%**	**274%**
2020/2021	**11%**	**11%**	**11%**	**11%**	**11%**	**11%**	**13%**	**10%**	**11%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.114*** below.

***Table 3.114:** Overview of activity data in the category 1A4bii*

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [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

YEAR	LIQUID FUELS [TJ NCV]	HARD COAL, BROWN COAL [TJ NCV]	GASEOUS FUELS [TJ NCV]	BIOMASS [TJ NCV]	OTHER FUELS [TJ NCV]
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	355.39	NA	NA	21.46	NA
2021	390.00	NA	NA	27.12	NA
1990/2021	**244%**	**-**	**-**	**-**	**-**
2020/2021	**10%**	**-**	**-**	**26%**	**-**

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_{2019} Tier 1 emission factors were used.

3.7.5.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2019}.

3.7.5.4 Source-specific recalculations

This chapter describes the recalculations of emissions. In the IIR 2023, there were no source-specific recalculations made.

3.7.6 AGRICULTURE/FORESTRY/FISHING: STATIONARY (NFR 1A4ci)

3.7.6.1 Overview

Activities listed within this category are shown in ***Table 3.115***.

Table 3.115: *Activities according to national categorization included in 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 3.116.***

Table 3.116: *Overview of emissions in the 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	NE	0.0307	0.0701	0.1533	0.0044	0.2780
1995	0.1156	0.0299	0.1557	NE	0.0326	0.0744	0.1628	0.0048	0.2952
2000	0.1124	0.0056	0.1689	NE	0.0418	0.0955	0.2089	0.0061	0.4136
2005	0.1542	0.0092	0.1420	NE	0.0462	0.0948	0.2044	0.0097	0.2216
2010	0.1022	0.0108	0.0266	NE	0.0329	0.0795	0.1791	0.0067	0.1218
2011	0.1020	0.0128	0.0194	NE	0.0357	0.0892	0.1984	0.0085	0.1267
2012	0.1129	0.0129	0.0292	NE	0.0303	0.0713	0.1543	0.0072	0.1518
2013	0.1258	0.0144	0.0336	NE	0.0276	0.0689	0.1528	0.0065	0.1589
2014	0.2434	0.0395	0.0698	NE	0.0313	0.0862	0.1967	0.0083	0.2094
2015	0.2736	0.0196	0.0908	NE	0.0297	0.0678	0.1451	0.0072	0.2131
2016	0.2515	0.0157	0.0722	NE	0.0308	0.0754	0.1648	0.0070	0.2072
2017	0.2266	0.0147	0.0555	NE	0.0269	0.0602	0.1265	0.0061	0.1891
2018	0.2215	0.0256	0.0564	NE	0.0363	0.0699	0.1343	0.0094	0.2005
2019	0.2276	0.0201	0.0552	NE	0.0389	0.0696	0.1312	0.0096	0.2027
2020	0.2664	0.0243	0.0415	NE	0.0388	0.0813	0.1634	0.0096	0.2010
2021	0.2543	0.0319	0.0412	NE	0.0437	0.0881	0.1733	0.0112	0.2333
1990/2021	**134%**	**13%**	**-72%**	**-**	**43%**	**26%**	**13%**	**155%**	**-16%**
2020/2021	**-5%**	**31%**	**-1%**	**-**	**13%**	**8%**	**6%**	**17%**	**16%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0035	0.0001	0.0002	0.0002	0.0005	0.0006	0.0037	0.0000	0.0053
1995	0.0599	0.0009	0.0024	0.0016	0.0053	0.0089	0.0118	0.0007	0.0898
2000	0.0408	0.0009	0.0017	0.0013	0.0048	0.0063	0.0187	0.0005	0.0720
2005	0.0201	0.0008	0.0009	0.0007	0.0034	0.0033	0.0162	0.0002	0.0483
2010	0.0058	0.0006	0.0004	0.0003	0.0015	0.0010	0.0039	0.0001	0.0277
2011	0.0051	0.0008	0.0003	0.0003	0.0016	0.0009	0.0012	0.0001	0.0345
2012	0.0042	0.0008	0.0003	0.0002	0.0015	0.0007	0.0007	0.0001	0.0333
2013	0.0041	0.0008	0.0003	0.0003	0.0016	0.0007	0.0007	0.0001	0.0350
2014	0.0031	0.0007	0.0003	0.0002	0.0014	0.0006	0.0005	0.0002	0.0323
2015	0.0048	0.0013	0.0004	0.0002	0.0025	0.0009	0.0006	0.0003	0.0579
2016	0.0035	0.0008	0.0003	0.0002	0.0016	0.0007	0.0008	0.0003	0.0365
2017	0.0038	0.0008	0.0003	0.0002	0.0017	0.0007	0.0008	0.0002	0.0377
2018	0.0053	0.0020	0.0003	0.0002	0.0036	0.0011	0.0009	0.0003	0.0820
2019	0.0041	0.0013	0.0003	0.0002	0.0024	0.0008	0.0011	0.0003	0.0545
2020	0.0041	0.0014	0.0003	0.0003	0.0026	0.0008	0.0006	0.0002	0.0596
2021	0.0048	0.0020	0.0004	0.0003	0.0037	0.0010	0.0009	0.0003	0.0835
1990/2021	**34%**	**3827%**	**91%**	**79%**	**636%**	**73%**	**-75%**	**488%**	**1476%**
2020/2021	**17%**	**43%**	**22%**	**27%**	**42%**	**24%**	**51%**	**17%**	**40%**

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	0.0068	0.0021	0.0029	0.0015	0.0013	0.0077	0.0000	0.0031
1995	0.1141	0.0282	0.0368	0.0145	0.0116	0.0912	0.0002	0.0552
2000	0.0784	0.0197	0.0261	0.0108	0.0088	0.0654	0.0003	0.0363
2005	0.0398	0.0102	0.0140	0.0063	0.0052	0.0358	0.0003	0.0168
2010	0.0138	0.0036	0.0052	0.0028	0.0025	0.0141	0.0002	0.0040
2011	0.0133	0.0031	0.0047	0.0025	0.0022	0.0126	0.0003	0.0032
2012	0.0115	0.0027	0.0049	0.0023	0.0021	0.0120	0.0003	0.0024
2013	0.0117	0.0029	0.0053	0.0025	0.0023	0.0130	0.0003	0.0023
2014	0.0095	0.0030	0.0107	0.0031	0.0030	0.0198	0.0003	0.0016

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]
2015	0.0151	0.0039	0.0141	0.0038	0.0037	0.0255	0.0005	0.0019
2016	0.0107	0.0033	0.0119	0.0033	0.0033	0.0217	0.0003	0.0017
2017	0.0114	0.0033	0.0112	0.0032	0.0031	0.0209	0.0003	0.0018
2018	0.0186	0.0039	0.0134	0.0036	0.0035	0.0245	0.0008	0.0010
2019	0.0136	0.0034	0.0121	0.0033	0.0033	0.0221	0.0005	0.0012
2020	0.0142	0.0034	0.0108	0.0034	0.0033	0.0210	0.0005	0.0009
2021	0.0181	0.0040	0.0124	0.0041	0.0040	0.0245	0.0008	0.0004
1990/2021	**166%**	**94%**	**330%**	**177%**	**211%**	**218%**	**6514%**	**-87%**
2020/2021	**28%**	**17%**	**14%**	**21%**	**21%**	**17%**	**44%**	**-56%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.117*** below.

Table 3.117: *Overview of activity data in the 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
1990/2021	**406%**	**-99%**	**154%**	**1080%**	**-**
2020/2021	**5%**	**-56%**	**18%**	**8%**	**-**

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 is 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 2021. NH_3 emissions from solid biomass combustion are reported as 'NO' because measurements show that NH_3 is not relevant (***Recommendation No 1A4ci-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 3.118***).

Table 3.118: *Emission factors for calculation of 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%	46%	207.06

The emissions of heavy metals and POPs are calculated at Tier 2 level. The data (fuel, technology and specific information) is compiled in the NEIS database, therefore this 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 heavy metals and POPs are default EF from EMEP/EEA GB_{2019} (***Table 3.119***).

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 3.119: *Emission factors for heavy metals and POPs in the category 1A4ci*

TYPE OF FUEL		LIQUID FUELS				HARD COAL/BROWN COAL	
T2	**UNIT**	**STANDARD BOILERS** (> 50 KWth ≤ 1 MWth)	**STANDARD BOILERS** (> 1 MWth ≤ 50 MWth)	**GAS TURBINES** (50 kWth – 50 MWth)	**STATIONARY RECIPROCATING ENGINES** (50 kWth – 50 MWth)	**STANDARD BOILERS** (> 50 KWth ≤ 1 MWth)	**STANDARD BOILERS** (>1 MWth ≤ 50 MWth)
Pb	[mg/GJ]	20	10	0.012	0.15	200	100
Cd	[mg/GJ]	0.3	0.3	0.001	0.01	3	1
Hg	[mg/GJ]	0.1	0.1	0.12	0.11	7	9
As	[mg/GJ]	1	1	0.002	0.06	5	4
Cr	[mg/GJ]	20	20	0.2	0.2	15	15
Cu	[mg/GJ]	10	3	0.13	0.3	17.5	10
Ni	[mg/GJ]	300	200	0.005	0.01	13	10
Se	[mg/GJ]	NA	0.5	0.002	0.22	1.8	2
Zn	[mg/GJ]	10	5	0.42	58	200	150
PCDD/F	[ng I-TEQ/GJ]	10	10	1.8	0.99	203	100
B(a)P	[mg/GJ]	8	1	NE	1.9	45.5	13
B(b)F	[mg/GJ]	9	2	NE	15	58.9	17
B(k)F	[mg/GJ]	6	1	NE	1.7	23.7	9
I()P	[mg/GJ]	3	1	NE	1.5	18.5	6
PAHs	[mg/GJ]	26	5	NE	20.1	146.6	45
HCB	[µg/GJ]	NE	NE	NE	0.22	0.62	0.62
PCBs	[µg/GJ]	NE	NE	NE	0.13	170	170

TYPE OF FUEL		GASEOUS FUELS				BIOMASS	
T2	**UNIT**	**STANDARD BOILERS** (> 50 KWth ≤ 1 MWth)	**STANDARD BOILERS** (> 1 MWth ≤ 50 MWth)	**GAS TURBINES** (50 kWth – 50 MWth)	**STATIONARY RECIPROCATING ENGINES** (50 kWth – 50 MWth)	**STANDARD BOILERS** (> 50 KWth ≤ 1 MWth)	**STANDARD BOILERS** (>1 MWth ≤ 50 MWth)
Pb	[mg/GJ]	0.0015	0.0015	0.0015	0.04	27	27
Cd	[mg/GJ]	0.00025	0.00025	0.00025	0.003	13	13
Hg	[mg/GJ]	0.1	0.1	0.1	0.1	0.56	0.56
As	[mg/GJ]	0.12	0.12	0.12	0.05	0.19	0.19
Cr	[mg/GJ]	0.00076	0.00076	0.00076	0.05	23	23
Cu	[mg/GJ]	0.000076	0.000076	0.000076	0.01	6	6

TYPE OF FUEL		GASEOUS FUELS				BIOMASS	
T2	UNIT	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (> 1 MWth ≤ 50 MWth)	GAS TURBINES (50 kWth – 50 MWth)	STATIONARY RECIPROCATING ENGINES (50 kWth – 50 MWth)	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (>1 MWth ≤ 50 MWth)
Ni	[mg/GJ]	0.00051	0.00051	0.00051	0.05	2	2
Se	[mg/GJ]	0.011	0.011	0.011	0.2	0.5	0.5
Zn	[mg/GJ]	0.0015	0.0015	0.0015	2.9	512	512
PCDD/F	[ng I-TEQ/GJ]	0.5	0.5	0.5	0.57	100	100
B(a)P	[mg/GJ]	0.56	0.56	0.56	1.2	10	10
B(b)F	[mg/GJ]	0.84	0.84	0.84	9	16	16
B(k)F	[mg/GJ]	0.84	0.84	0.84	1.7	5	5
I()P	[mg/GJ]	0.84	0.84	0.84	1.8	4	4
PAHs	[mg/GJ]	3.08	3.08	3.08	13.7	35	35
HCB	[μg/GJ]	NA	NA	NA	NA	5	5
PCBs	[μg/GJ]	NA	NA	NA	NA	0.03	0.007

DBC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2019}) (***Table 3.120***). The calculated BC emission values are presented in ***Table 3.116***.

Table 3.120: *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%

3.7.6.3 Completeness

Emissions are well covered. Emissions of NH_3 are reported as NE.

3.7.6.4 Source-specific recalculations

The recalculations were made based on changes in activity data. Results of the recalculations are in ***Table 3.121***.

Table 3.121: *Previous and revised emissions in the category 1A4ci*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0035	0.0035	0%	0.0001	0.0001	0%	0.0002	0.0002	1%
1991	0.0216	0.0216	0%	0.0003	0.0003	0%	0.0009	0.0009	0%
1992	0.0359	0.0359	0%	0.0005	0.0005	0%	0.0015	0.0015	0%
1993	0.0469	0.0469	0%	0.0007	0.0007	0%	0.0019	0.0019	0%
1994	0.0548	0.0548	0%	0.0008	0.0008	0%	0.0022	0.0022	0%
1995	0.0599	0.0599	0%	0.0009	0.0009	0%	0.0024	0.0024	0%
1996	0.0625	0.0625	0%	0.0009	0.0009	0%	0.0025	0.0025	0%
1997	0.0631	0.0631	0%	0.0010	0.0010	0%	0.0026	0.0026	0%
1998	0.0617	0.0617	0%	0.0011	0.0011	0%	0.0025	0.0025	0%
1999	0.0587	0.0587	0%	0.0011	0.0011	0%	0.0024	0.0024	0%
2000	0.0408	0.0408	0%	0.0009	0.0009	0%	0.0017	0.0017	0%
2001	0.0372	0.0372	0%	0.0011	0.0011	0%	0.0016	0.0016	0%
2002	0.0343	0.0343	0%	0.0011	0.0011	0%	0.0015	0.0015	0%
2003	0.0253	0.0253	0%	0.0009	0.0009	0%	0.0011	0.0011	0%

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2004	0.0184	0.0184	0%	0.0008	0.0008	0%	0.0008	0.0008	0%
2005	0.0201	0.0201	0%	0.0008	0.0008	0%	0.0009	0.0009	0%
2006	0.0094	0.0094	0%	0.0006	0.0006	0%	0.0005	0.0005	1%
2007	0.0082	0.0082	0%	0.0006	0.0006	0%	0.0004	0.0005	1%
2008	0.0077	0.0077	0%	0.0006	0.0006	0%	0.0005	0.0005	1%
2009	0.0070	0.0070	0%	0.0005	0.0005	0%	0.0004	0.0004	1%
2010	0.0058	0.0058	0%	0.0006	0.0006	0%	0.0004	0.0004	1%
2011	0.0051	0.0051	0%	0.0008	0.0008	0%	0.0003	0.0003	0%
2012	0.0042	0.0042	0%	0.0008	0.0008	0%	0.0003	0.0003	2%
2013	0.0041	0.0041	0%	0.0008	0.0008	0%	0.0003	0.0003	1%
2014	0.0082	0.0031	-62%	0.0031	0.0007	-77%	0.0004	0.0003	-24%
2015	0.0048	0.0048	0%	0.0013	0.0013	0%	0.0003	0.0004	3%
2016	0.0035	0.0035	0%	0.0008	0.0008	0%	0.0003	0.0003	0%
2017	0.0038	0.0038	0%	0.0008	0.0008	0%	0.0003	0.0003	0%
2018	0.0053	0.0053	0%	0.0020	0.0020	0%	0.0003	0.0003	2%
2019	0.0042	0.0041	0%	0.0013	0.0013	-1%	0.0003	0.0003	0%
2020	0.0041	0.0041	0%	0.0014	0.0014	0%	0.0003	0.0003	0%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0002	0.0002	0%	0.0005	0.0005	0%	0.0006	0.0006	0%
1991	0.0006	0.0006	0%	0.0019	0.0019	0%	0.0032	0.0032	0%
1992	0.0010	0.0010	0%	0.0031	0.0031	0%	0.0053	0.0053	0%
1993	0.0013	0.0013	0%	0.0040	0.0040	0%	0.0069	0.0069	0%
1994	0.0015	0.0015	0%	0.0048	0.0048	0%	0.0081	0.0081	0%
1995	0.0016	0.0016	0%	0.0053	0.0053	0%	0.0089	0.0089	0%
1996	0.0017	0.0017	0%	0.0056	0.0056	0%	0.0093	0.0093	0%
1997	0.0018	0.0018	0%	0.0059	0.0059	0%	0.0094	0.0094	0%
1998	0.0017	0.0017	0%	0.0060	0.0060	0%	0.0093	0.0093	0%
1999	0.0017	0.0017	0%	0.0061	0.0061	0%	0.0089	0.0089	0%
2000	0.0012	0.0013	0%	0.0048	0.0048	0%	0.0063	0.0063	0%
2001	0.0012	0.0012	0%	0.0050	0.0050	0%	0.0059	0.0059	0%
2002	0.0011	0.0011	0%	0.0049	0.0049	0%	0.0055	0.0055	0%
2003	0.0008	0.0008	0%	0.0039	0.0039	0%	0.0041	0.0041	0%
2004	0.0007	0.0007	0%	0.0037	0.0037	0%	0.0032	0.0032	0%
2005	0.0007	0.0007	0%	0.0034	0.0034	0%	0.0033	0.0033	0%
2006	0.0005	0.0005	0%	0.0027	0.0027	0%	0.0019	0.0019	0%
2007	0.0004	0.0004	0%	0.0017	0.0017	0%	0.0013	0.0013	0%
2008	0.0004	0.0004	0%	0.0016	0.0016	0%	0.0013	0.0013	0%
2009	0.0003	0.0003	0%	0.0015	0.0015	0%	0.0012	0.0012	0%
2010	0.0003	0.0003	0%	0.0015	0.0015	0%	0.0010	0.0010	0%
2011	0.0003	0.0003	0%	0.0016	0.0016	0%	0.0009	0.0009	0%
2012	0.0002	0.0002	1%	0.0015	0.0015	0%	0.0007	0.0007	0%
2013	0.0003	0.0003	0%	0.0016	0.0016	0%	0.0007	0.0007	0%
2014	0.0003	0.0002	-9%	0.0057	0.0014	-75%	0.0017	0.0006	-66%
2015	0.0002	0.0002	2%	0.0025	0.0025	0%	0.0009	0.0009	0%
2016	0.0002	0.0002	0%	0.0016	0.0016	0%	0.0007	0.0007	0%
2017	0.0002	0.0002	0%	0.0017	0.0017	0%	0.0007	0.0007	0%
2018	0.0002	0.0002	2%	0.0036	0.0036	0%	0.0011	0.0011	0%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2019	0.0002	0.0002	0%	0.0025	0.0024	-1%	0.0008	0.0008	0%
2020	0.0003	0.0003	0%	0.0026	0.0026	0%	0.0008	0.0008	0%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0037	0.0037	0%	0.0000	0.0000	6%	0.0053	0.0053	1%
1991	0.0048	0.0048	0%	0.0002	0.0002	1%	0.0323	0.0323	0%
1992	0.0062	0.0062	0%	0.0004	0.0004	0%	0.0538	0.0539	0%
1993	0.0079	0.0079	0%	0.0005	0.0005	0%	0.0703	0.0703	0%
1994	0.0098	0.0098	0%	0.0006	0.0006	0%	0.0821	0.0822	0%
1995	0.0118	0.0118	0%	0.0007	0.0007	0%	0.0898	0.0898	0%
1996	0.0138	0.0138	0%	0.0007	0.0007	0%	0.0942	0.0942	0%
1997	0.0157	0.0157	0%	0.0007	0.0007	0%	0.0977	0.0977	0%
1998	0.0176	0.0176	0%	0.0007	0.0007	0%	0.0986	0.0986	0%
1999	0.0192	0.0192	0%	0.0007	0.0007	1%	0.0972	0.0973	0%
2000	0.0187	0.0187	0%	0.0005	0.0005	1%	0.0719	0.0720	0%
2001	0.0205	0.0205	0%	0.0004	0.0004	1%	0.0747	0.0748	0%
2002	0.0215	0.0215	0%	0.0004	0.0004	1%	0.0728	0.0729	0%
2003	0.0169	0.0169	0%	0.0003	0.0003	2%	0.0588	0.0589	0%
2004	0.0223	0.0223	0%	0.0002	0.0002	2%	0.0469	0.0470	0%
2005	0.0162	0.0162	0%	0.0002	0.0002	3%	0.0483	0.0483	0%
2006	0.0184	0.0184	0%	0.0001	0.0001	5%	0.0315	0.0316	0%
2007	0.0040	0.0040	0%	0.0001	0.0001	5%	0.0305	0.0306	0%
2008	0.0048	0.0048	0%	0.0001	0.0001	6%	0.0278	0.0279	0%
2009	0.0033	0.0033	0%	0.0001	0.0001	5%	0.0275	0.0275	0%
2010	0.0039	0.0039	0%	0.0001	0.0001	6%	0.0276	0.0277	0%
2011	0.0012	0.0012	0%	0.0001	0.0001	3%	0.0344	0.0345	0%
2012	0.0007	0.0007	0%	0.0001	0.0001	11%	0.0331	0.0333	0%
2013	0.0007	0.0007	0%	0.0001	0.0001	3%	0.0349	0.0350	0%
2014	0.0009	0.0005	-43%	0.0003	0.0002	-28%	0.1275	0.0323	-75%
2015	0.0006	0.0006	6%	0.0003	0.0003	6%	0.0576	0.0579	0%
2016	0.0008	0.0008	0%	0.0003	0.0003	0%	0.0365	0.0365	0%
2017	0.0008	0.0008	0%	0.0002	0.0002	0%	0.0377	0.0377	0%
2018	0.0009	0.0009	0%	0.0003	0.0003	5%	0.0818	0.0820	0%
2019	0.0011	0.0011	0%	0.0003	0.0003	0%	0.0548	0.0545	-1%
2020	0.0006	0.0006	0%	0.0002	0.0002	0%	0.0596	0.0596	0%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0068	0.0068	0%	0.0075	0.0077	2%
1991	0.0412	0.0412	0%	0.0339	0.0341	0%
1992	0.0686	0.0686	0%	0.0551	0.0552	0%
1993	0.0895	0.0895	0%	0.0714	0.0715	0%
1994	0.1045	0.1045	0%	0.0833	0.0834	0%
1995	0.1141	0.1141	0%	0.0911	0.0912	0%
1996	0.1191	0.1191	0%	0.0954	0.0955	0%
1997	0.1203	0.1203	0%	0.0966	0.0967	0%
1998	0.1179	0.1179	0%	0.0950	0.0952	0%
1999	0.1124	0.1125	0%	0.0910	0.0913	0%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2000	0.0784	0.0784	0%	0.0651	0.0654	0%
2001	0.0722	0.0723	0%	0.0602	0.0605	1%
2002	0.0669	0.0669	0%	0.0560	0.0564	1%
2003	0.0500	0.0500	0%	0.0421	0.0424	1%
2004	0.0361	0.0361	0%	0.0322	0.0326	1%
2005	0.0398	0.0398	0%	0.0353	0.0358	1%
2006	0.0190	0.0190	0%	0.0188	0.0192	2%
2007	0.0179	0.0180	0%	0.0166	0.0170	2%
2008	0.0168	0.0168	0%	0.0163	0.0167	3%
2009	0.0156	0.0156	0%	0.0149	0.0152	2%
2010	0.0138	0.0138	0%	0.0138	0.0141	3%
2011	0.0133	0.0133	0%	0.0124	0.0126	2%
2012	0.0115	0.0115	0%	0.0113	0.0120	6%
2013	0.0117	0.0117	0%	0.0128	0.0130	2%
2014	0.0280	0.0095	-66%	0.0260	0.0198	-24%
2015	0.0150	0.0151	0%	0.0242	0.0255	5%
2016	0.0107	0.0107	0%	0.0217	0.0217	0%
2017	0.0114	0.0114	0%	0.0209	0.0209	0%
2018	0.0185	0.0186	0%	0.0234	0.0245	5%
2019	0.0137	0.0136	0%	0.0221	0.0221	0%
2020	0.0142	0.0142	0%	0.0209	0.0210	0%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0000	0.0000	0%	0.0031	0.0031	0%
1991	0.0001	0.0001	0%	0.0198	0.0198	0%
1992	0.0001	0.0001	0%	0.0331	0.0331	0%
1993	0.0002	0.0002	0%	0.0433	0.0433	0%
1994	0.0002	0.0002	0%	0.0505	0.0505	0%
1995	0.0002	0.0002	0%	0.0552	0.0552	0%
1996	0.0002	0.0002	0%	0.0575	0.0575	0%
1997	0.0002	0.0002	0%	0.0577	0.0577	0%
1998	0.0003	0.0003	0%	0.0562	0.0562	0%
1999	0.0003	0.0003	0%	0.0531	0.0531	0%
2000	0.0003	0.0003	0%	0.0363	0.0363	0%
2001	0.0003	0.0003	0%	0.0324	0.0324	0%
2002	0.0003	0.0003	0%	0.0295	0.0295	0%
2003	0.0003	0.0003	0%	0.0215	0.0215	0%
2004	0.0003	0.0003	0%	0.0148	0.0148	0%
2005	0.0003	0.0003	0%	0.0168	0.0168	0%
2006	0.0002	0.0002	0%	0.0067	0.0067	0%
2007	0.0002	0.0002	0%	0.0064	0.0064	0%
2008	0.0002	0.0002	0%	0.0061	0.0061	0%
2009	0.0002	0.0002	0%	0.0054	0.0054	0%
2010	0.0002	0.0002	0%	0.0040	0.0040	0%
2011	0.0003	0.0003	0%	0.0032	0.0032	0%
2012	0.0003	0.0003	0%	0.0024	0.0024	0%
2013	0.0003	0.0003	0%	0.0023	0.0023	0%
2014	0.0012	0.0003	-77%	0.0016	0.0016	0%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2015	0.0005	0.0005	0%	0.0019	0.0019	0%
2016	0.0003	0.0003	0%	0.0017	0.0017	0%
2017	0.0003	0.0003	0%	0.0018	0.0018	0%
2018	0.0008	0.0008	0%	0.0010	0.0010	0%
2019	0.0005	0.0005	-1%	0.0012	0.0012	0%
2020	0.0005	0.0005	0%	0.0009	0.0009	0%

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, harvesters and it is not considered as a key category. The overview of the emissions is shown in ***Table 3.122***.

Table 3.122: *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
1990/2021	**-79%**	**-85%**	**-80%**	**-80%**	**-79%**	**-79%**	**-79%**	**-79%**	**-97%**
2020/2021	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**

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
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

YEAR	Cd [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	B(a)P [t]	B(b)F [t]	PAHs [t]
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
1990/2021	**-80%**	**-80%**	**-80%**	**-80%**	**-80%**	**-80%**	**-81%**	**-80%**	**-80%**
2020/2021	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**	**-9%**

Slovakia was able to separate the consumption in this report for category **1A4cii** from other categories previously reported within this category (***Table 3.123***). 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 2021 was used 2 027.59 TJ of liquid fuels. An overview of the activity data (energy consumption) for this source category is in ***Table 3.123*** below.

Table 3.123: *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
1990/2021	**-82%**	**-**	**-**	**-**	**-**
2019/2021	**-8.75%**	**-**	**-**	**-9%**	**-**

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 the ***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_{2019} and for the emission estimation, EMEP/EEA GB_{2019} Tier 1 emission factors were used.

3.7.7.3 Completeness

Emissions are well covered. Notation keys are used according to EMEP/EEA GB_{2019}.

3.7.7.4 Source-specific recalculations

This chapter describes the recalculations of emissions. In the IIR 2023, there were no source-specific recalculations made.

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 3.124***.

Table 3.124: *Activities according to national categorization included in 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 the emissions is shown in ***Table 3.125***.

Table 3.125: *Overview of emissions in the 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	0.1822	0.0067	0.3165	0.0052	0.0377	0.0503	0.0952	0.0025	0.2203
1995	0.1888	0.0069	0.3280	0.0054	0.0391	0.0521	0.0987	0.0026	0.2282
2000	0.1571	0.0305	0.3803	0.0051	0.0575	0.0767	0.1453	0.0039	0.2958
2005	0.1958	0.4743	0.3183	0.0043	0.0218	0.0322	0.0800	0.0019	0.1827
2010	0.1304	0.5664	0.1006	0.0016	0.0120	0.0173	0.0351	0.0016	0.1396
2011	0.1740	0.5174	0.1186	0.0015	0.0143	0.0197	0.0391	0.0021	0.1770
2012	0.3651	0.6715	0.2344	0.0013	0.0244	0.0302	0.0510	0.0067	0.2433
2013	0.6197	0.7291	0.2973	0.0016	0.0271	0.0324	0.0522	0.0074	0.3603
2014	0.4491	0.7664	0.2368	0.0003	0.0230	0.0269	0.0388	0.0064	0.2366
2015	0.4062	0.8148	0.2074	0.0020	0.0218	0.0259	0.0391	0.0060	0.2101
2016	0.5112	0.8024	0.2863	0.0005	0.0264	0.0310	0.0455	0.0073	0.2621
2017	0.6503	0.8948	0.3673	0.0006	0.0171	0.0212	0.0357	0.0047	0.2710
2018	0.6149	0.8833	0.3471	0.0011	0.0155	0.0208	0.0442	0.0042	0.2641
2019	0.6353	0.8573	0.3577	0.0018	0.0141	0.0165	0.0211	0.0038	0.3601
2020	0.3977	0.5465	0.1885	0.0005	0.0142	0.0165	0.0202	0.0025	0.3501
2021	0.3803	0.5452	0.1534	0.0006	0.0154	0.0181	0.0223	0.0028	0.3655
1990/2021	**109%**	**8083%**	**-52%**	**-89%**	**-59%**	**-64%**	**-77%**	**12%**	**66%**
2020/2021	**-4%**	**0%**	**-19%**	**5%**	**8%**	**10%**	**10%**	**14%**	**4%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.3689	0.0045	0.0244	0.0126	0.0438	0.0453	0.0468	0.0058	0.5534
1995	0.1470	0.0018	0.0098	0.0051	0.0179	0.0181	0.0227	0.0023	0.2216
2000	0.0356	0.0005	0.0024	0.0014	0.0054	0.0046	0.0178	0.0006	0.0546
2005	0.0131	0.0002	0.0009	0.0005	0.0023	0.0017	0.0087	0.0002	0.0219
2010	0.0080	0.0002	0.0006	0.0004	0.0013	0.0011	0.0042	0.0002	0.0148
2011	0.0052	0.0002	0.0005	0.0003	0.0010	0.0007	0.0026	0.0002	0.0140
2012	0.0442	0.0188	0.0014	0.0007	0.0339	0.0094	0.0056	0.0011	0.7494
2013	0.0522	0.0232	0.0017	0.0008	0.0416	0.0112	0.0058	0.0015	0.9252
2014	0.0572	0.0259	0.0016	0.0007	0.0463	0.0124	0.0063	0.0014	1.0291
2015	0.0631	0.0286	0.0017	0.0007	0.0511	0.0137	0.0069	0.0015	1.1331
2016	0.0578	0.0257	0.0017	0.0007	0.0461	0.0124	0.0061	0.0015	1.0220
2017	0.0747	0.0339	0.0021	0.0009	0.0606	0.0162	0.0066	0.0019	1.3474

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2018	0.0284	0.0120	0.0010	0.0005	0.0216	0.0060	0.0030	0.0010	0.4820
2019	0.0254	0.0108	0.0009	0.0004	0.0195	0.0054	0.0026	0.0009	0.4362
2020	0.0245	0.0106	0.0009	0.0004	0.0191	0.0052	0.0024	0.0009	0.4276
2021	0.0247	0.0107	0.0009	0.0004	0.0192	0.0053	0.0025	0.0009	0.4286
1990/2021	**-93%**	**136%**	**-96%**	**-97%**	**-56%**	**-88%**	**-95%**	**-85%**	**-23%**
2020/2021	**1%**	**0%**	**-3%**	**-1%**	**0%**	**1%**	**2%**	**-6%**	**0%**

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	0.5352	0.1106	0.1451	0.0620	0.0477	0.3654	0.0018	0.4859
1995	0.2137	0.0445	0.0586	0.0253	0.0196	0.1480	0.0007	0.1933
2000	0.0518	0.0111	0.0150	0.0068	0.0054	0.0383	0.0002	0.0459
2005	0.0194	0.0043	0.0060	0.0028	0.0023	0.0154	0.0001	0.0166
2010	0.0126	0.0033	0.0058	0.0025	0.0022	0.0138	0.0001	0.0097
2011	0.0091	0.0030	0.0091	0.0029	0.0028	0.0179	0.0001	0.0062
2012	0.1534	0.0185	0.0384	0.0115	0.0100	0.0785	0.0072	0.0065
2013	0.1861	0.0232	0.0566	0.0155	0.0139	0.1093	0.0089	0.0050
2014	0.2058	0.0238	0.0516	0.0145	0.0125	0.1025	0.0100	0.0040
2015	0.2267	0.0257	0.0525	0.0152	0.0130	0.1063	0.0110	0.0045
2016	0.2052	0.0242	0.0542	0.0151	0.0131	0.1066	0.0099	0.0057
2017	0.2685	0.0309	0.0675	0.0188	0.0163	0.1336	0.0130	0.0056
2018	0.0990	0.0138	0.0395	0.0101	0.0093	0.0728	0.0046	0.0043
2019	0.0897	0.0127	0.0371	0.0094	0.0087	0.0679	0.0042	0.0031
2020	0.0872	0.0122	0.0354	0.0090	0.0084	0.0650	0.0041	0.0027
2021	0.0880	0.0121	0.0333	0.0087	0.0080	0.0622	0.0041	0.0025
1990/2021	**-84%**	**-89%**	**-77%**	**-86%**	**-83%**	**-83%**	**131%**	**-99%**
2020/2021	**1%**	**-1%**	**-6%**	**-3%**	**-4%**	**-4%**	**0%**	**-5%**

An overview of the activity data (energy consumption) for this source category is in ***Table 3.126*** below.

Table 3.126: *Overview of activity data in the 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
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
1990/2021	**59%**	**-95%**	**-24%**	**1019%**	**-**
2020/2021	**2%**	**-5%**	**12%**	**-5%**	**-**

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 is 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 2021.

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 3.127***).

Table 3.127: *Emission factors for calculation of historical years*

	NOx [g/tGJ]	NMVOC [g/tGJ]	SOx [g/tGJ]	NH_3 [g/GJ]	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	40%	53%	91.77

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 this 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 heavy metals and POPs are default EF from EMEP/EEA GB_{2019} (***Table 3.128***).

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 3.128: *Emission factors for heavy metals and POPs in the category 1A5a*

TYPE OF FUEL		LIQUID FUELS				HARD COAL/BROWN COAL	
T2	UNIT	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (> 1 MWth ≤ 50 MWth)	GAS TURBINES (50 kWth – 50 MWth)	STATIONARY RECIPROCATING ENGINES (50 kWth – 50 MWth)	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (>1 MWth ≤ 50 MWth)
Pb	[mg/GJ]	20	10	0.012	0.15	200	100
Cd	[mg/GJ]	0.3	0.3	0.001	0.01	3	1
Hg	[mg/GJ]	0.1	0.1	0.12	0.11	7	9
As	[mg/GJ]	1	1	0.002	0.06	5	4
Cr	[mg/GJ]	20	20	0.2	0.2	15	15
Cu	[mg/GJ]	10	3	0.13	0.3	17.5	10
Ni	[mg/GJ]	300	200	0.005	0.01	13	10
Se	[mg/GJ]	NA	0.5	0.002	0.22	1.8	2
Zn	[mg/GJ]	10	5	0.42	58	200	150
PCDD/F	[ng I-TEQ/GJ]	10	10	1.8	0.99	203	100
B(a)P	[mg/GJ]	8	1	NE	1.9	45.5	13
B(b)F	[mg/GJ]	9	2	NE	15	58.9	17
B(k)F	[mg/GJ]	6	1	NE	1.7	23.7	9
I()P	[mg/GJ]	3	1	NE	1.5	18.5	6

TYPE OF FUEL		LIQUID FUELS				HARD COAL/BROWN COAL	
PAHs	[mg/GJ]	26	5	NE	20.1	146.6	45
HCB	[µg/GJ]	NE	NE	NE	0.22	0.62	0.62
PCBs	[µg/GJ]	NE	NE	NE	0.13	170	170

TYPE OF FUEL		GASEOUS FUELS				BIOMASS	
T2	UNIT	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (> 1 MWth ≤ 50 MWth)	GAS TURBINES (50 kWth – 50 MWth)	STATIONARY RECIPROCATING ENGINES (50 kWth – 50 MWth)	STANDARD BOILERS (> 50 KWth ≤ 1 MWth)	STANDARD BOILERS (>1 MWth ≤ 50 MWth)
Pb	[mg/GJ]	0.0015	0.0015	0.0015	0.04	27	27
Cd	[mg/GJ]	0.00025	0.00025	0.00025	0.003	13	13
Hg	[mg/GJ]	0.1	0.1	0.1	0.1	0.56	0.56
As	[mg/GJ]	0.12	0.12	0.12	0.05	0.19	0.19
Cr	[mg/GJ]	0.00076	0.00076	0.00076	0.05	23	23
Cu	[mg/GJ]	0.000076	0.000076	0.000076	0.01	6	6
Ni	[mg/GJ]	0.00051	0.00051	0.00051	0.05	2	2
Se	[mg/GJ]	0.011	0.011	0.011	0.2	0.5	0.5
Zn	[mg/GJ]	0.0015	0.0015	0.0015	2.9	512	512
PCDD/F	[ng I-TEQ/GJ]	0.5	0.5	0.5	0.57	100	100
B(a)P	[mg/GJ]	0.56	0.56	0.56	1.2	10	10
B(b)F	[mg/GJ]	0.84	0.84	0.84	9	16	16
B(k)F	[mg/GJ]	0.84	0.84	0.84	1.7	5	5
I()P	[mg/GJ]	0.84	0.84	0.84	1.8	4	4
PAHs	[mg/GJ]	3.08	3.08	3.08	13.7	35	35
HCB	[µg/GJ]	NA	NA	NA	NA	5	5
PCBs	[µg/GJ]	NA	NA	NA	NA	0.03	0.007

DBC emissions were estimated in this submission for this category based on total $PM_{2.5}$ emissions – using corrected EF for BC (EMEP/EEA GB_{2019}) (***Table 3.129***). The calculated BC emission values are presented in ***Table 3.125***.

Table 3.129: *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%

3.7.9.3 Completeness

Emissions are well covered.

3.7.9.4 Source-specific recalculations

The recalculations were made based on changes in activity data. The results of the recalculations are in ***Table 3.130***.

Table 3.130: *Previous and revised emissions in the category 1A5a*

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.3689	0.3689	0%	0.0045	0.0045	0%	0.0244	0.0244	0%
1991	0.3119	0.3119	0%	0.0038	0.0038	0%	0.0206	0.0206	0%

YEAR	Pb [t]			Cd [t]			Hg [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1992	0.2617	0.2617	0%	0.0032	0.0032	0%	0.0173	0.0173	0%
1993	0.2178	0.2178	0%	0.0027	0.0027	0%	0.0144	0.0144	0%
1994	0.1797	0.1797	0%	0.0022	0.0022	0%	0.0118	0.0118	0%
1995	0.1470	0.1470	0%	0.0018	0.0018	0%	0.0098	0.0098	0%
1996	0.1193	0.1193	0%	0.0015	0.0015	0%	0.0080	0.0080	0%
1997	0.0961	0.0961	0%	0.0012	0.0012	0%	0.0064	0.0064	0%
1998	0.0769	0.0769	0%	0.0010	0.0010	1%	0.0052	0.0052	0%
1999	0.0613	0.0614	0%	0.0008	0.0008	1%	0.0041	0.0041	0%
2000	0.0356	0.0356	0%	0.0005	0.0005	1%	0.0024	0.0024	0%
2001	0.0302	0.0302	0%	0.0004	0.0004	2%	0.0020	0.0020	0%
2002	0.0249	0.0249	0%	0.0003	0.0004	2%	0.0017	0.0017	0%
2003	0.0206	0.0206	0%	0.0003	0.0003	3%	0.0014	0.0014	0%
2004	0.0148	0.0148	0%	0.0002	0.0002	4%	0.0010	0.0010	0%
2005	0.0131	0.0131	0%	0.0002	0.0002	5%	0.0009	0.0009	0%
2006	0.0106	0.0106	0%	0.0002	0.0002	7%	0.0008	0.0008	0%
2007	0.0114	0.0114	0%	0.0002	0.0002	6%	0.0009	0.0009	0%
2008	0.0129	0.0129	0%	0.0005	0.0005	0%	0.0010	0.0010	0%
2009	0.0070	0.0070	0%	0.0002	0.0002	0%	0.0005	0.0005	1%
2010	0.0080	0.0080	0%	0.0002	0.0002	0%	0.0006	0.0006	0%
2011	0.0052	0.0052	0%	0.0002	0.0002	0%	0.0005	0.0005	4%
2012	0.0442	0.0442	0%	0.0188	0.0188	0%	0.0014	0.0014	0%
2013	0.0521	0.0522	0%	0.0232	0.0232	0%	0.0017	0.0017	-1%
2014	0.0572	0.0572	0%	0.0259	0.0259	0%	0.0016	0.0016	0%
2015	0.0631	0.0631	0%	0.0286	0.0286	0%	0.0017	0.0017	1%
2016	0.0578	0.0578	0%	0.0257	0.0257	0%	0.0017	0.0017	0%
2017	0.0747	0.0747	0%	0.0339	0.0339	0%	0.0021	0.0021	0%
2018	0.0284	0.0284	0%	0.0120	0.0120	0%	0.0010	0.0010	1%
2019	0.0254	0.0254	0%	0.0108	0.0108	0%	0.0009	0.0009	4%
2020	0.0245	0.0245	0%	0.0106	0.0106	0%	0.0009	0.0009	3%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0126	0.0126	0%	0.0438	0.0438	0%	0.0453	0.0453	0%
1991	0.0107	0.0107	0%	0.0371	0.0371	0%	0.0383	0.0383	0%
1992	0.0090	0.0090	0%	0.0312	0.0312	0%	0.0321	0.0321	0%
1993	0.0075	0.0075	0%	0.0261	0.0261	0%	0.0268	0.0268	0%
1994	0.0061	0.0061	0%	0.0216	0.0216	0%	0.0221	0.0221	0%
1995	0.0051	0.0051	0%	0.0178	0.0179	0%	0.0181	0.0181	0%
1996	0.0042	0.0042	0%	0.0146	0.0146	0%	0.0147	0.0147	0%
1997	0.0034	0.0034	0%	0.0120	0.0120	0%	0.0119	0.0119	0%
1998	0.0028	0.0028	0%	0.0097	0.0098	0%	0.0095	0.0095	0%
1999	0.0023	0.0023	0%	0.0080	0.0080	0%	0.0076	0.0076	0%
2000	0.0014	0.0014	0%	0.0054	0.0054	0%	0.0045	0.0046	0%
2001	0.0012	0.0012	0%	0.0048	0.0048	0%	0.0039	0.0039	0%
2002	0.0009	0.0009	0%	0.0036	0.0036	0%	0.0032	0.0032	0%
2003	0.0008	0.0008	0%	0.0032	0.0032	0%	0.0026	0.0026	0%
2004	0.0006	0.0006	0%	0.0025	0.0025	1%	0.0019	0.0019	0%
2005	0.0005	0.0005	0%	0.0022	0.0023	1%	0.0017	0.0017	0%
2006	0.0005	0.0005	0%	0.0020	0.0020	1%	0.0014	0.0014	0%

YEAR	As [t]			Cr [t]			Cu [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2007	0.0005	0.0005	0%	0.0016	0.0016	1%	0.0014	0.0014	0%
2008	0.0006	0.0006	0%	0.0024	0.0024	0%	0.0016	0.0016	0%
2009	0.0003	0.0003	1%	0.0013	0.0013	0%	0.0010	0.0010	0%
2010	0.0004	0.0004	0%	0.0013	0.0013	0%	0.0011	0.0011	0%
2011	0.0003	0.0003	3%	0.0009	0.0010	1%	0.0007	0.0007	0%
2012	0.0007	0.0007	0%	0.0339	0.0339	0%	0.0094	0.0094	0%
2013	0.0008	0.0008	-5%	0.0416	0.0416	0%	0.0112	0.0112	0%
2014	0.0007	0.0007	0%	0.0463	0.0463	0%	0.0124	0.0124	0%
2015	0.0007	0.0007	1%	0.0511	0.0511	0%	0.0137	0.0137	0%
2016	0.0007	0.0007	0%	0.0461	0.0461	0%	0.0124	0.0124	0%
2017	0.0009	0.0009	0%	0.0606	0.0606	0%	0.0162	0.0162	0%
2018	0.0005	0.0005	2%	0.0216	0.0216	0%	0.0060	0.0060	0%
2019	0.0004	0.0004	5%	0.0195	0.0195	0%	0.0054	0.0054	0%
2020	0.0004	0.0004	3%	0.0191	0.0191	0%	0.0052	0.0052	0%

YEAR	Ni [t]			Se [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0468	0.0468	0%	0.0058	0.0058	0%	0.5534	0.5534	0%
1991	0.0402	0.0402	0%	0.0049	0.0049	0%	0.4682	0.4683	0%
1992	0.0346	0.0346	0%	0.0041	0.0041	0%	0.3931	0.3932	0%
1993	0.0299	0.0299	0%	0.0034	0.0034	0%	0.3273	0.3275	0%
1994	0.0260	0.0260	0%	0.0028	0.0028	0%	0.2703	0.2704	0%
1995	0.0227	0.0227	0%	0.0023	0.0023	0%	0.2214	0.2216	0%
1996	0.0201	0.0201	0%	0.0019	0.0019	0%	0.1799	0.1801	0%
1997	0.0180	0.0180	0%	0.0015	0.0015	0%	0.1451	0.1453	0%
1998	0.0163	0.0163	0%	0.0012	0.0012	0%	0.1164	0.1166	0%
1999	0.0150	0.0150	0%	0.0010	0.0010	0%	0.0931	0.0933	0%
2000	0.0178	0.0178	0%	0.0006	0.0006	0%	0.0543	0.0546	0%
2001	0.0175	0.0175	0%	0.0005	0.0005	0%	0.0464	0.0467	1%
2002	0.0100	0.0100	0%	0.0004	0.0004	0%	0.0385	0.0388	1%
2003	0.0108	0.0108	0%	0.0003	0.0003	0%	0.0320	0.0324	1%
2004	0.0100	0.0100	0%	0.0003	0.0003	0%	0.0236	0.0240	2%
2005	0.0087	0.0087	0%	0.0002	0.0002	0%	0.0214	0.0219	2%
2006	0.0086	0.0086	0%	0.0002	0.0002	1%	0.0179	0.0184	3%
2007	0.0030	0.0030	0%	0.0002	0.0002	1%	0.0190	0.0195	3%
2008	0.0034	0.0034	0%	0.0002	0.0002	1%	0.0339	0.0340	0%
2009	0.0051	0.0051	0%	0.0001	0.0001	4%	0.0150	0.0151	1%
2010	0.0042	0.0042	0%	0.0002	0.0002	3%	0.0147	0.0148	1%
2011	0.0026	0.0026	0%	0.0002	0.0002	18%	0.0135	0.0140	4%
2012	0.0056	0.0056	0%	0.0011	0.0011	1%	0.7492	0.7494	0%
2013	0.0058	0.0058	0%	0.0015	0.0015	4%	0.9243	0.9252	0%
2014	0.0063	0.0063	0%	0.0014	0.0014	0%	1.0291	1.0291	0%
2015	0.0069	0.0069	0%	0.0015	0.0015	1%	1.1328	1.1331	0%
2016	0.0061	0.0061	1%	0.0015	0.0015	0%	1.0220	1.0220	0%
2017	0.0066	0.0066	0%	0.0019	0.0019	0%	1.3474	1.3474	0%
2018	0.0030	0.0030	0%	0.0010	0.0010	1%	0.4819	0.4820	0%
2019	0.0026	0.0026	0%	0.0009	0.0009	6%	0.4354	0.4362	0%
2020	0.0024	0.0024	0%	0.0009	0.0009	5%	0.4270	0.4276	0%

YEAR	PCDD/F [g I-TEQ]			PAHs [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.5352	0.5352	0%	0.3653	0.3654	0%
1991	0.4526	0.4526	0%	0.3092	0.3093	0%
1992	0.3798	0.3798	0%	0.2595	0.2596	0%
1993	0.3160	0.3161	0%	0.2160	0.2161	0%
1994	0.2606	0.2606	0%	0.1769	0.1770	0%
1995	0.2136	0.2137	0%	0.1479	0.1480	0%
1996	0.1736	0.1737	0%	0.1221	0.1222	0%
1997	0.1399	0.1400	0%	0.0992	0.0993	0%
1998	0.1122	0.1122	0%	0.0808	0.0810	0%
1999	0.0895	0.0895	0%	0.0646	0.0647	0%
2000	0.0518	0.0518	0%	0.0383	0.0383	0%
2001	0.0439	0.0440	0%	0.0330	0.0331	0%
2002	0.0364	0.0364	0%	0.0269	0.0269	0%
2003	0.0302	0.0302	0%	0.0234	0.0235	0%
2004	0.0218	0.0219	0%	0.0173	0.0174	0%
2005	0.0193	0.0194	0%	0.0153	0.0154	0%
2006	0.0161	0.0162	1%	0.0151	0.0152	1%
2007	0.0173	0.0174	1%	0.0154	0.0155	1%
2008	0.0197	0.0197	0%	0.0156	0.0158	1%
2009	0.0112	0.0112	0%	0.0113	0.0117	3%
2010	0.0126	0.0126	0%	0.0134	0.0138	3%
2011	0.0090	0.0091	1%	0.0154	0.0179	16%
2012	0.1534	0.1534	0%	0.0778	0.0785	1%
2013	0.1862	0.1861	0%	0.1066	0.1093	2%
2014	0.2058	0.2058	0%	0.1025	0.1025	0%
2015	0.2266	0.2267	0%	0.1051	0.1063	1%
2016	0.2052	0.2052	0%	0.1066	0.1066	0%
2017	0.2685	0.2685	0%	0.1336	0.1336	0%
2018	0.0989	0.0990	0%	0.0717	0.0728	1%
2019	0.0895	0.0897	0%	0.0642	0.0679	6%
2020	0.0871	0.0872	0%	0.0620	0.0650	5%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0018	0.0018	0%	0.4859	0.4859	0%
1991	0.0015	0.0015	0%	0.4108	0.4108	0%
1992	0.0013	0.0013	0%	0.3446	0.3446	0%
1993	0.0011	0.0011	0%	0.2867	0.2867	0%
1994	0.0009	0.0009	0%	0.2365	0.2365	0%
1995	0.0007	0.0007	0%	0.1933	0.1933	0%
1996	0.0006	0.0006	0%	0.1567	0.1567	0%
1997	0.0005	0.0005	0%	0.1261	0.1261	0%
1998	0.0004	0.0004	1%	0.1007	0.1007	0%
1999	0.0003	0.0003	1%	0.0802	0.0802	0%
2000	0.0002	0.0002	1%	0.0459	0.0459	0%
2001	0.0002	0.0002	2%	0.0386	0.0386	0%
2002	0.0001	0.0001	2%	0.0322	0.0322	0%
2003	0.0001	0.0001	3%	0.0264	0.0264	0%
2004	0.0001	0.0001	4%	0.0188	0.0188	0%

YEAR	HCB [kg]			PCB [kg]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.0001	0.0001	5%	0.0166	0.0166	0%
2006	0.0001	0.0001	7%	0.0133	0.0133	0%
2007	0.0001	0.0001	6%	0.0147	0.0147	0%
2008	0.0002	0.0002	0%	0.0169	0.0169	0%
2009	0.0001	0.0001	0%	0.0084	0.0084	0%
2010	0.0001	0.0001	0%	0.0097	0.0097	0%
2011	0.0001	0.0001	0%	0.0062	0.0062	0%
2012	0.0072	0.0072	0%	0.0065	0.0065	0%
2013	0.0089	0.0089	0%	0.0050	0.0050	0%
2014	0.0100	0.0100	0%	0.0040	0.0040	0%
2015	0.0110	0.0110	0%	0.0045	0.0045	0%
2016	0.0099	0.0099	0%	0.0057	0.0057	0%
2017	0.0130	0.0130	0%	0.0056	0.0056	0%
2018	0.0046	0.0046	0%	0.0043	0.0043	0%
2019	0.0042	0.0042	0%	0.0031	0.0031	0%
2020	0.0041	0.0041	0%	0.0027	0.0027	0%

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 150.19 TJ in 2021. This consumption includes petrol, diesel oil and jet fuel. Emissions of mobile combustion in the military are shown in ***Table 3.131***.

Table 3.131: *Overview of emissions in the 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	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1995	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2000	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2005	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2010	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2011	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2012	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2013	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2014	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2015	0.0773	0.0004	0.0045	0.0000	0.0004	0.0004	0.0004	0.0002	0.0337	0.0000
2016	0.0779	0.0004	0.0045	0.0000	0.0005	0.0005	0.0005	0.0002	0.0339	0.0000
2017	0.0724	0.0004	0.0042	0.0000	0.0004	0.0004	0.0004	0.0002	0.0315	0.0000
2018	0.0564	0.0003	0.0033	0.0000	0.0003	0.0003	0.0003	0.0002	0.0246	0.0000
2019	0.0502	0.0003	0.0029	0.0000	0.0003	0.0003	0.0003	0.0001	0.0219	0.0000
2020	0.0495	0.0003	0.0029	0.0000	0.0003	0.0003	0.0003	0.0001	0.0215	0.0000
2021	0.0495	0.0003	0.0029	0.0000	0.0003	0.0003	0.0003	0.0001	0.0215	0.0000
1990/2021	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
2020/2021	**0%**	**0%**	**0%**	**50%**	**0%**	**0%**	**0%**	**0%**	**0%**	**8%**

3.7.10.2 Methodological issues

For the emission estimation, GBEMEP/EEA$_{2019}$ 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_{2019}.

3.7.10.4 Source-specific recalculations

No recalculations in this submission.

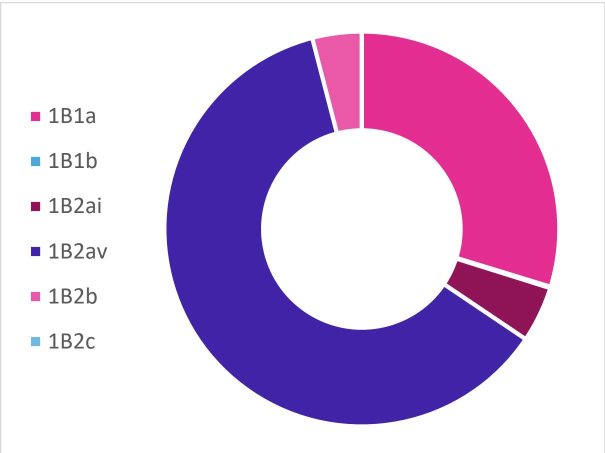
3.8 FUGITIVE EMISSIONS (NFR 1B)

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. The share of emissions of NMVOC from each category is presented in ***Figure 3.10***.

Figure 3.10: *Share of emissions of NMVOC in 1B in 2021*



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 3.132***.

Table 3.132: *Overview of emissions and activity data in the category 1B1a*

YEAR	COAL PRODUCED [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	3.46	10.3680	0.1382	0.9677	2.0390
1995	3.76	11.2773	0.1504	1.0525	2.2179
2000	3.65	10.9479	0.1460	1.0218	2.1531
2005	2.51	7.5336	0.1004	0.7031	1.4816
2010	2.38	7.1326	0.0951	0.6657	1.4027
2011	2.38	7.1281	0.0950	0.6653	1.4019
2012	2.29	6.8766	0.0917	0.6418	1.3524
2013	2.35	7.0582	0.0941	0.6588	1.3881
2014	2.19	6.5632	0.0875	0.6126	1.2908
2015	1.94	5.8180	0.0776	0.5430	1.1442
2016	1.85	5.5414	0.0739	0.5172	1.0898
2017	1.83	5.5020	0.0734	0.5135	1.0821
2018	1.50	4.5060	0.0601	0.4206	0.8862
2019	1.43	4.2930	0.0572	0.4007	0.8443
2020	0.98	2.9415	0.0392	0.2745	0.5785
2021	1.07	3.2223	0.0430	0.3007	0.6337
1990/2021	**-69%**	**-69%**	**-69%**	**-69%**	**-69%**
2020/2021	**10%**	**10%**	**10%**	**10%**	**10%**

3.8.1.2 Methodological issues

Tier 2 emission factors for Underground mining from EMEP/EEA GB_{2019} were used for calculations of NMVOC and PMs emissions (***Table 3.133***).

Table 3.133: *Emission factors in the category 1B1a*

T2	UNIT	EF
NMVOC	[kg/Mg coal produced]	3
$PM_{2.5}$	[kg/hole drilledl]	0.04
PM_{10}	[kg/hole drilledl]	0.28
TSP	[kg/hole drilledl]	0.59

3.8.1.3 Completeness

Notation keys were used following EMEP/EEA GB_{2019}.

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 is shown in ***Table 3.134***.

Table 3.134: *Overview of emissions and activity data in the category 1B1b*

YEAR	COKE PRODUCED [Mt]	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	2.34	0.0021	0.0180	0.0019	0.0087	0.1427	0.3416	0.8120	0.0699	1.0764
1995	1.85	0.0017	0.0143	0.0015	0.0069	0.1131	0.2707	0.6433	0.0554	0.8528
2000	1.60	0.0014	0.0123	0.0013	0.0059	0.0974	0.2332	0.5541	0.0477	0.7346
2005	1.74	0.0016	0.0134	0.0014	0.0064	0.1061	0.2540	0.6038	0.0520	0.8004
2010	1.55	0.0014	0.0119	0.0012	0.0057	0.0946	0.2263	0.5379	0.0463	0.7130
2011	1.52	0.0014	0.0117	0.0012	0.0056	0.0927	0.2219	0.5274	0.0454	0.6992
2012	1.47	0.0013	0.0113	0.0012	0.0054	0.0897	0.2146	0.5101	0.0439	0.6762
2013	1.44	0.0013	0.0111	0.0012	0.0053	0.0878	0.2102	0.4997	0.0430	0.6624
2014	1.47	0.0013	0.0113	0.0012	0.0054	0.0897	0.2146	0.5101	0.0439	0.6762
2015	1.53	0.0014	0.0118	0.0012	0.0057	0.0933	0.2234	0.5309	0.0457	0.7038
2016	1.54	0.0014	0.0119	0.0012	0.0057	0.0939	0.2248	0.5344	0.0460	0.7084
2017	1.49	0.0013	0.0115	0.0012	0.0055	0.0909	0.2175	0.5170	0.0445	0.6854
2018	1.50	0.0014	0.0116	0.0012	0.0056	0.0915	0.2190	0.5205	0.0448	0.6900
2019	1.32	0.0012	0.0102	0.0011	0.0049	0.0805	0.1927	0.4580	0.0395	0.6072
2020	1.11	0.0010	0.0085	0.0009	0.0041	0.0677	0.1621	0.3852	0.0332	0.5106
2021	1.63	0.0015	0.0125	0.0013	0.0060	0.0992	0.2374	0.5642	0.0486	0.7480
1990/2021	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**
2020/2021	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.8892	0.0164	0.0281	0.0304	0.3978	0.1123	0.2808	0.0374	0.5148
1995	0.7045	0.0130	0.0222	0.0241	0.3152	0.0890	0.2225	0.0297	0.4079
2000	0.6068	0.0112	0.0192	0.0208	0.2715	0.0767	0.1916	0.0256	0.3513
2005	0.6612	0.0122	0.0209	0.0226	0.2958	0.0835	0.2088	0.0278	0.3828
2010	0.5890	0.0109	0.0186	0.0202	0.2635	0.0744	0.1860	0.0248	0.3410
2011	0.5776	0.0106	0.0182	0.0198	0.2584	0.0730	0.1824	0.0243	0.3344
2012	0.5586	0.0103	0.0176	0.0191	0.2499	0.0706	0.1764	0.0235	0.3234
2013	0.5472	0.0101	0.0173	0.0187	0.2448	0.0691	0.1728	0.0230	0.3168
2014	0.5586	0.0103	0.0176	0.0191	0.2499	0.0706	0.1764	0.0235	0.3234
2015	0.5814	0.0107	0.0184	0.0199	0.2601	0.0734	0.1836	0.0245	0.3366
2016	0.5852	0.0108	0.0185	0.0200	0.2618	0.0739	0.1848	0.0246	0.3388
2017	0.5662	0.0104	0.0179	0.0194	0.2533	0.0715	0.1788	0.0238	0.3278
2018	0.5700	0.0105	0.0180	0.0195	0.2550	0.0720	0.1800	0.0240	0.3300
2019	0.5016	0.0092	0.0158	0.0172	0.2244	0.0634	0.1584	0.0211	0.2904
2020	0.4218	0.0078	0.0133	0.0144	0.1887	0.0533	0.1332	0.0178	0.2442
2021	0.6179	0.0114	0.0195	0.0211	0.2764	0.0780	0.1951	0.0260	0.3577
1990/2021	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**
2020/2021	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
1990	7.0200	0.3744	0.4680	0.2340	0.1638	1.2402
1995	5.5620	0.2966	0.3708	0.1854	0.1298	0.9826
2000	4.7908	0.2555	0.3194	0.1597	0.1118	0.8464
2005	5.2200	0.2784	0.3480	0.1740	0.1218	0.9222
2010	4.6500	0.2480	0.3100	0.1550	0.1085	0.8215
2011	4.5600	0.2432	0.3040	0.1520	0.1064	0.8056
2012	4.4100	0.2352	0.2940	0.1470	0.1029	0.7791
2013	4.3200	0.2304	0.2880	0.1440	0.1008	0.7632
2014	4.4100	0.2352	0.2940	0.1470	0.1029	0.7791
2015	4.5900	0.2448	0.3060	0.1530	0.1071	0.8109
2016	4.6200	0.2464	0.3080	0.1540	0.1078	0.8162
2017	4.4700	0.2384	0.2980	0.1490	0.1043	0.7897
2018	4.5000	0.2400	0.3000	0.1500	0.1050	0.7950
2019	3.9600	0.2112	0.2640	0.1320	0.0924	0.6996
2020	3.3300	0.1776	0.2220	0.1110	0.0777	0.5883
2021	4.8780	0.2602	0.3252	0.1626	0.1138	0.8618
1990/2021	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**	**-31%**
2020/2021	**46%**	**46%**	**46%**	**46%**	**46%**	**46%**

3.8.2.2 Methodological issues

The category reports all emissions according to the method of EMEP/EEA GB2019. Default emission factors were used for the calculation of the emissions (***Table 3.135***).

Table 3.135: *Default EF used in fugitive emission from solid fuels transformation*

T1	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

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, 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 3.136***.

Table 3.136: *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 3.137***. The production and transportation of crude oil show 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 3.137: *Overview of emissions and activity data in the category 1B2ai*

YEAR	CRUDE OIL PRODUCED AND TRANSPORTED [Mt]	NMVOC [kt]
1990	13.65	1.0625
1995	13.66	1.0675
2000	9.36	0.7677
2005	10.69	0.7153
2010	10.09	0.6029
2011	9.94	0.6051
2012	8.43	0.5061
2013	9.80	0.5735
2014	8.95	0.5234
2015	9.94	0.5795
2016	9.18	0.5329
2017	9.59	0.5434
2018	9.47	0.5340
2019	9.00	0.5054
2020	9.98	0.5480
2021	8.82	0.4967
1990/2021	**-27%**	**-53%**
2020/2021	**11%**	**-9%**

3.8.4.2 Methodological issues

For the calculation of NMVOC emissions is used data from the Statistical Office of the Slovak Republic and directly from producers. Calculation of the fugitive NMVOC emissions is based on EFs provided in the 2006 IPCC GL. These EFs are providing more detailed calculations on Tier 1 as there are provided separately EFs for exploration, production and transport. Also, this change harmonizes emission estimation with GHG emissions. These EFs are shown in ***Table 3.138***. EFs for land exploration and production of crude oil in developed countries are used. Conservative approach was used and the upper limit of EFs is used.

Table 3.138: *Overview of emission factors for exploration, production and transport of crude oil*

EMISSION	CRUDE OIL PRODUCED [Gg/10^3 m^3 oil]	CRUDE OIL PRODUCED [Gg/10^3 m^3 oil]
NMVOC (low)	0.000002	0.000054
NMVOC (high)	0.004500	0.000054
Uncertainty	±100%	

3.8.4.3 Completeness

Notation key of NA is used for the emissions of main pollutants except SOx and PCDD/F where notation key NE is used in compliance with the EMEP/EEA GB_{2019}.

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 3.139***. Emissions in this category show a decreasing trend which is connected with a decrease in activity.

Table 3.139: *Overview of emissions and activity data in the category 1B2aiv*

YEAR	CRUDE OIL REFINED [Mt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PCDD /F [g I-TEQ]
1990	6.22	0.0317	0.0317	0.0317	0.0317	0.0317	0.0317	0.0317	0.0317	0.0317	0.0355
1995	5.17	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0264	0.0295
2000	5.44	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0310
2005	5.60	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0285	0.0319
2010	5.45	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0311
2011	5.99	0.0306	0.0306	0.0306	0.0306	0.0306	0.0306	0.0306	0.0306	0.0306	0.0341
2012	5.40	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0308
2013	5.87	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0335
2014	5.22	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0298
2015	5.95	0.0304	0.0304	0.0304	0.0304	0.0304	0.0304	0.0304	0.0304	0.0304	0.0339
2016	5.74	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0327
2017	5.56	0.0283	0.0283	0.0283	0.0283	0.0283	0.0283	0.0283	0.0283	0.0283	0.0317
2018	5.46	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0311
2019	5.11	0.0261	0.0261	0.0261	0.0261	0.0261	0.0261	0.0261	0.0261	0.0261	0.0291
2020	6.44	0.0328	0.0328	0.0328	0.0328	0.0328	0.0328	0.0328	0.0328	0.0328	0.0367
2021	5.51	0.0281	0.0281	0.0281	0.0281	0.0281	0.0281	0.0281	0.0281	0.0281	0.0314
1990/2021	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**	**-11%**

YEAR	CRUDE OIL REFINED [Mt]	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]	PCDD /F [g I-TEQ]
2020/2021	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**	**-14%**

3.8.5.2 Methodological issues

Emission factors used for the calculation of heavy metals and POPs are default EF from EMEP/EEA GB$_{2019}$ (***Table 3.140***).

Table 3.140: *Emission factors in the category 1B2aiv*

T1	UNIT	EF
Pb	g/Mg crude oil input	0.0051
Cd	g/Mg crude oil input	0.0051
Hg	g/Mg crude oil input	0.0051
As	g/Mg crude oil input	0.0051
Cr	g/Mg crude oil input	0.0051
Cu	g/Mg crude oil input	0.0051
Ni	g/Mg crude oil input	0.0051
Se	g/Mg crude oil input	0.0051
Zn	g/Mg crude oil input	0.0051
PCDD/F	µg I-TEQ/Mg crude oil input	0.0057

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$_{2019}$.

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 3.141***. All data is from the operator – facility data.

Table 3.141: *Activities according to national categorization included in 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

An overall trend of activity data is shown in ***Table 3.142***. The emissions in this category show an increasing trend which is connected with an increase in activity.

Table 3.142: *Overview of emissions and activity data in the category 1B2av*

YEAR	OIL CONSUMED [Mt]	NMVOC [kt]
1990	1.59	3.1841
1995	1.39	2.7738
2000	1.34	2.6887
2005	1.96	3.9290
2010	2.18	4.3668
2011	2.04	4.0887
2012	2.17	4.3479

YEAR	OIL CONSUMED [Mt]	NMVOC [kt]
2013	2.11	4.2168
2014	2.16	4.3160
2015	2.38	4.7571
2016	2.42	4.8460
2017	2.47	4.9337
2018	2.52	5.0320
2019	2.56	5.1259
2020	2.33	4.6693
2021	3.33	6.6693
1990/2021	**109%**	**109%**
2020/2021	**43%**	**43%**

3.8.6.2 Methodological issues

Emission factor EMEP/EEA GB_{2019} (**EF = 2 kg/Mg oil**) was used for the calculation of NMVOC emissions using of T1 methodology.

3.8.6.3 Completeness

The notation key of NA is used for the emissions of main pollutants except SOx and PCDD/F whereas the notation key NE is used in compliance with the EMEP/EEA GB_{2019}.

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 3.143***. 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 3.143: *Overview of emissions and activity data in the category 1B2b*

YEAR	PRODUCTION [mil. m^3]	PROCESSING [mil. m^3]	TRANSMISSION AND STORAGE [mil. m^3]	DISTRIBUTION [mil. m^3]	OTHER [mil. m^3]	NMVOC [kt]
1990	444.00	444.00	73 600.00	6 666.00	1.00	1.0747
1995	344.00	344.00	73 600.00	6 485.00	159.40	0.9699
2000	173.00	173.00	68 600.00	7 136.00	524.30	0.7710
2005	147.00	147.00	73 900.00	7 399.00	50.00	0.7856
2010	104.00	104.00	65 302.00	6 098.00	103.00	0.6518
2011	121.00	121.00	68 093.00	5 630.00	395.00	0.6591
2012	150.00	150.00	45 470.00	5 289.00	385.00	0.4965
2013	124.00	124.00	52 780.00	5 820.00	132.00	0.5594
2014	100.00	100.00	46 500.00	4 535.00	319.00	0.4872
2015	93.00	93.00	55 800.00	4 639.00	139.00	0.5525
2016	92.00	92.00	60 600.00	4 716.00	246.00	0.5907
2017	140.00	140.00	64 200.00	4 901.25	418.00	0.6184
2018	93.00	93.00	59 700.00	4 777.99	423.00	0.5815
2019	124.00	124.00	69 060.00	4 841.46	1 922.00	0.6371
2020	65.26	65.26	56 980.00	5 003.88	2 783.82	0.5465
2021	65.33	65.33	40 361.57	5 471.00	4 368.00	0.4383

YEAR	PRODUCTION [mil. m³]	PROCESSING [mil. m³]	TRANSMISSION AND STORAGE [mil. m³]	DISTRIBUTION [mil. m³]	OTHER [mil. m³]	NMVOC [kt]
1990/2021	-85%	-85%	-45%	-18%	436700%	-59%
2020/201	0%	0%	-29%	9%	57%	-20%

For the calculation of NMVOC emissions is used data from the Statistical Office of the Slovak Republic and directly from producers. Calculation of the fugitive NMVOC emissions is based on EFs provided in the 2006 IPCC GL. These EFs are providing more detailed calculations on Tier 1 as there are provided separately EFs for 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 3.144***. EFs for land exploration and production of crude oil in developed countries are used. Conservative approach was used and the upper limit of EFs is used.

Table 3.144: *Overview of emission factors for exploration, production, processing, transmission, distribution and storage of natural gas*

EMISSION	NATURAL GAS PRODUCED [Gg/10⁶ m³ NG]	NATURAL GAS PROCESSED [Gg/10⁶ m³ NG]	NATURAL GAS TRANSMITTION [Gg/10⁶ m³ NG]	NATURAL GAS DISTRIBUTION [Gg/10⁶ m³ NG]	NATURAL GAS STORAGE [Gg/10⁶ m³ NG]
NMVOC (low)	0.0000950	0.0002200	0.0000070	0.0000160	0.0000004
NMVOC (high)	0.0005500	0.0004700	0.0000070	0.0000160	0.0000004
Uncertainty	±100%	±100%	±100%	±100%	-20% to +500%

3.8.7.3 Completeness

Notation keys were used in compliance with EMEP/EEA GB_{2019}.

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_{2019}.

Flaring is observed in some extent only in NG production. It is not occurring in the distribution, transport and transmission of crude oil and natural gas in Slovakia.

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_{2019} and IE for the other emissions. Further data analysis is needed to establish a methodology for natural gas venting 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)

Notation key NO is used in this category. Geothermal energy is not developed in the Slovak Republic. Most of the sources are used for recreational purposes and they are considered negligible.

CHAPTER 4: INDUSTRIAL PROCESSES AND PRODUCT USE (NFR 2)

Last update: 15.3.2023

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/ 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 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		METHODOLOGY/TIER					
	LONGNAME OF CATEGORY	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

NFR	LONGNAME OF CATEGORY	METHODOLOGY/TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TZL	BC	HM	POPs
2B10b	Storage, handling and transport of chemical products	T3	T3	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
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	NK	NK	NK	NK
2H3	Other industrial processes	T3	T3	T3	NK	NK	NK
2I	Wood processing	T3	T3	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	45.9006	11.3398	0.2605	2.3378	4.6750	15.4662	0.0372	84.8237

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1995	6.7682	43.8686	10.1563	0.2695	2.2857	3.8186	11.8706	0.0818	75.4156
2000	7.9732	38.1972	13.9137	0.2066	2.9472	4.9475	15.1159	0.1084	93.4023
2005	6.7133	38.0796	11.4549	0.2667	1.4781	3.5462	10.3893	0.0906	104.3432
2010	5.9232	27.7821	7.3310	0.1221	0.9559	2.1660	6.7127	0.1161	94.2074
2011	6.6758	31.9988	9.2230	0.2206	0.9439	2.0670	6.4540	0.1138	107.1259
2012	6.3180	26.2870	8.0566	0.2194	0.9191	1.6643	5.1780	0.1161	105.6835
2013	6.1896	26.8605	7.3835	0.1645	0.9606	2.0140	6.3800	0.1027	105.0621
2014	6.8971	28.6050	8.0188	0.1240	1.0435	2.0355	6.5122	0.1097	119.8514
2015	6.4984	31.9142	9.0880	0.1665	1.1808	3.6496	11.7870	0.1104	119.9171
2016	5.8978	30.1352	10.2831	0.2269	0.9090	1.9103	5.9485	0.1091	121.8027
2017	6.9338	28.2297	11.7132	0.2190	0.9744	2.4382	7.7015	0.1166	124.1939
2018	7.5900	30.4411	9.4025	0.2362	0.8714	1.7901	5.4600	0.1141	111.7930
2019	6.1286	26.4060	7.7212	0.2135	0.8244	1.9039	5.1503	0.1209	73.4620
2020	5.7511	26.7709	6.6518	0.2689	0.8325	2.6611	7.4536	0.1020	70.5006
2021	7.0832	23.9095	7.5909	0.2999	0.8568	2.4541	6.6969	0.1184	106.0956
1990/2021	**0%**	**-48%**	**-33%**	**15%**	**-63%**	**-48%**	**-57%**	**218%**	**25%**
2020/2021	**23%**	**-11%**	**14%**	**12%**	**3%**	**-8%**	**-10%**	**16%**	**50%**

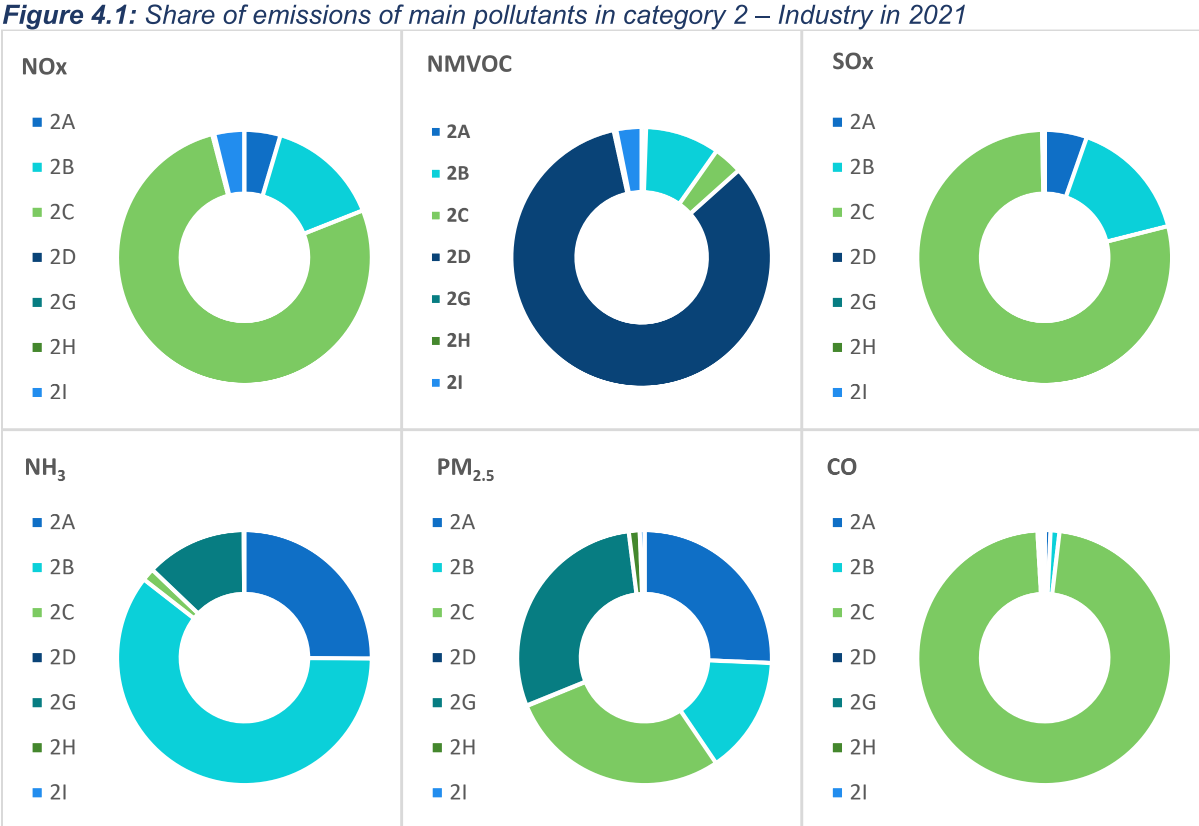
YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	20.7627	0.4293	0.2871	0.7115	1.4525	3.1740	1.3299	0.1629	12.8693
1995	17.7175	0.2975	0.2515	0.5943	1.2981	2.6335	1.0199	0.1643	11.8014
2000	19.0604	0.1256	0.2690	0.5350	0.8480	1.7325	0.9546	0.1696	12.9962
2005	6.3569	0.2069	0.1241	0.5362	0.9881	1.5362	0.2460	0.2569	13.0132
2010	4.9838	0.2538	0.1158	0.4886	1.5432	2.2447	0.2330	0.2901	13.9027
2011	5.0975	0.2558	0.1189	0.4575	1.5877	2.5974	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	0.1209	0.4787	1.0202	1.7001	0.2886	0.3180	14.3907
2014	5.5665	0.1502	0.1276	0.4750	1.2328	2.0577	0.2714	0.3271	14.4380
2015	5.4358	0.1455	0.1272	0.4623	1.4971	2.5823	0.2524	0.3210	14.7114
2016	5.6933	0.1498	0.1277	0.4862	1.7206	2.9670	0.2613	0.3226	15.4450
2017	6.1605	0.1582	0.1284	0.5062	1.6844	3.0118	0.2836	0.3298	16.0950
2018	5.5814	0.1470	0.1275	0.4665	1.6961	0.8573	0.2651	0.3296	15.8245
2019	4.4714	0.1298	0.1248	0.3645	1.8216	0.7936	0.2209	0.2720	12.8028
2020	3.2792	0.1122	0.1152	0.2927	1.6839	0.4743	0.1805	0.3429	10.8060
2021	5.4154	0.1540	0.1237	0.4837	1.8871	0.6669	0.2639	0.3728	14.1787
1990/2021	**-74%**	**-64%**	**-57%**	**-32%**	**30%**	**-79%**	**-80%**	**129%**	**10%**
2020/2021	**65%**	**37%**	**7%**	**65%**	**12%**	**41%**	**46%**	**9%**	**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 [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	26.9706	0.0124	0.0037	0.0037	0.0020	10.5515	0.0744	21.7213
2011	30.4951	0.0124	0.0037	0.0037	0.0020	9.9112	0.0876	20.0066
2012	32.4522	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

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]
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
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
1990/2021	**-76%**	**-98%**	**-99%**	**-99%**	**-97%**	**-8%**	**-19%**	**19%**
2020/2021	**-68%**	**9%**	**9%**	**9%**	**10%**	**43%**	**28%**	**44%**

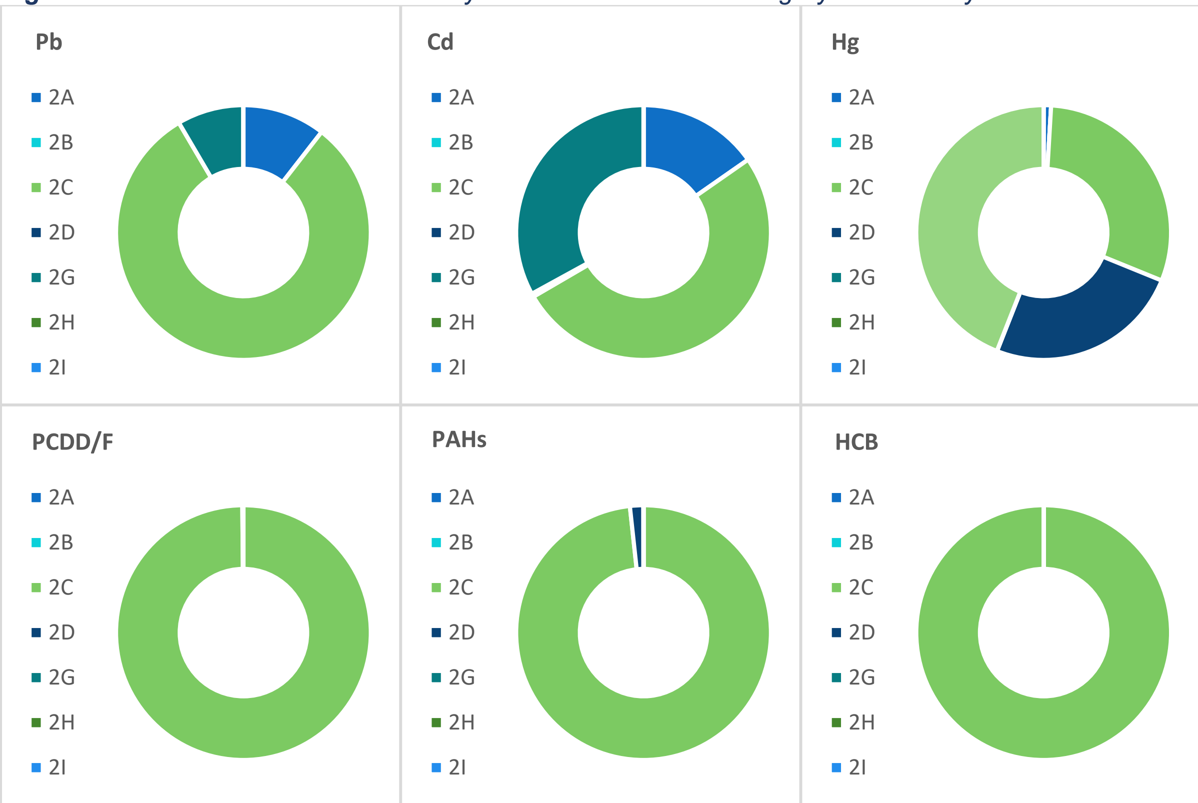
As shown in ***Figure 4.1***, the main contributor to NOx emissions in the industry sector is Iron and steel production (**2C1**). The most significant decrease was recorded in the period 2001-2009, since then, emissions have had a fluctuating trend. Solvents use contributes by an average of 78% to NMVOC emissions. The emission trend shows a decreasing trend due to stricter limits and technical requirements for solvent use. SOx emissions have a decreasing trend until 2009 in the sector industry, and since then emissions are fluctuating. 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 2004-2014 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 2021*



Metal production categories emitted most of the emissions of heavy metals and persistent organic pollutants. Emissions of these pollutants have in general 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 2021*



4.3 RECALCULATIONS, IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

The industry sector undertakes continuing improvements. Several errors were corrected during this reporting cycle in categories **2C1**, **2C3**, **2C7a** (due to correction of IEF for calculation of historical years), **2D3**i (due to recalculation of fleet structure in the COPERT model), **2G** (***Recommendation No SK-2G-2022-0001)*** and **2H2** (correction of AD).

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. Slovakia 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 exception of SOx and NH_3, which have an increasing trend, as well as heavy metals (***Table 4.3***).

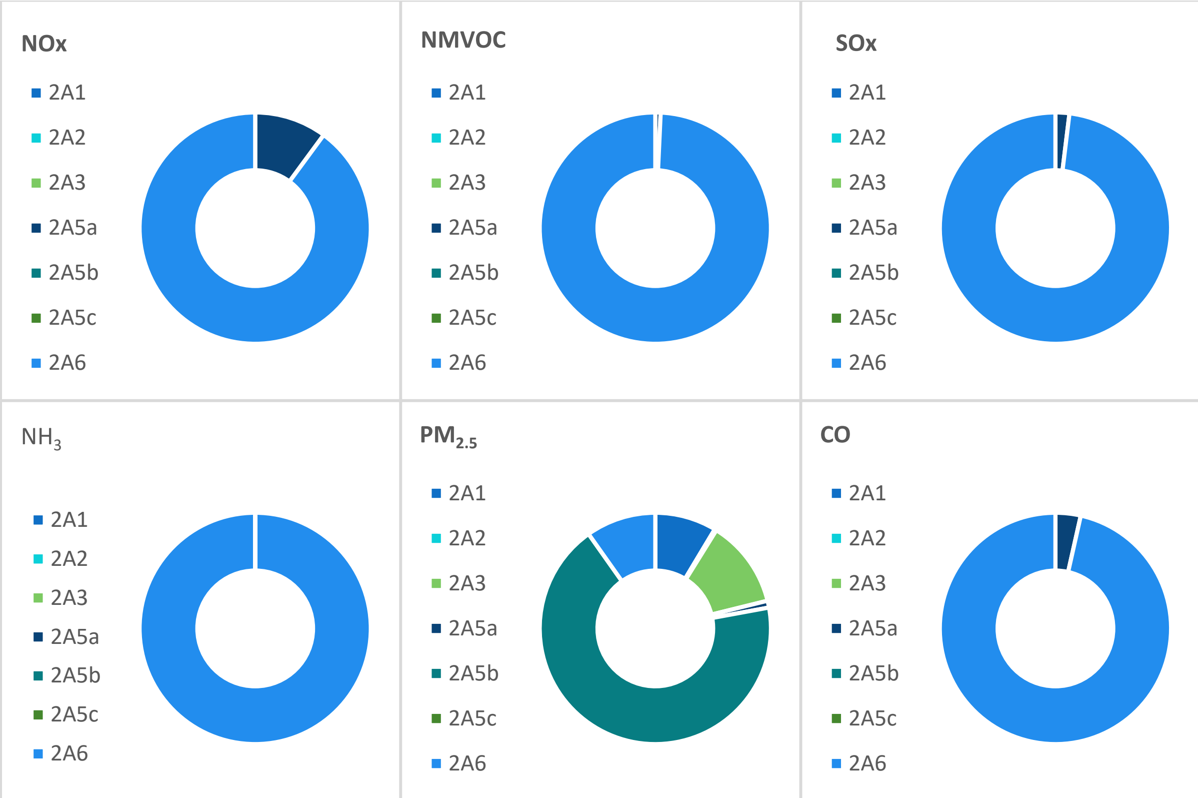
Table 4.3: *Overview of emissions in the category 2A*

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	0.2199	1.6309	5.4873	0.0006	0.7855
1990/2021	**-7%**	**-24%**	**113%**	**10051%**	**-44%**	**3%**	**4%**	**-76%**	**-40%**
2020/2021	**12%**	**49%**	**-10%**	**173%**	**-10%**	**-14%**	**-14%**	**-15%**	**12%**

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	0.1429
1990/2021	**109%**	**307%**	**66%**	**307%**	**307%**	**66%**	**307%**	**307%**	**66%**
2020/2021	**4%**	**4%**	**10%**	**4%**	**4%**	**10%**	**4%**	**4%**	**10%**

Shares of NO_X, NMVOC, SO_X, NH_3, $PM_{2.5}$, and CO emissions in 2021 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 2021*



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 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.

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	2835.75	0.0773	0.1824	0.4489	0.0023
1995	2235.75	0.0610	0.1438	0.3539	0.0018
2000	2313.71	0.0954	0.2251	0.5541	0.0029
2005	2352.68	0.0370	0.0872	0.2149	0.0011
2010	1653.59	0.0256	0.0598	0.1423	0.0008

YEAR	CLINKER PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
2011	2433.86	0.0307	0.0716	0.1704	0.0009
2012	2126.12	0.0276	0.0644	0.1534	0.0008
2013	2161.32	0.0365	0.0852	0.2027	0.0011
2014	2415.34	0.0574	0.1340	0.3190	0.0017
2015	2506.12	0.0458	0.1068	0.2542	0.0014
2016	2599.39	0.0495	0.1154	0.2748	0.0015
2017	2698.82	0.0207	0.0484	0.1151	0.0006
2018	2695.74	0.0170	0.0396	0.0944	0.0005
2019	2854.64	0.0275	0.0643	0.1531	0.0008
2020	2945.23	0.0214	0.0500	0.1191	0.0006
2021	3170.29	0.0189	0.0441	0.1051	0.0006
1990/2021	**12%**	**-76%**	**-76%**	**-77%**	**-76%**
2020/2021	**8%**	**-12%**	**-12%**	**-12%**	**-12%**

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 is 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)***. Share of $PM_{2.5}$ and PM_{10} in TSP are 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_{2019}

4.4.2.3 Completeness

Pollutants originating from combustion actives were reported under the category **1A2f**, as these pollutants cannot be separated in the NEIS database in the whole time series. Therefore, 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

No recalculation was made.

4.4.3 LIME PRODUCTION (NFR 2A2)

4.4.3.1 Overview

The production of lime during the year 2021 in Slovakia 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	879.71	0.0006	0.0067	0.0560	0.0000
1990/2021	**-18%**	**-93%**	**-93%**	**-93%**	**-93%**
2020/2021	**71%**	**9%**	**9%**	**9%**	**9%**

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 designed 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 is 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*

0	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_{2019}

4.4.3.3 Completeness

Pollutants originating from combustion actives were reported under the category **1A2f**, as these pollutants cannot be separated in the NEIS database in the whole time series. Therefore, 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

No recalculations in this 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 (SO_x), nitrogen oxides (NO_x) 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 this submission. 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	34.03	0.0270	0.0282	0.0297	0.0000
1990/2021	**307%**	**67%**	**-**	**-57%**	**-68%**	**-68%**	**-68%**	**-68%**
2020/2021	**4%**	**21%**	**-**	**-3%**	**-16%**	**-16%**	**-16%**	**-16%**

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

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
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	0.1429
1990/2021	**109%**	**307%**	**66%**	**307%**	**307%**	**66%**	**307%**	**307%**	**66%**
2020/2021	**4%**	**4%**	**10%**	**4%**	**4%**	**10%**	**4%**	**4%**	**10%**

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 EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology is 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***). Share of $PM_{2.5}$ and PM_{10} in TSP are 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_{2019}

<u>HMs</u>

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 actives were reported under the category **1A2f**, as these pollutants cannot be separated in the NEIS database in the whole time series. Therefore, 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

No recalculation was made.

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 was occurring surface and underground quarrying and mining locations for various materials during the year 2021 (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 emission rising from the extractions of these minerals is 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 4.14***) are presented in the following figures.

Table 4.14: *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
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
1990/2021	**310%**	**500%**	**17%**	**19%**	**19%**	**19%**	**27%**
2020/2021	**1%**	**13%**	**21%**	**5%**	**5%**	**5%**	**2%**

4.4.5.2 Methodological issues

Activities listed within this category are shown in ***Table 4.15***.

Table 4.15*: 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 is 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 4.16***).

Table 4.16: *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 were recalculated due to a change of IEF for all rising pollutants. The average IEF of the years 2000-2004 was replaced with a weighted average of these years. Share of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009. (***Table 4.17***).

Table 4.17: *Emission factors for calculation of historical years*

	NOx [g/GJ ENERGY]	NMVOC [g/GJ ENERGY]	SOx [g/GJ ENERGY]	TSP [g/GJ ENERGY]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	CO [g/GJ ENERGY]
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

No recalculation was made.

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 4.18***.

Table 4.18: *Overview of activity data in 2A5b*

YEAR	AF. AREA OF HIGHWAYS AND EXPRESSWAYS [m²]	AF. AREA OF NEW BUILDINGS FOR ADMINISTRATION [m²]	AF. AREA OF COMPLETED FLATS [m²]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	789248.57	343411.83	2585482.60	0.1074	1.0737	3.5836
1995	NO	283364.71	637201.09	0.0191	0.1905	0.6323
2000	36000.00	223317.59	1805396.92	0.0416	0.4165	1.3863
2005	1618920.00	130400.00	2155845.12	0.1393	1.3926	4.6558
2010	1504692.00	64800.00	1586802.10	0.0880	0.8799	2.9428
2011	416628.00	84000.00	1363224.20	0.0735	0.7348	2.4540
2012	NO	76000.00	1421360.20	0.0302	0.3023	1.0068
2013	510480.00	19200.00	1447613.70	0.0601	0.6009	2.0080
2014	207360.00	77600.00	2314000.00	0.0504	0.5040	1.6812
2015	2038680.00	34736.80	2288000.00	0.2222	2.2219	7.4311
2016	344160.00	186400.00	2418000.00	0.0645	0.6453	2.1526
2017	1017360.00	43200.00	2483000.00	0.1189	1.1893	3.9747
2018	NO	52800.00	2782000.00	0.0626	0.6259	2.0858
2019	518400.00	97600.00	2873000.00	0.0883	0.8832	2.9482
2020	1857600.00	36000.00	3055000.00	0.1762	1.7621	5.8916
2021	1107900.00	63200.00	3081000.00	0.1498	1.4977	5.0045
1990/2021	**40%**	**-82%**	**19%**	**39%**	**39%**	**40%**
2020/2021	**-40%**	**76%**	**1%**	**-15%**	**-15%**	**-15%**

4.4.6.2 Methodological issues

The emissions are reported in the category according to the methodology of EMEP/EEA GB_{2019} 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.

Table 4.19: *EF used for the calculations in category 2A5b*

$EF_{GB2019\text{ - division}}$	$PM_{2.5}$ [kg/m²]	PM_{10} [kg/m²]	TSP[kg/m²]
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 this 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 the ***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 emission (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 4.20*** and ***Table 4.21***.

Table 4.20: *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

*m^2/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 4.21***.

Table 4.21: *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
2021	63.42	10.00	63.28

4.4.6.3 Completeness

All rising pollutants were reported.

4.4.6.4 Source-specific recalculations

No recalculation was made.

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 (2A6)

4.4.8.1 Overview

The category covers other industrial activities of the mineral industry not covered in described NFR categories. Reported emissions under the category and their trends are presented below (***Table 4.22***). 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 4.22: *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
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
1990/2021	**-14%**	**-24%**	**117%**	**10051%**	**-81%**	**-76%**	**-46%**	**-42%**
2020/2021	**13%**	**50%**	**-10%**	**173%**	**68%**	**48%**	**18%**	**12%**

4.4.8.2 Methodological issues

Activities listed within this category are shown in ***Table 4.23***.

Table 4.23: *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 is 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 4.24*** (valid for 2000-2021). Emission factors for the historical years were calculated as a weighted average of IEF of the period 2000-2004. Share of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009. (***Table 4.25***).

Table 4.24: *Emission factors provided by Bulletin of MoE*

PROCESS	EF	
	TSP	PM_{10}
	g/m³	
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
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 4.25: *Emission factors for calculation of historical years*

	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 (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**).

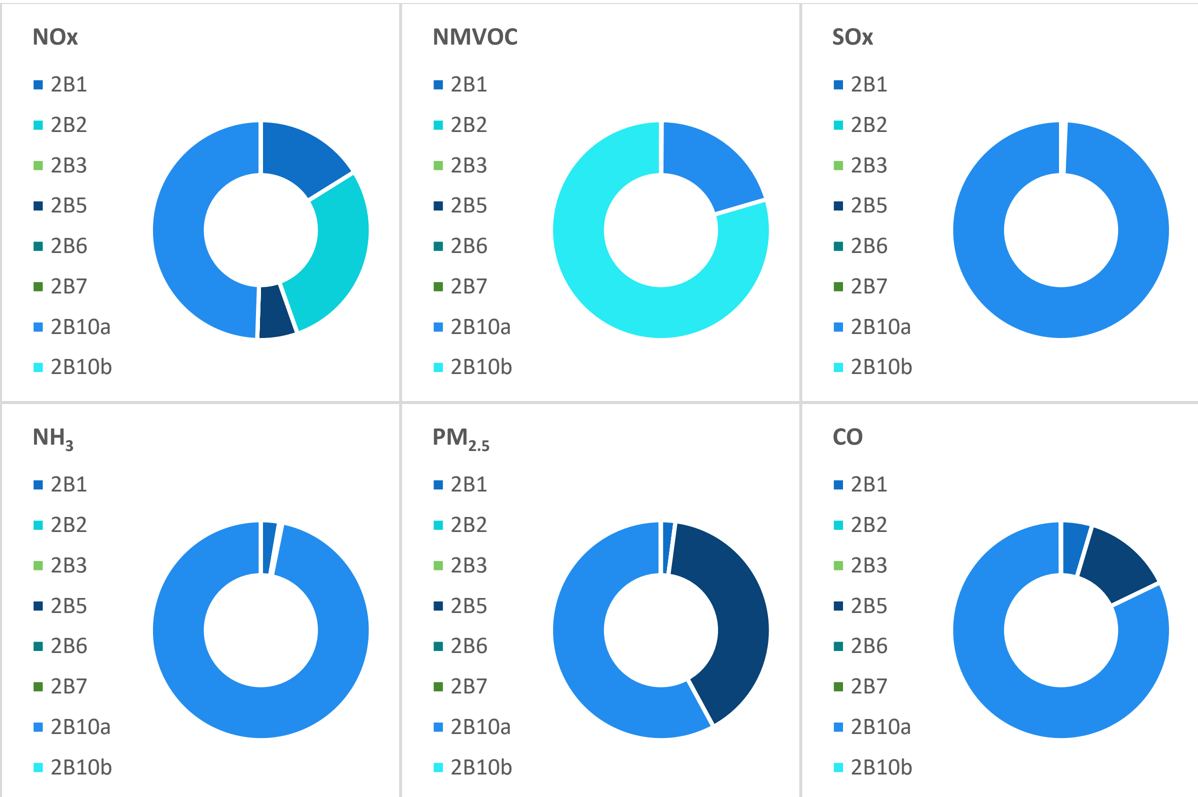
Emissions from this category have a general decreasing trend, except for the emissions of NOx (***Table 4.26***). It was caused by stricter legislation and the adoption of emissions limits for the main pollutants. Emissions of NOx originate mostly from category **2B10a** which includes the production 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 2021. NFR categories included are provided in the figure below (***Figure 4.4***).

Table 4.26: *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
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
1990/2021	**-6%**	**-63%**	**-26%**	**-26%**	**-39%**	**-36%**	**-31%**	**-61%**	**-71%**
2020/2021	**1%**	**5%**	**-6%**	**-11%**	**4%**	**3%**	**3%**	**12%**	**0%**

Figure 4.4: *Shares of emissions in 2B in 2021*



4.5.2 AMMONIA PRODUCTION (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 4.27***. The emissions of particulate matter from this source decreased significantly in 2004 due to abatement technology installation.

Table 4.27: *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
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
1990/2021	**61%**	**-23%**	**-40%**	**-19%**	**61%**	**-87%**	**-87%**	**-87%**	**-21%**
2020/2021	**6%**	**7%**	**1%**	**7%**	**6%**	**7%**	**7%**	**7%**	**7%**

4.5.2.2 Methodological issues

Activities listed within this category are shown in ***Table 4.28***.

Table 4.28: *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 EF were used for sources recorded in the database. Otherwise, general EFs of the Bulletin of the Ministry of Environment and detailed methodology is presented in **ANNEX IV**.

Emissions of NH_3 were calculated using the Tier 1 emission factor from the EMEP/EEA GB_{2019}. Historical years were calculated using a weighted average of IEF for each pollutant from the period 2000-2004 (***Table 4.29***). Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009.

Table 4.29: *Emission factors for calculation of historical years and NH_3 and CO emissions*

	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_{2019} – 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 (2B2)

4.5.3.1 Overview

NO_X emissions have had an overall increasing trend since 1990 due to the increase in the production of nitric acid (***Table 4.30***). Significant increases and subsequent decreases in NH_3 emissions between 2006/2007 were recorded due to temporal malfunction on the source. A significant decrease in 2019 was caused by single-source starting to use new technology to produce Nitric acid.

Table 4.30: *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	529.76	0.3955	0.0038
2019	528.71	0.3673	0.0010
2020	520.28	0.2717	0.0010
2021	576.21	0.2906	0.0015
1990/2021	**44%**	**67%**	**-62%**
2020/2021	**11%**	**7%**	**51%**

4.5.3.2 Methodological issues

The definition of activities covered by category **2B2** is provided in ***Table 4.31***. 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 4.31: *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 are 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 EF 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 **IEF_{NOx}= 434.60 g/t** and for ammonia, **IEF_{NH3} =9.74 g/t**.

4.5.3.3 Completeness

All rising pollutants were reported.

4.5.3.4 Source-specific recalculations

No recalculation was made.

4.5.4 ADIPIC ACID PRODUCTION (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 (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 is 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 4.32***) 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 process of carbide production.

Table 4.32: *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

YEAR	CARBIDE PRODUCED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
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	69.71	0.0600	0.0002	0.0083	0.0767	0.1279	0.2132	0.1688
2020	56.77	0.0716	0.0000	0.0067	0.0547	0.0912	0.1520	0.1464
2021	57.03	0.0607	0.0001	0.0073	0.0508	0.0847	0.1412	0.1597
1990/2021	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
2020/2021	**0%**	**-15%**	**161%**	**8%**	**-7%**	**-7%**	**-7%**	**9%**

4.5.5.2 Methodological issues

The definition of activities covered by category **2B5** is provided in ***Table 4.33***. The characteristic of involved industrial activity is wider, but the only activity of calcium carbide production belongs to the occurring production activities.

Table 4.33: *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 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. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from 2005-2009 (***Table 4.34***).

Table 4.34: *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]	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_{2019}. In the years 1990 and 1991, notation key NO was used, because production started in 1992.

4.5.5.4 Source-specific recalculations

No recalculation was made.

4.5.6 TITANIUM DIOXIDE PRODUCTION (2B6)

4.5.6.1 Overview

Titanium dioxide is not produced in the Slovak Republic and NO notation key was used.

4.5.7 SODA ASH PRODUCTION (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 (2B10a)

4.5.8.1 Overview

The category included various activities of the chemical industry. The overview of emissions and activity data is provided in ***Table 4.35.*** Emissions of air pollutants show a decreasing tendency in the long term.

Table 4.35: *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
1990/2021	**-27%**	**-85%**	**-27%**	**-27%**	**-61%**	**-59%**	**-55%**	**-61%**	**-76%**
2020/2021	**-3%**	**2%**	**-6%**	**-12%**	**12%**	**11%**	**11%**	**12%**	**-1%**

4.5.8.2 Methodological issues

The definition of activities covered by category **2B10a** is provided in ***Table 4.36***.

Table 4.36: *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
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

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
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 4.37***).

Table 4.37: *Emission factors for calculation of historical years*

	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_{2019}

4.5.8.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2019}.

4.5.8.4 Source-specific recalculations

No recalculation was made.

4.5.9 STORAGE, HANDLING AND TRANSPORT OF CHEMICAL PRODUCTS (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 4.38***.

Table 4.38: *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
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
1990/2021	**173%**	**-44%**	**99%**	**-**	**4650%**	**4651%**	**4651%**	**6347%**
2020/2021	**5%**	**6%**	**42%**	**-**	**16%**	**16%**	**16%**	**0%**

4.5.9.2 Methodological issues

Activities listed within this category are shown in ***Table 4.39***.

Table 4.39: *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 2000-2021. 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_{2019}.

4.5.9.4 Source-specific recalculations

No recalculations in this submission.

4.6 METAL PRODUCTION (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 4.40***) due to stricter legislation and the adoption of emission limits as well as BAT technologies in this industry.

Table 4.40: *Overview of emissions in the category 2C*

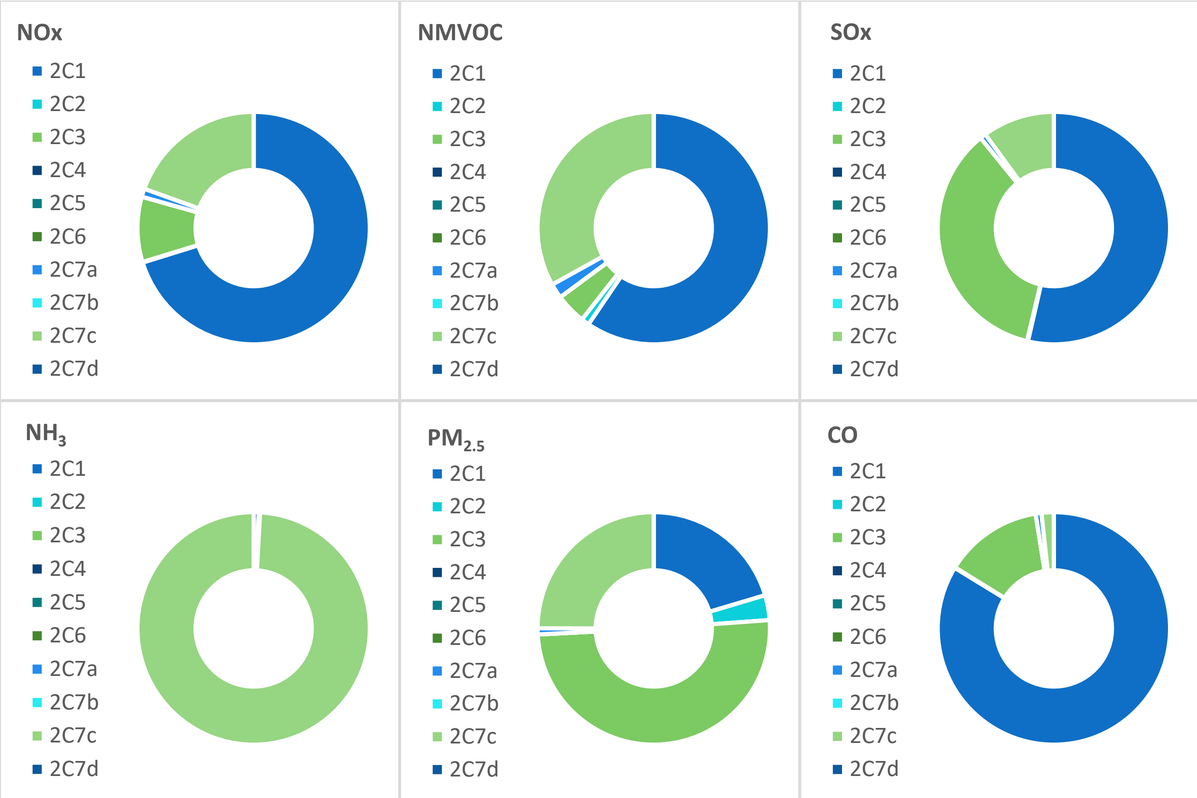
YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	5.3556	0.3482	9.5119	0.0077	1.5525	2.3511	8.7088	0.0208	78.8745
1995	4.8373	0.3181	8.3694	0.0075	1.3862	2.1099	7.9009	0.0167	69.3173
2000	6.0021	0.2698	12.7058	0.0081	1.9146	2.8538	10.0320	0.0366	86.6576
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
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
1990/2021	**2%**	**147%**	**-37%**	**-37%**	**-84%**	**-87%**	**-95%**	**-82%**	**31%**
2020/2021	**30%**	**24%**	**22%**	**-5%**	**4%**	**6%**	**21%**	**4%**	**52%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	20.4632	0.4196	0.2036	0.6972	1.4332	3.1534	1.3089	0.0903	9.0824
1995	17.3194	0.2641	0.1670	0.5766	1.2737	2.5534	0.9858	0.0746	8.1779
2000	18.3403	0.0890	0.1839	0.5172	0.8178	1.4653	0.9079	0.0825	8.9934
2005	5.2889	0.1563	0.0390	0.5011	0.9325	1.1513	0.1753	0.0826	7.0866
2010	4.3882	0.1870	0.0302	0.4442	1.4849	2.1420	0.1676	0.0628	6.9609
2011	4.0686	0.1886	0.0338	0.4116	1.5200	2.2541	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
1990/2021	**-79%**	**-81%**	**-82%**	**-39%**	**26%**	**-89%**	**-87%**	**-14%**	**-23%**
2020/2021	**77%**	**72%**	**30%**	**79%**	**12%**	**26%**	**69%**	**30%**	**74%**

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	26.9623	0.0114	0.0033	0.0033	0.0016	10.4849	0.0744	21.1782
2011	30.4855	0.0114	0.0033	0.0033	0.0016	9.8373	0.0876	19.4672
2012	32.4441	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	11.6510	0.0963	22.6512
1990/2021	**-76%**	**-98%**	**-99%**	**-99%**	**-98%**	**-7%**	**-19%**	**20%**
2020/2021	**-68%**	**8%**	**8%**	**8%**	**8%**	**44%**	**28%**	**45%**

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 2021 included in NFR categories **2C** are presented in ***Figure 4.5***.

Figure 4.5: Shares of emissions in 2C in 2021



4.6.2 IRON AND STEEL PRODUCTION

4.6.2.1 Overview

An overview of the activity data, emissions and trends is shown in ***Table 4.41***. The emission of most of the pollutants increased in 2021 compared to the year 2020 because, in 2020, one of the blast furnaces was under reconstruction and in 2021 started to operate in full operation again. The decrease in emissions of PCDD/Fin 2021 was caused by new abatement technology to reduce these emissions from sinter production with an efficiency of 98.9%.

The figures below show the emission trend of the pollutants for which **2C1** is a key category. Emissions show an overall decreasing trend due to the installation of abatement technologies (***Table 4.41***).

There is one major producer of sinter, pig iron and steel from primary raw materials and two smaller producers of steel from secondary raw materials in the Slovak Republic.

Table 4.41: *Trends in emissions of air pollutants and 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
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

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]
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
1990/2021	**-19%**	**13%**	**32%**	**25%**	**19%**
2020/2021	**28%**	**46%**	**22%**	**80%**	**32%**

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
2021	3.8258	0.5117	3.1983	0.0000	0.0494	0.0708	0.1803	0.0002	86.3580
1990/2021	**17%**	**127%**	**-59%**	**-97%**	**-96%**	**-96%**	**-98%**	**-96%**	**35%**
2020/2021	**51%**	**40%**	**33%**	**34%**	**59%**	**62%**	**96%**	**59%**	**67%**

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	1.5349	0.9446	0.0903	9.0824
1995	16.5822	0.0806	0.1662	0.4677	0.7375	1.3722	0.8233	0.0746	8.1779
2000	18.3350	0.0884	0.1839	0.5168	0.8142	1.4591	0.9079	0.0825	8.9934
2005	4.4864	0.0794	0.0383	0.4343	0.3975	0.2150	0.1709	0.0826	7.0866
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
1990/2021	**-78%**	**-13%**	**-83%**	**-19%**	**-53%**	**-83%**	**-82%**	**-14%**	**-23%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2020/2021	**77%**	**74%**	**32%**	**79%**	**78%**	**38%**	**69%**	**30%**	**74%**

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
1990/2021	**-87%**	**10%**	**-19%**	**20%**
2020/2021	**-80%**	**44%**	**28%**	**45%**

4.6.2.2 Methodological issues

Activities defined in national legislation involved in the category are presented in ***Table 4.42***.

Table 4.42: *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 2021).

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.

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 4.43***). 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 EMEP/EEA GB_{2019} emission factor thought the whole time series.

Table 4.43: *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	438.08	30.17	1043.62	0.15	1077.92	15%	23%	0.36%	8587.70

*Tier 1 EMEP/EEA GB_{2019}

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 in Oceliareň 2 in 2003. 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 4.44***.

Table 4.44*: 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-	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	0.015
Pig iron production	-	2003-2021	Dry ESP default EFs	0.000009	0.000000015	0.000084	0.0000005	0.000006	0.15
Steel production	Basic oxygen furnace	1990-2005	Dry ESP Upper EFs	0.025	0.0003	0.0009	0.002	0.002	NE
Steel production	Basic oxygen furnace	2006-2021	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	2002-2021	wSV Default EFs	1.8	0.03	0.0018	0.18	0.16	0.02
Steel production	Electric furnace	1990-2021	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	-	2003-2021	Dry ESP	0.00025	0.02	0.06	8	0.3	0.03	0.09
Sinter production		2021-	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	-	2003-2021	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	NE	NE	NE	0.69	0.1	NE	2.5
Steel production	Basic oxygen furnace	2006-2021	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	2002-2021	wSV Default EFs	0.06	NE	2.7	0.69	0.1	NE	2.5
Steel production	Electric furnace	1990-2021	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 EMEP/EEA GB_{2019}.

4.6.2.4 Source-specific recalculations

Emissions were recalculated due to a correction of the error in the calculation of IEF for the historical years (***Table 4.45***).

Table 4.45: *Previous and revised emissions in the category 2C1*

YEAR	NOx [kt]			NMVOC [kt]			SOx [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	3.2565	3.2673	0%	0.2243	0.2250	0%	7.7580	7.7837	0%
1991	2.9118	2.9392	1%	0.2006	0.2024	1%	6.9367	7.0020	1%
1992	2.7202	2.7483	1%	0.1874	0.1893	1%	6.4803	6.5471	1%
1993	2.9415	2.9610	1%	0.2026	0.2039	1%	7.0074	7.0538	1%
1994	3.0566	3.0772	1%	0.2105	0.2119	1%	7.2816	7.3306	1%
1995	2.9480	2.9719	1%	0.2030	0.2047	1%	7.0230	7.0798	1%
1996	2.6941	2.7253	1%	0.1856	0.1877	1%	6.4181	6.4924	1%
1997	2.8290	2.8566	1%	0.1949	0.1968	1%	6.7394	6.8052	1%
1998	2.8539	2.8812	1%	0.1966	0.1984	1%	6.7988	6.8638	1%
1999	3.1365	3.1555	1%	0.2160	0.2173	1%	7.4720	7.5172	1%

YEAR	NH_3 [kt]			TSP [kt]			CO [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0011	0.0011	0%	8.0130	8.0395	0%	63.8386	64.0501	0%
1991	0.0010	0.0010	1%	7.1647	7.2321	1%	57.0804	57.6179	1%
1992	0.0009	0.0009	1%	6.6933	6.7623	1%	53.3248	53.8744	1%

YEAR	NH_3 [kt]			TSP [kt]			CO [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1993	0.0010	0.0010	1%	7.2377	7.2857	1%	57.6625	58.0445	1%
1994	0.0010	0.0010	1%	7.5209	7.5715	1%	59.9184	60.3219	1%
1995	0.0010	0.0010	1%	7.2538	7.3124	1%	57.7904	58.2577	1%
1996	0.0009	0.0009	1%	6.6290	6.7058	1%	52.8131	53.4246	1%
1997	0.0009	0.0010	1%	6.9609	7.0289	1%	55.4573	55.9985	1%
1998	0.0010	0.0010	1%	7.0222	7.0894	1%	55.9454	56.4806	1%
1999	0.0010	0.0011	1%	7.7175	7.7643	1%	61.4850	61.8573	1%

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]			BC [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	1.1859	1.1899	0%	1.8758	1.8822	0%	0.0043	0.0043	0%
1991	1.0604	1.0704	1%	1.6773	1.6932	1%	0.0038	0.0039	1%
1992	0.9906	1.0009	1%	1.5669	1.5832	1%	0.0036	0.0036	1%
1993	1.0712	1.0784	1%	1.6944	1.7057	1%	0.0039	0.0039	1%
1994	1.1131	1.1207	1%	1.7607	1.7726	1%	0.0040	0.0040	1%
1995	1.0736	1.0823	1%	1.6981	1.7120	1%	0.0039	0.0039	1%
1996	0.9811	0.9925	1%	1.5519	1.5700	1%	0.0035	0.0036	1%
1997	1.0302	1.0404	1%	1.6296	1.6456	1%	0.0037	0.0037	1%
1998	1.0393	1.0493	1%	1.6439	1.6598	1%	0.0037	0.0038	1%
1999	1.1422	1.1492	1%	1.8067	1.8178	1%	0.0041	0.0041	1%
2000	1.3391	1.3392	0%	2.1181	2.1182	0%	0.0048	0.0048	0%
2001	1.2751	1.2752	0%	2.0169	2.0171	0%	0.0046	0.0046	0%
2002	1.1350	1.1350	0%	1.7952	1.7953	0%	0.0041	0.0041	0%
2003	0.6468	0.6468	0%	1.0230	1.0231	0%	0.0023	0.0023	0%
2004	0.5973	0.5974	0%	0.9448	0.9449	0%	0.0022	0.0022	0%

4.6.3 FERROALLOYS PRODUCTION (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 gave a decreasing trend due to the installation of abatement technologies. Activity data, emissions and trends are presented in ***Table 4.46***.

Table 4.46: *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
2018	113.69	0.0107	0.0245	0.0173	0.0000	0.0142	0.0180	0.0200	0.0014	0.1273

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]
2019	105.52	0.0081	0.0143	0.0195	0.0000	0.0115	0.0146	0.0162	0.0012	0.0907
2020	115.72	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
1990/2021	**-32%**	**-99%**	**-67%**	**-95%**	**-83%**	**-94%**	**-94%**	**-94%**	**-94%**	**-97%**
2020/2021	**0%**	**-42%**	**-14%**	**-31%**	**8%**	**-25%**	**-25%**	**-25%**	**-25%**	**-17%**

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 4.47: *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 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. Shares of $PM_{2.5}$ and PM_{10} in TSP are calculated using average shares from the period 2005-2009 (***Table 4.48***). Emissions of BC were calculated using EMEP/EEA GB_{2019} emission factor thought the whole time series.

Table 4.48: *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	1 574.00	71%	90%	10%	17 156.55

*Tier 1 EMEP/EEA GB_{2019}

4.6.3.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2019}.

4.6.3.4 Source-specific recalculations

No recalculation was made.

4.6.4 ALUMINIUM PRODUCTION (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 Slovakia, the plants for aluminium production use a modern technology where the majority of HF and other fluorides escaped 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 is only one source producing aluminium in the Slovak Republic. Emissions of the main pollutants have an increasing trend due to the increase 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 4.49***).

Table 4.49: *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	151.69	0.4991	0.0473	1.8154	0.1168	0.1310	0.1424	0.0027	13.1902	0.0182
2021	NO	164.15	0.4941	0.0367	2.1134	0.1220	0.1368	0.1487	0.0028	14.1074	0.0197
1990/2021	**-**	**-**	**119%**	**2256%**	**195%**	**152%**	**151%**	**152%**	**152%**	**147%**	**-99%**
2020/2021	**-**	**8%**	**-1%**	**-22%**	**16%**	**4%**	**4%**	**4%**	**4%**	**7%**	**8%**

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 EF 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 4.50***). Emissions of BC were calculated using EMEP/EEA GB_{2019} emission factor thought the whole time series.

Table 4.50: *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 4.51***)

Table 4.51: *Emission factors of PAHs calculation for primary aluminium 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	1996-2021	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_{2019}.

4.6.4.4 Source-specific recalculations

Emissions were recalculated due to changes in the calculation of IEF for the historical years, as the activity data for 2003 was corrected (***Table 4.52***).

Table 4.52: *Previous and revised emissions in the category 2C3*

	NOx [kt]			NMVOC [kt]			SOx [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.2258	0.2258	0%	0.0016	0.0016	0%	0.7164	0.7164	0%
1991	0.2222	0.2222	0%	0.0015	0.0015	0%	0.7047	0.7047	0%
1992	0.2067	0.2067	0%	0.0014	0.0014	0%	0.6558	0.6558	0%
1993	0.1293	0.1293	0%	0.0009	0.0009	0%	0.4103	0.4103	0%
1994	0.1099	0.1099	0%	0.0008	0.0008	0%	0.3486	0.3486	0%
1995	0.1092	0.1092	0%	0.0008	0.0008	0%	0.3465	0.3465	0%
1996	0.3733	0.3733	0%	0.0026	0.0026	0%	1.1841	1.1841	0%
1997	0.3692	0.3692	0%	0.0025	0.0025	0%	1.1712	1.1712	0%
1998	0.3619	0.3619	0%	0.0025	0.0025	0%	1.1480	1.1480	0%
1999	0.3659	0.3659	0%	0.0025	0.0025	0%	1.1607	1.1607	0%

	$PM_{2.5}$ [kt]			PM_{10} [kt]			TSP [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.2258	0.2258	0%	0.0016	0.0016	0%	0.7164	0.7164	0%
1991	0.2222	0.2222	0%	0.0015	0.0015	0%	0.7047	0.7047	0%
1992	0.2067	0.2067	0%	0.0014	0.0014	0%	0.6558	0.6558	0%
1993	0.1293	0.1293	0%	0.0009	0.0009	0%	0.4103	0.4103	0%
1994	0.1099	0.1099	0%	0.0008	0.0008	0%	0.3486	0.3486	0%
1995	0.1092	0.1092	0%	0.0008	0.0008	0%	0.3465	0.3465	0%
1996	0.3733	0.3733	0%	0.0026	0.0026	0%	1.1841	1.1841	0%
1997	0.3692	0.3692	0%	0.0025	0.0025	0%	1.1712	1.1712	0%
1998	0.3619	0.3619	0%	0.0025	0.0025	0%	1.1480	1.1480	0%
1999	0.3659	0.3659	0%	0.0025	0.0025	0%	1.1607	1.1607	0%

	BC [kt]			CO [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0011	0.0011	0%	5.7010	5.7010	0%
1991	0.0011	0.0011	0%	5.6080	5.6080	0%
1992	0.0010	0.0010	0%	5.2189	5.2189	0%
1993	0.0006	0.0006	0%	3.2650	3.2650	0%
1994	0.0005	0.0005	0%	2.7744	2.7744	0%
1995	0.0005	0.0005	0%	2.7575	2.7575	0%
1996	0.0018	0.0018	0%	9.4227	9.4227	0%
1997	0.0018	0.0018	0%	9.3204	9.3204	0%
1998	0.0018	0.0018	0%	9.1352	9.1351	0%
1999	0.0018	0.0018	0%	9.2367	9.2366	0%

4.6.5 MAGNESIUM PRODUCTION (2C4)

4.6.5.1 Overview

Emissions from magnesite clinker production were reallocated into category **2C7c** to comply with the emission inventory of GHG. From this submission, notation key NO will be used for all the emissions in this category.

4.6.6 LEAD PRODUCTION (2C5)

4.6.6.1 Overview

The production, regeneration and disposal of electric accumulators and cells occurring in the Slovak Republic in the period 2011-2021. Therefore this activity was included in category **2C5**. The trends of emissions from production and activity data are presented in ***Table 4.53***.

Table 4.53: *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
1990/2021	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
2020/2021	**24%**	**-100%**	**-100%**	**-100%**	**-100%**	**-100%**	**-100%**	**-100%**

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
1990/2021	**-**	**-**	**-**	**-**	**-**	**-**	**-**
2020/2021	**24%**	**24%**	**24%**	**24%**	**24%**	**24%**	**24%**

4.6.6.2 Methodological issues

Activities defined in national legislation involved in the category are presented in ***Table 4.54***.

Table 4.54: *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_{2019} (***Table 4.55***).

Table 4.55: *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_{2019}.

4.6.6.4 Source-specific recalculations

No recalculation was made.

4.6.7 ZINC PRODUCTION (2C6)

4.6.7.1 Overview

The category is reported with notation key NO except for the period 2012-2014 when activity data were recorded. The overview of emissions is shown in ***Table 4.56***.

Table 4.56: *Activity data and emissions in the category 2C6*

YEAR	ZINC PROD [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
1990/2021	-	-	-	-	-	-	-	-
2020/2021	-	-	-	-	-	-	-	-

YEAR	As [t]	Zn [t]	PCDD/F [g I-TEQ]	PCBs [kg]
1990	NO	NO	NO	NO
1995	NO	NO	NO	NO

YEAR	As [t]	Zn [t]	PCDD/F [g I-TEQ]	PCBs [kg]
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
1990/2021	-	-	-	-
2020/2021	-	-	-	-

4.6.7.2 Methodological issues

Tie 1 methodology from EMEP/EEA GB_{2019} was used to calculate emissions from this source. Emission factors are displayed in ***Table 4.57***.

Table 4.57: *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	0.2	16	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_{2019}. For the period 1990-2013 and 2015-2021, notation key NO was used.

4.6.7.3 Source-specific recalculations

No recalculation was made.

4.6.8 COPPER PRODUCTION (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 the 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 4.58***. The emission trend of these pollutants is increasing due to the activity within the category.

Table 4.58: *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	72.49	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
1990/2021	-	**365%**	**286%**	**394%**	**386%**	**-57%**	**-57%**	**-80%**	**-57%**	**-44%**
2020/2021	-	**2%**	**-34%**	**23%**	**56%**	**-30%**	**-30%**	**-30%**	**-30%**	**-43%**

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	0.0009	0.1714	0.6093	1.6185	0.3643	0.9523	0.0001
1995	0.7372	0.1835	0.0008	0.1089	0.5361	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	3.0829	0.0003
2011	0.0005	0.1156	0.0017	0.0182	1.1598	2.0296	0.0000	3.2618	0.0003
2012	0.0005	0.1156	0.0017	0.0182	1.1598	2.0296	0.0000	3.2618	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
1990/2021	**-100%**	**-100%**	**132%**	-	**132%**	**-94%**	**-100%**	**318%**	**274%**
2020/2021	**2%**	**2%**	**2%**	-	**2%**	**2%**	**2%**	**2%**	**2%**

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 2000-2021 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 4.59***).

Table 4.59: 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]	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_{2019} were used (***Table 4.60***). 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 4.61***).

Table 4.60*: 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	1990-2021	-	-	0.023	-	16	-	-	-	0.9
T2 Primary production	1990-1999	16	15	-	7	-	57	19	0.01	-
T2 Secondary production	1990-2021	24	2.3	-	2	-	28	0.13	50	-

Table 4.61: 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	2018-2021	99.99%	99.60%	100.00%	96%	99.99%	10%

*Default values from EMEP/EEA GB_{2019}

4.6.8.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2019}.

4.6.8.4 Source-specific recalculations

Emissions were recalculated due to error correction in the calculation of IEF for the historical years (***Table 4.62***).

Table 4.62: Previous and revised emissions in the category 2C7a

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]			BC [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0048	0.0048	0%	0.0061	0.0061	0%	0.0000	0.0000	0%
1991	0.0069	0.0069	0%	0.0087	0.0087	0%	0.0000	0.0000	0%
1992	0.0090	0.0090	0%	0.0114	0.0114	0%	0.0000	0.0000	0%
1993	0.0072	0.0072	0%	0.0091	0.0091	0%	0.0000	0.0000	0%
1994	0.0054	0.0054	0%	0.0069	0.0069	0%	0.0000	0.0000	0%

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]			BC [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1995	0.0042	0.0042	0%	0.0054	0.0053	0%	0.0000	0.0000	0%
1996	0.0080	0.0080	0%	0.0102	0.0102	0%	0.0000	0.0000	0%
1997	0.0082	0.0082	0%	0.0104	0.0103	0%	0.0000	0.0000	0%
1998	0.0063	0.0063	0%	0.0080	0.0080	0%	0.0000	0.0000	0%
1999	0.0003	0.0003	0%	0.0004	0.0004	0%	0.0000	0.0000	0%
2020	0.0000	0.0000	0%	0.0001	0.0001	0%	0.0000	0.0000	0%
2001	0.0023	0.0023	0%	0.0029	0.0029	0%	0.0000	0.0000	0%
2002	0.0020	0.0020	0%	0.0025	0.0025	0%	0.0000	0.0000	0%
2003	0.0016	0.0016	0%	0.0021	0.0021	0%	0.0000	0.0000	0%
2004	0.0024	0.0024	0%	0.0030	0.0030	0%	0.0000	0.0000	0%

4.6.9 NIKEL PRODUCTION (2C7b)

4.6.9.1 Overview

The category is reported with 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 (2C7c)

4.6.10.1 Overview

The trends of emission from other metal production are presented in ***Table 4.63***. 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 4.63: *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
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
1990/2021	**-25%**	**254%**	**-16%**	**-27%**	**-61%**	**-65%**	**-74%**	**-63%**
2020/2021	**0%**	**14%**	**4%**	**-5%**	**-17%**	**-17%**	**-13%**	**17%**

4.6.10.2 Methodological issues

Activities defined in national legislation involved in the category are presented in ***Table 4.64***. In this submission, emissions from the source magnesite clinker production were reallocated in this category.

Table 4.64: *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 2000-2021 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 4.65***).

Table 4.65: *Emission factors for calculation of historical years*

	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	232 173.93	95 633.52	176 668.20	7 615.01	120 069.23	73%	90%	1 017 423.02

4.6.10.3 Completeness

All rising pollutants were reported. Notation keys were used in compliance with EMEP/EEA GB_{2019}.

4.6.10.4 Source-specific recalculations

No recalculations in this submission.

4.6.11 STORAGE, HANDLING AND TRANSPORT OF METAL PRODUCTS (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 AND OTHER PRODUCT USE (NFR 2D, 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 4.66***.

Table 4.66: *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 4.67***. Shares of released emissions of NMVOC in 2021 included in NFR categories **2D** are presented in ***Figure 4.6***.

Figure 4.6: *The share in NMVOC emissions of individual categories in 2D in 2021*

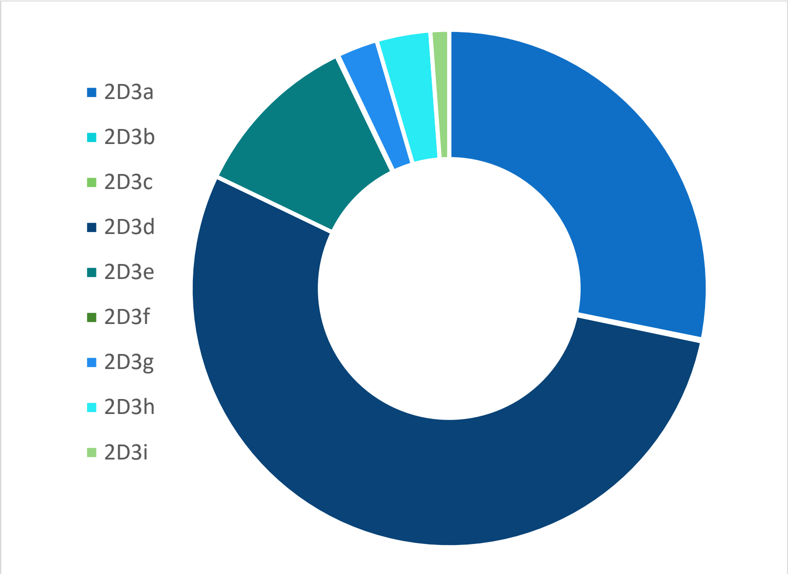


Table 4.67: *Overview of emissions in the category 2D*

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	0.0273	0.0015	0.0028	0.0104	0.0000	0.0003	0.0004	0.0305
2014	22.5021	0.0279	0.0011	0.0023	0.0095	0.0000	0.0003	0.0004	0.0305
2015	25.6429	0.0301	0.0005	0.0020	0.0129	0.0000	0.0003	0.0004	0.0306
2016	23.9248	0.0316	0.0007	0.0015	0.0066	0.0000	0.0004	0.0004	0.0306
2017	21.7249	0.0326	0.0005	0.0012	0.0059	0.0000	0.0004	0.0004	0.0307
2018	24.1538	0.0338	0.0005	0.0011	0.0052	0.0000	0.0004	0.0005	0.0307
2019	20.5470	0.0224	0.0004	0.0010	0.0051	0.0000	0.0004	0.0005	0.0308
2020	20.8513	0.0211	0.0005	0.0011	0.0051	0.0000	0.0003	0.0005	0.0308
2021	19.8864	0.0220	0.0005	0.0016	0.0090	0.0000	0.0004	0.0006	0.0307
1990/2021	**-48%**	**50%**	**-99%**	**-99%**	**-97%**	**-99%**	**125%**	**209%**	**3%**
2020/2021	**-5%**	**5%**	**6%**	**41%**	**75%**	**25%**	**5%**	**33%**	**0%**

YEAR	As [t]	Cr [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
1995	0.0002	0.0005	0.0001	0.0034	0.0001	3.4896	0.0120
2000	0.0002	0.0004	0.0001	0.0024	0.0001	3.7594	0.0043
2005	0.0003	0.0004	0.0001	0.0018	0.0001	5.6020	0.0079
2010	0.0004	0.0004	0.0002	0.0014	0.0002	6.7983	0.0074
2011	0.0004	0.0004	0.0002	0.0016	0.0002	6.4890	0.0088
2012	0.0004	0.0004	0.0002	0.0016	0.0002	6.9798	0.0072
2013	0.0004	0.0005	0.0002	0.0022	0.0002	6.8365	0.0060
2014	0.0005	0.0006	0.0002	0.0032	0.0002	6.9937	0.0055
2015	0.0005	0.0005	0.0002	0.0021	0.0002	7.5426	0.0103
2016	0.0005	0.0007	0.0002	0.0035	0.0002	7.9169	0.0074
2017	0.0005	0.0006	0.0002	0.0028	0.0002	8.1600	0.0077
2018	0.0006	0.0007	0.0002	0.0037	0.0002	8.4633	0.0090
2019	0.0006	0.0007	0.0002	0.0034	0.0002	6.9608	0.0093
2020	0.0006	0.0007	0.0002	0.0035	0.0002	6.5433	0.0093
2021	0.0008	0.0008	0.0003	0.0042	0.0002	6.8394	0.0108
1990/2021	**176%**	**-11%**	**200%**	**-36%**	**64%**	**85%**	**-58%**
2020/2021	**36%**	**12%**	**29%**	**21%**	**14%**	**5%**	**16%**

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 4.68***.

Table 4.68: *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

YEAR	INHABITANTS	NMVOC [kt]	Hg [t]
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
1990/2021	**3%**	**19%**	**3%**
2020/2021	**0%**	**-13%**	**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_{2019} (***Table 4.69***). Emissions from the insecticides, fungicides and herbicides were calculated using the Tier 2b method, emission factors were taken from EMEP/EEA GB_{2019} (***Table 4.70***). In 2021, a decrease is reported in NMVOC emissions (-0.56 kt) from the use of herbicides (-39%).

Table 4.69: *Used solvent contents and emissions factors (per t of solvent) for Tier 2a method according to the EMEP/EEA GB_{2019}.*

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

SOURCE	SOLVENT CONTENT [%]	EF NMVOC [kg/t]
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 4.70: *Used solvent contents and emissions factors (per t of product) for Tier 2b method according to the EMEP/EEA GB_{2019}.*

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 2021. 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 4.71***.

Table 4.71: *Activity data ($consumption = production + import - export$) in the category 2D3a*

YEAR	PERFUMES AND TOILET WATERS	HAIR LACQUERS	PRE-SHAVE, SHAVING OR AFTERSHAVE PREPARATIONS	PERSONAL DEODORANTS AND ANTIPERSPIRANTS
1999	0.888	0.409	1.160	2.163
2000	0.890	0.410	1.162	2.166
2001	0.887	0.409	1.158	2.159
2002	0.887	0.409	1.159	2.159
2003	0.887	0.409	1.159	2.161
2004	0.889	0.409	1.161	2.163
2005	0.890	0.410	1.162	2.166
2006	0.891	0.411	1.164	2.169
2007	0.892	0.411	1.166	2.172
2008	0.894	0.412	1.168	2.177
2009	0.897	0.413	1.171	2.183
2010	0.865	0.264	0.855	1.858
2011	1.580	0.164	1.065	1.596
2012	0.662	0.514	2.735	1.800
2013	0.653	0.097	0.665	1.822
2014	0.529	0.117	0.736	1.853
2015	0.948	0.249	0.840	1.768
2016	0.880	0.216	1.002	2.439
2017	1.282	0.775	1.421	3.265
2018	1.155	0.952	1.306	2.940
2019	1.105	0.805	1.135	2.587
2020	1.267	0.722	1.277	2.385
2021	2.050	0.559	0.832	1.359

YEAR	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
1999	0.132	0.199	1.656
2000	0.061	0.203	2.351

YEAR	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
2001	0.150	0.192	2.590
2002	0.164	0.144	3.370
2003	0.133	0.136	3.583
2004	0.103	0.268	2.879
2005	0.092	0.413	3.266
2006	0.085	0.461	2.678
2007	0.152	0.433	2.681
2008	0.180	0.504	1.671
2009	0.143	0.337	1.669
2010	0.202	0.145	1.246
2011	0.236	0.613	1.337
2012	0.264	0.549	5.065
2013	0.288	0.649	3.902
2014	0.292	0.721	3.286
2015	0.238	0.655	3.275
2016	0.170	1.154	3.508
2017	0.258	0.722	3.158
2018	0.170	0.717	3.305
2019	0.136	0.772	3.316
2020	0.116	0.764	4.769
2021	0.153	0.710	4.205

YEAR	WINDSCREEN WIPERS, DEFROSTERS AND DEMISTERS FOR MOTORCYCLES OR MOTOR VEHICLES	INSECTICIDES	FUNGICIDES	HERBICIDES, ANTI-SPROUTING PRODUCTS AND PLANT-GROWTH REGULATORS
1999	0.032	1.551	1.929	4.568
2000	0.031	1.554	1.932	4.574
2001	0.045	1.548	1.925	4.559
2002	0.061	1.549	1.926	4.560
2003	0.066	1.550	1.927	4.563
2004	0.094	1.552	1.929	4.568
2005	0.120	1.554	1.932	4.574
2006	0.365	1.556	1.934	4.580
2007	0.133	1.558	1.938	4.588
2008	0.679	1.562	1.942	4.598
2009	0.346	1.566	1.947	4.610
2010	0.500	1.189	1.376	3.317
2011	0.139	1.187	1.904	4.564
2012	0.138	1.260	2.189	4.114
2013	0.282	1.291	1.604	5.446
2014	0.166	1.487	1.321	4.169
2015	0.081	2.082	2.044	4.230
2016	0.466	1.963	2.310	4.572
2017	0.433	1.586	2.478	4.677
2018	0.594	1.714	1.985	5.102
2019	0.707	1.967	2.340	6.105
2020	0.526	1.722	2.369	7.739

YEAR	WINDSCREEN WIPERS, DEFROSTERS AND DEMISTERS FOR MOTORCYCLES OR MOTOR VEHICLES	INSECTICIDES	FUNGICIDES	HERBICIDES, ANTI-SPROUTING PRODUCTS AND PLANT-GROWTH REGULATORS
2021	0.719	1.838	2.144	4.715

4.7.1.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2019}.

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 fees 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 4.72***).

Table 4.72: *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
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
1990/2021	**-58%**	**-70%**	**-99%**	**-95%**	**-95%**	**-99%**	**-58%**
2020/2021	**16%**	**38%**	**84%**	**84%**	**84%**	**84%**	**16%**

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 4.73: *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 tonnes/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 NO_X, SO_X and CO are assumed of having the combustion origin. And it is also assumed that VOC, TSP and PMs do not create a significant part of released emissions from NG. The allocation of NO_X, SO_X 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

[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

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 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 2021.

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 share from TSP in previous years 2005–2009.

EF_{NMVOC} = 0.19 [g/Mg Asphalt]

EF_{TSP} = 0.51 [g/Mg Asphalt]

$EF_{PM2.5}$ = 8.71% EF_{TSP}

EF_{PM10} = 11.65% % EF_{TSP}

4.7.2.3. Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2019}.

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 4.74***). Two operators were identified that produce asphalt shingles. One operator operated in the period 1990-2014 and the second in 2013-2021.

Table 4.74: *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
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
1990/2021	**-50%**	**-95%**	**-99%**	**-99%**	**-99%**	**-99%**
2020/2021	**2%**	**15%**	**14%**	**14%**	**14%**	**14%**

4.7.3.2 Methodological issues

The source of emissions is the NEIS database – recorded facility data from operators.

***Table 4.75**: 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 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 are harmonized with GHG emission inventory.

Historical data: The emissions are taken from the NEIS for the years 2005 to 2021.

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_{2019}.

EF_{NMVOC} = 358.89 [g/Mg Asphalt Use for Roofing]

EF_{TSP} = 1 088.76 [g/Mg Asphalt Use for Roofing]

$EF_{PM2.5}$ = 79% EF_{TSP}

EF_{PM10} = 99% EF_{TSP}

EF_{BC} = 0.013% $EF_{PM2.5}$

4.7.3.3 Completeness

All pollutants are covered. Emissions of CO were reallocated from this category to category **1A2gviii**, as they originate from the combustion of fuels. Notation keys were used following the EMEP/EEA GB_{2019}.

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 4.76***).

***Table 4.76:** 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

YEAR	COATINGS APPLIED [kt]	NMVOC [kt]
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
1990/2021	**-**	**-34%**
2020/2021	**-10%**	**-1%**

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 4.77**: 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 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 2021. 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 4.78: *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

YEAR	SB	WB
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

Table 4.79: *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
2019	5 184	4 150
2020	7 549	3 235
2021	7 466	3 241

4.7.4.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2019}.

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 4.80***). The peak of recorded emissions in 2011 relates to the activity data from statistics, namely the decrease of exported solvents and increased amount of imported.

Table 4.80: *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
1990/2021	**-79%**	**-79%**
2020/2021	**-4%**	**-42%**

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 4.81: *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 4.82: *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

4.7.5.3 Completeness

All pollutants are covered. Notation keys were used following the EMEP/EEA GB_{2019}.

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 4.83***).

Table 4.83: *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

YEAR	SOLVENTS USED [kt]	NMVOC [kt]
2018	0.04	0.0361
2019	0.04	0.0334
2020	0.03	0.0224
2021	0.02	0.0199
1990/2021	**-74%**	**-69%**
2020/2021	**-9%**	**-11%**

4.7.6.2 Methodological issues

The source of emissions is the NEIS database – recorded facility data from operators.

Table 4.84: *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 tonnes/year b) a projected amount of bleached or dyed textiles or fibres in tonnes/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.

$$E_{TOTAL} = E_{NEIS}$$

<u>*Calculations in the NEIS:*</u> 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 differently calculated for direct and indirect emissions

Historical data: The emissions are taken from the NEIS for the years 2005 to 2021. 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_{2019}.

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 4.85***). The most remarkable decline was in 2006. Emissions of HMs and PAHs were reported for the first time in this submission. As the activity data for the second operator was added to the calculations, emissions of HMs and PAHs are reported for the whole time series.

Table 4.85: *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
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
1990/2021	**8%**	**-39%**	**-88%**	**-39%**	**-39%**	**-39%**	**-39%**	**-39%**	**-39%**
2020/2021	**-6%**	**22%**	**19%**	**22%**	**22%**	**22%**	**22%**	**22%**	**22%**

4.7.7.2 Methodological issues

The source of emissions is the NEIS database – recorded facility data from operators.

Table 4.86: *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

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
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_{2019}. The emission factors used for the calculation are listed in ***Table 4.87***.

Table 4.87: *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

<u>*Calculations in the NEIS:*</u> 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_{2019} 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 (NO_X, SO_X, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO) were allocated to the **1A2gviii** to be in line with EMEP/EEA GB_{2019}.

Historical data: The emissions are taken from the NEIS for the years 2005 to 2021. 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_{2019}.

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 4.88***).

Table 4.88: *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
1990/2021	**4%**	**-69%**
2020/2021	**17%**	**4%**

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 4.89: *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 the 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 2021. 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_{2019}.

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 4.90***. Emissions in this category calculated from lubricant consumption in transport are presented in ***Table 4.91***.

Table 4.90: *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
1990/2021	**30%**	**-45%**
2020/2021	**-11%**	**-8%**

Table 4.91: *Emissions from lubricant consumption in transport*

YEAR	SOx	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
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

YEAR	SOx	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
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	0.0273	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.8365
2014	0.0279	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.9937
2015	0.0301	0.0003	0.0004	0.0002	0.0005	0.0003	0.0002	0.0002	0.0001	7.5426
2016	0.0316	0.0004	0.0004	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	7.9169
2017	0.0326	0.0004	0.0004	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	8.1600
2018	0.0338	0.0004	0.0005	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	8.4633
2019	0.0224	0.0004	0.0005	0.0003	0.0006	0.0004	0.0002	0.0003	0.0002	6.9608
2020	0.0211	0.0003	0.0005	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	6.5433
2021	0.0220	0.0004	0.0006	0.0002	0.0007	0.0003	0.0003	0.0003	0.0002	6.8394
1990/2021	**50%**	**125%**	**226%**	**150%**	**241%**	**150%**	**200%**	**200%**	**150%**	**85%**
2020/2021	**5%**	**5%**	**33%**	**-1%**	**37%**	**1%**	**29%**	**18%**	**13%**	**5%**

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 4.92***.

Table 4.92: *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 tonnes/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 tonnes/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 2021. 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_{2019}

4.7.9.4 Source-specific recalculation

Recalculation was made due because emissions from lubricant use were recalculated in the COPERT model due to the improvement of quality data about the fleet structure for the period 2013-2021.

Table 4.93: *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	0.0300	0.0273	-9%	0.0003	0.0003	-14%	0.0004	0.0004	-5%
2014	0.0273	0.0279	2%	0.0003	0.0003	-4%	0.0004	0.0004	-3%
2015	0.0328	0.0301	-8%	0.0004	0.0003	-8%	0.0004	0.0004	-8%

YEAR	SOx [kt]			Pb [t]			Cd [t]		
	P	R	C	P	R	C	P	R	C
2016	0.0354	0.0316	-11%	0.0004	0.0004	-11%	0.0005	0.0004	-11%
2017	0.0342	0.0326	-5%	0.0004	0.0004	-5%	0.0005	0.0004	-5%
2018	0.0375	0.0338	-10%	0.0004	0.0004	-9%	0.0005	0.0005	-9%
2019	0.0229	0.0224	-2%	0.0004	0.0004	-2%	0.0007	0.0005	-23%
2020	0.0224	0.0211	-6%	0.0004	0.0003	-6%	0.0006	0.0005	-26%

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%	0.0002	0.0003	39%	0.0002	0.0002	0%
2014	0.0002	0.0002	-3%	0.0004	0.0004	-3%	0.0002	0.0003	44%	0.0002	0.0002	-3%
2015	0.0002	0.0002	-8%	0.0005	0.0005	-8%	0.0002	0.0003	37%	0.0002	0.0002	-8%
2016	0.0002	0.0002	-11%	0.0005	0.0005	-11%	0.0002	0.0003	33%	0.0002	0.0002	-11%
2017	0.0002	0.0002	-5%	0.0005	0.0005	-5%	0.0002	0.0003	42%	0.0002	0.0002	-5%
2018	0.0003	0.0002	-9%	0.0006	0.0005	-9%	0.0004	0.0003	-9%	0.0002	0.0002	-9%
2019	0.0003	0.0003	3%	0.0008	0.0006	-25%	0.0004	0.0004	2%	0.0003	0.0002	-21%
2020	0.0002	0.0002	-1%	0.0007	0.0005	-28%	0.0003	0.0003	-3%	0.0003	0.0002	-24%

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	4%	7.4507	6.8365	-8%
2014	0.0002	0.0002	-3%	0.0001	0.0001	-3%	5.1187	6.9937	37%
2015	0.0002	0.0002	-8%	0.0002	0.0001	-8%	8.2335	7.5426	-8%
2016	0.0003	0.0002	-11%	0.0002	0.0002	-11%	8.8852	7.9169	-11%
2017	0.0002	0.0002	-5%	0.0002	0.0002	-5%	8.5626	8.1600	-5%
2018	0.0003	0.0002	-9%	0.0002	0.0002	-9%	9.2705	8.4633	-9%
2019	0.0003	0.0003	-13%	0.0002	0.0002	-9%	7.1021	6.9608	-2%
2020	0.0003	0.0002	-17%	0.0002	0.0002	-13%	6.9522	6.5433	-6%

P - Previous, R – Revised, C – Change in %

4.7.10 OTHER PRODUCT USE (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.

Emissions in this sector were reported for the first time in this submission. ***Table 4.94*** below shows a significant increase in emissions in this category from 1990 due to an increase in tobacco and fireworks use. In ***Table 4.94*** emission trend of NMVOC is shown.

[3] U.S. Dept. of Health and Human Services, 1981: The Health Consequences of Smoking: The Changing Cigarette

***Table 4.94:** Overview of emissions in the category Other product use*

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
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
1990/2021	**1285%**	**1282%**	**1607%**	**1282%**	**1282%**	**1282%**	**1282%**	**1282%**	**1285%**
2020/2021	**17%**	**17%**	**77%**	**17%**	**17%**	**17%**	**17%**	**17%**	**17%**

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
1990/2021	**1607%**	**1287%**	**1607%**	**1607%**	**1607%**	**1545%**	**1400%**	**1553%**
2020/2021	**77%**	**17%**	**77%**	**77%**	**77%**	**64%**	**36%**	**65%**

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

YEAR	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
2015	0.0008	0.0009	0.0004	0.0004	0.0004	0.0021
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
1990/2021	**1282%**	**1282%**	**1282%**	**1282%**	**1282%**	**1282%**
2020/2021	**17%**	**17%**	**17%**	**17%**	**17%**	**17%**

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 was reconsidered and replaced by the value calculated as a trend. For calculations of fireworks used ***Equation 4.15*** for the period 1991-2021 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. 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 2005-2021 and cigars and cigarillos for the period 2009-2021. 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 4.95*** shows the results of these calculations.

Table 4.95*: 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

Emission factors for the calculations originate from the Tier 2 methodology in EMEP/EEA GB$_{2019}$ (***Table 4.96, 4.97***). **Condensable component of PMs** is included in emission factors for tobacco combustion, for use of fireworks is this information unknown.

Table 4.96: *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 4.97: *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 PM2.5]	[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	PAH
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

Recalculation was made because the activity data for tobacco combustion for the years 2005 and 2007 were replaced by the trend value of previous and following years following ***Recommendation No SK-2G-2022-0001*** (***Table 4.98***).

Table 4.98: *Previous and revised emissions in the category 2G*

YEAR	NOx [kt]			NMVOC [kt]			NH_3 [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.0447	0.0119	-73%	0.1196	0.0316	-74%	0.1025	0.0271	-74%
2006	0.0115	0.0115	-	0.0307	0.0307	-	0.0264	0.0264	-
2007	0.0279	0.0128	-54%	0.0747	0.0342	-54%	0.0641	0.0294	-54%

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]			TSP [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.6670	0.1761	-74%	0.6671	0.1762	-74%	0.6671	0.1762	-74%
2006	0.1716	0.1716	-	0.1716	0.1716	-	0.1716	0.1716	-
2007	0.4168	0.1910	-54%	0.4168	0.1910	-54%	0.4168	0.1910	-54%

YEAR	BC [kt]			CO [kt]			Cd [t]		
	PREVIOUS	REVISED	PREVIOUS	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.3001	0.0792	-74%	1.3667	0.3649	-73%	0.1346	0.0364	-73%
2006	0.0772	0.0772	-	0.3521	0.3521	-	0.0347	0.0347	-
2007	0.1875	0.0859	-54%	0.8530	0.3922	-54%	0.0839	0.0387	-54%

YEAR	Cu [t]			Ni [t]			Zn [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.4810	0.3828	-20%	0.0902	0.0411	-54%	0.2702	0.2212	-18%
2006	0.1601	0.1601	-	0.0257	0.0257	-	0.0908	0.0908	-
2007	0.2371	0.1919	-19%	0.0521	0.0295	-43%	0.1317	0.1091	-17%

YEAR	PCDD/F [g I-TEQ]			B(a)P [t]			B(b)F [t]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2005	0.0025	0.0007	-74%	0.0027	0.0007	-74%	0.0011	0.0003	-74%
2006	0.0006	0.0006	-	0.0007	0.0007	-	0.0003	0.0003	-
2007	0.0015	0.0007	-54%	0.0017	0.0008	-54%	0.0007	0.0003	-54%

YEAR	B(k)F [t]			I()P [t]			PAHs [t]		
	PREVIOUS	REVISED	PREVIOUS	PREVIOUS	REVISED	CHANGE	PREVIOUS	PREVIOUS	CHANGE
2005	0.0011	0.0003	-74%	0.0011	0.0003	-74%	0.0061	0.0016	-74%
2006	0.0003	0.0003	-	0.0003	0.0003	-	0.0016	0.0016	-
2007	0.0007	0.0003	-54%	0.0007	0.0003	-54%	0.0038	0.0017	-54%

4.8 OTHER PROCESSES (NFR 2H)

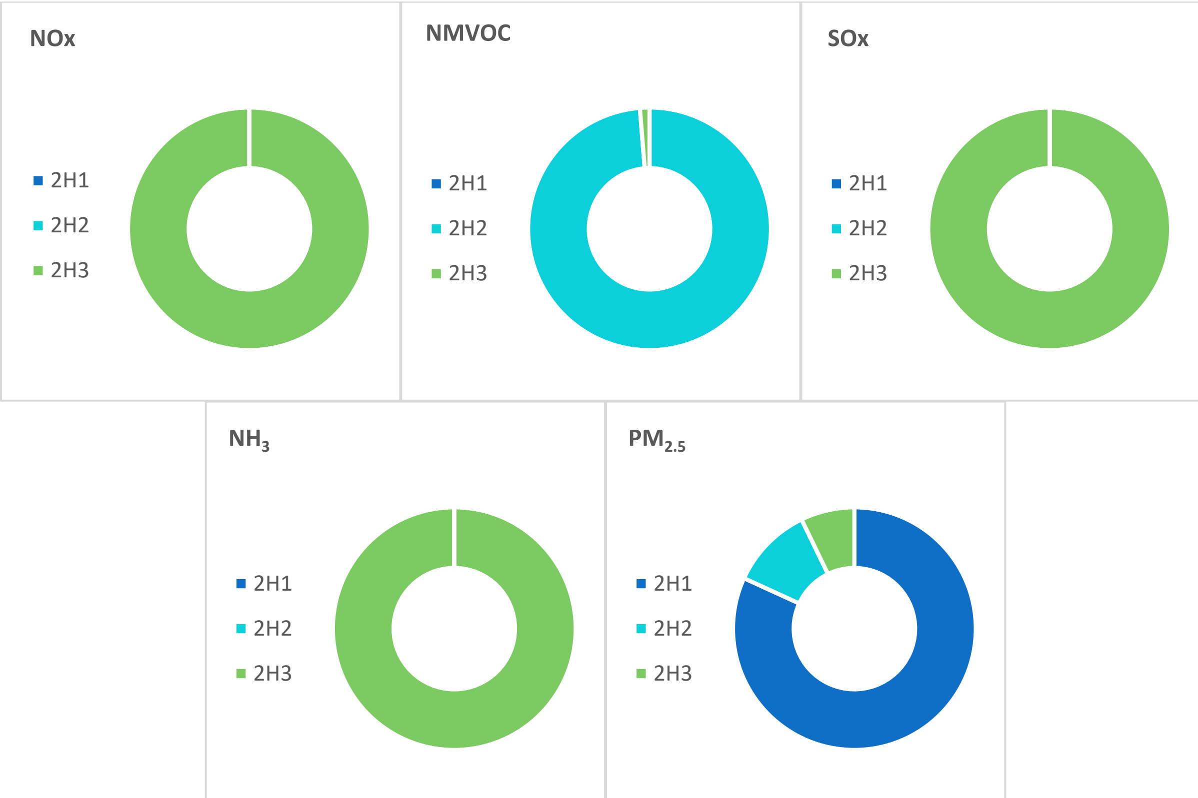
The chapter is divided into 3 industrial activities: Pulp and paper industry (**2H1**), Food and beverages industry (**2H2**) and other industrial processes (**2H3**). An overview of emissions and their trends are listed in ***Table 4.99***. Emissions of PMs and NH_3 have a decreasing trend due to the 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. NMVOC emissions from category **2H2** were calculated for the first time in this submission.

Table 4.99: *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	0.5413	0.0000	0.0018	0.0183	0.0682	0.1673	0.0005	0.0000
1995	0.0003	1.3633	0.0000	0.0021	0.0291	0.1089	0.2671	0.0007	0.0000
2000	0.0001	2.1723	0.0000	0.0059	0.0389	0.1454	0.3565	0.0010	0.0000
2005	0.0007	2.8013	0.0000	0.0000	0.0547	0.2133	0.5295	0.0013	0.0001
2010	0.0001	2.3961	0.0000	0.0000	0.0146	0.0545	0.1336	0.0003	0.0001
2011	0.0002	2.5713	0.0000	0.0000	0.0265	0.1020	0.2525	0.0006	0.0001
2012	0.0003	2.2111	0.0000	0.0000	0.0232	0.0897	0.2223	0.0005	0.0001
2013	0.0001	2.7312	0.0000	0.0000	0.0305	0.1189	0.2953	0.0007	0.0001
2014	0.0009	2.9193	0.0012	0.0000	0.0171	0.0655	0.1617	0.0004	0.0000
2015	0.0014	2.6587	0.0020	0.0000	0.0102	0.0377	0.0923	0.0002	0.0001
2016	0.0021	2.8652	0.0030	0.0000	0.0095	0.0342	0.0832	0.0002	0.0014
2017	0.0021	2.8321	0.0030	0.0000	0.0106	0.0384	0.0935	0.0002	NO
2018	0.0021	2.4133	0.0031	0.0000	0.0101	0.0363	0.0883	0.0002	NO
2019	0.0021	2.5104	0.0030	0.0000	0.0095	0.0337	0.0859	0.0002	NO
2020	0.0014	2.4871	0.0020	0.0000	0.0129	0.0477	0.1167	0.0003	NO
2021	0.0007	2.5878	0.0011	0.0000	0.0134	0.0496	0.1215	0.0003	NO
1990/2021	**197%**	**378%**	**30383%**	**-99%**	**-27%**	**-27%**	**-27%**	**-38%**	**-**
2020/2021	**-47%**	**4%**	**-47%**	**134333%**	**3%**	**4%**	**4%**	**7%**	**-**

Shares of NO_X, NMVOC, SO_X, NH_3 and $PM_{2.5}$ emissions in 2021 included in NFR categories are shown in ***Figure 4.7***.

Figure 4.7: Shares of emissions in 2H in 2021



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 depends on the nature of the feedstock and the desired qualities of the end product.

Several companies were operating during the year 2021 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 4.100*** can be seen that emissions of all pollutants decreased in general since the year 1990.

Table 4.100: 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
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

YEAR	PULP PRODUCED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]
2021	765.02	0.0109	0.0409	0.1004	0.0003
1990/2021	**327%**	**-38%**	**-37%**	**-37%**	**-38%**
2020/2021	**7%**	**7%**	**9%**	**9%**	**7%**

4.8.1.2 Methodological issues

Activities assigned in this category are listed in ***Table 4.101***.

Table 4.101: *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 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 EMEP/EEA GB_{2019} (***Table 4.102***).

Table 4.102: *Emission factors for calculation of historical years and BC*

	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP [g/t]	BC %$PM_{2.5}$
EF	11%	41%	895.06	2.60%

4.8.1.3 Completeness

Heavy metals, PCDD/F and HCB are reported with notation key NA, other POPs are reported using notation key NE in complying with the EMEP/EEA GB_{2019}. Combustion emissions (NOx, NMVOC, SOx, NH_3, CO) were allocated to the category **1A2d**, therefore, 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.

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 4.103***).

Table 4.103: *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	15.34	20.69	27.31	3.23	89.05	NO
1995	53.57	1.77	39.54	53.35	70.41	8.34	229.57	NO
2000	86.40	2.85	63.77	86.04	113.55	13.45	370.24	NO
2005	110.04	3.63	81.22	109.59	144.63	17.13	471.57	NO
2010	99.62	2.60	69.63	110.13	148.34	8.86	136.37	1.90
2011	95.83	2.81	71.78	91.76	177.92	8.20	110.75	2.10
2012	93.42	2.74	66.94	77.00	138.43	7.17	170.19	2.20
2013	89.11	2.60	67.57	60.84	176.89	15.06	252.29	2.01
2014	91.30	2.60	65.22	59.56	199.58	13.89	214.47	2.03
2015	89.74	2.62	72.28	111.79	171.19	13.55	234.04	2.23
2016	87.18	2.88	39.10	125.36	197.12	13.92	213.44	2.35
2017	87.61	2.63	40.60	153.60	187.72	14.02	272.23	2.50
2018	83.71	2.56	38.44	147.28	150.28	13.59	257.50	2.22
2019	84.98	2.50	34.89	168.06	155.77	14.01	282.46	2.43
2020	86.05	1.77	31.32	152.22	148.80	13.71	330.96	2.29
2021	83.50	1.36	39.99	162.62	158.67	13.71	330.96	2.40
1990/2021	**302%**	**98%**	**161%**	**686%**	**481%**	**324%**	**272%**	**-**
2020/2021	**-3%**	**-23%**	**28%**	**7%**	**7%**	**0%**	**0%**	**5%**

YEAR	WINE UNSPECIFIED COLOUR [kt]	BEER INCLUDING DE-ALCOHOLIZIED [kt]	SPIRITS UNSPECIFIED SORT [kt]	OTHER SPIRITS [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	16.42	73.24	0.12	1.11	0.5188	0.0004	0.0014	0.0035
1995	42.34	188.81	0.32	2.87	1.3374	0.0009	0.0036	0.0091
2000	68.29	304.52	0.51	4.62	2.1570	0.0005	0.0018	0.0045
2005	98.17	387.86	0.65	5.89	2.7483	0.0021	0.0083	0.0209
2010	85.52	300.16	0.73	5.79	2.3026	0.0014	0.0057	0.0142
2011	95.22	297.32	0.52	6.12	2.5446	0.0015	0.0060	0.0149
2012	84.90	299.84	0.49	5.19	2.1770	0.0012	0.0049	0.0121
2013	85.23	288.25	0.96	4.61	2.7045	0.0016	0.0065	0.0162
2014	82.48	264.80	0.96	4.56	2.8881	0.0018	0.0073	0.0181
2015	84.21	240.43	0.25	5.21	2.6251	0.0020	0.0079	0.0198
2016	76.68	221.10	0.36	5.17	2.8285	0.0017	0.0069	0.0173
2017	83.24	235.36	0.40	7.88	2.8077	0.0020	0.0079	0.0197
2018	74.27	189.96	0.41	7.97	2.3903	0.0020	0.0080	0.0200
2019	79.33	192.09	0.40	8.00	2.4829	0.0016	0.0064	0.0199
2020	84.80	238.91	0.71	6.68	2.4596	0.0018	0.0073	0.0182
2021	72.27	220.32	0.76	8.34	2.5549	0.0015	0.0059	0.0147
1990/2021	**340%**	**201%**	**518%**	**650%**	**392%**	**316%**	**316%**	**316%**
2020/2021	**-15%**	**-8%**	**7%**	**25%**	**4%**	**-19%**	**-19%**	**-19%**

4.8.2.2 Methodological issues

Emissions were calculated using Tier 2 emission factors from the EMEP/EEA GB_{2019}. Activity data were obtained from the national PRODCOM database and Import/export statistics for the period 2005-2021. 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 EMEP/EEA GB_{2019} (***Table 4.104***).

Table 4.104: *Emission factors for calculation of NMVOC in the category 2H2*

	NMVOC [kg/t]	$PM_{2.5}$ [% of TSP]	PM_{10} [% of TSP]	TSP [g/t]
Bread typical Europe	4.5	10.00%	40.00%	19.94
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_{2019}.

4.8.2.4 Source-specific recalculations

Recalculations were made due to the correction of activity data for wine unspecified for the period 2005-2009 and beer for 2016-2021. The changes are shown in the following table.

Table 4.105: *Previous and revised emissions in the category 2H2*

YEARS	NMVOC [kt]		
	PREVIOUS	REVISED	CHANGE
2005	2.7474	2.7483	0%
2006	2.8066	2.8075	0%
2007	2.7254	2.7263	0%
2008	2.6022	2.6030	0%
2009	2.3590	2.3601	0%
2010	2.3026	2.3026	-
2011	2.5446	2.5446	-
2012	2.1770	2.1770	-
2013	2.7045	2.7045	-
2014	2.8881	2.8881	-
2015	2.6251	2.6251	-
2016	2.8287	2.8285	0%

YEARS	NMVOC [kt]		
	PREVIOUS	REVISED	CHANGE
2017	2.8079	2.8077	0%
2018	2.3984	2.3903	0%
2019	2.4905	2.4829	0%
2020	2.4538	2.4596	0%

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 4.106*** 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 significant 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.

Table 4.106: *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
1990/2021	**197%**	**46%**	**30383%**	**-99%**	**141%**	**99%**	**89%**	**-**
2020/2021	**-47%**	**19%**	**-47%**	**134333%**	**4%**	**0%**	**-1%**	**-**

4.8.3.2 Methodological issues

Activities listed in ***Table 4.107*** were reported in this category.

Table 4.107: *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 4.108***). Activity data for the calculation of implied emission factors are the total energy used in this category.

Table 4.108: Emission factors for calculation of historical years

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	$PM_{2.5}$ %TSP	PM_{10} %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_{2019}. The notation key for the CO in the period 2017-2021 is NO.

4.8.31.4 Source-specific recalculations

No recalculation was made.

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.

Emission trends in this category, where emissions decrease in general. An overview of emissions and their trends are presented in ***Table 4.109***.

Table 4.109: 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
1990/2021	**-13%**	**150%**	**-95%**	**-92%**	**-89%**	**-89%**	**-89%**	**13%**
2020/2021	**16%**	**45%**	**25%**	**36%**	**15%**	**15%**	**15%**	**66%**

4.9.2 METHODOLOGICAL ISSUES

The definition of activities covered by category **2I** is provided in ***Table 4.110***. The activity is involved in **2D3d**, where only VOC is balanced. Other rising emissions (NO_X, SO_X, NMVOC, NH_3, TSP, $PM_{2.5}$, PM_{10}, CO) are reported here.

Table 4.110: *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
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 4.111***). Activity data for the calculation of implied emission factors is the total energy used in this category.

Table 4.111: *Emission factors for calculation of historical years*

	NOx [g/GJ]	NMVOC [g/GJ]	SOx [g/GJ]	NH_3 [g/GJ]	$PM_{2.5}$ %TSP	PM_{10} %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_{2019}.

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 4.112***.

Table 4.112: *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

YEAR	INHABITANTS	Hg [t]	PCBs [kg]
2014	5 418 649	0.0542	0.5419
2015	5 423 800	0.0542	0.5424
2016	5 430 798	0.0543	0.5431
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
1990/2021	**3%**	**3%**	**3%**
2020/2021	**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 (NO_X, NMVOC, SO_X, 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:

$$E = EF\ GB_{2019} \times AD(\text{ŠÚ}\ SR)$$

The emission factors used for the calculation are shown in ***Table 4.113***.

Table 4.113: *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_{2019}.

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: 15.3.2023

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_{2019} 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, 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.

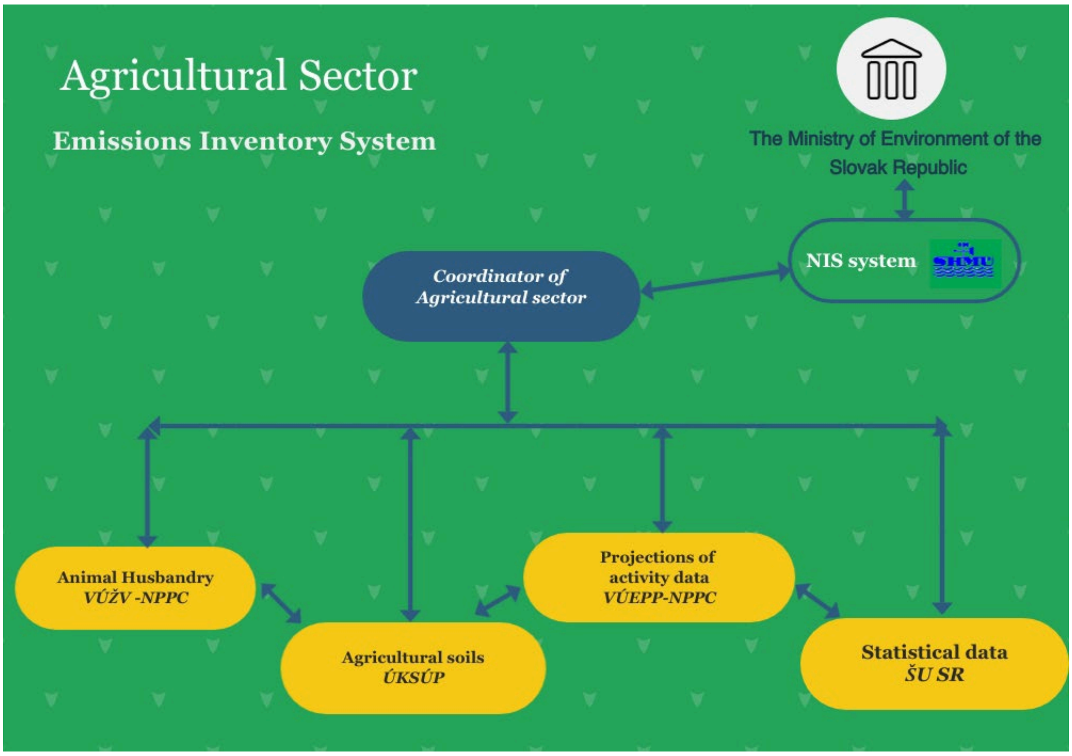
5.1 OVERVIEW OF THE SECTOR (NFR 3)

The share of the agriculture and food industry in the national economy has decreased in the macro-economic indicators (intermediate consumption, sectoral employment, gross production) except gross value added, sectoral employment in 2021 compared to 2020 and increased in parameter employee's average wage by 0.08%. The share of foreign agri-food trade in exports (0.05%) and imports decreased by 0.37%. The increase in gross agricultural production was caused by a higher value of plant production by 12.2% with a simultaneous increase in animal production by 3.8%, while the overall increase in gross agricultural production was mainly contributed by an increase in prices by 8.9% with a simultaneous increase in the amount of subsidies for products. Agriculture, according to data, achieved a negative moderate interannual economic result in 2021. The subsidies from the Common Agricultural Policies (CAP) played the stabilized role of financial support for Slovak agriculture, which help the majority of the farmers avoid the negative economic situation. The subsidies from the CAP decreased by 12.3% due to a decrease of the EU resources by 19%.

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. Number of livestock decreased in all species with impacts decrease of animal products except slaughter poultry (1.8%), cattle (9.8%) and pigs (3.9%) (Green Report 2021).

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 avoid bankruptcy, and to be self-competitiveness 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 policies.[1]

[1] http://www.mpsr.sk/index.php?start&navID=78&id=1325%20 (in Slovak)

Table 5.1: *Overview of the GHG gases and Tiers reported in the Agriculture sector according to the CRF categories in 2021*

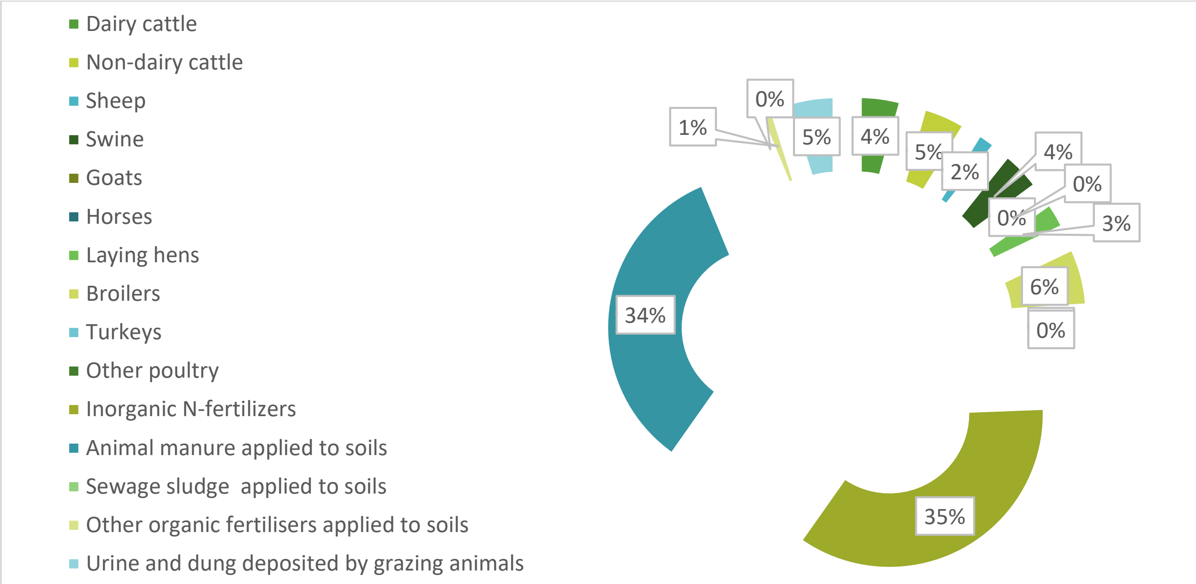
CATEGORY (CODE AND NAME)	TIER/POLLUTANTS
3B1a Dairy cattle	NH_3-T3, NOx-T2, PM-T1, NMVOC-T2, TSP-T1
3B1b Non-dairy cattle	NH_3-T3, NOx-T2, PM-T1, NMVOC-T2, TSP-T1
3B2 Sheep	NH_3-T3, NOx-T2,PM-T1, NMVOC-T1, TSP-T1
3B3 Swine	NH_3-T3, NOx-T2,PM-T1, NMVOC-T1, TSP-T1
3B4d Goats	NH_3-T2, NOx-T2,PM-T1, NMVOC-T1, 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
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
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 88% of the national total in 2021. The largest share of ammonia emissions was generated by **3D** Agricultural soils, which produced 16.77kt (76%) of NH_3 within the sector in 2021. The significant source of NH_3 emissions is the Inorganic N-fertilizers with a share of 35%, followed by the Animal manure applied to soils category representing 34% of the total NH_3 emissions. Emissions from **3B1** Cattle, **3B3** Swine and **3B2** Sheep produced 3.30kt of NH_3 (15%) in the sector in 2021. ***Figure 5.2*** shows the distribution of significant categories of ammonia from agriculture for 2021.

Figure 5.2: *NH₃ emissions per subsectors in %*



Agricultural NH_3 emissions have decreased by 60% since 1990, and 8% compared to the previous year (***Table 5.2*** and ***Figure 5.3***). The main drivers of this drop were 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 had the continuing dominant share compared to emissions from animal production (76% to 12%), which correlated with the overall economic and production situation in the agricultural sector.

Figure 5.3: *NH₃ emission trend by sectors*

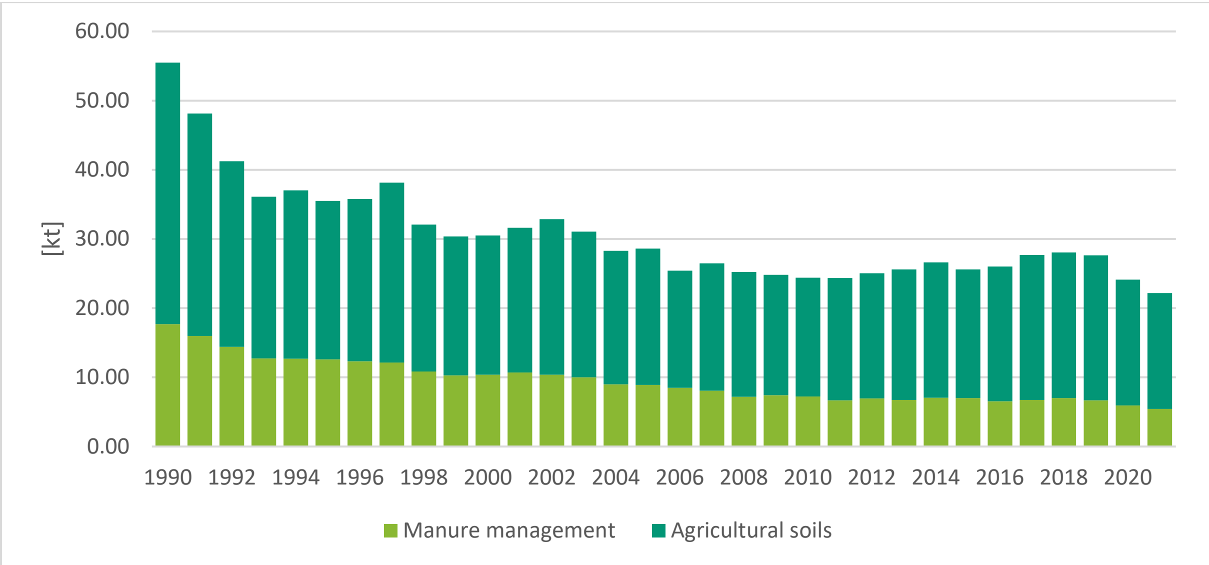


Table 5.2: NH_3 emission time-series by sub-sectors in kt

YEARS	3B MANURE MANAGEMENT	3D AGRICULTURAL SOILS	3 AGRICULTURE TOTAL
	[kt]		
1990	17.712	37.776	55.488
1995	12.622	22.901	35.523
2000	10.359	20.162	30.521
2005	8.901	19.722	28.623
2010	7.214	17.186	24.400
2011	6.661	17.673	24.334
2012	6.943	18.108	25.052
2013	6.731	18.863	25.594
2014	7.052	19.567	26.620
2015	6.981	18.616	25.597
2016	6.558	19.456	26.014
2017	6.741	20.936	27.677
2018	6.991	21.065	28.056
2019	6.690	20.937	27.627
2020	5.959	18.144	24.103
2021	5.411	16.774	22.185
1990/2021	**-69%**	**-56%**	**-60%**
2005/2021	**-39%**	**-15%**	**-22%**

5.2.2 PARTICULATE MATTERS

In 2021, agriculture accounted for 1.4% (0.26 kt) of $PM_{2.5}$, 13% (3.29 kt) of PM_{10} and 11% (3.6 kt) of the national total, TSP emissions. The Agriculture sector is no key source ofparticulate matter. The contribution of the **3Dc** was 11% (2.8 kt) to the total PM_{10} emissions from the sector.

$PM_{2.5}$, PM_{10}, and TSP emissions from agriculture have decreased in the 2005-2021 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. PM_{10} emissions from Agriculture are shown in ***Figure 5.4***.

Figure 5.4: *PM_{10} emission trends by sectors*

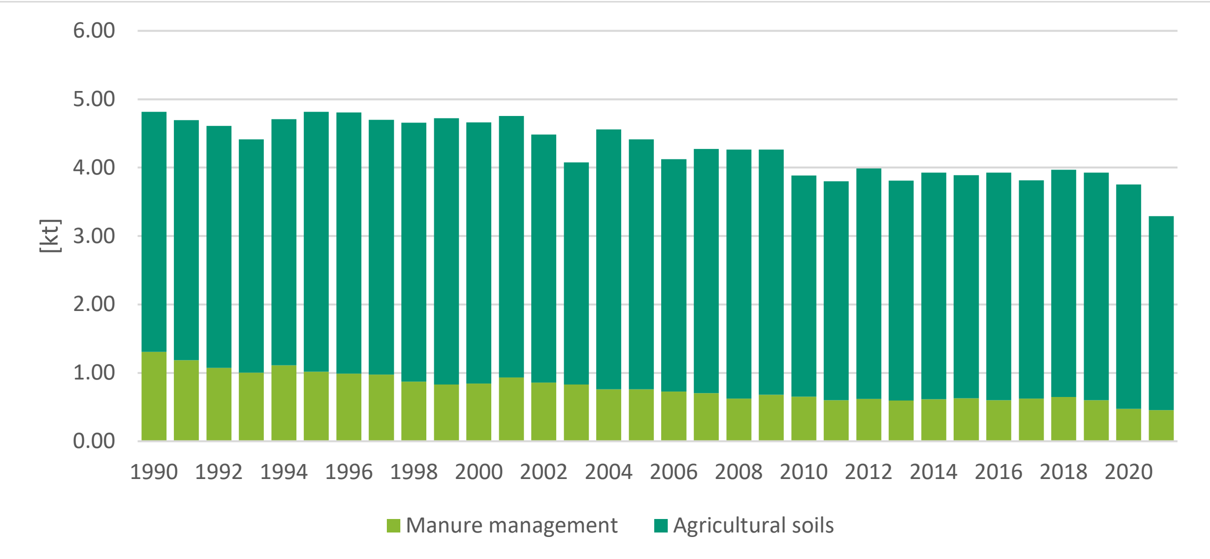


Figure 5.5: *PM$_{2.5}$ emission trends by sectors*

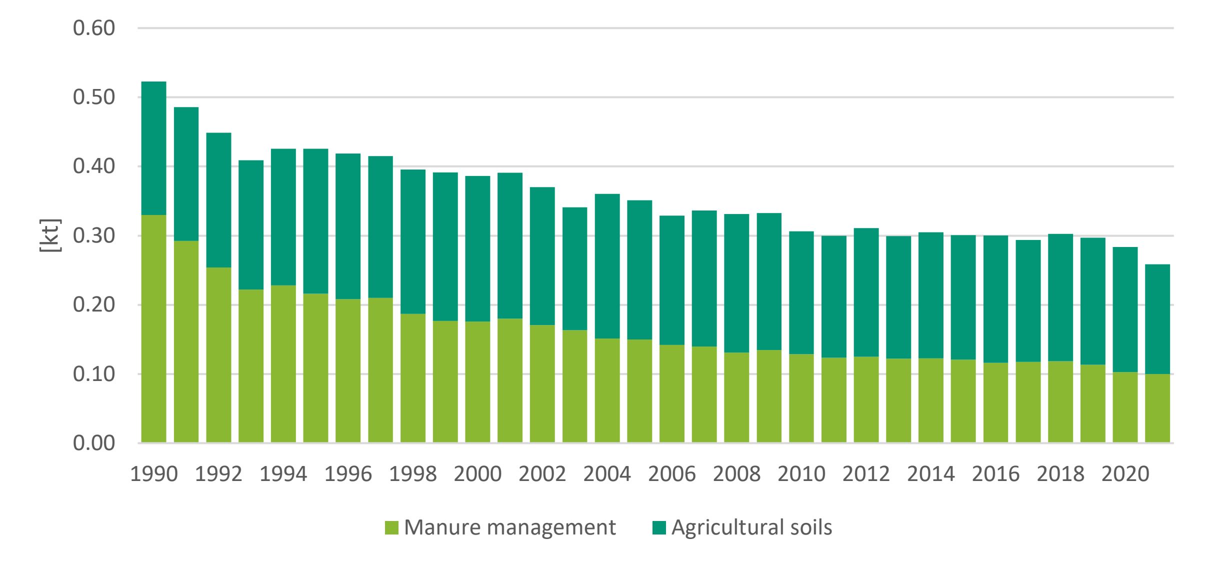


Table 5.3: *TSP emission time-series by sub-sectors in kt*

YEARS	3B MANURE MANAGEMENT	3D AGRICULTURAL SOILS	3 AGRICULTURE TOTAL
		[kt]	
1990	5.215	2.414	7.629
1995	4.231	2.580	6.811
2000	3.300	2.728	6.027
2005	2.882	2.733	5.615
2010	2.477	2.639	5.116
2011	2.281	2.598	4.879
2012	2.368	2.617	4.984
2013	2.252	2.592	4.844
2014	2.289	2.608	4.897
2015	2.360	2.583	4.944
2016	2.261	2.606	4.867
2017	2.312	2.603	4.915
2018	2.407	2.636	5.042
2019	2.229	2.609	4.838
2020	1.675	2.605	4.280
2021	1.582	2.024	3.606
1990/2021	**-70%**	**-16%**	**-53%**
2005/2021	**-45%**	**-26%**	**-36%**

5.2.3 NON-METHANE VOLATILE ORGANIC COMPOUNDS (NMVOC)

In 2021, Agricultural NMVOC emissions consisted of 6.25 kt and 6.8% share of the national total (***Table 5.4***). The primary agricultural source of MNVOC emissions is the 3B Manure management accounting for 6.6% of national total NMVOC emission (6.12 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 (71%), while cultivated crops were an insignificant source with a share of 0.1% of total NMVOC emissions in 2021. NMVOC emissions have decreased by 73% over the period 1990-2021, as a result of the dropping of animal livestock and applied mitigation measures in ammonia emissions from 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	22.910	0.137	23.048
1995	14.216	0.146	14.362
2000	11.719	0.156	11.875
2005	10.353	0.159	10.512
2010	8.437	0.164	8.601
2011	8.311	0.162	8.473
2012	8.257	0.161	8.418
2013	8.070	0.162	8.232
2014	7.967	0.161	8.129
2015	8.220	0.161	8.381
2016	7.855	0.165	8.020
2017	7.999	0.165	8.165
2018	7.514	0.167	7.681
2019	7.324	0.164	7.489
2020	6.857	0.164	7.021
2021	6.119	0.128	6.248
1990/2021	**-70%**	**19%**	**-70%**
2005/2021	**-34%**	**3%**	**-33%**

5.2.4 NITROGEN OXIDES (NOx)

In 2021, Agricultural NOx emissions consisted of 7.01 kt and a share of 12% of the national total Agricultural NOx emissions have decreased by 48% 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 2016-2021, NOx emissions from the agricultural sector increased due to a marked increase in inorganic fertilizer.

Table 5.5: *NOx emission time-series by sub-sectors in kt*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
	[kt]		
1990	0.337	13.216	13.553
1995	0.221	5.775	5.996
2000	0.194	5.921	6.115
2005	0.176	6.240	6.416
2010	0.150	6.402	6.551
2011	0.142	6.989	7.131
2012	0.146	6.164	6.310
2013	0.141	6.712	6.854
2014	0.148	7.057	7.205
2015	0.146	6.886	7.031
2016	0.139	6.996	7.135
2017	0.142	6.830	6.972
2018	0.148	7.153	7.300
2019	0.145	7.181	7.327
2020	0.137	6.982	7.119
2021	0.119	6.966	7.085

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
	[kt]		
1990/2021	-65%	-47%	-48%
2005/2021	-32%	12%	10%

5.3 CATEGORY-SPECIFIC IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

According to the Final Review Report, 2023 of the second phase of the review of national air pollution emission inventories, recommendations in the Agriculture sector were received:

- **3B4h** Manure Management - Other Animals, NO_X, NH_3, NMVOC, $PM_{2.5}$, PM_{10}

  The TERT recommends that Slovakia calculate the emissions for **3B4h** in future submissions to improve the completeness of its inventory – this recommendation was not implemented. The category will be implemented in the 2024 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_{2019}.

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 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 had 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 had 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 2022 submission.*

	CATEGORY	YEAR	POLLUTION	DESCRIPTION	REFERENCES
	15. FEBRUARY 2023				
1	3B2, Manure management - Non-dairy cattle	1990-2019	PM_{10}, $PM_{2.5}$, TSP	Recalculation was made due to the wrong transcription between NFR etemplate and calculation sheets.	**5.8**
2	3B2, Manure management - Non-dairy cattle	2016	NMVOC	Recalculation was made due to the wrong transcription between NFR etemplate and calculation sheets.	**5.8**
3	3B2, Manure management - Swine	1994	NMVOC	Recalculation was made due to the wrong transcription between NFR etemplate and calculation sheets.	**5.8**
3	3De Cultivated crops	1994	NMVOC	Recalculation was made due to the wrong transcription between NFR etemplate and calculation sheets.	**5.11**
4	3Dc, Farm-level agricultural operations including storage, handling and transport of agricultural products	1991-2020	PM_{10}	The incorrect frequency of soil cultivation operations was taken into account in the calculation of PM_{10} emissions from barley	**5.11**

5.6 NATIONAL CIRCUMSTANCES AND TIME-SERIES CONSISTENCY

Slovak farmers have adapted to changes in agriculture since. 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 22-25 litres/day. In other regions, milk productivity is 16-18 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 litres/day) need to be fed 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 (286.56 MJ/head/day) (***Figure 5.6***).

Table 5.7: *The comparison of the Slovak milk yield with other regions in 2021*

DAIRY COWS	SLOVAKIA[2]	WESTERN EUROPE[3] (AVERAGE)	EASTERN EUROPE[6] (AVERAGE)	NORTH AMERICA[6] (AVERAGE)
	kg/year/head			
Milk yield	8037	7 465	4 853	10 304

[2] The animal production, sales of primary production and crop balance (in Slovak) www.statistics.sk

[3] Producing Animals (Slaughtered), Milk Production http://www.fao.org/faostat/en/#data/QL

Figure 5.6*: Trend in average gross energy intake (MJ/day) in different Slovak regions*

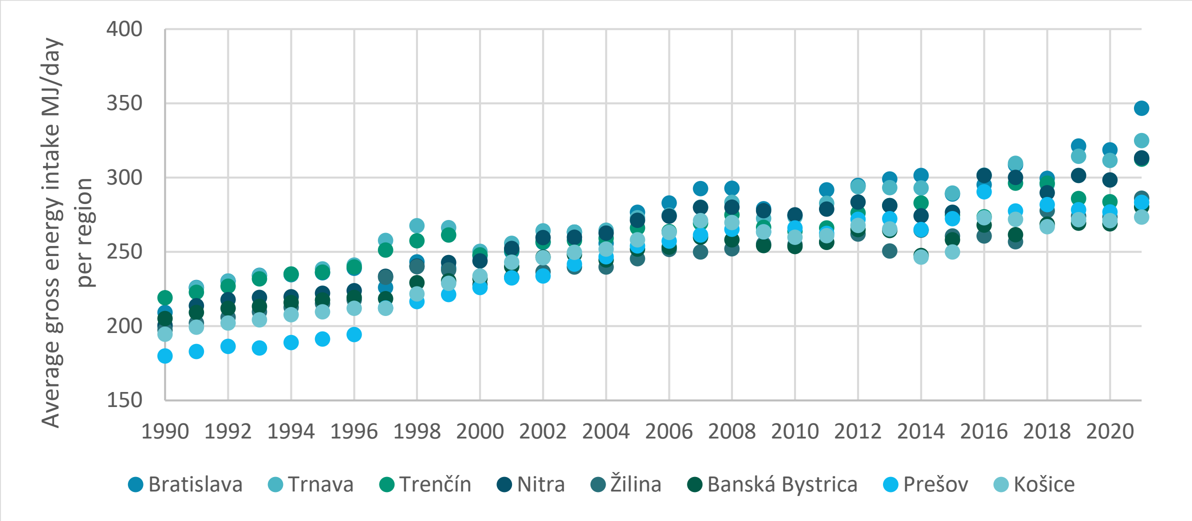
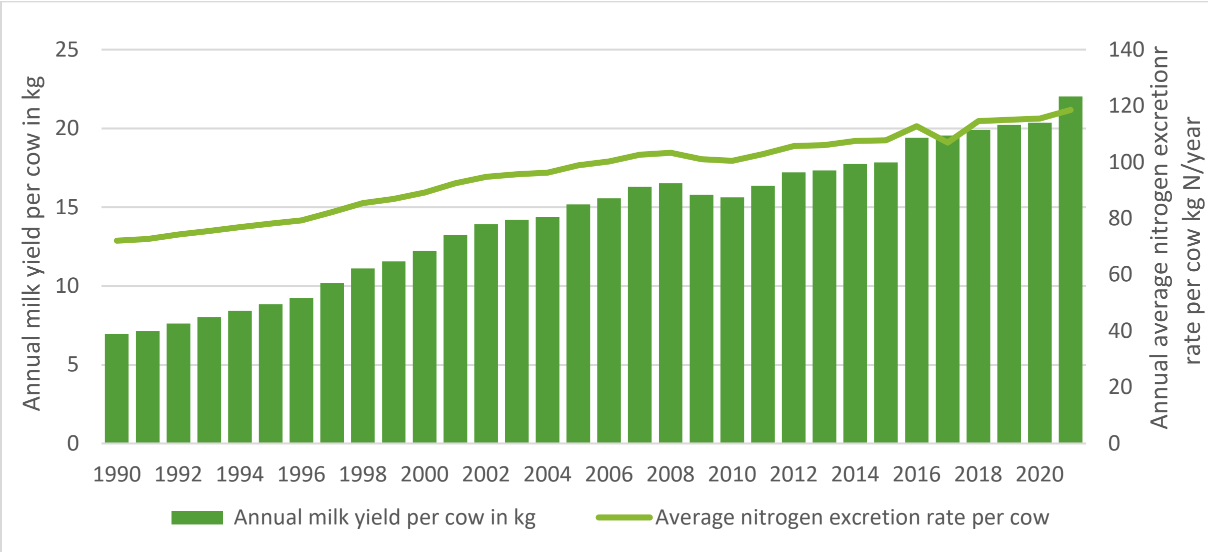
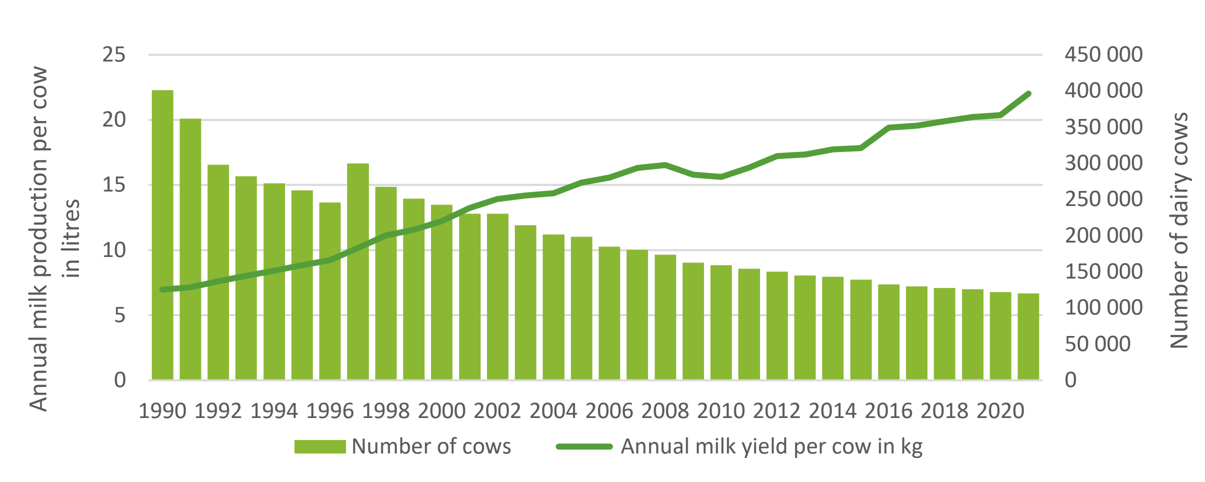


Figure 5.7: *Correlation of milk production (kg/day/head) and nitrogen excretion rate (kg N/y/head)*



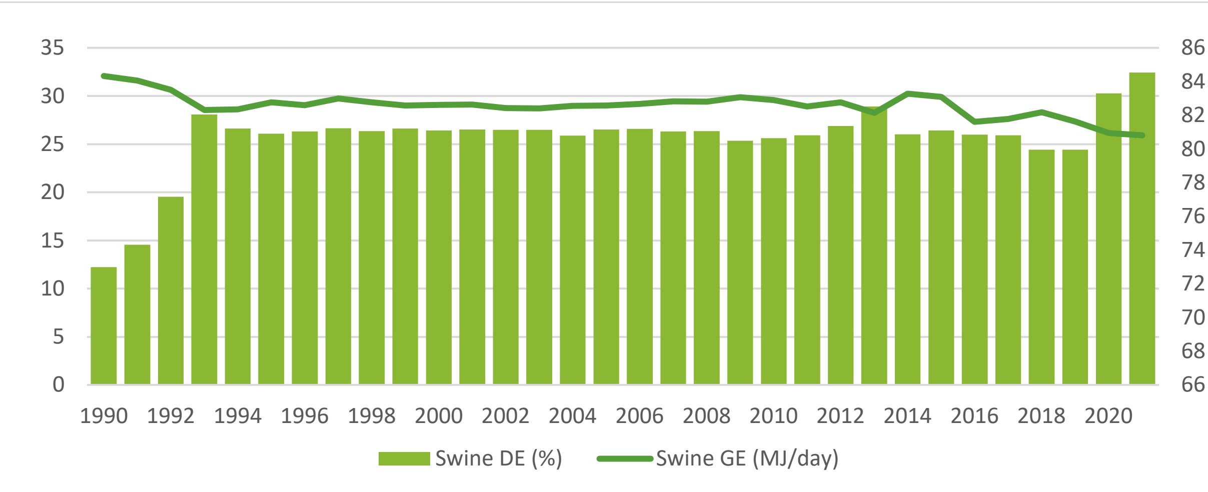
The number of dairy cows decreased according to data from the ŠU SR by 69% in 2021 compared to 1990 (***Figure 5.8***. Milk production increased up to 216% in 2021 (***Figure 5.8***) compared to 1990, despite the continuously decreasing number of dairy cows. The main reason for this trend is the increase 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 8 000 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 fattening 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 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 technics. 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 (***Figure 5.9***). 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. In 2021, a visible increase in the digestibility of feeding doses occurred. This value was estimated by VÚŽV and correlated with an increase in pig performance in that year. The opposite trend is visible in the last 4 years mainly in breeding pigs. The decrease in crude proteins and cereals had an impact on the decrease of monitored parameters. Pig breeding in Slovakia has problems mainly due to the risk of persistent morbidity - African swine fever and other economic reasons, which lead to a decrease in the numbers of pigs.

Figure 5.9: Trend of feed digestibility and gross energy intake of swine in the Slovak Republic



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_{2019} 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 2006 GL 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's categories were calculated by the Tier 1 approach, and the EMEP/EEA GB_{2019} was considered. The TSP, PM_{10}, and $PM_{2.5}$ were calculated by the EMEP/EEA GB_{2019}. The tier 1 approach was used for all animal species because the Tier 2 methodology is unavailable.

5.8.1 ANIMAL WASTE MANAGEMENT SYSTEMS

Activity data on the allocation of manure to animal waste management systems are based on the survey, which analysed manure management practices. A questionnaire survey in farms was performed in cooperation with the NPPC - VÚŽV and other research institutions in 2014. Farmers reported the amount of solid and liquid manure and manure, which was processed in anaerobic digesters by regions. This survey defined more accurately defined number 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.

Allocation according to the climate conditions is 100% for a cool climate for all animals based on the IPCC 2006 methodology and climate data for the Slovak Republic. Western Europe's default value for nitrogen excretion was used; the reasons for this choice are described in **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 estimations 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 5.8.***

Table 5.8: Additional parameters for estimation of nitrogen excretion rate:

PARAMETER	UNITS*	SOURCES
Crude protein per litre of milk	85g per litre	P.Petrikovič – A Sommer Nutrition for cattle
Share of protein in calf meat	21.5%	Kerešteš, 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%	Kerešteš, 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	680g/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.*[4] 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:

$$CP_{m-Total} = \left[(4.93 * H^{0.75} * U_m) - \left(\frac{CP_m}{100} * U_m\right)\right]$$

$$CP_{l-Total} = \left[(MY * CP_l) - \left(\frac{MY * 1000}{100 * SP_l}\right)\right]$$

$$CP_{p-Total} = \frac{C_{p1} + C_{p2}}{100} * U_p$$

$$Total_{CP} \frac{\frac{(CP_{m-Total} + CP_{l-Total}) * \text{lactation period}}{1000} + \frac{(CP_{m-Total} + CP_{p-Total}) * \text{time without milking}}{1000}}{\text{intervening period}} * 365$$

$$N_{intake\,(T)} = \left(\frac{\frac{Total_{Cp}}{100}}{6.25}\right)$$

$$NEX_{(T)} = N_{intake\,(T)} + \left(N_{intake\,(T)} * O_N\right)$$

[4] 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

Non-dairy cattle:

$$CP_{m-Total} = \left[(4.93 * H^{0.75} * U_m) - \left(\frac{CP_m}{100} * U_m\right)\right]$$

$$CP_{dg-Total} = \left[\left(200 + (4.43 * H^{0.75})\right) * dg\right] * SP_m$$

$$Total_{CP} = \frac{(CP_{m-Total} + CP_{dg-Total})}{1000} * 365$$

$$N_{intake\,(T)} = \left(\frac{\frac{Total_{Cp}}{100}}{6.25}\right)$$

$$NEX_{(T)} = N_{intake\,(T)} + (N_{intake\,(T)} * O_N)$$

Where: **$CP_{m\text{-}Total}$** = 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 **$CP_{l\text{-}Total}$** = crude protein for lactation g per day, **$CP_{p\text{-}Total}$** = crude protein for pregnancy in g per day, **$CP_{dg\text{-}Total}$** = 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 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 – a country-specific nitrogen excretion rate was used for the swine category, based on the tier 2 method from the IPCC 2006 GL. 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 gross energy intake were calculated according to the publication *P. Petrikovič at all: Nutrition for Pigs*. 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.

$$N_{intake\,(T)} = \frac{GE}{18.45} * \left(\frac{\frac{CP\,\%}{100}}{6.25}\right)$$

Where: **N_{INTAKE} (T)** = daily N consumed per animal of category T, kg N/head/day, **GE** = gross energy intake from feeding ration MJ/animal/day, **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 5.9** - **5.13**. 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 2006 GL:

$$NEX_{(T)} = N_{intake\,(T)} * (1 - N_{retention})$$

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 2006 GL).

Table 5.9: *Country-specific regional parameters for swine for the period for 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 UNPREGNAN T	**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
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	14.10
	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 Bystráca, G: Prešov, H: Košice

Table 5.10: Country-specific regional parameters for swine for the period for 2021

2021		A	B	C	D	E	F	G	H
SOWS	CP (%)	17.30	16.90	16.60	16.50	16.10	16.50	16.80	15.90
	N-intake (kg N animal/day)	0.072	0.082	0.081	0.074	0.067	0.087	0.084	0.069
	N_{EX} (kgN/animal/year)	18.50	21.10	20.70	18.90	17.10	22.20	21.40	17.60
GILTS PREGNANT	CP (%)	13.60	14.04	12.43	13.05	13.60	13.29	13.79	12.75
	N-intake (kg N animal/day)	0.055	0.057	0.051	0.053	0.055	0.054	0.056	0.052
	N_{EX} kg N/animal/year)	14.10	14.60	12.90	13.60	14.10	13.80	14.30	13.20
GILTS UNPREGNANT	CP (%)	13.60	14.00	12.40	13.00	13.60	13.30	13.80	12.80
	N-intake (kg N animal/day)	0.045	0.046	0.041	0.043	0.045	0.044	0.045	0.042
	N_{EX} (kg N/animal/year)	11.40	11.70	10.40	10.90	11.40	11.10	11.50	10.70
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	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	N_{EX} (kg N/animal/year)	13.30	19.00	19.00	19.00	19.00	19.00	19.00	19.00
PIGLETS	CP (%)	13.60	14.00	12.40	13.00	13.60	13.30	13.80	12.80
	N-intake (kg N animal/day)	0.014	0.014	0.013	0.013	0.014	0.014	0.014	0.013
	N_{EX} (kg N/animal/year)	3.50	3.60	3.20	3.40	3.50	3.50	3.60	3.30
PIGS 21-50 kg	CP (%)	13.60	14.00	12.40	13.00	13.60	13.30	13.80	12.80
	N-intake (kg N animal/day)	0.026	0.027	0.024	0.025	0.026	0.025	0.026	0.024
	N_{EX} (kg N/animal/year)	6.60	6.80	6.10	6.40	6.60	6.50	6.70	6.20
FATTENING PIGS UP TO 20 kg	CP (%)	14.30	15.00	14.10	14.50	12.60	14.30	12.70	13.70
	N-intake (kg N animal/day)	0.015	0.015	0.014	0.015	0.013	0.015	0.013	0.014
	N_{EX} (kg N/animal/year)	3.70	3.90	3.70	3.80	3.30	3.70	3.30	3.60
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)	0.026	0.028	0.026	0.027	0.023	0.026	0.024	0.025
	N_{EX} (kg N/animal/year)	6.70	7.10	6.70	6.90	6.00	6.70	6.00	6.5
FATTENING PIGS 50-80 kg	CP (%)	14.30	15.00	14.10	14.50	12.60	14.30	12.70	13.70
	N-intake (kg N animal/day)	0.039	0.041	0.038	0.039	0.034	0.039	0.034	0.037
	N_{EX} (kg N/animal/year)	9.90	10.40	9.80	10.10	8.70	9.90	8.80	9.50
FATTENING PIGS 80-110 kg	CP (%)	14.30	15.00	14.10	14.50	12.60	14.30	12.70	13.70
	N-intake (kg N animal/day)	0.052	0.054	0.051	0.053	0.046	0.052	0.046	0.050
	N_{EX} (kg N/animal/year)	13.20	13.90	13.00	13.40	11.70	13.20	11.70	12.70
FATTENING PIGS FROM 110 kg	CP (%)	14.30	15.00	14.10	14.50	12.60	14.30	12.70	13.70
	N-intake (kg N animal/day)	0.058	0.061	0.057	0.059	0.051	0.058	0.051	0.055
	N_{EX} (kg N/animal/year)	14.70	15.50	14.50	15.00	13.00	14.70	13.10	14.10

REGIONS: A: Bratislava, B: Trnava, C: Trenčín, D: Nitra, E: Žilina, F: Banská Bystrica, G: Prešov, H: Košice

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 2006 GL, Equation 10.30.

$$NEX_T = N_{rate(T)} * \frac{TAM}{1000} * 365$$

Where: $\mathbf{N_{EXT}}$ = annual N-excretion for each livestock spices respectively category in kg N per animal; $\mathbf{N_{RATE(T)}}$ = default N-excretion rate in kg N (100 kg/animal mass)/day (IPCC 2006 GL), **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:

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	75.83	589	16.56	82.62	0.82	NO
Dairy cows Žilina region	66.06	589	5.93	75.34	18.73	NO
Dairy cows Banská Bystrica region	71.65	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 2021*

CATEGORIES	N_{EX}	BODY MASS	LIQUID	SOLID	PASTURE	ANAEROBIC DIGESTER
	[kg N head/year]	[kg]	[%]			
Dairy cows Bratislava region	130	599	0.00	99.53	0.47	0.00
Dairy cows Trnava region	131	599	8.11	76.94	1.40	13.55
Dairy cows Trenčín region	125	599	7.58	77.23	6.23	8.95
Dairy cows Nitra region	128	599	16.49	80.41	0.69	2.40
Dairy cows Žilina region	109	599	5.89	56.72	30.69	6.70
Dairy cows Banská Bystrica region	112	599	13.95	68.61	11.73	5.70
Dairy cows Prešov region	108	599	6.35	70.33	20.65	2.67
Dairy cows Košice region	107	599	3.04	76.64	11.77	8.55

Table 5.13: *N_{EX} and share (%) for different domestic livestock and share in AWMS in 2021*

CATEGORIES		N_{EX}	LIQUID	SOLID	PASTURE	OTHER (LITTER)
		N kg/head	%			
NON-DAIRY	Suckler cows	47.43	-	45.21	54.79	-
	Calves in 6 month (milk type)	19.96	-	-	100.00	-
	Heifer (milk type)	39.43	-	97.56	2.44	-

CATEGORIES		N_{EX}	LIQUID	SOLID	PASTURE	OTHER (LITTER)
		N kg/head	%			
	Heifer (pregnant) (milk type)	59.20	-	97.55	2.45	-
	Fattening (milk type)	46.14	10.00	90.00	-	-
	Oxen (milk type)	97.94	-	100.00	-	-
	Breeding bull (milk type)	66.21	-	100.00	-	-
	Calves in 6 month (beef type)	21.56	-	100.00	60.00	-
	Heifer (beef type)	38.18	-	45.21	54.79	-
	Heifer (pregnant) (beef type)	54.52	-	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	-
	2021*	**43.08**	**2.33**	**72.86**	**24.81**	**-**
SHEEP	Mature ewes (milk type)	18.62	-	49.59	50.41	-
	Mature ewes (beef type)	21.72	-	45.20	54.80	-
	2021*	**19.70**	**-**	**48.06**	**51.94**	**-**
	Growing lambs (milk type)	10.80	-	49.59	50.41	-
	Growing lambs pregnant (milk type)	17.60	-	49.59	50.41	-
	Growing lambs (beef type)	14.74	-	45.21	54.79	-
	Growing lambs pregnant (beef type)	20.17	-	45.21	54.79	-
	2021*	**14.16**		**48.23**	**51.77**	**-**
	Rams (milk type)	24.82	-	83.56	16.44	-
	Rams (beef type)	27.92	-	83.56	16.44	-
	2020*	**25.88**		**83.56**	**16.44**	**-**
GOATS	Mature female goats	25.70	-	49.60	50.40	-
	Pregnant goats	22.19	-	49.60	50.40	-
	Other mature goats	10.5	-	49.60	50.40	-
	2021*	**21.62**		**49.60**	**50.40**	**21.62**
HORSES	Young horses	27.28	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	-
	2021*	**48.48**	**70.00**		**30.00**	**-**
POULTRY	Laying hens + cocks	1.10	-			100.00
	Broilers	0.80	-			100.00
	Turkeys	1.84	-			100.00
	Ducks	1.21	-			100.00
	Geese	1.82	-			100.00
	2021*	**0.91**				**100.00**

* 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_{2019} and country-specific values whenever possible.

5.8.2.2 Emissions factors NH_3 and NOx

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_{2019} 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 5.14: *Country-specific liquid NH_3 emission factors for the period 2006-2021*

SPECIFIC EFS	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS	DUCKS	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
YEARS	SOLID [kg NH_3/kg N]										
2006	0.2482	0.2482	NO	NO	NO	NO	NO	NO	0.1093	0.1095	NO
2007	0.2482	0.2484	NO	NO	NO	NO	NO	NO	0.1093	0.1094	NO
2008	0.2480	0.2479	NO	NO	NO	NO	NO	NO	0.1094	0.1091	NO
2009	0.2475	0.2476	NO	NO	NO	NO	NO	NO	0.1094	0.1091	NO
2010	0.2474	0.2477	NO	NO	NO	NO	NO	NO	0.1090	0.1088	NO
2011	0.2468	0.2470	NO	NO	NO	NO	NO	NO	0.1090	0.1087	NO
2012	0.2472	0.2472	NO	NO	NO	NO	NO	NO	0.1091	0.1087	NO
2013	0.2359	0.2351	NO	NO	NO	NO	NO	NO	0.1046	0.1055	NO
2014	0.2356	0.2350	NO	NO	NO	NO	NO	NO	0.1038	0.1051	NO
2015	0.2356	0.2349	NO	NO	NO	NO	NO	NO	0.1038	0.1050	NO
2016	0.2358	0.2352	NO	NO	NO	NO	NO	NO	0.1033	0.1047	NO
2017	0.2355	0.2352	NO	NO	NO	NO	NO	NO	0.1031	0.1045	NO
2018	0.2355	0.2345	NO	NO	NO	NO	NO	NO	0.1031	0.1047	NO
2019	0.2354	0.2346	NO	NO	NO	NO	NO	NO	0.1037	0.1051	NO
2020	0.2360	0.2345	NO	NO	NO	NO	NO	NO	0.1038	0.1050	NO
2021	0.1726	0.1686	NO	NO	NO	NO	NO	NO	0.0781	0.0864	NO

Table 5.15: *Country-specific solid NH_3 emission factors for the period 2006-2021*

SPECIFIC EFS	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS	DUCKS	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
Years	SOLID [kg NH_3/kg N]										
2006	0.302	0.297	0.295	0.079	0.139	0.208	0.208	0.350	0.255	0.250	0.280
2007	0.304	0.303	0.298	0.079	0.160	0.240	0.240	0.350	0.261	0.256	0.278
2008	0.303	0.303	0.299	0.079	0.160	0.240	0.240	0.350	0.264	0.257	0.278
2009	0.303	0.303	0.298	0.079	0.160	0.240	0.240	0.350	0.263	0.259	0.278
2010	0.305	0.304	0.299	0.078	0.160	0.240	0.240	0.350	0.266	0.260	0.278
2011	0.306	0.307	0.299	0.078	0.160	0.240	0.240	0.350	0.265	0.258	0.280
2012	0.305	0.307	0.298	0.078	0.160	0.240	0.240	0.350	0.264	0.256	0.280
2013	0.305	0.308	0.299	0.078	0.160	0.240	0.240	0.350	0.265	0.259	0.280
2014	0.306	0.307	0.298	0.079	0.160	0.240	0.240	0.350	0.265	0.258	0.280

SPECIFIC EFS	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS	DUCKS	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
Years	SOLID [kg NH_3/kg N]										
2015	0.306	0.307	0.299	0.079	0.160	0.240	0.240	0.350	0.265	0.259	0.280
2016	0.306	0.307	0.299	0.079	0.160	0.240	0.240	0.350	0.265	0.259	0.280
2017	0.306	0.307	0.299	0.079	0.160	0.240	0.240	0.350	0.266	0.259	0.280
2018	0.307	0.307	0.299	0.079	0.160	0.240	0.240	0.341	0.263	0.258	0.280
2019	0.306	0.307	0.299	0.079	0.160	0.240	0.240	0.332	0.264	0.256	0.274
2020	0.306	0.307	0.299	0.079	0.160	0.240	0.240	0.332	0.264	0.258	0.275
2021	0.2778	0.2810	0.2976	0.0774	0.1600	0.2400	0.2400	0.2940	0.2173	0.2028	0.2558

For the remaining input data as well as for the emission factors, standards and default values provided in the EMEP/EEA GB_{2019} were applied.

Table 5.16: *Country-specific NH_3 emission factors for 3B1a Dairy cattle and background data for the period 1990-2021*

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	5.85
1995	590.21	8.83	78.18	6.29
2000	591.02	12.24	89.22	7.17
2005	594.76	15.18	98.93	7.87
2010	597.81	15.62	100.52	7.72
2011	597.86	16.35	102.87	7.94
2012	598.08	17.22	105.70	8.10
2013	598.37	17.34	106.11	8.15
2014	598.50	17.74	107.51	8.13
2015	598.57	17.85	107.74	8.04
2016	598.65	19.41	112.79	7.77
2017	598.70	19.56	106.94	7.94
2018	598.75	19.89	114.64	8.64
2019	598.88	20.22	115.01	8.58
2020	598.89	20.36	115.48	8.61
2021	598.98	20.02	118.57	7.98

*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 1990–2021 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 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 the 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, 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, the 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 emissions estimation is summarized in ***Table 5.17***. Detailed statistical information is available at the regional level and emissions are estimated by the 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 the 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 the 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 (-82%) compared to 1990. The main reason for this decrease is the data gap on self-sufficiency - small household's farmers and morbidity of animals. The same reason was the cause of the decline of poultry (-19%) and horses (-12%).

Between 2005 and 2021, the production of most agricultural crops showed a declining trend. The decrease was recorded for tobacco by -99%, for beans by -91%, for potato by -68% and for ray by 58%. On the contrary, the harvested area of meadows increased by +27.8%, oil plants by +57.9% soya, leguminous plant and clover during the given period.

Since 2005, livestock numbers have decreased for all farmed species. Between 2005 and 2021, the number of cattle decreased by -17.7%, pigs by -59.1%, poultry by -26.4% and sheep by -9.2%.

Table 5.17: *Animal population according to the districts for the year 2021*

REGION		A	B	C	D	E	F	G	H
DAIRY CATTLE		4 612	19 941	13 854	19 596	20 553	15 747	17 645	8 120
NON-DAIRY CATTLE	Suckling cows	1 516	2 020	4 030	1 632	9 066	18 036	22 489	12 472
	Calves in 6 month (milk sort)	1 760	9 441	5 860	9 683	7 129	5 645	5 546	2 639
	Heifer (milk sort)	1 212	6 041	4 812	6 466	7 343	5 967	6 883	2 524
	Heifer (pregnant) (milk sort)	1 477	5 119	3 460	7 358	4 789	3 472	3 845	1 588
	Fattening (milk sort)	424	9 870	3 903	7 431	4 546	3 617	2 948	1 843
	Oxen (milk sort)	0	41	15	18	132	48	5	9
	Breeding bull (milk sort)	73	101	98	194	322	403	425	242

REGION		A	B	C	D	E	F	G	H
	Calves in 6 month (beef sort)	579	956	1 704	806	3 145	6 465	7 069	4 054
	Heifer (beef sort)	399	612	1 400	539	3 239	6 835	8 773	3 878
	Heifer (pregnant) (beef sort)	486	519	1006	613	2 112	3 977	4 901	2 440
	Fattening (beef sort)	139	1000	1 135	619	2 005	4 142	3 758	2 831
	Oxen (beef sort)	0	4	5	1	58	56	6	13
	Breeding bull (beef sort)	146	201	196	388	645	805	849	484
SHEEP	Mature ewes	1 358	1 382	19 167	6 612	50 778	61 327	40 576	17 822
	Growing lambs	244	676	6 268	1 197	14 280	18 552	9 905	4 081
	Growing lambs (pregnant)	88	98	3 766	1 050	7 847	9 223	6 581	2 289
	Other mature sheep	36	37	574	192	1 466	1 764	1 179	503
SWINE	Breeding swine	3 473	25 088	7 564	7 800	202	1 947	3 068	1 023
	Fattening swine	11 692	185 013	30 897	125 429	1 674	16 820	23 147	8 239
HORSES	Horses (0-3year)	240	77	234	282	92	124	116	204
	Stallions	23	45	86	119	38	69	40	30
	Mares	305	250	326	519	392	572	412	435
	Castrated stallions	173	95	221	180	241	373	210	215
GOATS	Mature goats	247	216	657	244	1 494	1 503	1 427	1 048
	Growing goats (pregnant)	58	7	50	205	493	52	136	138
	Other mature goats	51	75	275	216	233	320	838	451
POULTRY	Laying hens and roosters	551 992	94 725	300 146	1 063 056	387 260	542 674	27 900	194 399
	Broilers	44 874	1 141 656	752 635	1 138 791	435 158	1 593 883	95 153	850 364
	Turkeys	0	6 054	149	96 786	39 524	28	5	3037
	Ducks	4	15 469	5	165	55	163	2	31
	Geese	6	150	3	484	0	44	10	33

REGIONS: A: Bratislava, B: Trnava, C: Trenčín, D: Nitra, E: Žilina, F: Banská Bystrica, G: Prešov, H: Košice

5.8.4 CATEGORY-SPECIFIC RECALCULATIONS

No recalculations were made.

5.8.5 PARTICULAR MATTERS (PM_{10}, $PM_{2.5}$ & 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 2021, manure management contributed 1.8% and 0.53% to the national total PM emissions given as 5%TSP of the sectorial emissions relates to poultry production. Total $PM_{2.5}$ from manure management decreased from 0.33 kt in 1990 to 0.10 kt in 2021, which is a decrease of 70% compared to a basic year and a decrease of nearly 3% compared to the previous year. Total PM_{10} from manure management decreased from 1.31 kt in 1990 to 0.46 kt in 2021, which is a decrease of 65% compared to 1990 and a decrease of 4% compared to the previous year. Total TSP from manure management decreased from 5.22 kt in 1990 to 1.58 kt in 2021, which is a decrease of 70% and a decrease of 6% 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_{2019}. The PM emissions are related to the annual average population (AAP) and to the time the animal is housed (***Table 5.18***). The PM emission from grazing animals is considered negligible.

If the AAP is estimated from the number of places (n_{places}), according to the equation:

$$\mathrm{AAP} = \mathrm{n_{places}} \ \mathrm{x} \left(1 - \mathrm{t_{empty}}/365\right)$$

Where: **AAP:** annual average population, Number of animals of a particular category that are present, on average, within the year, $\mathbf{n_{places}}$**:** animal places**,** Average capacity for a livestock category in the animal housing that is usually occupied, $\mathbf{t_{empty}}$: Empty period, The average duration during the year when the animal place is empty (in d)

Table 5.18: *Time to spend animals in grassland*

CATEGORIES	GRASSING TIME [days]
Dairy cattle	150
Calves	148
Heifers unpregnant	9
Heifers pregnant	9
Fattening	0
Oxen	0
Suckled cows	200
Calves	290
Heifers unpregnant	225
Heifers pregnant	225
Fattening	0
Oxen	0
Breeding bulls	90
Sows 180 kg	0
Piglets	0
Fattening pigs	0
Laying hens including cocks	0
Broilers	0
Turkeys	0
Ducks	0
Geese	0
Horses	109
Goats	181
Mature ewes	181

5.8.5.2 Emission factors (PM_{10}, $PM_{2.5}$ & 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 5.19***). The same emissions factors were used for all years.

Table 5.19: *Default emissions PM and TSP factors*

CATEGORIES	EMISSION FACTOR TSP	EMISSION FACTOR PM_{10}	EMISSION FACTOR $PM_{2.5}$
	[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	0.1
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
Suckled cows	0.59	0.27	0.18
Calves	0.34	0.16	0.1
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	1.38	0.63	0.41
Growing lambs unpregnant	0.34	0.16	0.1
Rams	0.59	0.27	0.18
Mature ewes	0.59	0.27	0.18
Growing lambs pregnant	0.59	0.27	0.18
Growing lambs unpregnant	0.59	0.27	0.18
Rams	0.59	0.27	0.18

5.8.5.3 Activity data

The number of livestock describes in **Chapter 5.8.3.**

5.8.5.4 Category-specific recalculations

The emissions were recalculated in **3B3** Manure management – Non-dairy cattle in 1990-2019 due to wrong transcription between calculation sheets and template. The recalculation led to decreasing in TSP and PMs emissions from manure management by -0.70% and PM_{10} and $PM_{2.5}$ in 2019 as shown in ***Table 5.20***.

***Table 5.20:** The impact of recalculations of TSP, $PM_{2.5}$, and PM_{10} emissions in manure management in 1990–2019*

CATEGORY	MANURE MANAGEMENT PM_{10} [kt]		MANURE MANAGEMENT $PM_{2.5}$ [kt]		MANURE MANAGEMENT TSP [kt]	
YEAR OF SUBMISSION	2022	2023	2022	2023	2022	2023
1990	0.23	0.23	0.15	0.15	0.50	0.50
1991	0.20	0.20	0.13	0.13	0.44	0.44
1992	0.17	0.17	0.11	0.11	0.37	0.37
1993	0.14	0.14	0.09	0.09	0.30	0.30
1994	0.12	0.12	0.08	0.08	0.27	0.27
1995	0.13	0.13	0.09	0.08	0.28	0.28
1996	0.13	0.12	0.08	0.08	0.27	0.27
1997	0.11	0.11	0.07	0.07	0.23	0.23
1998	0.09	0.09	0.06	0.06	0.20	0.20
1999	0.09	0.09	0.06	0.06	0.19	0.19
2000	0.09	0.09	0.06	0.06	0.19	0.19
2001	0.09	0.08	0.06	0.06	0.19	0.18
2002	0.08	0.08	0.05	0.05	0.17	0.17
2003	0.08	0.08	0.05	0.05	0.17	0.17
2004	0.07	0.07	0.05	0.05	0.15	0.15
2005	0.07	0.07	0.04	0.04	0.15	0.15
2006	0.06	0.06	0.04	0.04	0.14	0.14
2007	0.06	0.06	0.04	0.04	0.14	0.14
2008	0.06	0.06	0.04	0.04	0.14	0.14
2009	0.06	0.06	0.04	0.04	0.14	0.14
2010	0.06	0.06	0.04	0.04	0.13	0.13
2011	0.06	0.06	0.04	0.04	0.13	0.13
2012	0.06	0.06	0.04	0.04	0.13	0.13
2013	0.06	0.06	0.04	0.04	0.13	0.13
2014	0.06	0.06	0.04	0.04	0.13	0.13
2015	0.06	0.06	0.04	0.04	0.12	0.12
2016	0.05	0.05	0.04	0.04	0.12	0.12
2017	0.05	0.05	0.04	0.04	0.12	0.12
2018	0.05	0.05	0.04	0.04	0.12	0.12
2019	0.05	0.05	0.03	0.03	0.11	0.11
2022/2023 (2019)		**-0.7%**		**-0.7%**		**-0.7%**

5.8.6 NMVOC EMISSIONS

Recalculations of NMVOC emissions in **3B** Manure management were done in the isolated year 1994 in **3B3** Manure management - Swine due to wrong transcription between calculation sheets and template. Recalculation of NMVOC leads to an increase in emissions by +321%% compared to the previous submission (2022).

Recalculations of NMVOC emissions in **3B** Manure management were done in the isolated year 2016 in **3B1b** Manure management - Non-dairy cattle due to wrong transcription between calculation sheets and template. Recalculation of NMVOC leads to an increase in emissions by -2%% compared to the previous submission (2022).

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_{2019}.

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_{2019}.

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 5.21-Table 5.23***).

NMVOC for cattle is based on the following equations [1]:

$$E_{NMVOC\,i} = N_A.\left(E_{NMVOC.storr\ silage\ \ i} + E_{NMVOC.silage\ feeding\ i+} + E_{NMVOC.\ \ house\ i} + E_{MVOC.applic.i} + E_{NMVOC.pasture\ i}\right)$$

$$E_{NMVOC.silage\ store\ i} = MJ_i.\,x_{house\ i}\left(EF_{NMVOC.silage\ feeding\ \ i}.\,Frac_{silage}\right)$$

$$E_{NMVOC.\ \ silage\ feeding\ i} = MJ_i.\,x_{housing\ i}.\left(EF_{NMVOC\ feed\ silage\ i}.\,Frac_{silage}\right)$$

$$E_{NMVOC\ house\ i} = MJ_i.\,x_{house\ i}.\left(EF_{NMVOC\ silage}\right)$$

$$E_{NMVOC\ manure\ store\ i} = E_{NMVOC\ \ house\ i}.\,x_{house\ i}.\left(\frac{E_{NH_3\ storage\ i}}{E_{NH_3\ house\ i}}\right)$$

$$E_{NMVOC\ application\ i} = E_{NMVOC\ \ house\ i}.\,x_{house\ i}.\left(\frac{E_{NH_3\ appli\ i}}{E_{NH_3\ house\ i}}\right)$$

$$E_{NMVOC\ graz\ i} = MJ_i.\left(1 - x_{house\ i}\right).\,EF_{NMVOC.graz\ i}$$

Where:
$\boldsymbol{MJ_i}$: Gross feed intake in MJ year. $\boldsymbol{x_i}$: Share of time the animals spend in the animal house (%),$\boldsymbol{Frac_{silage}}$: If silage feeding is dominant $\boldsymbol{Frac_{silage}}$ 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. $\boldsymbol{E_{NH_3\ applic\ i}}$ $\boldsymbol{E_{NH_3\ house\ i}}$ $\boldsymbol{E_{NH_3\ storage\ i}}$. Emissions from ***3B*** Manure Management.

Table 5.21: *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	0.515	0.380	0.866	0.000	0.082	1.020	0.629	5.362
1991	90 071	0.503	0.308	0.801	0.000	0.066	0.943	0.510	4.957
1992	90 184	0.505	0.262	0.673	0.000	0.056	0.792	0.433	4.165
1993	90 728	0.506	0.251	0.649	0.000	0.054	0.764	0.415	4.018
1994	91 556	0.506	0.245	0.638	0.000	0.053	0.751	0.405	3.948

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]
1995	92 447	0.506	0.239	0.626	0.000	0.051	0.736	0.395	3.872
1996	92 731	0.506	0.225	0.594	0.000	0.049	0.700	0.373	3.679
1997	94 338	0.505	0.275	0.755	0.000	0.059	0.889	0.455	4.674
1998	95 625	0.500	0.254	0.699	0.000	0.055	0.823	0.420	4.329
1999	96 477	0.506	0.252	0.665	0.000	0.054	0.783	0.417	4.116
2000	98 771	0.505	0.247	0.661	0.000	0.053	0.778	0.408	4.090
2001	100 412	0.511	0.241	0.651	0.000	0.052	0.762	0.398	4.028
2002	101 109	0.510	0.231	0.672	0.000	0.050	0.787	0.383	4.156
2003	101 531	0.513	0.231	0.628	0.000	0.049	0.735	0.381	3.884
2004	101 827	0.515	0.218	0.594	0.000	0.047	0.694	0.360	3.672
2005	102 927	0.515	0.208	0.605	0.000	0.044	0.706	0.343	3.742
2006	104 118	0.517	0.232	0.559	0.000	0.049	0.581	0.341	3.143
2007	104 676	0.517	0.205	0.566	0.000	0.043	0.593	0.302	3.174
2008	105 371	0.519	0.200	0.550	0.000	0.042	0.574	0.294	3.084
2009	103 978	0.517	0.193	0.500	0.000	0.040	0.519	0.281	2.780
2010	103 901	0.519	0.195	0.484	0.000	0.041	0.509	0.285	2.691
2011	105 628	0.523	0.198	0.478	0.000	0.041	0.506	0.289	2.654
2012	106 895	0.521	0.191	0.482	0.000	0.039	0.506	0.279	2.673
2013	107 906	0.522	0.198	0.462	0.000	0.037	0.483	0.290	2.564
2014	104 803	0.520	0.177	0.469	0.000	0.033	0.484	0.259	2.600
2015	109 602	0.517	0.158	0.463	0.000	0.029	0.470	0.230	2.563
2016	111 167	0.513	0.162	0.460	0.000	0.030	0.468	0.236	2.546
2017	112 583	0.512	0.140	0.430	0.000	0.025	0.435	0.204	2.380
2018	104 551	0.510	0.170	0.447	0.000	0.031	0.457	0.249	2.487
2019	104 535	0.509	0.148	0.447	0.000	0.027	0.456	0.218	2.494
2020	104 898	0.515	0.148	0.435	0.000	0.027	0.442	0.216	2.424
2021	104 886	0.516	0.132	0.445	0.000	0.013	0.368	0.155	2.007

*all parameters are weighted average represent aggregation in level SR

Table 5.22: *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	0.254	0.617	2.117	0.133	2.047	1.022	10.767	1.887
1991	44 203	0.252	0.518	1.926	0.111	1.868	0.857	9.825	1.778
1992	46 541	0.248	0.439	1.643	0.094	1.593	0.726	8.377	1.574
1993	46 395	0.245	0.379	1.393	0.082	1.376	0.628	7.239	1.385
1994	45 463	0.237	0.343	1.269	0.074	1.268	0.568	6.670	1.292
1995	46 019	0.244	0.359	1.271	0.077	1.246	0.595	6.552	1.297
1996	45 711	0.249	0.342	1.233	0.074	1.209	0.567	6.357	1.251
1997	40 483	0.287	0.361	1.141	0.078	1.175	0.598	6.181	1.128
1998	41 767	0.296	0.329	1.040	0.071	1.079	0.545	5.673	1.055
1999	42 762	0.280	0.336	1.007	0.072	1.045	0.556	5.494	1.023
2000	43 489	0.277	0.316	0.989	0.068	1.034	0.524	5.436	1.032
2001	43 695	0.285	0.302	0.950	0.065	0.992	0.499	5.238	1.007
2002	44 186	0.272	0.284	0.946	0.061	0.997	0.469	5.262	1.037
2003	44 306	0.265	0.286	0.924	0.061	0.964	0.472	5.089	1.012
2004	44 813	0.270	0.266	0.855	0.057	0.896	0.439	4.735	0.948
2005	45 349	0.269	0.254	0.887	0.054	0.937	0.420	4.960	0.962

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]
2006	46 333	0.260	0.280	0.857	0.059	0.793	0.421	4.332	0.956
2007	46 527	0.261	0.255	0.866	0.054	0.832	0.384	4.447	0.953
2008	47 247	0.250	0.273	0.939	0.057	0.864	0.402	4.633	0.928
2009	47 214	0.261	0.231	0.775	0.048	0.722	0.337	3.852	0.877
2010	48 384	0.230	0.233	0.772	0.048	0.725	0.340	3.828	0.891
2011	48 585	0.229	0.235	0.766	0.049	0.726	0.342	3.904	0.883
2012	48 599	0.223	0.233	0.804	0.048	0.755	0.340	3.955	0.929
2013	49 187	0.226	0.244	0.797	0.046	0.763	0.358	3.884	0.928
2014	47 343	0.237	0.219	0.829	0.041	0.771	0.321	4.073	0.968
2015	50 233	0.224	0.194	0.825	0.036	0.758	0.285	4.050	0.966
2016	50 099	0.216	0.198	0.818	0.037	0.755	0.291	4.010	0.961
2017	51 499	0.221	0.189	0.819	0.034	0.745	0.276	3.973	0.952
2018	45 000	0.222	0.222	0.859	0.041	0.791	0.327	4.211	1.006
2019	44 998	0.221	0.200	0.854	0.037	0.785	0.295	4.202	0.993
2020	45 200	0.223	0.204	0.870	0.038	0.795	0.300	4.259	1.006
2021	45 569	0.218	0.188	0.856	0.018	0.646	0.223	3.415	1.002

*all parameters are weighted averages representing aggregation in level SR

Table 5.23: *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 kg/MJ feed intake)	0.000007	0.000007	0.000007	0.000007	0.000007	0.000007

Other animals

NMVOC emissions from other animal categories were calculated using the Tier 1 methodology and emission factors outlined in the EMEP/EEA GB_{2019}. Used emission factors are summarized in ***Table 5.24***. There is no evidence about adding silage into the feeding ratio for other animal categories.

Table 5.24: *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

5.8.6.3 Activity data

See **Chapter 5.8.3**.

5.8.4.4 Category-specific recalculations

Recalculations of NMVOC emissions in ***3De*** Cultivated crops were done in the isolated year 1994 due to wrong transcription between calculation sheets and template. Recalculation of NMVOC leads to an increase in emissions by 0.29% compared to the previous submission (2022).

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_{2019}. 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 is stable with small fluctuations caused by changes in animal population and inter-annual changes in categories, **3D1** - Inorganic Nitrogen Fertilizers.

Table 5.25: *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	TOTAL EMISSIONS
1990	7.7150	27.7936	0.0430	0.0510	2.1735	37.7761
1995	2.9094	18.4056	0.0271	0.0452	1.5139	22.9012
2000	3.2181	15.5579	0.0112	0.1074	1.2677	20.1623
2005	4.6408	13.8612	0.0349	0.0115	1.1738	19.7222
2010	4.8149	10.9781	0.0087	0.2773	1.1069	17.1859
2011	5.3950	10.6799	0.0045	0.4927	1.1010	17.6731
2012	5.9476	10.7515	0.0075	0.2608	1.1411	18.1084
2013	6.9391	10.3270	0.0049	0.4659	1.1266	18.8635
2014	7.1356	10.6772	0.0030	0.6042	1.1476	19.5675
2015	6.1733	10.6742	0.0035	0.6296	1.1353	18.6160
2016	8.0392	10.2164	0.0049	0.0716	1.1241	19.4562
2017	9.5912	10.2023	0.0016	0.0420	1.0990	20.9361
2018	9.1991	10.6843	0.0012	0.0428	1.1375	21.0651
2019	9.1854	10.3708	0.0002	0.2685	1.1117	20.9366
2020	7.5008	9.3004	0.000004	0.2615	1.0817	18.1444
2021	7.8485	7.5450	0.0000	0.2999	1.0811	16.77448

Table 5.26: *NOx 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	8.8902	2.7279	0.0132	0.0255	1.5587	13.2156
1995	2.7835	1.8647	0.0083	0.0226	1.0961	5.7752
2000	3.3844	1.5669	0.0034	0.0537	0.9130	5.9214
2005	3.9904	1.3833	0.0107	0.0057	0.8497	6.2399
2010	4.2605	1.1726	0.0027	0.1386	0.8271	6.4016
2011	4.8222	1.0962	0.0014	0.2463	0.8228	6.9889
2012	4.0402	1.1380	0.0023	0.1304	0.8530	6.1638
2013	4.5433	1.0939	0.0015	0.2329	0.8407	6.7123
2014	4.7614	1.1405	0.0009	0.3021	0.8522	7.0572
2015	4.5909	1.1372	0.0011	0.3148	0.8417	6.8858
2016	5.0494	1.0781	0.0015	0.0358	0.8313	6.9962
2017	4.9016	1.0928	0.0005	0.0210	0.8143	6.8302
2018	5.1591	1.1377	0.0004	0.0214	0.8342	7.1528
2019	5.1413	1.0963	0.0001	0.1343	0.8092	7.1812
2020	5.1071	0.9705	0.000001	0.1308	0.7737	6.9819
2021	5.0998	0.9456	0.0000	0.1499	0.7708	6.9661

Figure 5.10: *The share of NH_3 emissions by categories within agricultural soils in 2021*

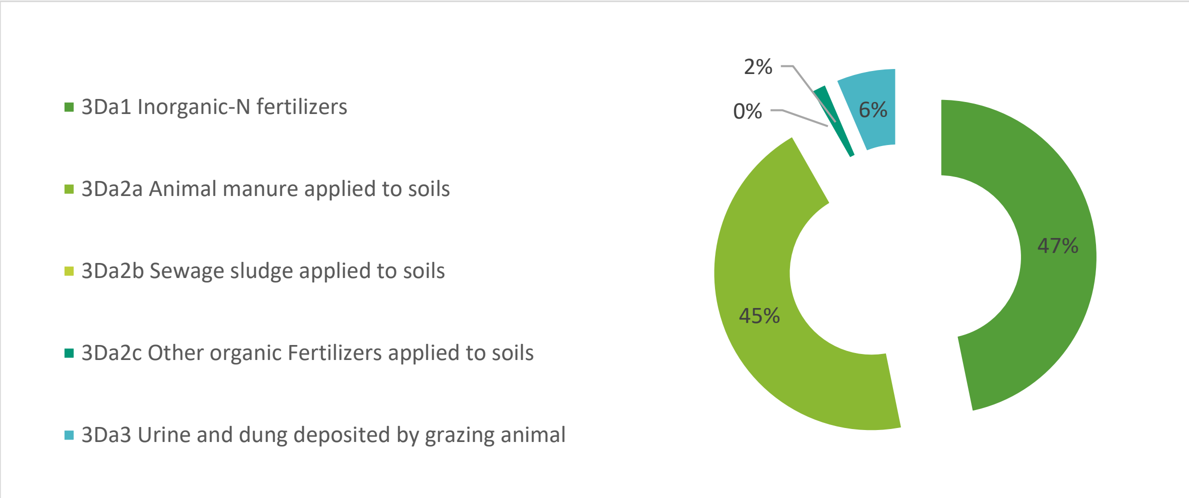
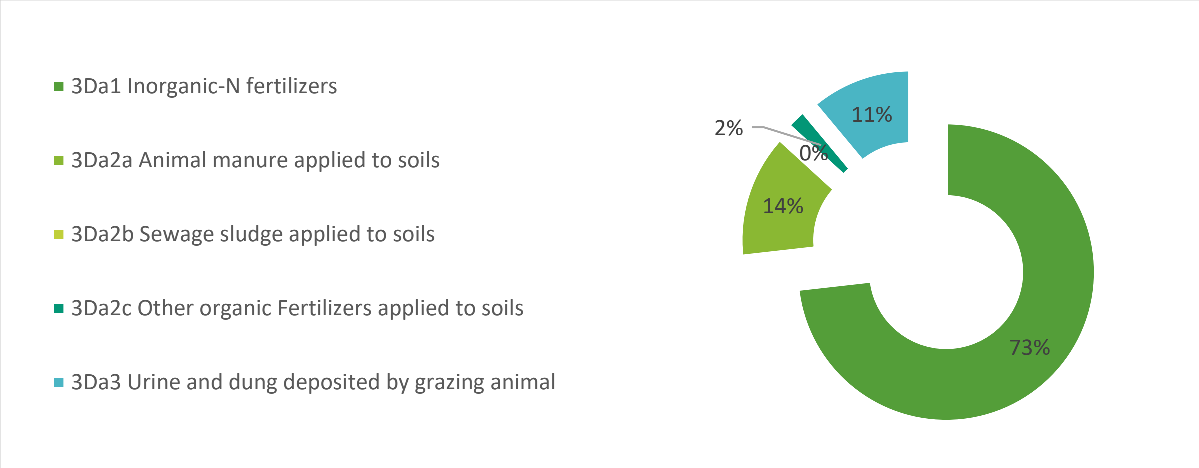


Figure 5.11: *The share of NOx emissions by categories within agricultural soils in 2021*



5.9.1 ACTIVITY DATA

Data of sown areas were taken from the ŠÚ SR. Data is available on 20th May every year (***Table 5.27***).

Table 5.27: *A Sown area in thousand hectares for the years 1990-2021*

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
1990/2021	**-13%**	**-75%**	**332%**	**-38%**	**-41%**	**14%**
2020/2021	**-9%**	**-22%**	**8%**	**-40%**	**-12%**	**22%**

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 very large range. The best information on NH_3 emissions from cultivated soils in the Slovak Republic is based on applied nitrogen fertilizers. Emissions also depend on the type of fertilizers, soil parameters (pH), meteorological conditions and time of fertilizers' application concerning crop development. 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 obligatory to report the amount of applied fertilizers to the UKSÚP each year. The UKSÚP as admin of databases made validation each year.

The consumption of synthetic fertilizers decreased during the last decade of the 20[th] century, from 222 kt in 1990 to 127.5 kt in 2021 (-43%). Consumption of synthetic fertilizers increased by +28% in 2020 compared with 2005 and then decreased by almost -0.1%% in comparison with the year 2020. 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 5.28: *Input parameters in 3Da1 Inorganic N fertilizers*

YEAR	TYPE OF FERTILIZERS [t]									
	AMMONIUM NITRATE	AMMONIUM SULPHATE	CALC. AMM. NITRATE	NITROGEN SOLUTIONS	OTHER N STRAIGHT	UREA	AMMONIUM PHOSPHATE	NK COMPOUND	NPK COMPOUND	OTHER NP
1990	8	22 156	55 114	1 731	NO	8 239	1 939	NO	49 220	500
1991	54 885	14 589	36 289	1 140	NO	5 425	1 276	NO	32 238	500
1992	33 824	8 991	22 364	702	5 567	3 343	787	NO	14 208	400
1993	24 323	6 465	16 082	505	NO	2 404	566	NO	14 208	300
1994	11 400	4 700	22 000	8 500	NO	10 169	700	NO	11 000	200
1995	16 000	6 100	24 200	7 600	NO	3 787	NO	NO	11 400	500
1996	4 000	6 200	29 500	8 600	500	9 064	NO	NO	11 700	4 900
1997	4 000	7 000	25 000	9 000	500	27 517	NO	NO	10 000	5 000
1998	5 600	6 300	35 100	8 300	1 000	10 342	NO	NO	14 200	1 000
1999	3 100	4 500	29 300	8 000	NO	9 892	NO	NO	9 800	800
2000	2 200	4 900	29 000	10 000	8 700	3 553	900	11 956	12 600	800
2001	2 000	5 000	30 000	10 000	9 000	5 032	1 000	26 391	13 000	1 000
2002	5 300	5 300	34 200	10 700	NO	18 760	1 000	23 247	13 000	NO
2003	8 000	9 000	23 000	14 000	NO	8 300	5 000	16 427	14 000	NO
2004	4 000	9 000	30 000	10 000	NO	7 911	4 000	17 240	15 000	NO
2005	3 000	10 000	31 000	9 000	NO	8 317	5 000	18 443	15 000	NO
2006	5 000	8 000	36 000	8 000	NO	681	7 000	18 342	14 000	NO
2007	7 000	11 000	29 000	8 000	NO	8 935	8 000	24 363	17 000	NO
2008	5 000	9 000	38 000	2 000	NO	13 737	3 000	33 698	17 000	NO
2009	3 000	6 000	32 000	3 000	NO	15 058	1 000	19 276	17 000	NO
2010	4 000	9 000	33 000	2 000	NO	11 873	1 000	19 640	26 000	NO
2011	2 000	1 000	40 000	17 000	6 000	13 969	1 000	27 586	12 000	NO
2012	NO	1 000	41 000	18 000	7 000	19 004	1 000	NO	12 000	2 000
2013	NO	2 000	45 000	18 000	12 000	25 581	1 000	NO	10 000	NO
2014	2 000	2 000	45 000	15 000	15 000	28 036	1 000	NO	10 000	1 000
2015	2 000	1 300	44 000	17 000	14 000	19 473	1 000	NO	14 000	2 000
2016	2 000	1 600	42 800	18 100	13 600	30 536	3 300	NO	12 300	2 000
2017	NO	2 000	40 000	23 600	NO	37 741	1 600	900	12 000	4 700
2018	1 100	1 103	31 983	16 463	25 966	41 299	1 125	NO	9 939	NO
2019	880	1 365	34	16 814	53 258	39 779	1 717	3 348	10 982	355
2020	1 413	1 346	85	NO	75 610	39 434	NO	NO	9 461	328
2021	1 394	1 744	34 465	40	34 138	40 615	0	18	11 193	3 888

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.

***Table 5.29:** Emission factors per fertilizers 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 5.30:** Input parameters and EFs in 3Da1 Inorganic N fertilizers in particular years*

YEAR	NITROGEN INPUT INTO SOILS	EMISSION FACTOR NH_3	EMISSION FACTOR NO_x	EMISSIONS NH_3	EMISSIONS NO_x
	[kg/year]	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1990	222 255 000	0.03	0.04	7.7150	8.8902
1995	69 587 000	0.04	0.04	2.9094	2.7835
2000	84 609 000	0.04	0.04	3.0387	2.9061
2005	99 760 000	0.05	0.04	4.3641	3.2527
2010	106 513 000	0.05	0.04	4.5203	3.4749
2011	120 555 000	0.04	0.04	4.9812	3.7188
2012	101 004 000	0.06	0.04	5.9476	4.0402
2013	113 581 390	0.06	0.04	6.9391	4.5433
2014	119 036 050	0.06	0.04	7.1356	4.7614
2015	114 773 000	0.05	0.04	6.1733	4.5909
2016	126 235 769	0.06	0.04	8.0392	5.0494
2017	122 541 152	0.08	0.04	9.5912	4.9016
2018	128 976 885	0.07	0.04	9.1991	5.1591
2019	128 532 971	0.07	0.04	9.1854	5.1413
2020	127 676 520	0.06	0.04	7.5008	5.1071
2021	127 494 597	0.06	0.04	7.8485	5.0998
1990/2021	**-43%**			**-5%**	**-43%**
2020/2021	**-0.14%**			**-4.6%**	**-0.14%**

5.9.4 ANIMAL MANURE APPLIED TO THE SOILS (NFR 3Da2a) NH_3, NOx, 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 fields 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 to 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 decreased.

5.9.4.1 Activity data

See ***Chapter 5.8.3***.

5.9.4.2 Methodological issues-Method-NH_3, NOx

Default NH_3 emission factors of the EMEP/EEA GB_{2019} 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_{2019} 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 5.31: *EFs of ammonia in 3Da2a Animal applied to the soils per animal species in particular years*

SPECIFIC EFS	DAIRY CATTLE	NON-DAIRY CATTLE	POULTRY	HORSES	BREEDING SWINE	FATTENING SWINE
YEARS	LIQUID [kg NH_3/kg N]					
2006	0.4897	0.4903	NO	NO	0.2585	0.3569
2007	0.4889	0.4902	NO	NO	0.2582	0.3577
2008	0.4868	0.4877	NO	NO	0.2557	0.3547
2009	0.4857	0.4865	NO	NO	0.2559	0.3537
2010	0.4853	0.4873	NO	NO	0.2536	0.3527
2011	0.4851	0.4871	NO	NO	0.2534	0.3536
2012	0.4850	0.4873	NO	NO	0.2533	0.3541
2013	0.4851	0.4879	NO	NO	0.2548	0.3544
2014	0.4854	0.4884	NO	NO	0.2557	0.3565
2015	0.4862	0.4891	NO	NO	0.2564	0.3562
2016	0.4864	0.4889	NO	NO	0.2563	0.3568
2017	0.4873	0.4903	NO	NO	0.2565	0.3582
2018	0.4886	0.4909	NO	NO	0.2571	0.3576
2019	0.4889	0.4919	NO	NO	0.2570	0.3564
2020	0.4889	0.4918	NO	NO	0.2580	0.3569
2021	0.3806	0.3902	NO	NO	0.2013	0.2742

Table 5.32: *EFs of ammonia in 3Da2a Animal applied to the soils per animal species in particular years*

SPECIFIC EFS	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS	DUCKS	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
YEARS	SOLID [kg NH_3/kg N]										
2006	0.6055	0.6062	0.3591	0.4377	0.4179	0.5014	0.5014	NO	NO	0.4012	0.4016

SPECIFIC EFS	DAIRY CATTLE	NON-DAIRY CATTLE	BROILERS	LAYING HENS	GEESE	TURKEYS	DUCKS	HORSES	BREEDING SWINE	FATTENING SWINE	SHEEP
YEARS	SOLID [kg NH_3/kg N]										
2007	0.6045	0.6060	0.3636	0.4397	0.4250	0.5100	0.5100	0.7650	0.4006	0.4024	0.7996
2008	0.6016	0.6026	0.3663	0.4402	0.4200	0.5040	0.5040	0.7650	0.3974	0.3989	0.8005
2009	0.6006	0.6013	0.3669	0.4395	0.4313	0.5175	0.5175	0.7650	0.3977	0.3978	0.8055
2010	0.6004	0.6024	0.3660	0.4403	0.4260	0.5112	0.5112	0.7560	0.3947	0.3960	0.7906
2011	0.6006	0.6025	0.3668	0.4366	0.4275	0.5130	0.5130	0.7550	0.3935	0.3968	0.7872
2012	0.6008	0.6027	0.3661	0.4369	0.4318	0.5181	0.5181	0.7605	0.3935	0.3978	0.7771
2013	0.6010	0.6036	0.3653	0.4297	0.4262	0.5114	0.5114	0.7581	0.3959	0.3984	0.7811
2014	0.6014	0.6040	0.3667	0.4327	0.4331	0.5198	0.5198	0.7463	0.3975	0.4008	0.7768
2015	0.6026	0.6049	0.3684	0.4381	0.4395	0.5274	0.5274	0.7479	0.3983	0.4005	0.7847
2016	0.6029	0.6047	0.3683	0.4398	0.4420	0.5304	0.5304	0.7577	0.3977	0.4009	0.7872
2017	0.6029	0.6047	0.3683	0.4398	0.4420	0.5304	0.5304	0.7577	0.3977	0.4009	0.7872
2018	0.6062	0.6074	0.3687	0.4408	0.4410	0.5292	0.5292	0.7926	0.3995	0.4036	0.7976
2019	0.6065	0.6088	0.3687	0.4412	0.4373	0.5247	0.5247	0.8013	0.3994	0.4023	0.8010
2020	0.6066	0.6087	0.3678	0.4418	0.4347	0.5217	0.5217	0.8071	0.4003	0.4028	0.8038
2021	0.4765	0.4844	0.3438	0.4268	0.4026	0.4832	0.4832	0.6955	0.3143	0.3126	0.6731

The default NOx emission factor of the EMEP/EEA GB_{2019} for spreading was used. NH_3 emissions were calculated 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**. Used notation key IE.

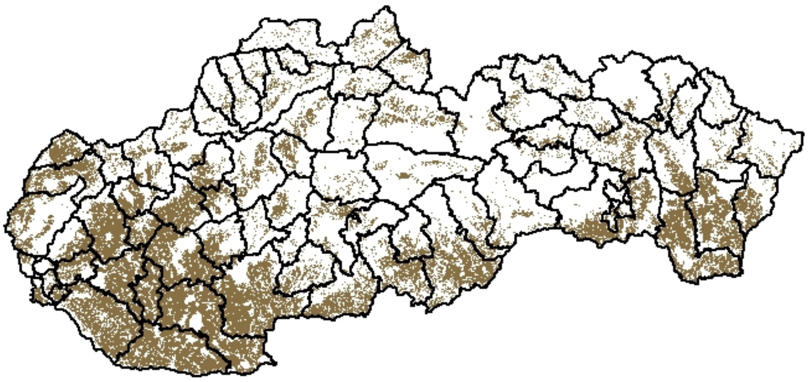
5.9.5 SEWAGE SLUDGE APPLIED TO SOILS (NFR 3Da2b)

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 5.33***) 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). In the 2022 submission, industrial sludge was implemented into inventory for the first time. 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 – 2021, 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 5.12: *The map of sensitive parts of Slovakia where sludge cannot be applied*



Brown area: area, where it is allowed to apply sewage sludge.

5.9.5.2 Methodological issues - Method-NH_3, NO_x

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_{2019}. The Percentage of pure nitrogen in sewage sludge was provided by the Soil Science and Conservation Research Institute.[5] Emissions were estimated using these equations:

$$A_{\text{sewage sludge}} = N_{\text{sewage sludge}} * P_N$$

$$NO_{\text{sewage sludge}} = A_{\text{sewage sludge}} * EF_{NO}$$

$$NH_{3\ \text{sewage sludge}} = A_{\text{sewage sludge}} * EF_{NH3}$$

Where: $\mathbf{NH_{3\ sewage\ sludge}}$. $\mathbf{NO_{sewage\ sludge}}$: Emissions from sewage sludge applied into the soil in kg. $N_{\text{Sewage sludge}}$: the amount of sludge from wastewater treatment in kg. $\mathbf{P_N}$: Weight percentage of nitrogen from sewage sludge (3.31%).
$\mathbf{EF_{NO.\ NH3}}$: Emissions factors for NH_3 and NO kg NO respectively NH_3.

Table 5.33: *Input parameters and EFs in 3Da2b - Sewage Sludge in particular years*

YEAR	MUNICIPAL SLUDGE	INDUSTRIAL SLUDGE	INPUT INTO SOIL	N-INPUT FROM SEWAGE SLUDGE	EMISSIONS NH_3	EMISSIONS NO_x
	[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
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

[5] *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	EMISSIONS NH_3	EMISSIONS NO_X
	[t]	[t]	*t*	*kg*	[kt]	[kt]
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

5.9.6 OTHER ORGANIC FERTILIZERS APPLIED TO SOILS (NFR 3.Da2c)

Emissions of NH_3 and NOx from compost applied to soils contributed less than 1% to the emissions from agricultural soils in 2021.

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 5.35***) is provided by the UKSÚP. The Data are converted into nitrogen content (**NC**). Conversion factors are presented in ***Table 5.34***.

Data is available from 2000 to 2021. 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 5.34: *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[6]	1	*ÚKSÚP*
Hay	8.2	*https://nasepole.sk/dusikate-hnojenie-po-zbere-obilnin/*
Vitahum (organic - humus fertilizer made from natural substances)[7]	1	*ÚKSÚP*
Green fertilizers	1	*ÚKSÚP*

Table 5.35: *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	0	0	33 430	234	0	0	0	0	28 290	283	12 013	120
1991	0	0	34 303	336	0	0	0	0	26 501	265	11 752	118
1992	0	0	35 177	246	0	0	0	0	24 713	247	11 492	115
1993	0	0	36 050	252	0	0	0	0	22 924	229	11 231	112
1994	0	0	36 924	362	0	0	0	0	21 136	211	10 970	110
1995	0	0	37 797	265	0	0	0	0	19 348	193	10 709	107

[6] https://www.biotika.sk/

[7] 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]											
1996	0	0	38 671	271	0	0	0	0	17 559	176	10 449	104
1997	0	0	39 544	388	0	0	0	0	15 771	158	10 188	102
1998	0	0	40 418	283	0	0	0	0	13 982	140	9 927	99
1999	0	0	41 291	289	0	0	0	0	12 194	122	9 666	97
2000	0	0	74 923	734	0	0	0	0	50 641	506	10 245	102
2001	0	0	40 885	286	0	0	0	0	54 338	543	18 285	183
2002	0	0	36 422	255	0	0	0	0	42 810	428	10 920	109
2003	0	0	34 225	240	0	0	0	0	9 321	93	6 206	62
2004	0	0	42 904	300	0	0	0	0	2 845	28	18 990	190
2005	0	0	7 006	49	0	0	0	0	3 552	36	5 905	59
2006	0	0	13 878	97	0	0	0	0	10 828	108	7 006	70
2007	0	0	21 762	152	0	0	8 868	727	8 758	88	3 540	35
2008	0	0	21 317	149	0	0	90 977	7 460	7 185	72	13 534	135
2009	0	0	25 364	178	0	0	68 637	5 628	195	2	16 642	166
2010	0	0	40 097	281	0	0	36 774	3 015	4 999	50	11 956	120
2011	0	0	50 583	354	5 367	54	66 704	5 470	2 261	23	25 837	258
2012	108 181	995	18 291	128	7 132	71	25 020	2 052	0	0	1 401	14
2013	301 580	2 775	63 145	442	5 896	59	30 698	2 517	500	5	2 547	25
2014	382 111	3 515	85 907	601	1 693	17	40 912	3 355	0	0	6 375	64
2015	543 489	5 000	90 967	637	555	6	26 554	2 177	1 015	10	4 036	40
2016	388 174	577	46 701	318	0	0	0	0	0	0	0	0
2017	32 517	163	46 649	327	0	0	0	0	17 928	36	0	0
2018	28 406	102	43 257	411	0	0	0	0	1 345	23	0	0
2019	776 427	3 057	37 618	300	0	0	0	0	0	0	0	0
2020	800 393	2 936	43 557	250	0	0	0	0	0	0	34 089	83
2021	796 945		60 047		0		0		0		0	

5.9.6.2 Methodological issues – Methods – NOx, NH_3

Default methodology Tier 1 according to EMEP/EEA GB_{2019} 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.[8] 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: $\mathbf{N_{compost}}$ is the input of pure nitrogen in compost applied to the soil in kg. $\mathbf{N_{compost}}$ is the amount of compost from the composting plant. $\mathbf{P_N}$ is 1 tonne of compost = 7 kg N

[8] *Guideline for sewage sludge application (In Slovak):*http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

Table 5.36: *Emission factors and emissions in 3Da2c - Other organic fertilizers applied to soils*

YEARS	EMISSION FACTORS NH_3	EMISSION FACTORS NOx	EMISSIONS NH_3	EMISSIONS NOx
	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1990	0.08	0.04	0.0510	0.0255
1995	0.08	0.04	0.0452	0.0226
2000	0.08	0.04	0.1074	0.0537
2005	0.08	0.04	0.0115	0.0057
2010	0.08	0.04	0.2773	0.1386
2011	0.08	0.04	0.4927	0.2463
2012	0.08	0.04	0.2608	0.1304
2013	0.08	0.04	0.4659	0.2329
2014	0.08	0.04	0.6042	0.3021
2015	0.08	0.04	0.6296	0.3148
2016	0.08	0.04	0.0716	0.0358
2017	0.08	0.04	0.0420	0.0210
2018	0.08	0.04	0.0428	0.0214
2019	0.08	0.04	0.2685	0.1343
2020	0.08	0.04	0.2615	0.1308
2021	0.08	0.04	0.2999	0.1499
1990/2021	-	-	+488%	+488%
2020/2021	-	-	+15%%	+15%%

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 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 5.16***. 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, NOx

The estimation of NH_3 and NOx from pasture is based on the Tier 2 method according to the EMEP/EEA GB_{2019}. 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 5.37: Input parameters, EFs and emissions in 3Da3- Urine and dung deposited by grazing animals

YEARS	NITROGEN EXCRETED DURING PASTURE	IMPLIED EMISSION FACTORS NH_3	IMPLIED EMISSION FACTORS NOx	EMISSIONS NH_3	EMISSIONS NOx
	[kg/year]	[kg NH_3/kg N]	[kg NOx/kg N]	[kt]	[kt]
1990	14 709 368.12	0.15	0.11	2.1735	1.5587
1995	10 339 335.14	0.15	0.11	1.5139	1.0961
2000	6 914 660.56	0.18	0.13	1.2677	0.9130
2005	6 427 598.37	0.18	0.13	1.1738	0.8497
2010	7 407 080.08	0.15	0.11	1.1069	0.8271
2011	7 339 829.30	0.15	0.11	1.1010	0.8228
2012	7 849 987.97	0.15	0.11	1.1411	0.8530
2013	7 844 223.82	0.14	0.11	1.1266	0.8407
2014	8 105 557.80	0.14	0.11	1.1476	0.8522
2015	8 077 931.32	0.14	0.10	1.1353	0.8417
2016	7 902 001.33	0.14	0.11	1.1241	0.8313
2017	7 683 159.20	0.14	0.11	1.0990	0.8143
2018	8 165 247.79	0.14	0.10	1.1375	0.8342
2019	7 875 679.97	0.14	0.10	1.1117	0.8092
2020	7 455 856.72	0.15	0.10	1.0817	0.7737
2021	7 770 813.84	0.15	0.10	1.0811	0.7708

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.

5.10 NMVOC EMISSIONS FROM CULTIVATED CROPS (NFR 3De)

Emissions of NMVOC from crops may arise to attract pollinating insects, eliminate waste products or as a means of losing surplus energy. It is difficult to quantify NMVOCs in atmospheric samples. Temperature and light intensity, plant growth stage, water stress, air pollution, and senescence can influence NMVOCs. NMVOC emissions from crop production are reported under the NFR **3De** category.

5.10.1 ACTIVITY DATA

Data of sown areas were taken from the ŠÚ SR. Data is available on 20th May every year.

Table 5.38: *Sowing areas in time series*

YEAR	CROPS - SOWING AREAS					
	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					
	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

5.10.2 METHODOLOGICAL ISSUES - METHODS

Emissions were estimated according to the EMEP/EEA GB_{2019} Tier 2 methodology. Used emission factors are presented in ***Table 5.39***.

Table 5.39: *Used emission factors in kg/ha*

TYPE OF CROPS	EMISSION FACTORS [kg/ha]
Wheat	0.11
Rye	0.05
Rapeseed	0.13
Grass	0.1

Calculations were prepared following the following equation:

$$E_{NMVOC} = S_{Area} * EF_{NMVOC}$$

Where: $\mathbf{E_{NMVOC}}$: Amount of the emitted pollutant (kg).$\mathbf{S_{Area}}$: Annual sown area (ha).$\mathbf{EF_{NMVOC}}$: Annual default emission factor (**kg.ha^{-1}**)

Figure 5.13: *Trend of NMVOC emissions from NFR 3De cultivated crops*

5.10.3 CATEGORY-SPECIFIC RECALCULATIONS

Recalculations of NMVOC emissions in 3De Cultivated crops were done in the isolated year 1994 due to wrong transcription between calculation sheets and template. Recalculation of NMVOC leads to an increase in emissions by 0.29% compared to the previous submission (2022).

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 - METHODS

Pollution TSP was calculated using the Tier 1 methodology from EMEP/EEA GB_{2019}. $PM_{2.5}$ and PM_{10} were calculated using Tier 2 EMEP/EEA GB_{2019} 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 that, TSP emissions are lower ten 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 due to NFR ***3Dc*** category is the key category of PM_{10} emissions.

Table 5.40: *Used emission factors in kg/ha*

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	0.00	0.00	0.00
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	0.0000	0.0000	0.00
Grass	0.015	0.0100	0.0000	0

Emissions of TSP were calculated with the following equation (tier 1 approach):

$$E_{TSP} = EF_{TSP} * \sum S_{area}$$

Where:

$\boldsymbol{E_{TSP}}$ Emissions PM_{10} and $PM_{2.5}$ ($kg.a^{-1}$).$\boldsymbol{EF_{TSP}}$ Annual default emission factor in ($kg\ ha^{-1}$)
.$\boldsymbol{S_{area}}$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):

$$E_{PM} = \sum_{1=l}^{l} \sum_{n=0}^{Nlk} EF_{PM} * S_{area}$$

Where:

$\boldsymbol{E_{PM}}$ Emissions PM_{10} and $PM_{2.5}$ (kg.a^{-1}).$\boldsymbol{EF_{PM}}$ Annual default emission factor in (kg ha^{-1}).$\boldsymbol{S_{area}}$ The annual sown area of the crop in ha, $N_{l,k}$ is the number of times the $k_{t,h}$ operation is performed on the crop in a^{-1}

***Table 5.41:** Frequency of operations in 1990-2021*

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.

5.11.3 CATEGORY-SPECIFIC RECALCULATIONS

The frequency of soil cultivation operations of barley in the calculation of PM_{10} emissions was not assigned correctly from 1991-2020. Recalculation of PM_{10} leads to an increase in emissions by 22 % compared to the previous submission (2022).

***Table 5.42:** The impact of recalculations of PM_{10} Emissions in 3Dc category in 1990-2020*

CATEGORY	FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE. HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCTS - PM_{10} [kt]	
YEAR OF SUBMISSION	2023	2022
1990	3.509	3.509
1991	3.512	3.135
1992	3.538	3.153
1993	3.411	3.023
1994	3.597	3.123
1995	3.802	3.311
1996	3.817	3.177
1997	3.722	3.106
1998	3.785	3.136
1999	3.894	3.201
2000	3.819	3.122
2001	3.821	3.114
2002	3.623	2.942
2003	3.248	2.672
2004	3.802	3.015
2005	3.657	2.929
2006	3.397	2.737
2007	3.569	2.852

CATEGORY	FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE. HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCTS - PM_{10} [kt]	
YEAR OF SUBMISSION	**2023**	**2022**
2008	3.642	2.899
2009	3.588	2.861
2010	3.229	2.641
2011	3.200	2.630
2012	3.369	2.765
2013	3.215	2.663
2014	3.309	2.725
2015	3.261	2.680
2016	3.328	2.736
2017	3.193	3.168
2018	3.324	2.727
2019	3.326	2.722
2020	3.281	2.681
2022/2023 Submission 2023	**+22%**	

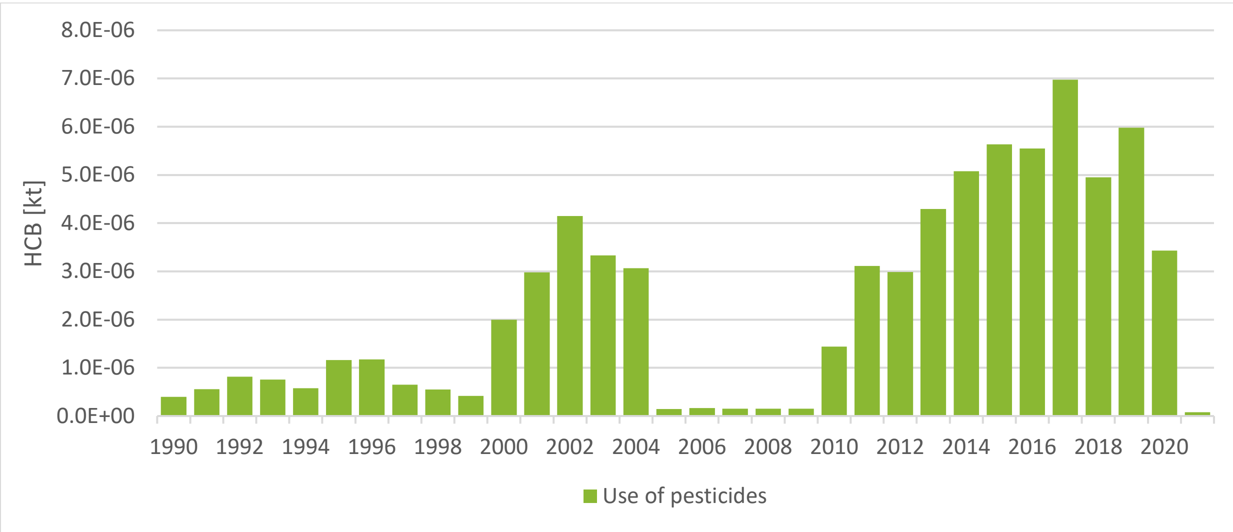
5.12 AGRICULTURE OTHER INCLUDING USE OF PESTICIDES (NFR 3Df)

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 - METHODS

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 4 of EMEP/EEA GB_{2019}.

Figure 5.14: *HCB from pesticides used*



5.12.2 ACTIVITY DATA

Data on pesticide consumption was provided by the Central Control and Testing Institute in Agriculture. Consumptions are collected annually direct 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 f pesticides by active substances are available in ***Table 5.43***.

Table 5.43: *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	4509	24	NO	1209	NO

5.12.3 CATEGORY-SPECIFIC RECALCULATIONS

No recalculation in this submission.

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: 15.3.2023

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)*

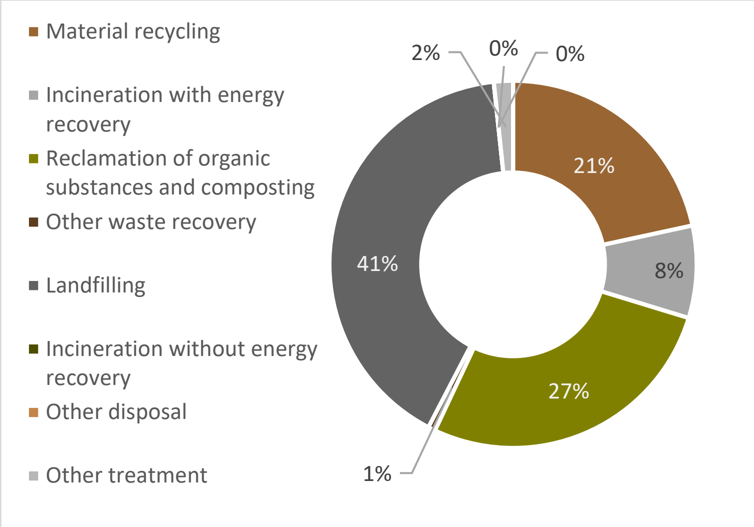
NFR CODE	LONGNAME	METHOD
5A	Biological treatment of waste - Solid waste disposal on land	T2/T3
5B1	Biological treatment of waste - Composting	T2
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	T1
5C1a	Municipal waste incineration	T3/T2
5C1bi	Industrial waste incineration	T1
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	
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 temporary stored in place of origin – not included in the inventory.

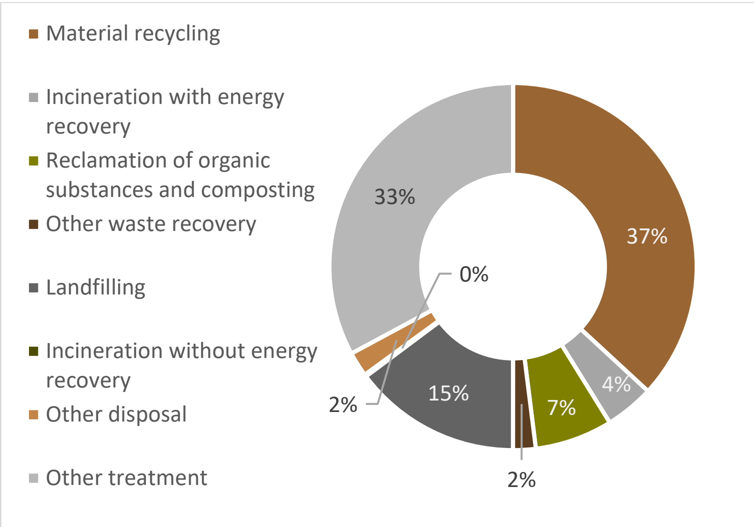
According to the annual statistics of the Statistical Office of the Slovak Republic, the total municipal waste produced in the Slovak Republic in 2021 was 2 702.30 kt. The amount of municipal waste produced increased compared to the previous year (11%). The generation of municipal waste per capita (496.80) in the Slovak Republic is still below the European average. However, the predominant waste treatment is still landfilling (41%). The amount of waste recovered increased significantly in 2021 to 58% (compared to 51% in 2020). In 2020, prevailed waste recovery treatment was material recycling (47% of recovered waste, 24% of all waste); in 2021, it was also material recycling (37% of recovered waste, 22% of all waste). The share of composting and energy utilization increased significantly (composting by over 54% and Incineration by almost 17%). ***Figure 6.1*** shows a detailed share of municipal waste treatment.

Figure 6.1: *Municipal waste treatment in the Slovak Republic in 2021*



In the year 2021, total industrial and other waste was produced in the amount of 9 943.50 kt. The amount decreased by 5% compared to the year 2020. The largest share represents waste from construction and demolition (43%) which has decreased by 10% annually due to Covid 19 pandemic and a drop in construction output in all three construction segments - residential, non-residential and civil engineering.

Figure 6.2: *Industrial waste treatment in the Slovak Republic in 2021*



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 are increasing. 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 2021*

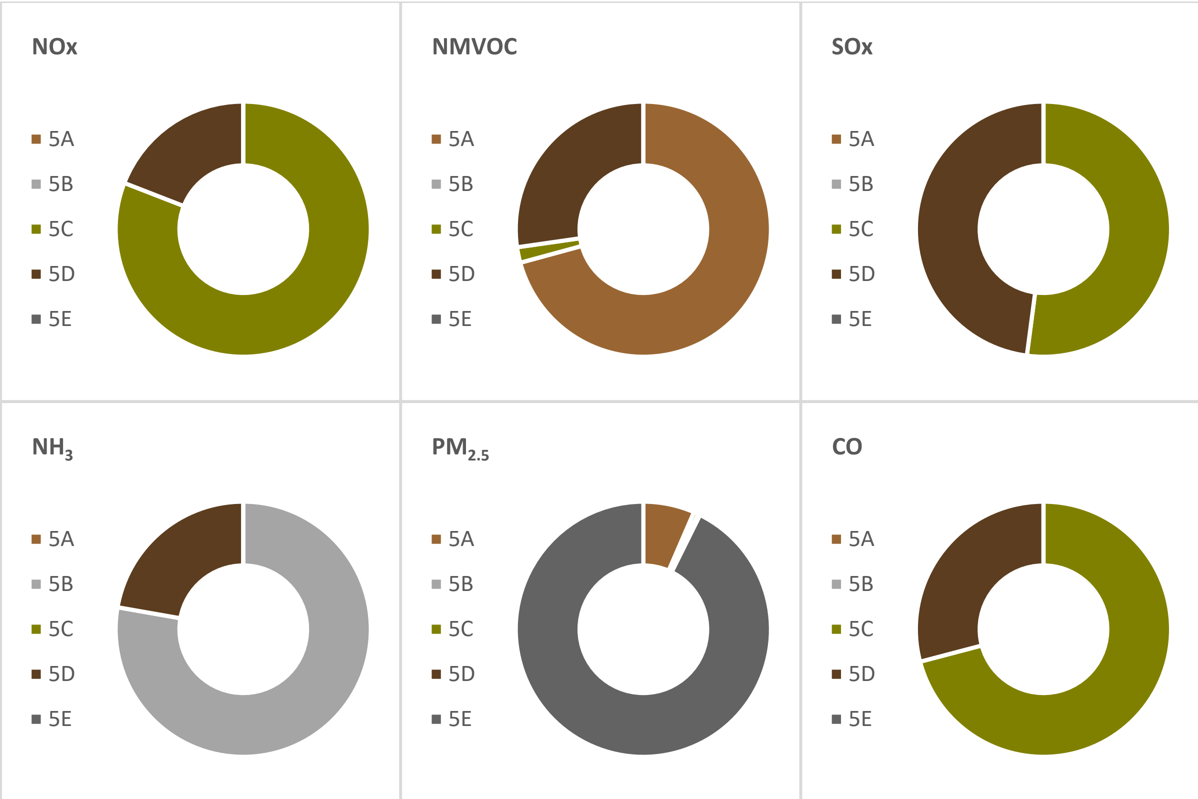


Figure 6.4 presents emissions of HMs and POPs are all emitted mostly from sources in the category of waste incineration (**5C**).

Figure 6.4: *Share of subsectors of the waste sector on emissions of the HMs and POPs in 2021*

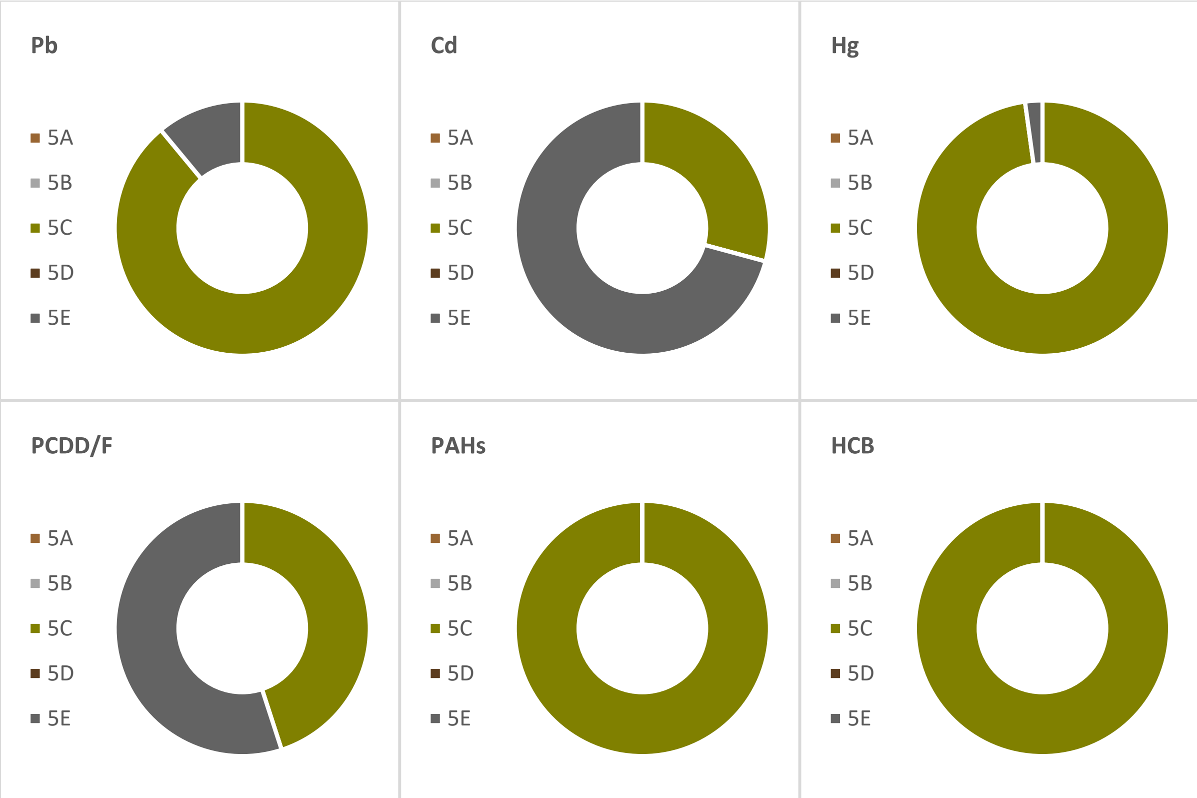


Table 6.2: *The overview of the pollutants in the Waste sector and their trends*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [k]
1990	0.0216	1.4521	0.0071	1.2872	0.1791	0.3737	0.6335	0.0001	0.0106
1995	0.0227	1.5183	0.0075	1.1947	0.1759	0.3091	0.4882	0.0001	0.0112
2000	0.0181	2.2466	0.0033	1.0005	0.1661	0.2943	0.4671	0.0001	0.0099
2005	0.0259	1.5057	0.0046	0.9137	0.1728	0.2897	0.4453	0.0001	0.0069
2010	0.0266	1.0134	0.0046	0.7705	0.1989	0.3071	0.4495	0.0000	0.0064
2011	0.0260	0.9596	0.0049	0.6570	0.2195	0.3363	0.4902	0.0000	0.0071
2012	0.0223	0.9502	0.0044	0.6628	0.2139	0.3279	0.4778	0.0000	0.0052
2013	0.0245	1.0303	0.0048	0.5634	0.2103	0.3505	0.5349	0.0000	0.0070
2014	0.0238	0.9455	0.0048	0.5281	0.1814	0.2884	0.4290	0.0000	0.0080
2015	0.0269	0.9844	0.0062	0.5847	0.2092	0.3209	0.4678	0.0000	0.0101
2016	0.0226	0.9832	0.0044	0.4639	0.2139	0.3215	0.4629	0.0000	0.0049
2017	0.0210	0.9999	0.0046	0.4113	0.2231	0.3318	0.4747	0.0000	0.0045
2018	0.0257	1.0232	0.0052	0.4022	0.2014	0.2964	0.4212	0.0000	0.0054
2019	0.0286	1.0266	0.0062	0.3657	0.1809	0.2622	0.3692	0.0000	0.0058
2020	0.0301	1.0150	0.0057	0.4471	0.1934	0.2789	0.3913	0.0000	0.0061
2021	0.0361	1.0048	0.0073	0.4389	0.1996	0.2724	0.3681	0.0000	0.0071
1990/2021	**67%**	**-31%**	**2%**	**-66%**	**11%**	**-27%**	**-42%**	**-98%**	**-33%**
2020/2021	**20%**	**-1%**	**27%**	**-2%**	**3%**	**-2%**	**-6%**	**3%**	**17%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0719	0.0068	0.1052	0.0016	0.0020	0.0145	0.0017	0.0001	0.0010
1995	0.0713	0.0068	0.1053	0.0017	0.0021	0.0145	0.0017	0.0001	0.0011
2000	0.0774	0.0072	0.1147	0.0017	0.0021	0.0154	0.0018	0.0001	0.0012
2005	0.0441	0.0046	0.0634	0.0018	0.0018	0.0109	0.0022	0.0002	0.0017

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
2010	0.0103	0.0020	0.0229	0.0019	0.0018	0.0066	0.0016	0.0003	0.0021
2011	0.0078	0.0019	0.0228	0.0021	0.0019	0.0081	0.0014	0.0002	0.0020
2012	0.0081	0.0018	0.0214	0.0020	0.0019	0.0058	0.0012	0.0003	0.0020
2013	0.0094	0.0019	0.0257	0.0020	0.0019	0.0056	0.0014	0.0003	0.0025
2014	0.0085	0.0017	0.0250	0.0018	0.0016	0.0051	0.0013	0.0003	0.0024
2015	0.0107	0.0020	0.0274	0.0021	0.0019	0.0054	0.0015	0.0003	0.0027
2016	0.0045	0.0015	0.0269	0.0021	0.0019	0.0048	0.0007	0.0003	0.0027
2017	0.0050	0.0016	0.0233	0.0021	0.0020	0.0046	0.0007	0.0003	0.0023
2018	0.0075	0.0017	0.0290	0.0020	0.0019	0.0047	0.0011	0.0004	0.0029
2019	0.0077	0.0016	0.0325	0.0019	0.0017	0.0040	0.0011	0.0004	0.0033
2020	0.0067	0.0016	0.0373	0.0020	0.0019	0.0044	0.0011	0.0005	0.0038
2021	0.0049	0.0015	0.0496	0.0022	0.0021	0.0048	0.0010	0.0006	0.0052
1990/2021	**-93%**	**-77%**	**-53%**	**34%**	**4%**	**-67%**	**-41%**	**436%**	**436%**
2020/2021	**-28%**	**-4%**	**33%**	**8%**	**10%**	**9%**	**-7%**	**34%**	**34%**

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	74.7862	0.0000	0.0000	0.0000	0.0000	0.0001	0.2323	0.0461
1995	74.1009	0.0000	0.0000	0.0000	0.0000	0.0001	0.2300	0.0460
2000	80.3391	0.0000	0.0000	0.0000	0.0000	0.0001	0.2500	0.0501
2005	41.3195	0.0000	0.0000	0.0000	0.0000	0.0002	0.2139	0.0426
2010	7.5119	0.0000	0.0000	0.0000	0.0000	0.0001	0.1297	0.0280
2011	8.2663	0.0000	0.0000	0.0000	0.0000	0.0001	0.1704	0.0368
2012	5.7562	0.0000	0.0000	0.0000	0.0000	0.0001	0.0799	0.0186
2013	5.9726	0.0000	0.0000	0.0000	0.0000	0.0001	0.0811	0.0196
2014	5.4901	0.0000	0.0000	0.0000	0.0000	0.0001	0.0790	0.0193
2015	5.9783	0.0000	0.0000	0.0000	0.0000	0.0001	0.0700	0.0174
2016	3.6320	0.0000	0.0000	0.0000	0.0000	0.0001	0.0343	0.0122
2017	3.4475	0.0000	0.0000	0.0000	0.0000	0.0001	0.0196	0.0082
2018	4.3347	0.0000	0.0000	0.0000	0.0000	0.0001	0.0392	0.0128
2019	3.8933	0.0000	0.0000	0.0000	0.0000	0.0001	0.0292	0.0117
2020	3.7484	0.0000	0.0000	0.0000	0.0000	0.0001	0.0291	0.0133
2021	3.3976	0.0000	0.0000	0.0000	0.0000	0.0001	0.0322	0.0176
1990/2021	**-95%**	**436%**	**436%**	**436%**	**436%**	**-60%**	**-86%**	**-62%**
2020/2021	**-9%**	**34%**	**34%**	**34%**	**34%**	**-38%**	**11%**	**33%**

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 treatment of waste 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	T2/T3	ŠÚ SR	-	$E_{TOTAL} = AD * EF_{GB2019}$	
5B1	T2	ŠÚ SR	-	$E_{TOTAL} = AD * EF_{GB2019}$	
5B2	T2	ŠÚ SR	-	$E_{TOTAL} = AD * EF_{GB2019}$	
5C1a	T3*	NEIS*	-	$E_{TOTAL} = AD * EF_{GB2019} - 1 - ATE$	1A1a
	T3	NEIS**	NEIS	E_{TOTAL} = 100% NEIS	1A1a
5C1bi	T1	NEIS	-	$E_{TOTAL} = AD * EF_{GB2019}$	
	T1	NEIS**	NEIS	$E_{TOTAL} = 100\%\ NEIS$	1A1b,1A2c; 1A2f
5C1bii	T2	NEIS	-	$E_{TOTAL} = AD * EF_{GB2019}$	
5C1biii	T2	NEIS	-	$E_{TOTAL} = AD * EF_{GB2019} - 1 - ATE$	
5C1biv	T2	VÚVH-SR	-	$E_{TOTAL} = AD * EF_{GB2019}$	
5C1bv	T1	Operators	-	$E_{TOTAL} = AD * EF_{GB2019}$	
5C1bvi	-	-	-	-	NO
5C2	-	-	-	-	NO
5D1	T1/T2/T3	ŠÚ SR VÚVH SR	-	$E_{TOTAL} = AD * EF_{GB2019}$	
	T3	NEIS*1	NEIS	$E_{TOTAL} = 100\%\ NEIS$	
5D2	T1	ŠÚ SR		$E_{TOTAL} = AD * EF_{GB2019}$	
	T3	NEIS*1	NEIS	$E_{TOTAL} = 100\%\ NEIS$	
5D3					NO
5E	T2	PTaEÚ MV SR	-	$E_{TOTAL} = AD * EF_{GB2019}$	
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_{2019}.

The QC checks (e.g. consistency check between NFR data and national statistics) were done during the NFR and IIR compilation, General QC questionnaire was filled out and archived by 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 five recommendations. This is described below and referenced in relevant paragraphs of this chapter. Improvements are implemented in line with the Improvement Plan for the year 2022.

The Recommendation No. ***SK-5B1-2022-000*** asks to use the wet weight of waste to calculate emissions. This is described in **Chapter 6.5.2.4**.

The Recommendation No. ***SK-5C2-2022-0001*** concerns an increase of transparency in the description of legislation which prohibits the open burning of agricultural waste. This issue is described in **Chapter 6.6.5**.

The Recommendation No. ***SK-5D1-2022-0001*** focused on the description of the calculation of PM emissions from category **5D1**. This issue is described in **Chapter 6.7.2.4**.

The Recommendation No. ***SK-5D2-2022-0003*** focused on the description of the calculation of PM emissions from category **5D2**. This issue is described in **Chapter 6.7.3.4**.

The Recommendation No. ***SK-5D2-2022-0004*** aimed to improve the accuracy of the calculation of NMVOC. This issue is described in **Chapter 6.7.3.4**.

Also, in category **5A**, the emissions of PM were improved by the appliance of the higher tier methodology.

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

[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

technical requirements for their construction. The next legislative regulation on solid waste management and disposal entered into force on 1st July 2001. The 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 technical parameters of landfills. New landfills must be provided with the building of the isolation by bio-membrane or geotextile, a drainage system and degassing system.

These measurements decline the release of emissions into the atmosphere. In 2016, new legislation restricting the landfill of bio-waste entered into force[7]. As shown in ***Table 6.4***, this act caused a significant reduction in landfilling of these types of waste.

Activity data for industrial waste disposal on land are extrapolated for 2020 as the official statistics are not yet available.

Table 6.4: *Activity data and emissions in the category 5A*

YEAR	CH_4 [kt]	BIOGAS mil. m^3	DEPOSITED MSW [kt]	DEPOSITED ISW [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	27.92	78.21	1368.49	5486.10	0.4419	0.0347	0.2293	0.4849
1995	26.85	75.22	1116.15	3573.66	0.4250	0.0238	0.1569	0.3318
2000	30.90	86.57	1055.93	3456.75	0.4891	0.0229	0.1510	0.3192
2005	36.47	102.17	1226.57	2888.36	0.5772	0.0208	0.1377	0.2911
2010	41.86	117.27	1411.54	2397.24	0.6626	0.0193	0.1274	0.2694
2011	43.37	121.49	1320.07	2794.87	0.6864	0.0208	0.1377	0.2911
2012	44.15	123.69	1297.48	2717.35	0.6988	0.0203	0.1343	0.2840
2013	44.66	125.10	1201.91	3736.24	0.7068	0.0250	0.1652	0.3493
2014	44.21	123.85	1210.04	2555.61	0.6998	0.0191	0.1260	0.2664
2015	44.78	125.43	1303.85	2629.69	0.7087	0.0199	0.1316	0.2783
2016	44.64	125.05	1289.90	2499.44	0.7065	0.0192	0.1268	0.2681
2017	45.01	126.08	1312.79	2517.43	0.7124	0.0194	0.1282	0.2710
2018	45.31	126.92	1250.28	2093.80	0.7171	0.0169	0.1119	0.2366
2019	45.18	126.55	1198.25	1666.72	0.7150	0.0145	0.0959	0.2027
2020	44.86	125.65	1177.94	1832.87	0.7099	0.0153	0.1007	0.2130
2021	44.93	125.86	1092.05	1470.10	0.7111	0.0130	0.0857	0.1813
1990/2021	**61%**	**61%**	**-20%**	**-73%**	**61%**	**-63%**	**-63%**	**-63%**
2020/2021	**0%**	**0%**	**-7%**	**-20%**	**0%**	**-15%**	**-15%**	**-15%**

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 in the long term, although in the last four years the emission trend stable. The decrease in the year 2005 was caused by the regression in construction and demolition activities.

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***.

[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

Table 6.5: *Amounts of sludge landfilled*

YEAR	SEWAGE SLUDGE LANDFILLED [kt]	INDUSTRIAL SLUDGE LANDFILLED [kt]
2005	8.53	8.53
2010	0.02	0.02
2011	2.31	2.31
2012	1.62	1.62
2013	1.67	1.67
2014	1.07	1.07
2015	1.71	1.71
2016	2.36	2.36
2017	2.64	2.64
2018	2.45	2.45
2019	2.30	2.30
2020	2.30	2.30
2021	0.46	0.46
2005/2021	**-95%**	**-95%**
2020/2021	**-80%**	**-80%**

6.4.2 METHODOLOGICAL ISSUES

Activity data for this category was obtained from publications Waste in the Slovak Republic[8]. The amount of solid waste deposited in landfill sites was used. Activity data in the period 1990-1997 were not available; therefore, extrapolated data were used. Tier 1 emission factors from EMEP/EEA GB_{2019} were used (***Table 6.6***). For the calculation of PM emissions, the tier 3 approach was used and emission factors were calculated using ***Equation 6.1*** for each landfill site.

Equation 6.1: *Calculation of PM emissions*

$$E = k(0{,}0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where:
E: emission factor (kg/Mg)
k: particle size multiplier; k (PMTSP) = 0.74, k (PM10) = 0.35 and k (PM2.5) = 0.053
U: mean wind speed (m/s)
M: material moisture content (%)

The parameter of windspeed was taken from the map of an Annual mean wind velocity from Climate Atlas of Slovakia (Šťastný, et al., 2015). This map was overlaid with the map of landfill sites with coordinates of each site to assign mean windspeed to each landfill site. The parameter of material moisture content was calculated using parameters of dry content for MSW from Table 2.4 in Chapter 2.3.1, for ISW from Table 2.5 in Chapter 2.3.3 and sludge from Chapter 2.3.2 of IPCC 2006 GL (***Table 6.6*** and ***6.7***).

Table 6.6: *Parameters of calculating moisture content of MSW*

WASTE TYPE	OTHER	FOOD	GARDEN	PAPER	WOOD	TEXTILE
Unit	%					
Dry Matter	0.9	0.4	0.4	0.9	0.854	0.8
Moisture content	0.1	0.6	0.6	0.1	0.146	0.2

[8] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

Table 6.7: *Parameters of calculating moisture content of ISW and sludge*

WASTE TYPE*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 NO IS	IS
Unit	%																			
Dry Matter	0.9	0.625	0.9	0.8	1	1	1	1	0.9	0.9	0.9	0.9	1	1	0.9	0.9	1	0.6	0.9	0.22
Moisture content	0.1	0.375	0.1	0.2	0	0	0	0	0.1	0.1	0.1	0.1	0	0	0.1	0.1	0	0.4	0.1	0.78

The **condensable component of PMs** is not included in EF.

CH_4 emissions from GHG inventory were taken and following the instructions given in the note of Table 3-1 of EMEP/EEA GB_{2019} (Part solid waste disposal on land), the emissions of NMVOC were calculated. As the activity data, the amount of methane emissions was used to calculate the volume of biogas (***Table 6.4***). The emission factor for NMVOC is **5.65 g/m^3 landfill gas**.

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 because methane emissions from the SDWS were recalculated. Emissions of PM were recalculated due to a change of approach from Tier 1 to Tier 3. ***Table 6.8*** shows the difference between the 2020 and 2021 submissions and the percentage change.

Table 6.8: *Previous and revised emissions from landfilling*

YEAR	NMVOC			$PM_{2.5}$		
	PREVIOUS [kt]	REVISED [kt]	CHANGE	PREVIOUS [kt]	REVISED [kt]	CHANGE
1990	0.4419	0.4419	-	0.0002	0.0347	15253%
1991	0.4556	0.4556	-	0.0002	0.0291	15253%
1992	0.4571	0.4571	-	0.0002	0.0286	15253%
1993	0.4621	0.4621	-	0.0002	0.0243	15253%
1994	0.4187	0.4187	-	0.0002	0.0255	15253%
1995	0.4250	0.4250	-	0.0002	0.0238	15253%
1996	0.4309	0.4309	-	0.0002	0.0252	15253%
1997	0.4448	0.4448	-	0.0002	0.0245	15253%
1998	0.4596	0.4596	-	0.0001	0.0225	15253%
1999	0.4731	0.4731	-	0.0001	0.0223	15253%
2000	0.4891	0.4891	-	0.0001	0.0229	15253%
2001	0.5019	0.5019	-	0.0001	0.0227	15253%
2002	0.5146	0.5146	-	0.0002	0.0241	15253%
2003	0.5347	0.5347	-	0.0002	0.0251	15253%
2004	0.5576	0.5576	-	0.0002	0.0276	15253%
2005	0.5772	0.5772	-	0.0001	0.0208	15253%
2006	0.5899	0.5899	-	0.0002	0.0356	15253%
2007	0.6056	0.6056	-	0.0002	0.0282	15253%
2008	0.6148	0.6148	-	0.0002	0.0232	15253%
2009	0.6404	0.6404	0%	0.0001	0.0207	15253%
2010	0.6626	0.6626	0%	0.0001	0.0193	15253%
2011	0.6864	0.6864	0%	0.0001	0.0208	15253%
2012	0.6988	0.6988	0%	0.0001	0.0203	15253%
2013	0.7068	0.7068	0%	0.0002	0.0250	15253%

YEAR	NMVOC			$PM_{2.5}$		
	PREVIOUS [kt]	REVISED [kt]	CHANGE	PREVIOUS [kt]	REVISED [kt]	CHANGE
2014	0.6998	0.6998	0%	0.0001	0.0191	15253%
2015	0.7087	0.7087	0%	0.0001	0.0199	15253%
2016	0.7065	0.7065	0%	0.0001	0.0192	15253%
2017	0.7124	0.7124	0%	0.0001	0.0194	15253%
2018	0.7171	0.7171	0%	0.0001	0.0169	15253%
2019	0.7150	0.7150	0%	0.0001	0.0145	15253%
2020	0.7099	0.7099	0%	0.0001	0.0153	15253%

YEAR	PM_{10}			TSP		
	PREVIOUS [kt]	REVISED [kt]	CHANGE	PREVIOUS [kt]	REVISED [kt]	CHANGE
1990	0.0015	0.2293	15178%	0.0032	0.4849	15179%
1991	0.0013	0.1918	15178%	0.0027	0.4056	15179%
1992	0.0012	0.1886	15178%	0.0026	0.3988	15179%
1993	0.0011	0.1606	15178%	0.0022	0.3395	15179%
1994	0.0011	0.1687	15178%	0.0023	0.3567	15179%
1995	0.0010	0.1569	15178%	0.0022	0.3318	15179%
1996	0.0011	0.1663	15178%	0.0023	0.3517	15179%
1997	0.0011	0.1621	15178%	0.0022	0.3427	15179%
1998	0.0010	0.1489	15178%	0.0021	0.3147	15179%
1999	0.0010	0.1470	15178%	0.0020	0.3109	15179%
2000	0.0010	0.1510	15178%	0.0021	0.3192	15179%
2001	0.0010	0.1496	15178%	0.0021	0.3163	15179%
2002	0.0010	0.1594	15178%	0.0022	0.3370	15179%
2003	0.0011	0.1657	15178%	0.0023	0.3503	15179%
2004	0.0012	0.1826	15178%	0.0025	0.3860	15179%
2005	0.0009	0.1377	15178%	0.0019	0.2911	15179%
2006	0.0015	0.2353	15178%	0.0033	0.4974	15179%
2007	0.0012	0.1862	15178%	0.0026	0.3936	15179%
2008	0.0010	0.1533	15178%	0.0021	0.3241	15179%
2009	0.0009	0.1366	15178%	0.0019	0.2887	15179%
2010	0.0008	0.1274	15178%	0.0018	0.2694	15179%
2011	0.0009	0.1377	15178%	0.0019	0.2911	15179%
2012	0.0009	0.1343	15178%	0.0019	0.2840	15179%
2013	0.0011	0.1652	15178%	0.0023	0.3493	15179%
2014	0.0008	0.1260	15178%	0.0017	0.2664	15179%
2015	0.0009	0.1316	15178%	0.0018	0.2783	15179%
2016	0.0008	0.1268	15178%	0.0018	0.2681	15179%
2017	0.0008	0.1282	15178%	0.0018	0.2710	15179%
2018	0.0007	0.1119	15178%	0.0015	0.2366	15179%
2019	0.0006	0.0959	15178%	0.0013	0.2027	15179%
2020	0.0007	0.1007	15178%	0.0014	0.2130	15179%

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.

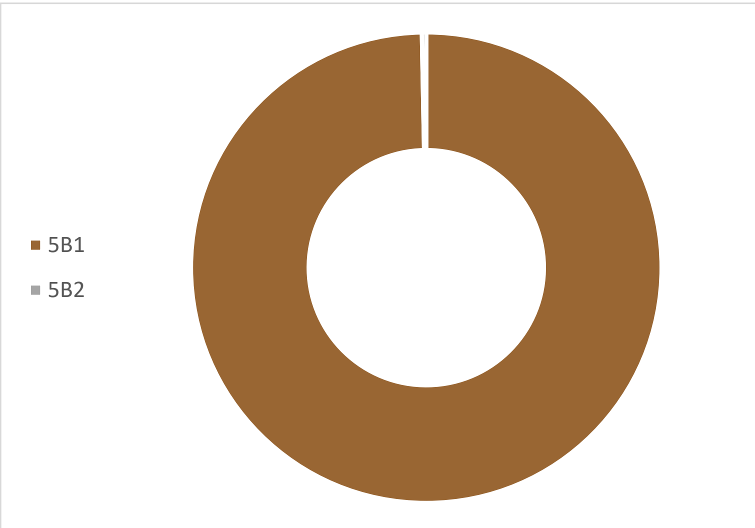
From this category, only emissions of NH_3 are emitted. An overview of the emission trend is shown in ***Table. 6.9***.

Table 6.9: *Overview of emissions in category 5B*

YEAR	NH_3 [kt]
1990	0.1558
1995	0.1595
2000	0.1597
2005	0.1500
2010	0.1609
2011	0.1809
2012	0.2042
2013	0.1805
2014	0.2102
2015	0.2734
2016	0.2231
2017	0.2613
2018	0.2797
2019	0.2641
2020	0.3494
2021	0.3413
1990/2021	**119%**
2020/2021	**-2%**

Shares of emissions of NH_3 in the individual categories are shown in ***Figure 6.5***.

Figure 6.5: *Share of NH_3 emissions of individual categories in 5B in 2021*



[9] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2020/348/vyhlasene_znenie.html

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 6.10***.

Table 6.10*: 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]
1990	20.00	629.00	NE	NE	0.1558
1995	35.46	629.00	NE	NE	0.1595
2000	36.35	629.00	NE	NE	0.1597
2005	45.00	579.15	151.14	4.71	0.1498
2010	90.72	578.54	214.27	28.95	0.1606
2011	99.84	652.55	227.78	45.35	0.1806
2012	122.76	726.56	211.12	32.27	0.2038
2013	130.67	619.85	205.73	35.12	0.1801
2014	145.11	728.11	166.02	21.06	0.2096
2015	200.49	934.99	157.68	14.76	0.2725
2016	212.48	713.26	157.70	15.24	0.2222
2017	317.37	767.38	156.44	15.73	0.2603
2018	378.56	783.56	149.92	16.00	0.2789
2019	441.87	655.10	146.44	15.46	0.2633
2020	662.87	789.44	166.19	17.70	0.3486
2021	736.98	680.71	169.50	14.50	0.3402
1990/2021	**3585%**	**8%**	**-**	**-**	**118%**
2020/2021	**11%**	**-14%**	**2%**	**-18%**	**-2%**

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 is published since 1992. The missing data for 1990 and 1991 were extrapolated. Data on industrial waste composting were collected and published since 1997. Methodology and emission factors of Tier 2 – Compost production from GB_{2019} was applied (***Table 6.11***).

[10] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/223/20160101

[11] Waste in the Slovak Republic – Yearbook – available since 2008, https://slovak.statistics.sk/

Table 6.11: *Emission factors in the category of Composting of waste*

POLLUTANT	NH_3
Unit	[kg/t]
Value	0.24

6.5.2.3 Completeness

Notation keys used were following EMEP/EEA GB_{2019}.

6.5.2.4 Source-specific recalculations

Following ***Recommendation No SK-5B1-2022-000***, emissions were recalculated using a wet weight of the waste (***Table 6.12***).

Table 6.12: *Previous and revised emissions of NMVOC from composting*

YEAR	PREVIOUS [kt]	REVISED [kt]	CHANGE
1990	0.0623	0.1558	150%
1991	0.0623	0.1558	150%
1992	0.0623	0.1558	150%
1993	0.0624	0.1561	150%
1994	0.0622	0.1555	150%
1995	0.0638	0.1595	150%
1996	0.0634	0.1585	150%
1997	0.0641	0.1603	150%
1998	0.0640	0.1601	150%
1999	0.0642	0.1604	150%
2000	0.0639	0.1597	150%
2001	0.0637	0.1592	150%
2002	0.0642	0.1604	150%
2003	0.0643	0.1607	150%
2004	0.0619	0.1548	150%
2005	0.0599	0.1498	150%
2006	0.0818	0.2046	150%
2007	0.0580	0.1450	150%
2008	0.0637	0.1592	150%
2009	0.0654	0.1635	150%
2010	0.0642	0.1606	150%
2011	0.0722	0.1806	150%
2012	0.0815	0.2038	150%
2013	0.0720	0.1801	150%
2014	0.0838	0.2096	150%
2015	0.1090	0.2725	150%
2016	0.0889	0.2222	150%
2017	0.1041	0.2603	150%
2018	0.1116	0.2789	150%
2019	0.1053	0.2633	150%
2020	0.1216	0.3486	187%

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.

In 2020 ninety-five biogas stations operated. After the Decree No. 221/2013 Coll.[13], which provides price regulation in the electricity sector, entered into force, and emissions started to increase in 2014. ***Table 6.13*** shows the NH_3 emission trend in this category.

Table 6.13: *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	0.18	0.0002
2010	0.26	0.0003
2011	0.26	0.0003
2012	0.33	0.0004
2013	0.35	0.0004
2014	0.58	0.0006
2015	0.78	0.0008
2016	0.80	0.0009
2017	0.85	0.0009
2018	0.77	0.0008
2019	0.77	0.0008
2020	0.77	0.0008
2021	0.95	0.0010
2005/2021	**416%**	**416%**
2020/2021	**23%**	**23%**

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. Tier 2 emission factor for pre-storage from EMEP/EEA GB_{2019} was used.

6.5.3.3 Completeness

Notation keys used in the inventory follow the EMEP/EEA GB_{2019}.

6.5.3.4 Source-specific recalculations

Data were recalculated to improve methodology as the tier 2 approach was used.

Table 6.14: *Previous and revised emissions of NMVOC from anaerobic digestion*

YEAR	PREVIOUS [kt]	REVISED [kt]	CHANGE
2001	0.0038	0.0001	-97%
2002	0.0037	0.0001	-97%
2003	0.0041	0.0001	-97%
2004	0.0047	0.0002	-97%

[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	PREVIOUS [kt]	REVISED [kt]	CHANGE
2005	0.0061	0.0002	-97%
2006	0.0067	0.0002	-97%
2007	0.0070	0.0002	-97%
2008	0.0078	0.0003	-97%
2009	0.0113	0.0004	-97%
2010	0.0087	0.0003	-97%
2011	0.0086	0.0003	-97%
2012	0.0109	0.0004	-97%
2013	0.0116	0.0004	-97%
2014	0.0192	0.0006	-97%
2015	0.0260	0.0008	-97%
2016	0.0267	0.0009	-97%
2017	0.0283	0.0009	-97%
2018	0.0256	0.0008	-97%
2019	0.0258	0.0008	-97%
2020	0.0256	0.0008	-97%

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 2021:

- Two large MSW incinerators with energy utilisation;
- Five ISW incinerators (three of them with energy utilisation, one of them is co-incinerating wastewater sludge);
- Two clinical waste incinerators 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 do have the same trend. Main pollutants (except NMVOC) have an increasing trend, as the amount of incinerated waste is growing slowly. The emissions of heavy metals and POPs have in general decreasing trend as many abatement technologies to reduce them were installed (***Table 6.15***).

In this submission, emissions from sewage sludge incineration were excluded from the category **5C1biv**, due to information from the Water Research Institute, the producer of the activity data. Following the sure information, there is no incineration of sewage without energy recovery, so the emissions allocated in this category were double counted with data in the energy sector.

Table 6.15: *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	0.0146	0.0499	0.0029	0.0002	0.0003	0.0044	0.0001	0.0046
1995	0.0151	0.0493	0.0030	0.0003	0.0003	0.0044	0.0001	0.0046
2000	0.0165	0.0536	0.0033	0.0003	0.0003	0.0048	0.0001	0.0051

[14] https://www.enviroportal.sk/ovzdusie/zoznam-spalovni-a-zariadeni-na-spoluspalovanie-odpadov-r-2019 (only in Slovak language)

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2005	0.0211	0.0784	0.0027	0.0004	0.0004	0.0027	0.0001	0.0051
2010	0.0192	0.0544	0.0019	0.0005	0.0005	0.0008	0.0000	0.0040
2011	0.0178	0.0402	0.0018	0.0005	0.0005	0.0009	0.0000	0.0045
2012	0.0165	0.0414	0.0018	0.0005	0.0005	0.0007	0.0000	0.0032
2013	0.0196	0.0485	0.0021	0.0006	0.0006	0.0008	0.0000	0.0036
2014	0.0188	0.0436	0.0021	0.0006	0.0006	0.0008	0.0000	0.0035
2015	0.0213	0.0556	0.0023	0.0006	0.0006	0.0008	0.0000	0.0037
2016	0.0167	0.0201	0.0021	0.0006	0.0006	0.0007	0.0000	0.0029
2017	0.0149	0.0230	0.0018	0.0005	0.0005	0.0006	0.0000	0.0024
2018	0.0198	0.0370	0.0023	0.0007	0.0007	0.0008	0.0000	0.0033
2019	0.0219	0.0379	0.0026	0.0007	0.0008	0.0009	0.0000	0.0035
2020	0.0238	0.0317	0.0029	0.0009	0.0009	0.0010	0.0000	0.0039
2021	0.0292	0.0197	0.0038	0.0011	0.0011	0.0013	0.0000	0.0050
1990/2021	**101%**	**-60%**	**28%**	**381%**	**347%**	**-70%**	**-98%**	**10%**
2020/2021	**23%**	**-38%**	**29%**	**33%**	**32%**	**31%**	**3%**	**28%**

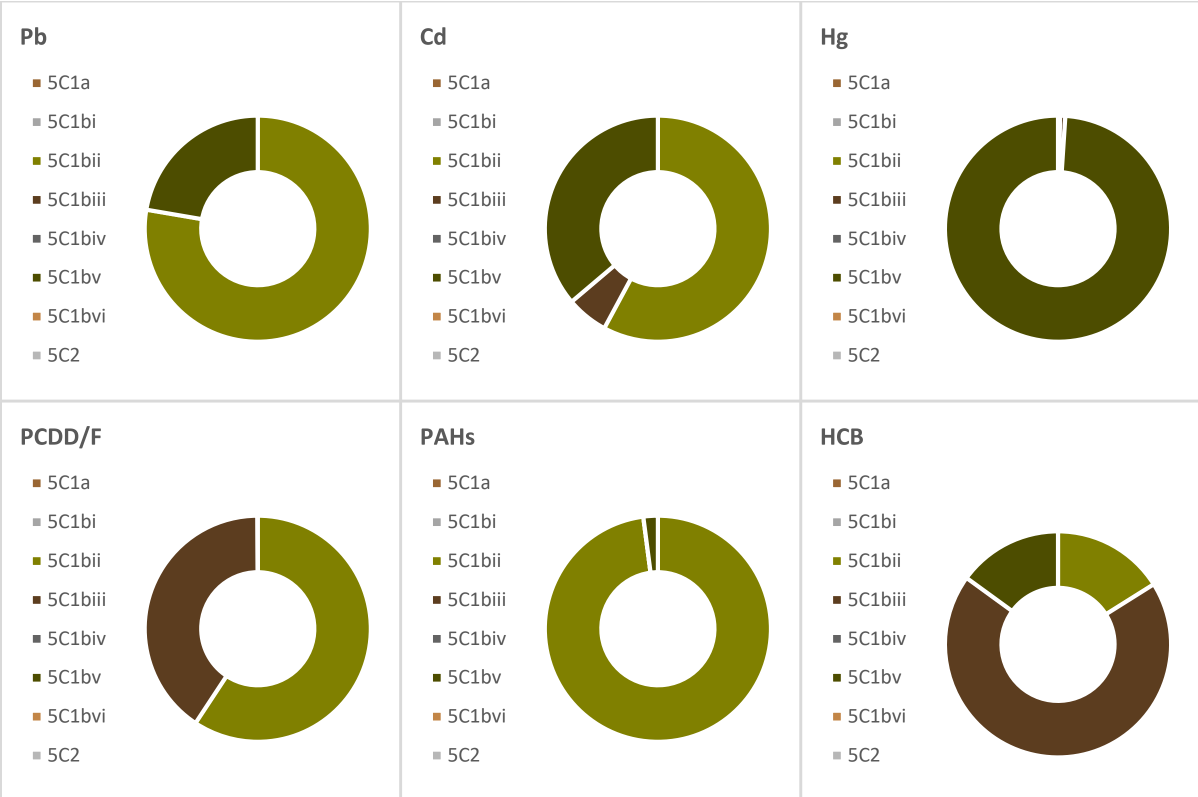
YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.0715	0.0060	0.1044	0.0004	0.0008	0.0116	0.0017	0.0001	0.0010
1995	0.0708	0.0059	0.1045	0.0004	0.0008	0.0115	0.0017	0.0001	0.0011
2000	0.0770	0.0064	0.1138	0.0004	0.0009	0.0125	0.0018	0.0001	0.0012
2005	0.0436	0.0037	0.0626	0.0004	0.0005	0.0078	0.0022	0.0002	0.0017
2010	0.0098	0.0009	0.0219	0.0003	0.0002	0.0029	0.0016	0.0003	0.0021
2011	0.0072	0.0008	0.0216	0.0003	0.0002	0.0040	0.0014	0.0002	0.0020
2012	0.0075	0.0007	0.0203	0.0003	0.0002	0.0018	0.0012	0.0003	0.0020
2013	0.0089	0.0008	0.0246	0.0003	0.0002	0.0018	0.0014	0.0003	0.0025
2014	0.0080	0.0007	0.0241	0.0003	0.0002	0.0018	0.0013	0.0003	0.0024
2015	0.0102	0.0009	0.0263	0.0003	0.0002	0.0015	0.0015	0.0003	0.0027
2016	0.0040	0.0004	0.0258	0.0003	0.0002	0.0009	0.0007	0.0003	0.0027
2017	0.0044	0.0004	0.0221	0.0002	0.0002	0.0005	0.0007	0.0003	0.0023
2018	0.0070	0.0006	0.0279	0.0003	0.0003	0.0009	0.0011	0.0004	0.0029
2019	0.0072	0.0006	0.0315	0.0004	0.0003	0.0007	0.0011	0.0004	0.0033
2020	0.0062	0.0006	0.0363	0.0004	0.0003	0.0007	0.0011	0.0005	0.0038
2021	0.0043	0.0004	0.0485	0.0005	0.0004	0.0009	0.0010	0.0006	0.0052
1990/2021	**-94%**	**-93%**	**-54%**	**33%**	**-44%**	**-92%**	**-41%**	**436%**	**436%**
2020/2021	**-30%**	**-21%**	**33%**	**22%**	**34%**	**32%**	**-7%**	**34%**	**34%**

YEAR	PCDD/F [g I-TEQ]	PAHs[t]	HCB [kg]	PCBs [kg]
1990	73.3828	0.0001	0.2323	0.0461
1995	72.6237	0.0001	0.2300	0.0460
2000	78.9339	0.0001	0.2500	0.0501
2005	39.7876	0.0002	0.2139	0.0426
2010	5.7001	0.0001	0.1297	0.0280
2011	6.2668	0.0001	0.1704	0.0368
2012	3.8032	0.0001	0.0799	0.0186
2013	4.1060	0.0001	0.0811	0.0196
2014	3.8549	0.0001	0.0790	0.0193
2015	4.0760	0.0001	0.0700	0.0174
2016	1.6699	0.0001	0.0343	0.0122
2017	1.3942	0.0001	0.0196	0.0082
2018	2.4748	0.0001	0.0392	0.0128

YEAR	PCDD/F [g I-TEQ]	PAHs[t]	HCB [kg]	PCBs [kg]
2019	2.2206	0.0001	0.0292	0.0117
2020	1.9569	0.0001	0.0291	0.0133
2021	1.5289	0.0001	0.0322	0.0176
1990/2021	**-98%**	**-60%**	**-86%**	**-62%**
2020/2021	**-22%**	**-38%**	**11%**	**33%**

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 2021*



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, 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 6.16***. 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 6.16***).

Table 6.16: *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
2005	193.18	0.2224	0.0016	0.0385	0.0006	0.0055	0.0082	0.0110	0.0002	0.0647
2010	191.93	0.1381	0.0018	0.0066	0.0006	0.0007	0.0010	0.0013	0.0000	0.0074
2011	204.13	0.1628	0.0018	0.0069	0.0006	0.0005	0.0007	0.0009	0.0000	0.0071
2012	180.55	0.1578	0.0020	0.0063	0.0005	0.0009	0.0013	0.0017	0.0000	0.0070
2013	181.52	0.1398	0.0026	0.0075	0.0005	0.0008	0.0012	0.0016	0.0000	0.0081
2014	211.89	0.1504	0.0023	0.0109	0.0006	0.0012	0.0018	0.0023	0.0000	0.0098
2015	200.76	0.1239	0.0021	0.0067	0.0006	0.0008	0.0012	0.0016	0.0000	0.0081
2016	216.54	0.1426	0.0016	0.0087	0.0006	0.0008	0.0012	0.0016	0.0000	0.0068
2017	231.89	0.1450	0.0016	0.0096	0.0007	0.0011	0.0016	0.0021	0.0000	0.0077
2018	245.61	0.1541	0.0018	0.0094	0.0007	0.0009	0.0013	0.0017	0.0000	0.0069
2019	243.04	0.1619	0.0007	0.0055	0.0007	0.0013	0.0019	0.0026	0.0000	0.0057
2020	234.51	0.1515	0.0002	0.0051	0.0007	0.0008	0.0013	0.0017	0.0000	0.0062
2021	230.71	0.0217	0.0001	0.0011	0.0007	0.0001	0.0001	0.0001	0.0000	0.0038
1990/2021	**28%**	**-93%**	**-98%**	**-100%**	**28%**	**-100%**	**-100%**	**-100%**	**-100%**	**-97%**
2020/2021	**-2%**	**-86%**	**-66%**	**-78%**	**-2%**	**-92%**	**-92%**	**-92%**	**-92%**	**-38%**

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
1990/2021	**0.0097**	**0.0039**	**0.0065**	**0.0020**	**0.0043**	**0.0063**	**0.0102**	**0.0027**	**0.0623**
2020/2021	**-100%**	**-99%**	**-99%**	**-99%**	**-87%**	**-62%**	**-53%**	**28%**	**-61%**

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

YEAR	PCDD/F [g I-TEQ]	PAHs[t]	HCB [kg]	PCBs [kg]
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
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
1990/2021	**-100%**	**28%**	**28%**	**28%**
2020/2021	**-2%**	**-2%**	**-2%**	**-2%**

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 the 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 6.17*** and values of abatement technology efficiency, separately for each operator in ***Table 6.18***.

Table 6.17: *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

[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/

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

Table 6.18: *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 2021, 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 6.19*** shows activity data of waste incineration with and without energy recovery and its allocation into NFR categories.

Table 6.19: *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	8.70	13.00	35.05	1.82	NO	6.13	0.39	2.18
1995	46.69	8.61	13.02	32.20	1.47	NO	6.07	0.38	2.16
2000	41.82	9.36	13.01	27.70	1.11	NO	6.60	0.42	2.35
2005	59.86	12.31	11.98	7.40	40.48	NO	8.45	1.94	1.92
2010	180.75	9.50	1.47	6.73	172.55	1.14	5.56	1.66	1.13
2011	204.78	7.95	5.39	6.75	192.64	1.10	3.69	1.58	1.58
2012	213.32	7.02	3.33	5.48	204.51	0.84	3.42	2.09	0.67
2013	255.89	8.00	12.51	4.80	238.57	0.88	3.84	2.62	0.66
2014	295.81	7.26	3.73	3.81	288.27	0.81	3.33	2.48	0.65
2015	289.03	8.83	3.55	4.51	280.97	0.87	5.21	2.22	0.53
2016	302.04	2.92	3.25	4.52	294.28	NO	0.21	2.45	0.26
2017	323.33	4.32	3.84	5.31	314.18	1.13	NO	3.08	0.11
2018	329.56	6.36	2.16	5.10	322.30	1.16	2.16	2.77	0.27
2019	19.51	6.25	2.39	4.23	12.89	1.02	2.39	2.68	0.16
2020	20.53	4.96	1.51	4.24	14.78	0.57	1.53	2.70	0.17
2021	17.60	2.96	1.48	2.89	13.24	0.15	NO	2.59	0.22
1990/2021	**-65%**	**-66%**	**-89%**	**-92%**	**627%**	**-**	**-**	**568%**	**-90%**
2020/2021	**-14%**	**-40%**	**-2%**	**-32%**	**-10%**	**-74%**	**-**	**-4%**	**30%**

6.6.3.2 Category-specific recalculations

In this submission, several activity data corrections were made in categories 5C1bi and 5C1biii. Sewage sludge incineration was removed from inventory after a discussion with the producer of the statistical data (VÚVH), which confirmed that sewage sludge is incinerated only with energy recovery.

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. In this submission, industrial sludge data were used in the wet weight, instead of dry weight, as all the other waste types included in the calculation are in that state. Activity data and resulting emissions are shown in ***Table 6.20***.

Table 6.20: *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	0.0053	0.0454	0.0003	0.0000	0.0000	0.0001	0.0000	0.0004
1995	6.07	0.0053	0.0449	0.0003	0.0000	0.0000	0.0001	0.0000	0.0004
2000	6.60	0.0057	0.0488	0.0003	0.0000	0.0000	0.0001	0.0000	0.0005
2005	8.45	0.0074	0.0625	0.0004	0.0000	0.0001	0.0001	0.0000	0.0006
2010	5.56	0.0048	0.0412	0.0003	0.0000	0.0000	0.0001	0.0000	0.0004
2011	3.69	0.0032	0.0273	0.0002	0.0000	0.0000	0.0000	0.0000	0.0003
2012	3.42	0.0030	0.0253	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002
2013	3.84	0.0033	0.0284	0.0002	0.0000	0.0000	0.0000	0.0000	0.0003
2014	3.33	0.0029	0.0246	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002
2015	5.21	0.0045	0.0386	0.0002	0.0000	0.0000	0.0001	0.0000	0.0004
2016	0.21	0.0002	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	NO	NO	NO	NO	NO	NO	NO	NO	NO
2018	2.16	0.0019	0.0160	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2019	2.39	0.0021	0.0177	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2020	1.53	0.0013	0.0113	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
2021	NO	NO	NO	NO	NO	NO	NO	NO	NO
1990/2021	-	-	-	-	-	-	-	-	-
2020/2021	-	-	-	-	-	-	-	-	-

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Ni [t]	PCDD/F [g I-TEQ]	PAHs [t]	HCB [kg]
1990	0.0080	0.0006	0.0003	0.0001	0.0009	2.1461	0.0001	0.0123
1995	0.0079	0.0006	0.0003	0.0001	0.0008	2.1239	0.0001	0.0121
2000	0.0086	0.0007	0.0004	0.0001	0.0009	2.3084	0.0001	0.0132
2005	0.0110	0.0008	0.0005	0.0001	0.0012	2.9580	0.0002	0.0169
2010	0.0072	0.0006	0.0003	0.0001	0.0008	1.9464	0.0001	0.0111
2011	0.0048	0.0004	0.0002	0.0001	0.0005	1.2901	0.0001	0.0074
2012	0.0044	0.0003	0.0002	0.0001	0.0005	1.1965	0.0001	0.0068
2013	0.0050	0.0004	0.0002	0.0001	0.0005	1.3432	0.0001	0.0077
2014	0.0043	0.0003	0.0002	0.0001	0.0005	1.1648	0.0001	0.0067
2015	0.0068	0.0005	0.0003	0.0001	0.0007	1.8247	0.0001	0.0104
2016	0.0003	0.0000	0.0000	0.0000	0.0000	0.0727	0.0000	0.0004
2017	NO	NO	NO	NO	NO	NO	NO	NO
2018	0.0028	0.0002	0.0001	0.0000	0.0003	0.7577	0.0000	0.0043
2019	0.0031	0.0002	0.0001	0.0000	0.0003	0.8372	0.0000	0.0048
2020	0.0020	0.0002	0.0001	0.0000	0.0002	0.5346	0.0000	0.0031
2021	NO	NO	NO	NO	NO	NO	NO	NO
1990/2021	-	-	-	-	-	-	-	-
2020/2021	-	-	-	-	-	-	-	-

6.6.3.3.1 Methodological issues

For industrial waste incineration sources without energy recovery, data from the NEIS database were used. 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, industrial sludge from wastewater treatment is included in this category.

Tier 1 methodology from the EMEP/EEA GB_{2019} was used to calculate emissions in this category. Emission factors are shown in ***Table 6.21***.

The **condensable component of PMs** is not included in EFs.

Table 6.21: *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	0.87	7.4	0.047	0.004	0.007	0.01	3.5	0.07

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	350	38.87	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_{2019}.

6.6.3.3.3 Source-specific recalculations

Recalculations in this category are the result of the improvement of extrapolation of activity data and change of state of industrial sludge from dry weight to wet weight, as all the other waste categories used for estimation of emissions were in wet weight. Emissions of PMs and BC changed to the same percentage as the TSP (***Table 6.22***).

Table 6.22: *Previous and revised emissions from industrial waste without energy recovery*

YEAR	NOx [kt]		NMVOC [kt]		SOx [kt]		CO [kt]		TSP [kt]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
1990	0.0053	0.0053	0.0447	0.0454	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1991	0.0052	0.0053	0.0446	0.0453	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1992	0.0052	0.0053	0.0445	0.0452	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1993	0.0053	0.0053	0.0448	0.0455	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1994	0.0053	0.0053	0.0448	0.0455	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1995	0.0052	0.0053	0.0442	0.0449	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1996	0.0053	0.0053	0.0448	0.0455	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1997	0.0054	0.0054	0.0456	0.0463	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1998	0.0051	0.0052	0.0437	0.0444	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
1999	0.0052	0.0052	0.0439	0.0446	0.0003	0.0003	0.0004	0.0004	0.0001	0.0001	2%
2000	0.0056	0.0057	0.0480	0.0488	0.0003	0.0003	0.0005	0.0005	0.0001	0.0001	2%
2001	0.0058	0.0060	0.0497	0.0507	0.0003	0.0003	0.0005	0.0005	0.0001	0.0001	2%
2002	0.0097	0.0162	0.0827	0.1381	0.0005	0.0009	0.0008	0.0013	0.0001	0.0002	67%
2003	0.0046	0.0095	0.0395	0.0810	0.0003	0.0005	0.0004	0.0008	0.0001	0.0001	105%
2004	0.0056	0.0131	0.0477	0.1114	0.0003	0.0007	0.0005	0.0011	0.0001	0.0002	134%
2005	0.0023	0.0074	0.0194	0.0625	0.0001	0.0004	0.0002	0.0006	0.0000	0.0001	222%
2006	0.0042	0.0130	0.0361	0.1108	0.0002	0.0007	0.0003	0.0010	0.0000	0.0001	207%
2007	0.0006	0.0029	0.0054	0.0246	0.0000	0.0002	0.0001	0.0002	0.0000	0.0000	355%
2008	0.0015	0.0067	0.0125	0.0566	0.0001	0.0004	0.0001	0.0005	0.0000	0.0001	355%
2009	0.0008	0.0036	0.0068	0.0308	0.0000	0.0002	0.0001	0.0003	0.0000	0.0000	355%
2010	0.0011	0.0048	0.0091	0.0412	0.0001	0.0003	0.0001	0.0004	0.0000	0.0001	355%
2011	0.0007	0.0032	0.0060	0.0273	0.0000	0.0002	0.0001	0.0003	0.0000	0.0000	355%
2012	0.0007	0.0030	0.0056	0.0253	0.0000	0.0002	0.0001	0.0002	0.0000	0.0000	355%
2013	0.0007	0.0033	0.0062	0.0284	0.0000	0.0002	0.0001	0.0003	0.0000	0.0000	355%
2014	0.0006	0.0029	0.0054	0.0246	0.0000	0.0002	0.0001	0.0002	0.0000	0.0000	355%
2015	0.0010	0.0045	0.0085	0.0386	0.0001	0.0002	0.0001	0.0004	0.0000	0.0001	355%
2016	0.0000	0.0002	0.0003	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	355%
2017	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-

YEAR	NOx [kt]		NMVOC [kt]		SOx [kt]		CO [kt]		TSP [kt]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
2018	0.0004	0.0019	0.0035	0.0160	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	355%
2019	0.0005	0.0021	0.0039	0.0177	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	355%
2020	0.0003	0.0013	0.0025	0.0113	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	360%

YEAR	Pb [t]		Cd [t]		Hg [t]		As [t]		Ni [t]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
1990	0.0078	0.0080	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0009	2%
1991	0.0078	0.0080	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0009	2%
1992	0.0078	0.0079	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0009	2%
1993	0.0079	0.0080	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0009	2%
1994	0.0079	0.0080	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0009	2%
1995	0.0078	0.0079	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0008	2%
1996	0.0079	0.0080	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0009	2%
1997	0.0080	0.0081	0.0004	0.0006	0.0003	0.0004	0.0001	0.0001	0.0009	0.0009	2%
1998	0.0077	0.0078	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0008	2%
1999	0.0077	0.0078	0.0004	0.0006	0.0003	0.0003	0.0001	0.0001	0.0008	0.0008	2%
2000	0.0084	0.0086	0.0005	0.0007	0.0004	0.0004	0.0001	0.0001	0.0009	0.0009	2%
2001	0.0087	0.0089	0.0005	0.0007	0.0004	0.0004	0.0001	0.0001	0.0009	0.0010	2%
2002	0.0145	0.0243	0.0008	0.0019	0.0006	0.0010	0.0002	0.0003	0.0016	0.0026	67%
2003	0.0069	0.0142	0.0004	0.0011	0.0003	0.0006	0.0001	0.0002	0.0007	0.0015	105%
2004	0.0084	0.0196	0.0005	0.0015	0.0004	0.0008	0.0001	0.0002	0.0009	0.0021	134%
2005	0.0034	0.0110	0.0002	0.0008	0.0001	0.0005	0.0000	0.0001	0.0004	0.0012	222%
2006	0.0063	0.0195	0.0003	0.0015	0.0003	0.0008	0.0001	0.0002	0.0007	0.0021	207%
2007	0.0010	0.0043	0.0001	0.0003	0.0000	0.0002	0.0000	0.0001	0.0001	0.0005	355%
2008	0.0022	0.0100	0.0001	0.0008	0.0001	0.0004	0.0000	0.0001	0.0002	0.0011	355%
2009	0.0012	0.0054	0.0001	0.0004	0.0001	0.0002	0.0000	0.0001	0.0001	0.0006	355%
2010	0.0016	0.0072	0.0001	0.0006	0.0001	0.0003	0.0000	0.0001	0.0002	0.0008	355%
2011	0.0011	0.0048	0.0001	0.0004	0.0000	0.0002	0.0000	0.0001	0.0001	0.0005	355%
2012	0.0010	0.0044	0.0001	0.0003	0.0000	0.0002	0.0000	0.0001	0.0001	0.0005	355%
2013	0.0011	0.0050	0.0001	0.0004	0.0000	0.0002	0.0000	0.0001	0.0001	0.0005	355%
2014	0.0010	0.0043	0.0001	0.0003	0.0000	0.0002	0.0000	0.0001	0.0001	0.0005	355%
2015	0.0015	0.0068	0.0001	0.0005	0.0001	0.0003	0.0000	0.0001	0.0002	0.0007	355%
2016	0.0001	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	355%
2017	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
2018	0.0006	0.0028	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0001	0.0003	355%
2019	0.0007	0.0031	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0001	0.0003	355%
2020	0.0004	0.0020	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0002	360%

YEAR	PCDD/F [g I-TEQ]		PAHs [t]		HCB [kg]		CHANGE
	P	R	P	R	P	R	
1990	2.1127	2.1461	0.0001	0.0001	0.0121	0.0123	2%
1991	2.1095	2.1428	0.0001	0.0001	0.0121	0.0122	2%
1992	2.1044	2.1376	0.0001	0.0001	0.0120	0.0122	2%
1993	2.1171	2.1505	0.0001	0.0001	0.0121	0.0123	2%
1994	2.1174	2.1509	0.0001	0.0001	0.0121	0.0123	2%
1995	2.0909	2.1239	0.0001	0.0001	0.0119	0.0121	2%
1996	2.1170	2.1504	0.0001	0.0001	0.0121	0.0123	2%
1997	2.1550	2.1890	0.0001	0.0001	0.0123	0.0125	2%
1998	2.0658	2.0984	0.0001	0.0001	0.0118	0.0120	2%

YEAR	PCDD/F [g I-TEQ]		PAHs [t]		HCB [kg]		CHANGE
	P	R	P	R	P	R	
1999	2.0744	2.1071	0.0001	0.0001	0.0119	0.0120	2%
2000	2.2725	2.3084	0.0001	0.0001	0.0130	0.0132	2%
2001	2.3487	2.3971	0.0001	0.0001	0.0134	0.0137	2%
2002	3.9138	6.5335	0.0002	0.0004	0.0224	0.0373	67%
2003	1.8704	3.8308	0.0001	0.0002	0.0107	0.0219	105%
2004	2.2545	5.2691	0.0001	0.0003	0.0129	0.0301	134%
2005	0.9198	2.9580	0.0001	0.0002	0.0053	0.0169	222%
2006	1.7061	5.2383	0.0001	0.0003	0.0097	0.0299	207%
2007	0.2564	1.1654	0.0000	0.0001	0.0015	0.0067	355%
2008	0.5894	2.6790	0.0000	0.0002	0.0034	0.0153	355%
2009	0.3206	1.4575	0.0000	0.0001	0.0018	0.0083	355%
2010	0.4282	1.9464	0.0000	0.0001	0.0024	0.0111	355%
2011	0.2838	1.2901	0.0000	0.0001	0.0016	0.0074	355%
2012	0.2632	1.1965	0.0000	0.0001	0.0015	0.0068	355%
2013	0.2955	1.3432	0.0000	0.0001	0.0017	0.0077	355%
2014	0.2563	1.1648	0.0000	0.0001	0.0015	0.0067	355%
2015	0.4014	1.8247	0.0000	0.0001	0.0023	0.0104	355%
2016	0.0160	0.0727	0.0000	0.0000	0.0001	0.0004	355%
2017	NO	NO	NO	NO	NO	NO	-
2018	0.1667	0.7577	0.0000	0.0000	0.0010	0.0043	355%
2019	0.1842	0.8372	0.0000	0.0000	0.0011	0.0048	355%
2020	0.1162	0.5346	0.0000	0.0000	0.0007	0.0031	360%

P-Previous, R-Revised

6.6.3.4 Hazardous waste incineration (NFR 5C1bii)

Emissions in this category have an increasing trend due to legislation that set the preference for the incineration of waste instead of disposal at landfill sites.

Table 6.23: *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	0.39	0.0003	0.0029	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.38	0.0003	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.42	0.0004	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	1.94	0.0017	0.0144	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
2010	1.66	0.0014	0.0123	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
2011	1.58	0.0014	0.0117	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
2012	2.09	0.0018	0.0155	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001
2013	2.62	0.0023	0.0194	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2014	2.48	0.0022	0.0183	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2015	2.22	0.0019	0.0164	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2016	2.45	0.0021	0.0181	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2017	3.08	0.0027	0.0228	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2018	2.77	0.0024	0.0205	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2019	2.68	0.0023	0.0198	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2020	2.70	0.0023	0.0200	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
2021	2.59	0.0023	0.0192	0.0001	0.0000	0.0000	0.0000	0.0000	0.0002
1990/2021	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**
2020/2021	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**

YEAR	Pb [t]	Cd [t]	Hg [t]	As [t]	Ni [t]	PCDD/F [g I-TEQ]	PAHs [t]	HCB [kg]
1990	0.0005	0.0000	0.0000	0.0000	0.0001	0.1358	0.0000	0.0008
1995	0.0005	0.0000	0.0000	0.0000	0.0001	0.1343	0.0000	0.0008
2000	0.0005	0.0000	0.0000	0.0000	0.0001	0.1460	0.0000	0.0008
2005	0.0025	0.0002	0.0001	0.0000	0.0003	0.6794	0.0000	0.0039
2010	0.0022	0.0002	0.0001	0.0000	0.0002	0.5823	0.0000	0.0033
2011	0.0021	0.0002	0.0001	0.0000	0.0002	0.5534	0.0000	0.0032
2012	0.0027	0.0002	0.0001	0.0000	0.0003	0.7314	0.0000	0.0042
2013	0.0034	0.0003	0.0001	0.0000	0.0004	0.9185	0.0001	0.0052
2014	0.0032	0.0002	0.0001	0.0000	0.0003	0.8668	0.0000	0.0050
2015	0.0029	0.0002	0.0001	0.0000	0.0003	0.7765	0.0000	0.0044
2016	0.0032	0.0002	0.0001	0.0000	0.0003	0.8570	0.0000	0.0049
2017	0.0040	0.0003	0.0002	0.0000	0.0004	1.0775	0.0001	0.0062
2018	0.0036	0.0003	0.0002	0.0000	0.0004	0.9712	0.0001	0.0055
2019	0.0035	0.0003	0.0001	0.0000	0.0004	0.9366	0.0001	0.0054
2020	0.0035	0.0003	0.0002	0.0000	0.0004	0.9436	0.0001	0.0054
2021	0.0034	0.0003	0.0001	0.0000	0.0004	0.9064	0.0001	0.0052
1990/2021	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**	**568%**
2020/2021	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**	**-4%**

6.6.3.4.1 Methodological issues

For hazardous waste incineration sources without energy recovery, data from the NEIS database were used. 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, hazardous waste was excluded from category **5C1bi** and allocated in this category. Abatement technology installed at the incineration plants is not included in the methodology.

Tier 1 methodology from the EMEP/EEA GB_{2019} was used to calculate emissions in this category. Emission factors are shown in ***Table 6.24***.

The **condensable component of PMs** is not included in EFs.

Table 6.24: *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	0.87	7.4	0.047	0.004	0.007	0.01	0.035	0.07

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	350	38.87	3

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_{2019}.

6.6.3.4.3 Source-specific recalculations

Recalculations in this category are the result of the improvement of activity data for the year 2020. In the previous submission, data for one operator were incorrect. Emissions of PMs and BC changed to the same percentage as the TSP (***Table 6.25***).

Table 6.25: Previous and revised emissions from hazardous industrial waste without energy recovery

YEAR	NOx [kt]		NMVOC [kt]		SOx [kt]		CO [kt]		TSP [kt]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
2020	0.0023	0.0023	0.0199	0.0200	0.0001	0.0001	0.0002	0.0002	0.0000	0.0000	0%

YEAR	Pb [t]		Cd [t]		Hg [t]		As [t]		Ni [t]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
2020	0.0035	0.0035	0.0003	0.0003	0.0002	0.0002	0.0000	0.0000	0.0004	0.0004	0%

YEAR	PCDD/F [g I-TEQ]		PAHs [t]		HCB [kg]		CHANGE
	P	R	P	R	P	R	
2020	0.9394	0.9436	0.0001	0.0001	0.0054	0.0054	0%

P-Previous, R-Revised

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 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 2018 it was only seven and only two of them were a part of the hospital area. 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 6.26*** shows emissions released into the air from this activity using the methodology described below.

Table 6.26: 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]	TSP [kt]	BC [kt]	CO [kt]
1990	2.18	0.0039	0.0015	0.0020	0.0041	0.0001	0.0033
1995	2.16	0.0039	0.0015	0.0019	0.0041	0.0001	0.0032
2000	2.35	0.0042	0.0016	0.0021	0.0044	0.0001	0.0035
2005	1.92	0.0034	0.0013	0.0010	0.0022	0.0000	0.0029
2010	1.13	0.0020	0.0008	0.0001	0.0003	0.0000	0.0017
2011	1.58	0.0028	0.0011	0.0001	0.0004	0.0000	0.0024

[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
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	CW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	TSP [kt]	BC [kt]	CO [kt]
2012	0.67	0.0012	0.0005	0.0001	0.0002	0.0000	0.0010
2013	0.66	0.0012	0.0005	0.0001	0.0002	0.0000	0.0010
2014	0.65	0.0012	0.0005	0.0001	0.0001	0.0000	0.0010
2015	0.53	0.0009	0.0004	0.0000	0.0001	0.0000	0.0008
2016	0.26	0.0005	0.0002	0.0000	0.0001	0.0000	0.0004
2017	0.11	0.0002	0.0001	0.0000	0.0000	0.0000	0.0002
2018	0.27	0.0005	0.0002	0.0000	0.0001	0.0000	0.0004
2019	0.16	0.0003	0.0001	0.0000	0.0000	0.0000	0.0002
2020	0.17	0.0003	0.0001	0.0000	0.0000	0.0000	0.0003
2021	0.22	0.0004	0.0002	0.0000	0.0001	0.0000	0.0003
1990/2021	**-90%**	**-90%**	**-90%**	**-99%**	**-99%**	**-99%**	**-90%**
2020/2021	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**

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	0.0629	0.0053	0.0950	0.0002	0.0007	0.0116	0.0007	71.1008	0.0000	0.2183	0.0437
1995	0.0622	0.0052	0.0941	0.0002	0.0007	0.0114	0.0006	70.3653	0.0000	0.2161	0.0432
2000	0.0676	0.0057	0.1022	0.0002	0.0008	0.0124	0.0007	76.4793	0.0000	0.2348	0.0470
2005	0.0298	0.0026	0.0465	0.0001	0.0003	0.0076	0.0006	36.1499	0.0000	0.1916	0.0383
2010	NO	0.0001	0.0018	0.0000	0.0000	0.0028	0.0003	3.1711	0.0000	0.1133	0.0227
2011	NO	0.0002	0.0026	0.0000	0.0000	0.0039	0.0005	4.4230	0.0000	0.1580	0.0316
2012	NO	0.0001	0.0011	0.0000	0.0000	0.0016	0.0002	1.8750	0.0000	0.0670	0.0134
2013	NO	0.0001	0.0011	0.0000	0.0000	0.0016	0.0002	1.8439	0.0000	0.0659	0.0132
2014	NO	0.0001	0.0011	0.0000	0.0000	0.0016	0.0002	1.8229	0.0000	0.0651	0.0130
2015	NO	0.0001	0.0009	0.0000	0.0000	0.0013	0.0002	1.4744	0.0000	0.0527	0.0105
2016	NO	0.0000	0.0004	0.0000	0.0000	0.0006	0.0001	0.7398	0.0000	0.0264	0.0053
2017	NO	0.0000	0.0002	0.0000	0.0000	0.0003	0.0000	0.3163	0.0000	0.0113	0.0023
2018	NO	0.0000	0.0004	0.0000	0.0000	0.0007	0.0001	0.7453	0.0000	0.0266	0.0053
2019	NO	0.0000	0.0003	0.0000	0.0000	0.0004	0.0000	0.4463	0.0000	0.0159	0.0032
2020	NO	0.0000	0.0003	0.0000	0.0000	0.0004	0.0001	0.4780	0.0000	0.0171	0.0034
2021	NO	0.0000	0.0004	0.0000	0.0000	0.0005	0.0001	0.6217	0.0000	0.0222	0.0044
1990/2021	**-**	**-99%**	**-100%**	**-100%**	**-99%**	**-95%**	**-90%**	**-99%**	**-90%**	**-90%**	**-90%**
2020/2021	**-**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**

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

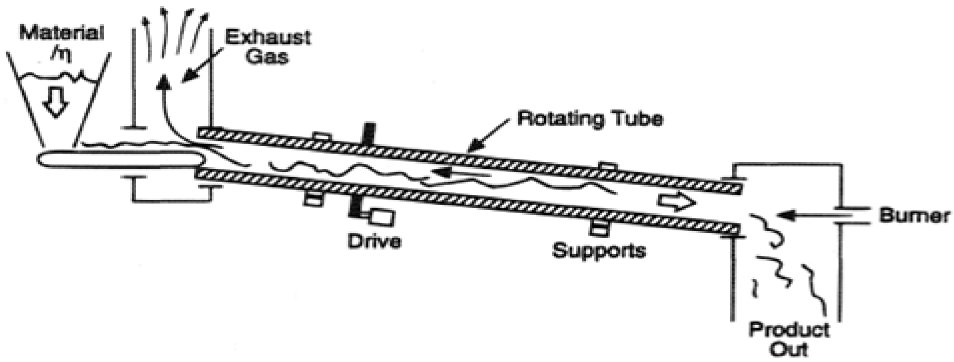
Activity data for this source of pollution is the NEIS database, which contains detailed information about amounts and types of waste incinerated in each plant for the years 2000-2021. Historical data were extrapolated using the trend of the category hospital and veterinary wastes. Activity data from 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**.

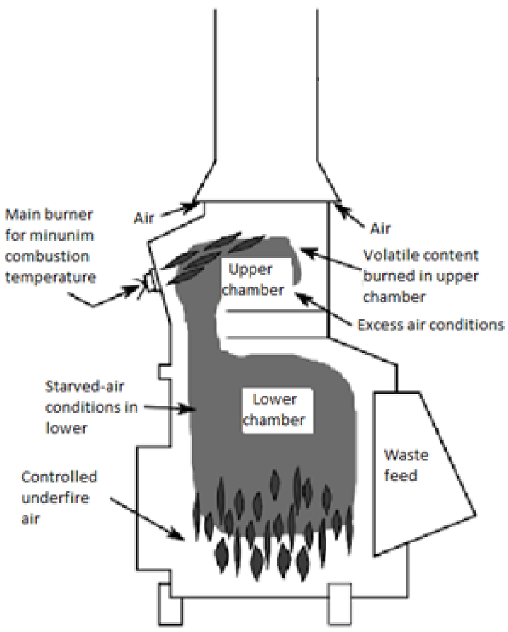
In the EMEP/EEA GB2019, there are described two types of abatement technologies. **A rotary kiln (*Figure 6.7*)** is defined as a technology where waste is fed into a slightly inclined, rotating, refractory-lined drum, which acts as a grate surface. The rotating action of the drum mixes it with air supplied through the walls.

Figure 6.7: *Scheme of rotary kiln*



Source: https://www.911metallurgist.com/blog/rotary-kiln-lining

Figure 6.8: *Scheme of controlled air incinerator*



Source: http://managemedmedicalwastedisposal.com/blog/date/2016/09

The controlled air incinerator (modular-starved air incinerator) consists of two stages. During the first stage (starved air section), the air-to-fuel ratio is kept low to promote drying and volatilisation at temperatures of ~800–900 °C. In the second stage (secondary combustion chamber), excess air is added and temperatures are elevated to ~1000 °C by support burners to ensure complete gas (***Figure 6.8***).

Data about the technology used to incinerate clinical waste and abatement technologies are available from the year 2000 when were these data published as a part of the Waste Management Program for the period 2001-2005. This program is updated every 5 years.

Emission estimates were calculated using the Tier 2 approach. Emission factors were taken from the EMEP/EEA GB2019. Technology-specific information was collected from operators and Waste Management Programs, and plants using a controlled rotary kiln and controlled air incineration were identified. ***Table 6.27*** shows the analysis of the distribution of clinical waste burned by combustion technologies in the period 1990-2021.

Table 6.27: *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		% OF WASTE BURNED IN WI WITH AIR POLLUTION CONTROL (APC)
		CONTROLLED AIR WI	ROTARY KILN WI	
1990-2000	80%	20%	-	20%
2001	77%	23%	-	23%
2002	63%	37%	-	37%
2003	66%	34%	-	34%
2004	60%	40%	-	40%
2005	43%	57%	-	57%
2006	-	100%	-	100%
2007	-	100%	-	100%
2008	-	100%	-	100%
2009	-	100%	-	100%
2010	-	100%	-	100%
2011	-	100%	-	100%
2012	-	100%	-	100%
2013	-	100%	-	100%
2014	-	100%	-	100%
2015	-	100%	-	100%
2016	-	100%	-	100%
2017	-	100%	-	100%
2018	-	100%	-	100%
2019	-	100%	-	100%
2020	-	100%	-	100%
2021	-	100%	-	100%
(dark orange)	No abatement			
(yellow)	The default value of abatement efficiency (GB_{2019})			

Operators of clinical waste were assigned to combustion technology based on data from Waste Management Programs and the NEIS database. Information about the type of air pollution control technology is available in Waste Management Programs (historical years) and the NEIS database (after 2005).

Emission factors and efficiencies of abatement technologies, which were used in calculations for incineration with/without energy recovery, are shown in ***Table 6.28***.

Table 6.28: *Emission factors and abatement technology efficiencies in the category of Clinical waste incineration*

POLLUTANT	NOx	CO	NMVOC	SOx	TSP	BC*	Pb	Cd	Hg	As	Cr	Cu	Ni
Unit	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[% of TSP]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
Value	1.8	1.5	0.7	1.1	2.3	2.3	36	3	54	0.1	0.4	6	0.3
% Efficiency rotary kiln	-	88	-	59	99	-	100	100	73	-	98	100	99
% Efficiency controlled air	-	-	-	92	90	-	100	96	97	99	96	59	-

* Tier 1

POLLUTANT	PCDD/F	Total 4 PAHs	HCB	PCB
Unit	[mg I-TEQ/t]	[mg/t]	[g/t]	[g/t]
Value	40	0.04	0.1	0.02
% Efficiency	93	-	-	-

6.6.3.5.2 Completeness

All rising pollutants are recorded and reported.

6.6.3.5.3 Source-specific recalculations

Recalculations in 2004, 2005 and 2019 were made due to the correction of the activity data (see ***Table 6.29***).

Table 6.29: *Previous and revised emissions from clinical waste without energy recovery*

YEAR	NOx [kt]		NMVOC [kt]		SOx [kt]		CO [kt]		TSP [kt]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
2004	0.0041	0.0039	0.0016	0.0015	0.0016	0.0015	0.0034	0.0032	0.0035	0.0032	-9%
2005	0.0041	0.0034	0.0016	0.0013	0.0014	0.0010	0.0034	0.0029	0.0030	0.0022	-28%
2019	0.0003	0.0003	0.0001	0.0001	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000	0%

YEAR	Pb [t]		Cd [t]		Hg [t]		As [t]		Ni [t]		CHANGE
	P	R	P	R	P	R	P	R	P	R	
2004	0.0512	0.0463	0.0044	0.0040	0.0783	0.0708	0.0001	0.0001	0.0007	0.0006	-6%
2005	0.0430	0.0298	0.0037	0.0026	0.0662	0.0465	0.0001	0.0001	0.0007	0.0006	-16%
2019	NO	NO	0.0000	0.0000	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0%

YEAR	PCDD/F [g I-TEQ]		PAHs [t]		HCB [kg]		CHANGE
	P	R	P	R	P	R	
2004	59.3449	53.8515	0.0000	0.0000	0.2283	0.2146	-6%
2005	50.7984	36.1499	0.0000	0.0000	0.2282	0.1916	-16%
2019	0.4475	0.4463	0.0000	0.0000	0.0160	0.0159	0%

P-Previous, R-Revised

6.6.3.6 Sewage sludge incineration (NFR 5C1biv)

Sewage sludge incineration was removed from the inventory after a discussion with activity data producer – VÚVH, which confirmed that there is no incineration of sewage sludge without energy recovery.

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 6.30***, 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 increase. In 2020 and 2021, it is partly a result of the covid-19 pandemic.

Table 6.30: *Overview of activity data, emissions and emission trends in the category of Cremation*

YEAR	HUMAN BODIES CREMATED [BODY]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [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

YEAR	HUMAN BODIES CREMATED [BODY]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
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
1990/2021	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**
2020/2021	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**

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
1990/2021	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**
2020/2021	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**

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

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]
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
1990/2021	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**	**436%**
2020/2021	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**	**34%**

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_{2019} emission factors. The values are given in the tables below (***Table 6.31***).

The inclusion/exclusion of the **condensable component of PMs** is unknown.

Table 6.31: *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

No recalculations in this submission.

6.6.5 OPEN BURNING OF WASTE (5C2)

This activity 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] (Recommendation No. ***SK-5C2-2022-0001***). It is forbidden to perform the open burning of agricultural waste. Open burning of forest residues is reported in category **11B**. Notation key NO is used.

[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/

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 0.27 kt in 2021. Compared to the previous years, these emissions continue to decrease, which is caused mainly by building and connecting the houses to the sewage systems. I

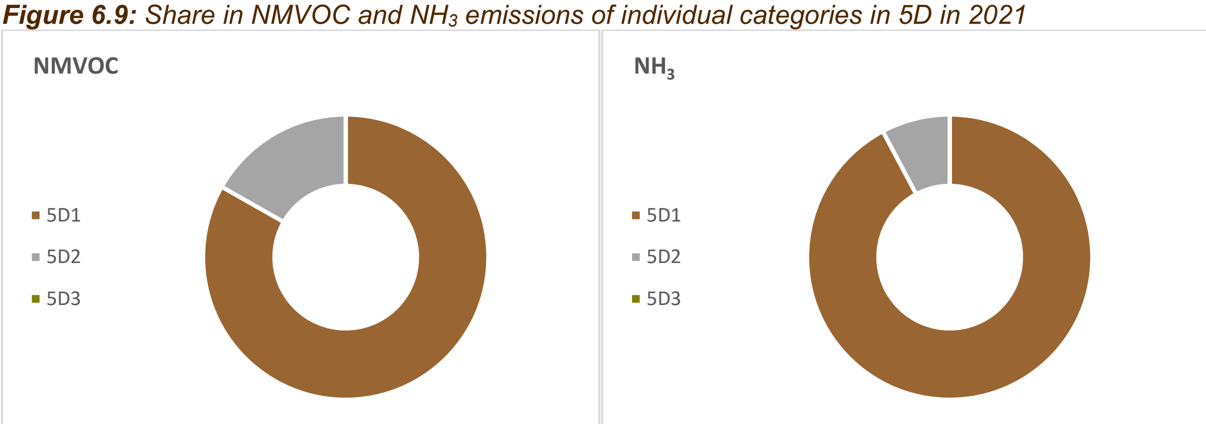
Table 6.32 shows trends of emissions from domestic and industrial wastewater during the last years.

Table 6.32: *Overview of emission trends in the category of Wastewater handling*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO[kt]
1990	0.0070	0.9603	0.0042	1.1315	0.0058	0.0058	0.0059	0.0060
1995	0.0077	1.0440	0.0045	1.0352	0.0063	0.0063	0.0064	0.0065
2000	0.0015	1.7039	0.0000	0.8408	0.0044	0.0044	0.0045	0.0048
2005	0.0048	0.8500	0.0019	0.7637	0.0005	0.0005	0.0005	0.0019
2010	0.0074	0.2964	0.0027	0.6096	0.0007	0.0007	0.0007	0.0023
2011	0.0082	0.2330	0.0031	0.4761	0.0008	0.0008	0.0008	0.0026
2012	0.0058	0.2099	0.0026	0.4586	0.0004	0.0004	0.0004	0.0021
2013	0.0048	0.2750	0.0026	0.3829	0.0007	0.0007	0.0007	0.0034
2014	0.0050	0.2021	0.0027	0.3179	0.0008	0.0008	0.0008	0.0045
2015	0.0057	0.2202	0.0039	0.3113	0.0011	0.0011	0.0011	0.0064
2016	0.0058	0.2566	0.0024	0.2409	0.0005	0.0005	0.0005	0.0019
2017	0.0061	0.2645	0.0028	0.1501	0.0004	0.0004	0.0004	0.0021
2018	0.0059	0.2692	0.0029	0.1225	0.0004	0.0004	0.0004	0.0021
2019	0.0067	0.2737	0.0036	0.1015	0.0005	0.0005	0.0005	0.0023
2020	0.0063	0.2733	0.0028	0.0977	0.0005	0.0005	0.0005	0.0021
2021	0.0069	0.2740	0.0035	0.0976	0.0005	0.0005	0.0005	0.0021
1990/2021	**-2%**	**-71%**	**-16%**	**-91%**	**-91%**	**-91%**	**-91%**	**-66%**
2020/2021	**9%**	**0%**	**26%**	**0%**	**9%**	**9%**	**9%**	**-4%**

Shares of NMVOC emission in 2021 NFR categories included in the wastewater treatment are shown in ***Figure 6.9***.

Figure 6.9: *Share in NMVOC and NH_3 emissions of individual categories in 5D in 2021*



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 6.33*** and ***6.34*** provides information on the data sources regarding the share of the distribution of domestic and industrial sludge treatment.

Table 6.33: *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	0	-	-	-	-	-
2000	56 279	35 358	-	-	-	13 796	7 125
2005	56 360	39 120	-	-	-	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	1 254	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

Table 6.34: *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	10 307	5 577	2 231	1 037	1 501	785	24
2010	25 571	19 769	1 102	6 369	1 228	11 058	13
2011	29 388	19 460	685	9 977	921	7 620	256
2012	22 567	18 483	478	7 099	1 543	6 351	3 012
2013	19 632	17 167	627	7 727	1 720	1 456	5 636
2014	12 377	8 434	688	4 632	1 763	1 237	114
2015	11 485	7 500	813	3 248	2 496	898	45
2016	13 651	12 200	1 134	3 353	2 021	5 641	50
2017	22 211	15 538	362	3 460	1 206	1 063	9 447
2018	49 669	40 462	287	3 520	3 307	1 006	32 341
2019	12 935	9 223	49	3 401	2 663	1 694	1 416
2020	32 611	28 611	1	3 893	1 326	6 445	16 946
2021	20 724	10 992	1	3 191	1 013	6 037	750

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 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 are discharging 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 6.35*** and ***6.36*** shows the emission trend of NH_3.

Table 6.35: *Overview of emission trends from biogas combustion in the category of Domestic wastewater handling*

YEAR	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO[kt]
1990	0.0041	0.0892	0.0041	0.0317	0.0009	0.0009	0.0009	0.0021
1995	0.0045	0.0970	0.0044	0.0344	0.0010	0.0010	0.0010	0.0023
2000	0.0007	0.0923	0.0000	0.0004	0.0001	0.0001	0.0001	0.0001
2005	0.0046	0.1711	0.0019	0.0565	0.0004	0.0004	0.0005	0.0018
2010	0.0073	0.1906	0.0027	0.0653	0.0006	0.0007	0.0007	0.0023
2011	0.0082	0.1991	0.0031	0.0702	0.0007	0.0007	0.0008	0.0026
2012	0.0058	0.1754	0.0026	0.0619	0.0004	0.0004	0.0004	0.0020
2013	0.0048	0.1864	0.0026	0.0660	0.0006	0.0006	0.0006	0.0034
2014	0.0050	0.1822	0.0027	0.0646	0.0008	0.0008	0.0008	0.0045
2015	0.0056	0.2001	0.0039	0.0718	0.0011	0.0011	0.0011	0.0064
2016	0.0058	0.2039	0.0023	0.0733	0.0004	0.0004	0.0005	0.0019
2017	0.0060	0.2123	0.0027	0.0754	0.0004	0.0004	0.0004	0.0021
2018	0.0059	0.2193	0.0028	0.0809	0.0004	0.0004	0.0004	0.0021
2019	0.0067	0.2218	0.0036	0.0812	0.0005	0.0005	0.0005	0.0023
2020	0.0063	0.2207	0.0027	0.0811	0.0005	0.0005	0.0005	0.0021
2021	0.0061	0.2220	0.0029	0.0813	0.0005	0.0005	0.0005	0.0020
1990/2021	**48%**	**149%**	**-30%**	**157%**	**-45%**	**-45%**	**-45%**	**-4%**
2020/2021	**-3%**	**1%**	**6%**	**0%**	**2%**	**2%**	**2%**	**-5%**

Table 6.36: *Overview of emission trends from water treatment and latrines in the category of Domestic wastewater handling*

YEAR	DOMESTIC WW DISCHARGED [th. m^3]	POPULATION USING DRY TOILETS [inhab]	NMVOC [kt]	NH_3 [kt]
1990	370 257.35	685 274.00	0.0056	1.0964
1995	402 528.74	623 177.40	0.0060	0.9971
2000	447 129.41	522 718.40	0.0067	0.8363
2005	411 842.63	439 789.80	0.0062	0.7037
2010	454 069.00	338 339.80	0.0068	0.5413
2011	364 941.00	252 108.84	0.0055	0.4034

[21] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31991L0271&from=EN

YEAR	DOMESTIC WW DISCHARGED [th. m^3]	POPULATION USING DRY TOILETS [inhab]	NMVOC [kt]	NH_3 [kt]
2012	337 545.00	246 164.10	0.0051	0.3939
2013	400 954.00	196 245.18	0.0060	0.3140
2014	377 445.00	156 568.30	0.0057	0.2505
2015	362 142.00	147 745.40	0.0054	0.2364
2016	385 463.00	100 234.50	0.0058	0.1604
2017	382 392.00	42 356.11	0.0057	0.0678
2018	369 599.00	21 807.43	0.0055	0.0349
2019	381 036.00	8 254.66	0.0057	0.0132
2020	404 305.00	6 032.49	0.0061	0.0097
2021	400 700.00	5 441.99	0.0060	0.0087
1990/2021	**8%**	**-99%**	**8%**	**-99%**
2020/2021	**-1%**	**-10%**	**-1%**	**-10%**

As shown in ***Table 6.36***, 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_{2019} (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_{2019} were applied for other pollutants. Also, data from the NEIS database for the incineration of residual gases were included in the calculation.

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 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 6.37***.

[22] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2010/363/20100915.html

Table 6.37: *Historical emission factors for biogas incineration in the category of Domestic wastewater handling*

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	0.01	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_{2019} (***Table 6.38***).

Table 6.38: *Emission factors for wastewater treatment in the category of Domestic wastewater handling*

POLLUTANT	NMVOC	NH_3
Unit	[mg/m^3[	[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

Following ***Recommendation No SK-5D1-2022-0001***, the origin of emission factors for PM was researched. An inconsistency between the EF in the NEIS Database and Decree no 363/20210 was identified. Emissions factors were therefore changed to comply with the legislation which led to recalculations of PM emissions (***Table 6.39***).

Table 6.39*: Previous and revised activity data in the category of Domestic wastewater treatment*

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	0.0009	0.0009	-2%	0.0009	0.0009	-2%
1991	0.0008	0.0008	-2%	0.0008	0.0008	-2%
1992	0.0010	0.0009	-2%	0.0010	0.0009	-2%
1993	0.0009	0.0009	-2%	0.0009	0.0009	-2%
1994	0.0010	0.0009	-2%	0.0010	0.0009	-2%
1995	0.0010	0.0010	-2%	0.0010	0.0010	-2%
1996	0.0011	0.0011	-2%	0.0011	0.0011	-2%
1997	0.0011	0.0011	-2%	0.0011	0.0011	-2%
1998	0.0011	0.0011	-2%	0.0011	0.0011	-2%
1999	0.0011	0.0010	-2%	0.0011	0.0010	-2%
2000	0.0001	0.0001	-2%	0.0001	0.0001	-2%
2001	0.0006	0.0006	-2%	0.0006	0.0006	-2%
2002	0.0005	0.0005	-2%	0.0005	0.0005	-2%
2003	0.0008	0.0008	-2%	0.0008	0.0008	-2%
2004	0.0030	0.0029	-2%	0.0030	0.0029	-1%
2005	0.0005	0.0004	-2%	0.0005	0.0004	-1%
2006	0.0007	0.0007	-2%	0.0007	0.0007	-1%
2007	0.0004	0.0004	-2%	0.0004	0.0004	-1%
2008	0.0005	0.0005	-2%	0.0005	0.0005	-2%
2009	0.0006	0.0006	-2%	0.0006	0.0006	-1%
2010	0.0007	0.0006	-2%	0.0007	0.0007	-1%
2011	0.0008	0.0007	-2%	0.0008	0.0007	-1%

YEAR	$PM_{2.5}$ [kt]			PM_{10} [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
2012	0.0004	0.0004	-2%	0.0004	0.0004	-2%
2013	0.0006	0.0006	-2%	0.0006	0.0006	-1%
2014	0.0008	0.0008	-2%	0.0008	0.0008	-1%
2015	0.0011	0.0011	-2%	0.0011	0.0011	-1%
2016	0.0005	0.0004	-2%	0.0005	0.0004	-2%
2017	0.0004	0.0004	-2%	0.0004	0.0004	-1%
2018	0.0004	0.0004	-2%	0.0004	0.0004	-1%
2019	0.0005	0.0005	2%	0.0005	0.0005	2%
2020	0.0005	0.0005	-2%	0.0005	0.0005	-1%

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 1990–2021. 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 6.40: *Overview of emissions and trends in the category of Industrial wastewater handling*

YEAR	INDUSTRIAL WASTEWATER DISCHARGED [th.m^3]	NOx [kt]	NMVOC BIOGAS COMB. [kt]	NMVOC WATER TREAT. [kt]	SOx [kt]	NH_3 [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	191 163.24	0.0029	0.8627	2.8674	0.0001	0.0034	0.0049	0.0049	0.0050	0.0039
1995	207 824.90	0.0032	0.9379	3.1174	0.0001	0.0037	0.0053	0.0053	0.0054	0.0042
2000	230 852.15	0.0009	1.6014	3.4628	0.0000	0.0041	0.0043	0.0043	0.0044	0.0047
2005	212 633.64	0.0002	0.6696	3.1895	0.0001	0.0036	0.0000	0.0000	0.0000	0.0001
2010	230 670.00	0.0001	0.0955	3.4601	0.0000	0.0029	0.0000	0.0000	0.0000	0.0000
2011	198 242.00	0.0000	0.0254	2.9736	0.0000	0.0026	0.0000	0.0000	0.0000	0.0000
2012	190 699.00	0.0000	0.0266	2.8605	0.0000	0.0028	0.0000	0.0000	0.0000	0.0000
2013	202 692.00	0.0000	0.0796	3.0404	0.0000	0.0029	0.0001	0.0001	0.0001	0.0000
2014	189 387.00	0.0000	0.0114	2.8408	0.0000	0.0028	0.0000	0.0000	0.0000	0.0000
2015	188 578.00	0.0000	0.0118	2.8287	0.0000	0.0032	0.0000	0.0000	0.0000	0.0000
2016	189 571.00	0.0000	0.0441	2.8436	0.0001	0.0072	0.0000	0.0000	0.0000	0.0000
2017	187 218.00	0.0000	0.0436	2.8083	0.0000	0.0069	0.0000	0.0000	0.0000	0.0000
2018	186 178.00	0.0000	0.0415	2.7927	0.0000	0.0067	0.0000	0.0000	0.0000	0.0000
2019	189 901.00	0.0000	0.0434	2.8485	0.0001	0.0072	0.0000	0.0000	0.0000	0.0000
2020	190 970.00	0.0001	0.0437	2.8646	0.0001	0.0070	0.0000	0.0000	0.0000	0.0000
2021	194 804.00	0.0008	0.0431	2.9221	0.0006	0.0076	0.0000	0.0000	0.0000	0.0000
1990/2021	**2%**	**-72%**	**-95%**	**2%**	**786%**	**124%**	**-99%**	**-99%**	**-99%**	**-99%**
2020/2021	**2%**	**1207%**	**-2%**	**2%**	**845%**	**8%**	**659%**	**659%**	**659%**	**79%**

In ***Table 6.40***, 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_{2019} was used and its value is **15mg/m^3**.

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 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 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 6.41***.

Table 6.41: *Historical emission factors for biogas incineration in the category of Industrial wastewater handling*

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	0.00	0.02	98.4%	98.5%	0.03	0.02

6.7.3.3 Completeness

NH_3 and PMs are reported as NE due to the change of approach used to calculate emissions and the absence of emission factors in EMEP/EEA GB_{2019}.

6.7.3.4 Source-specific recalculations

Following ***Recommendation No SK-5D2-2022-0003***, the origin of emission factors for PM was researched. An inconsistency between the EF in the NEIS Database and Decree no 363/20210 was identified. Emissions factors were therefore changed to comply with the legislation which led to recalculations of PM emissions. Also, due to the correction of the conversion factor, emissions of NMVOC were recalculated (***Recommendation No SK-5D2-2022-0004***). The results of the changes are presented in ***Table 6.42***.

Table 6.42: *Previous and revised NMVOC emissions in the category of Industrial wastewater treatment*

YEAR	NMVOC [kt]			$PM_{2.5}$ [kt]			PM_{10} [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1990	3.7301	0.8655	-77%	0.0050	0.0049	-2%	0.0050	0.0049	-1%
1991	3.3700	0.7820	-77%	0.0045	0.0044	-2%	0.0045	0.0044	-1%
1992	3.9666	0.9204	-77%	0.0053	0.0052	-2%	0.0053	0.0052	-1%
1993	3.7086	0.8605	-77%	0.0049	0.0049	-2%	0.0049	0.0049	-1%
1994	3.9827	0.9241	-77%	0.0053	0.0052	-2%	0.0053	0.0052	-1%
1995	4.0552	0.9410	-77%	0.0054	0.0053	-2%	0.0054	0.0053	-1%
1996	4.7287	1.0973	-77%	0.0063	0.0062	-2%	0.0063	0.0062	-1%

[23] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2010/363/20100915.html

YEAR	NMVOC [kt]			$PM_{2.5}$ [kt]			PM_{10} [kt]		
	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE	PREVIOUS	REVISED	CHANGE
1997	4.6469	1.0783	-77%	0.0062	0.0061	-2%	0.0062	0.0061	-1%
1998	4.5250	1.0500	-77%	0.0060	0.0059	-2%	0.0060	0.0059	-1%
1999	4.4189	1.0254	-77%	0.0059	0.0058	-2%	0.0059	0.0058	-1%
2000	5.0642	1.6048	-68%	0.0044	0.0043	-2%	0.0044	0.0043	-1%
2001	4.3712	1.0469	-76%	0.0192	0.0189	-2%	0.0192	0.0189	-1%
2002	4.2214	1.0522	-75%	0.0024	0.0023	-2%	0.0024	0.0023	-1%
2003	3.7679	0.7169	-81%	0.0019	0.0019	-2%	0.0019	0.0019	-1%
2004	3.8180	0.7628	-80%	0.0000	0.0000	-2%	0.0000	0.0000	-1%
2005	3.8591	0.6728	-83%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2006	3.4978	0.3996	-89%	0.0002	0.0002	-2%	0.0002	0.0002	-2%
2007	3.2587	0.2627	-92%	0.0001	0.0001	-2%	0.0001	0.0001	-1%
2008	3.2559	0.3178	-90%	0.0001	0.0001	-2%	0.0001	0.0001	-2%
2009	3.2444	0.0991	-97%	0.0001	0.0001	-2%	0.0001	0.0001	-2%
2010	3.5556	0.0990	-97%	0.0000	0.0000	-2%	0.0000	0.0000	-1%
2011	2.9991	0.0284	-99%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2012	2.8871	0.0295	-99%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2013	3.1200	0.0826	-97%	0.0001	0.0001	-2%	0.0001	0.0001	-2%
2014	2.8522	0.0143	-99%	0.0000	0.0000	-2%	0.0000	0.0000	-1%
2015	2.8405	0.0146	-99%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2016	2.8876	0.0469	-98%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2017	2.8519	0.0464	-98%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2018	2.8342	0.0443	-98%	0.0000	0.0000	-2%	0.0000	0.0000	-2%
2019	2.8919	0.0462	-98%	0.0000	0.0000	19%	0.0000	0.0000	19%
2020	2.9083	0.0466	-98%	0.0000	0.0000	-2%	0.0000	0.0000	-2%

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 6.43*** and ***Table 6.44*** overview of statistical activity data and emission trends are displayed.

Table 6.43*: 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
1990/2021	**-2%**	**-54%**	**53%**	**-27%**	**-16%**
2020/2021	**-17%**	**-56%**	**7%**	**-10%**	**-2%**

***Table 6.44:** 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
1990/2021	**34%**	**28%**	**28%**	**28%**	**28%**	**28%**	**28%**	**28%**	**28%**	**28%**
2020/2021	**5%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**

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 6.43***). Emissions from fires were calculated by multiplying activity data (number of fires) with emission factors from EMEP/EEA GB_{2019} (***Table 6.45***). Historical data (1990-1998) were extrapolated.

***Table 6.45:** 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: 15.3.2023

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	0.2819	0.1160	0.0088	0.0100	1.2084	1.4769	2.2825	0.1088	10.0561
1995	0.1968	0.0352	0.0027	0.0030	0.8988	1.0985	1.6978	0.0809	7.0204
2000	0.6892	0.4636	0.0352	0.0399	2.5277	3.0894	4.7745	0.2275	24.5811
2005	0.6701	0.2640	0.0201	0.0227	2.7482	3.3590	5.1911	0.2473	23.9004
2010	0.5112	0.0960	0.0073	0.0083	2.2820	2.7891	4.3105	0.2054	18.2343
2011	0.6138	0.2013	0.0153	0.0173	2.5639	3.1336	4.8429	0.2307	21.8906
2012	1.1732	0.8417	0.0640	0.0724	3.9580	4.8376	7.4763	0.3562	41.8448
2013	0.3890	0.1351	0.0103	0.0116	1.6043	1.9609	3.0304	0.1444	13.8755
2014	0.5774	0.0959	0.0073	0.0082	2.5966	3.1736	4.9047	0.2337	20.5945
2015	0.6483	0.1763	0.0134	0.0152	2.7729	3.3890	5.2376	0.2496	23.1228
2016	0.5359	0.0874	0.0066	0.0075	2.4115	2.9474	4.5550	0.2170	19.1125
2017	0.5952	0.1488	0.0113	0.0128	2.5707	3.1420	4.8558	0.2314	21.2289

[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]
2018	0.5875	0.1242	0.0094	0.0107	2.5841	3.1583	4.8810	0.2326	20.9524
2019	0.6883	0.2311	0.0176	0.0199	2.8467	3.4793	5.3771	0.2562	24.5492
2020	0.6225	0.2363	0.0180	0.0203	2.5166	3.0758	4.7536	0.2265	22.2010
2021	0.4511	0.0795	0.0060	0.0068	2.0152	2.4630	3.8065	0.1814	16.0882
1990/2021	**60%**	**-31%**	**-31%**	**-31%**	**67%**	**67%**	**67%**	**67%**	**60%**
2020/2021	**-28%**	**-66%**	**-66%**	**-66%**	**-20%**	**-20%**	**-20%**	**-20%**	**-28%**

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	0.6713	0.0403	0.0537	0.0228	0.0154	0.1322	0.0118	0.0806
1995	0.4993	0.0300	0.0399	0.0170	0.0115	0.0984	0.0088	0.0599
2000	1.4043	0.0843	0.1123	0.0477	0.0323	0.2766	0.0247	0.1685
2005	1.5268	0.0916	0.1221	0.0519	0.0351	0.3008	0.0269	0.1832
2010	1.2678	0.0761	0.1014	0.0431	0.0292	0.2498	0.0223	0.1521
2011	1.4244	0.0855	0.1140	0.0484	0.0328	0.2806	0.0251	0.1709
2012	2.1989	0.1319	0.1759	0.0748	0.0506	0.4332	0.0387	0.2639
2013	0.8913	0.0535	0.0713	0.0303	0.0205	0.1756	0.0157	0.1070
2014	1.4426	0.0866	0.1154	0.0490	0.0332	0.2842	0.0254	0.1731
2015	1.5405	0.0924	0.1232	0.0524	0.0354	0.3035	0.0271	0.1849
2016	1.3397	0.0804	0.1072	0.0456	0.0308	0.2639	0.0236	0.1608
2017	1.4282	0.0857	0.1143	0.0486	0.0328	0.2813	0.0251	0.1714
2018	1.4356	0.0861	0.1148	0.0488	0.0330	0.2828	0.0253	0.1723
2019	1.5815	0.0949	0.1265	0.0538	0.0364	0.3116	0.0278	0.1898
2020	1.3981	0.0839	0.1118	0.0475	0.0322	0.2754	0.0246	0.1678
2021	1.1196	0.0672	0.0896	0.0381	0.0257	0.2206	0.0197	0.1343
1990/2021	**67%**	**67%**	**67%**	**67%**	**67%**	**67%**	**67%**	**67%**
2020/2021	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**

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, compilation team. Activity data for the period 1990-2001 were changed in comparison with the last submission due to consistency with GHGs inventory. Tier 2 emissions factors for temperate forests from EMEP/EEA GB_{2019} were used to calculate emissions of main pollutants and particulate matter from this category. To maintain consistency with GHGs 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	26.51	95.28	121.79
1995	70.42	9.00	81.70	90.70
2000	232.00	29.21	105.05	134.26
2005	70.42	9.92	89.95	99.87
2010	927.25	147.73	133.12	280.85
2011	527.96	90.26	215.10	305.36
2012	191.96	34.88	218.68	253.56

YEAR	AREA AFFECTED BY WILDFIRES [ha]	BIOMASS BURNED BY WILDFIRES [kt]	BIOMASS BURNED BY CONTROLLED FIRES [kt]	TOTAL BIOMASS BURNED [kt]
2013	402.55	73.82	211.05	284.88
2014	1683.46	312.61	127.17	439.78
2015	270.26	50.58	127.68	178.26
2016	191.73	35.90	252.62	288.51
2017	352.57	66.25	241.85	308.09
2018	174.88	33.01	234.93	267.94
2019	297.66	56.28	229.36	285.63
2020	248.38	47.02	240.10	287.12
2021	462.17	88.00	228.30	316.30
1990/2021	**472.68**	**90.10**	**189.53**	**279.62**
2020/2021	**158.94**	**30.45**	**193.47**	**223.91**

Table 7.3: *Emission factors in the category of Forest fires*

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

Recalculation in this submission was made due to the recalculation of activity data for the amount of biomass burned (***Table 7.4***).

Table 7.4: *Previous and revised activity data and emissions in the category of Forest fires*

YEAR	NOx [kt]		$PM_{2.5}$ [kt]		PM_{10} [kt]		CHANGE
	PREVIOUS	REVISED	PREVIOUS	REVISED	PREVIOUS	REVISED	
1990	0.2557	0.2819	1.0961	1.2084	1.3397	1.4769	10%
1991	0.2114	0.2331	0.8945	0.9863	1.0933	1.2054	10%
1992	0.2929	0.3229	1.1193	1.2329	1.3681	1.5068	10%
1993	0.5472	0.6029	1.9026	2.0939	2.3254	2.5592	10%
1994	0.1493	0.1645	0.6973	0.7679	0.8523	0.9385	10%
1995	0.1787	0.1968	0.8163	0.8988	0.9977	1.0985	10%
1996	0.2483	0.2734	1.0502	1.1557	1.2835	1.4125	10%
1997	0.1937	0.2131	0.9120	1.0033	1.1147	1.2262	10%
1998	0.1900	0.2093	0.8960	0.9870	1.0952	1.2064	10%
1999	1.2383	1.3644	4.1189	4.5351	5.0343	5.5429	10%
2000	0.6253	0.6892	2.2937	2.5277	2.8034	3.0894	10%
2001	0.2908	0.3208	1.2796	1.4117	1.5640	1.7254	10%
2002	0.4859	0.5356	1.8653	2.0560	2.2798	2.5128	10%
2003	0.9468	1.0434	3.2902	3.6250	4.0213	4.4305	10%
2004	0.3291	0.3627	1.4762	1.6272	1.8043	1.9888	10%

YEAR	NOx [kt]		$PM_{2.5}$ [kt]		PM_{10} [kt]		CHANGE
	PREVIOUS	REVISED	PREVIOUS	REVISED	PREVIOUS	REVISED	
2005	0.6092	0.6701	2.4997	2.7482	3.0552	3.3590	10%
2006	0.3850	0.4240	1.7088	1.8814	2.0886	2.2994	10%
2007	0.6332	0.6971	2.4718	2.7204	3.0211	3.3250	10%
2008	0.3982	0.4377	1.8226	2.0030	2.2276	2.4481	10%
2009	0.5870	0.6457	2.3826	2.6198	2.9121	3.2020	10%
2010	0.4647	0.5112	2.0746	2.2820	2.5356	2.7891	10%
2011	0.5572	0.6138	2.3280	2.5639	2.8454	3.1336	10%
2012	1.0635	1.1732	3.5870	3.9580	4.3841	4.8376	10%
2013	0.3520	0.3890	1.4510	1.6043	1.7735	1.9609	11%
2014	0.5241	0.5774	2.3570	2.5966	2.8808	3.1736	10%
2015	0.5881	0.6483	2.5157	2.7729	3.0748	3.3890	10%
2016	0.4865	0.5359	2.1896	2.4115	2.6762	2.9474	10%
2017	0.5406	0.5952	2.3357	2.5707	2.8547	3.1420	10%
2018	0.5339	0.5875	2.3490	2.5841	2.8710	3.1583	10%
2019	0.6251	0.6883	2.5862	2.8467	3.1609	3.4793	10%
2020	0.5648	0.6225	2.2839	2.5166	2.7914	3.0758	10%

YEAR	TSP [kt]		BC [kt]		CO [lt]		CHANGE
	PREVIOUS	REVISED	PREVIOUS	REVISED	PREVIOUS	REVISED	
1990	2.0705	2.2825	0.0987	0.1088	9.1193	10.0561	10%
1991	1.6896	1.8630	0.0805	0.0888	7.5393	8.3155	10%
1992	2.1143	2.3287	0.1007	0.1110	10.4476	11.5156	10%
1993	3.5937	3.9551	0.1712	0.1884	19.5172	21.5050	10%
1994	1.3172	1.4505	0.0628	0.0691	5.3257	5.8654	10%
1995	1.5419	1.6978	0.0735	0.0809	6.3750	7.0204	10%
1996	1.9837	2.1829	0.0945	0.1040	8.8559	9.7495	10%
1997	1.7227	1.8951	0.0821	0.0903	6.9071	7.5989	10%
1998	1.6925	1.8644	0.0806	0.0888	6.7769	7.4655	10%
1999	7.7802	8.5662	0.3707	0.4082	44.1668	48.6625	10%
2000	4.3325	4.7745	0.2064	0.2275	22.3018	24.5811	10%
2001	2.4171	2.6665	0.1152	0.1271	10.3706	11.4402	10%
2002	3.5233	3.8835	0.1679	0.1850	17.3299	19.1032	10%
2003	6.2148	6.8471	0.2961	0.3262	33.7680	37.2131	10%
2004	2.7884	3.0735	0.1329	0.1464	11.7368	12.9374	10%
2005	4.7217	5.1911	0.2250	0.2473	21.7293	23.9004	10%
2006	3.2278	3.5537	0.1538	0.1693	13.7329	15.1211	10%
2007	4.6689	5.1386	0.2225	0.2448	22.5833	24.8635	10%
2008	3.4427	3.7834	0.1640	0.1803	14.2034	15.6118	10%
2009	4.5006	4.9486	0.2144	0.2358	20.9366	23.0307	10%
2010	3.9187	4.3105	0.1867	0.2054	16.5741	18.2343	10%
2011	4.3974	4.8429	0.2095	0.2307	19.8739	21.8906	10%
2012	6.7754	7.4763	0.3228	0.3562	37.9306	41.8448	10%
2013	2.7408	3.0304	0.1306	0.1444	12.5542	13.8755	11%
2014	4.4521	4.9047	0.2121	0.2337	18.6924	20.5945	10%
2015	4.7520	5.2376	0.2264	0.2496	20.9769	23.1228	10%
2016	4.1360	4.5550	0.1971	0.2170	17.3522	19.1125	10%
2017	4.4118	4.8558	0.2102	0.2314	19.2831	21.2289	10%
2018	4.4370	4.8810	0.2114	0.2326	19.0413	20.9524	10%
2019	4.8850	5.3771	0.2328	0.2562	22.2945	24.5492	10%

YEAR	TSP [kt]		BC [kt]		CO [lt]		CHANGE
	PREVIOUS	REVISED	PREVIOUS	REVISED	PREVIOUS	REVISED	
2020	4.3140	4.7536	0.2055	0.2265	20.1432	22.2010	10%

YEAR	PCDD/F [g I-TEQ]		PAHs [t]		HCB [kg]		PCB [kg]		CHANGE
	P	R	P	R	P	R	P	R	
1990	0.6090	0.6713	0.1200	0.1322	0.0107	0.0118	0.0731	0.0806	10%
1991	0.4969	0.5479	0.0979	0.1079	0.0087	0.0096	0.0596	0.0658	10%
1992	0.6218	0.6849	0.1225	0.1349	0.0109	0.0121	0.0746	0.0822	10%
1993	1.0570	1.1633	0.2082	0.2292	0.0186	0.0205	0.1268	0.1396	10%
1994	0.3874	0.4266	0.0763	0.0840	0.0068	0.0075	0.0465	0.0512	10%
1995	0.4535	0.4993	0.0893	0.0984	0.0080	0.0088	0.0544	0.0599	10%
1996	0.5834	0.6420	0.1149	0.1265	0.0103	0.0113	0.0700	0.0770	10%
1997	0.5067	0.5574	0.0998	0.1098	0.0089	0.0098	0.0608	0.0669	10%
1998	0.4978	0.5484	0.0981	0.1080	0.0088	0.0097	0.0597	0.0658	10%
1999	2.2883	2.5195	0.4508	0.4963	0.0403	0.0443	0.2746	0.3023	10%
2000	1.2743	1.4043	0.2510	0.2766	0.0224	0.0247	0.1529	0.1685	10%
2001	0.7109	0.7843	0.1400	0.1545	0.0125	0.0138	0.0853	0.0941	10%
2002	1.0363	1.1422	0.2041	0.2250	0.0182	0.0201	0.1244	0.1371	10%
2003	1.8279	2.0139	0.3601	0.3967	0.0322	0.0354	0.2193	0.2417	10%
2004	0.8201	0.9040	0.1616	0.1781	0.0144	0.0159	0.0984	0.1085	10%
2005	1.3887	1.5268	0.2736	0.3008	0.0244	0.0269	0.1666	0.1832	10%
2006	0.9494	1.0452	0.1870	0.2059	0.0167	0.0184	0.1139	0.1254	10%
2007	1.3732	1.5113	0.2705	0.2977	0.0242	0.0266	0.1648	0.1814	10%
2008	1.0126	1.1128	0.1995	0.2192	0.0178	0.0196	0.1215	0.1335	10%
2009	1.3237	1.4555	0.2608	0.2867	0.0233	0.0256	0.1588	0.1747	10%
2010	1.1526	1.2678	0.2271	0.2498	0.0203	0.0223	0.1383	0.1521	10%
2011	1.2934	1.4244	0.2548	0.2806	0.0228	0.0251	0.1552	0.1709	10%
2012	1.9928	2.1989	0.3926	0.4332	0.0351	0.0387	0.2391	0.2639	10%
2013	0.8061	0.8913	0.1588	0.1756	0.0142	0.0157	0.0967	0.1070	11%
2014	1.3094	1.4426	0.2580	0.2842	0.0230	0.0254	0.1571	0.1731	10%
2015	1.3976	1.5405	0.2753	0.3035	0.0246	0.0271	0.1677	0.1849	10%
2016	1.2165	1.3397	0.2396	0.2639	0.0214	0.0236	0.1460	0.1608	10%
2017	1.2976	1.4282	0.2556	0.2813	0.0228	0.0251	0.1557	0.1714	10%
2018	0.0013	1.4356	0.2571	0.2828	0.0230	0.0253	0.1566	0.1723	10%
2019	1.4368	1.5815	0.2830	0.3116	0.0253	0.0278	0.1724	0.1898	10%
2020	0.0013	1.3981	0.2500	0.2754	0.0223	0.0246	0.1523	0.1678	10%

P-Previous, R-Revised

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: 15.3.2023

8.1 OVERVIEW BY GASES

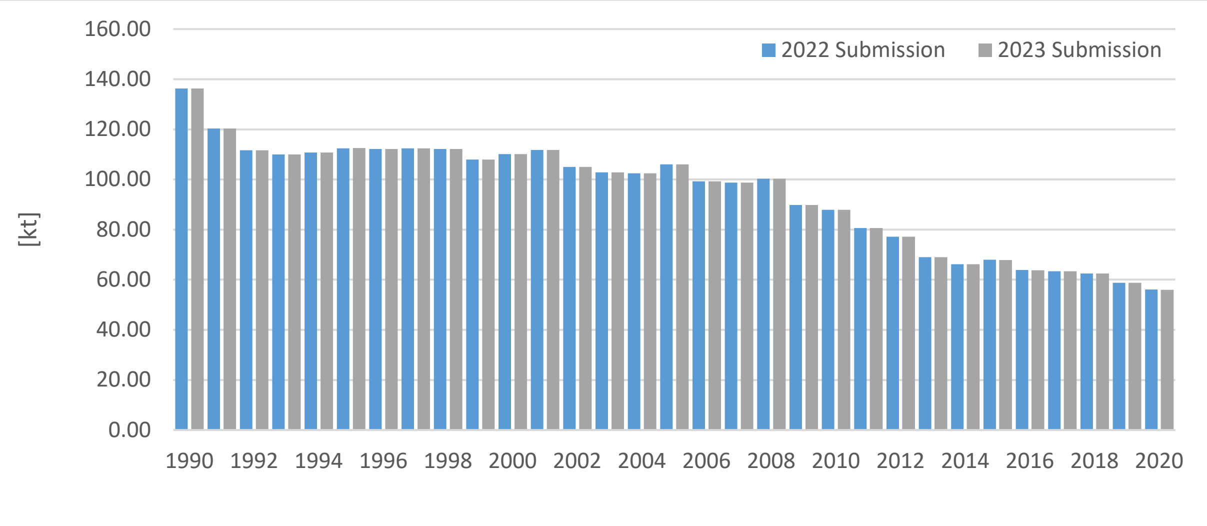
Sector specific-recalculations are described within each of the relevant chapters. These chapters should be referred to for details of recalculations and method changes. This chapter summarises the impact of these changes on the emissions totals of final versions of the submissions and highlights the largest changes for each pollutant.

8.1.1 NOx (as NO_2)

The impact of recalculations on NOx emission total in this submission is shown in ***Figure 8.1***.

Minor changes in the period 1990-1999 were caused by the update of IEF calculation for historical years for category **2C1** and in the period 2014-2020 by activity data recalculation in category **1A4bi**.

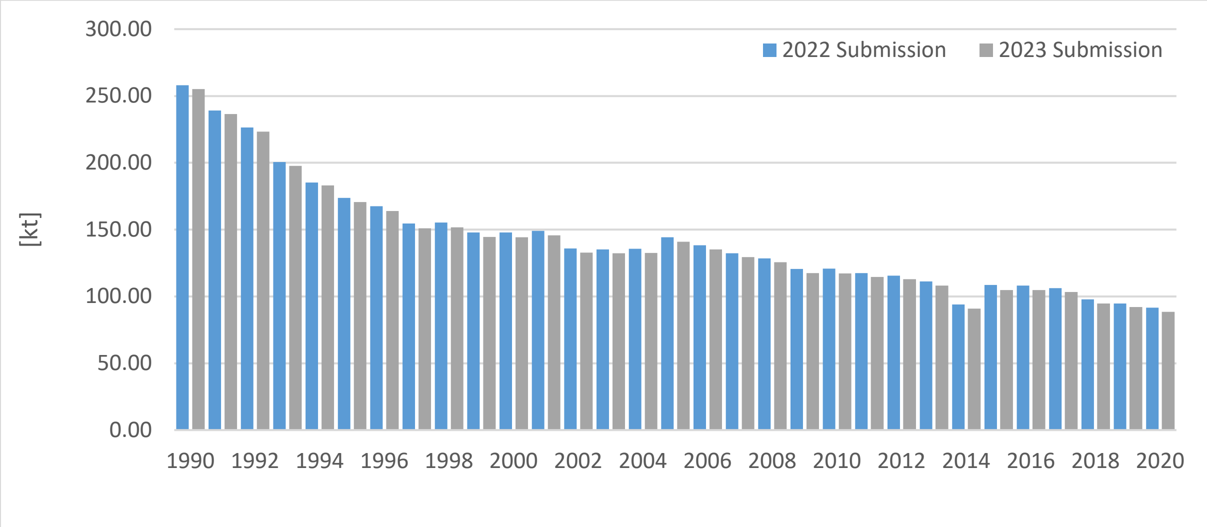
Figure 8.1: *Comparison of NOx emission total between 2022 final submission and 2023 final submission*



8.1.2 NMVOC

The slight decrease was caused by the correction of the conversion factor for the calculation of NMVOC from industrial wastewater treatment (***Figure 8.2***).

Figure 8.2: *Comparison of NMVOC emission total between 2022 final submission and 2023 final submission*

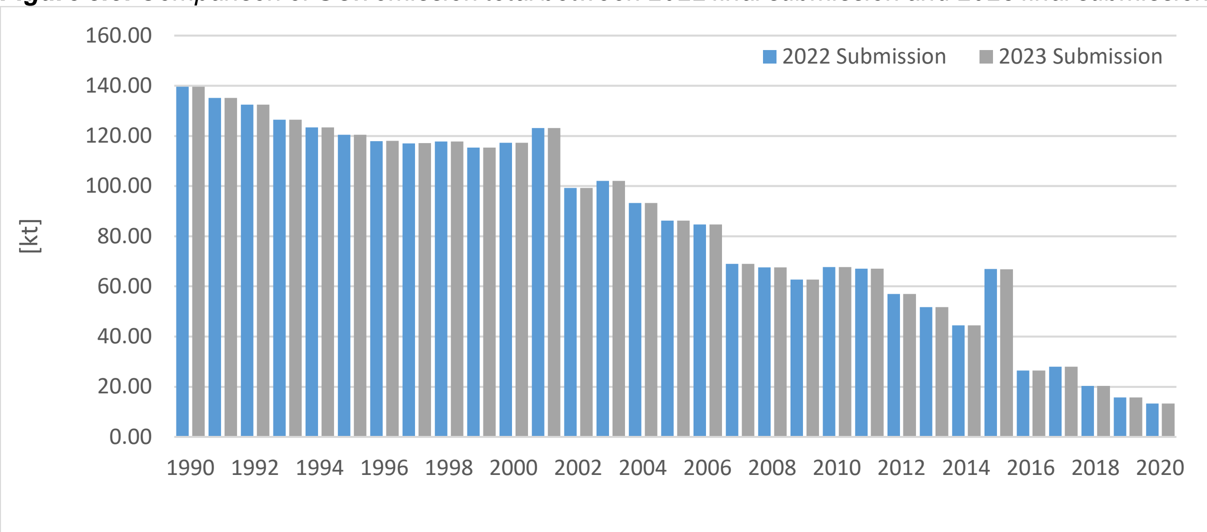


8.1.3 SOx (as SO_2)

The impact of recalculations on SOx emission total in this submission is shown in ***Figure 8.3***.

Minor changes in the period 1990-1999 were caused by the update of IEF calculation for historical years for category **2C1** and in the period 2014-2020 by activity data recalculation in category **1A4bi**.

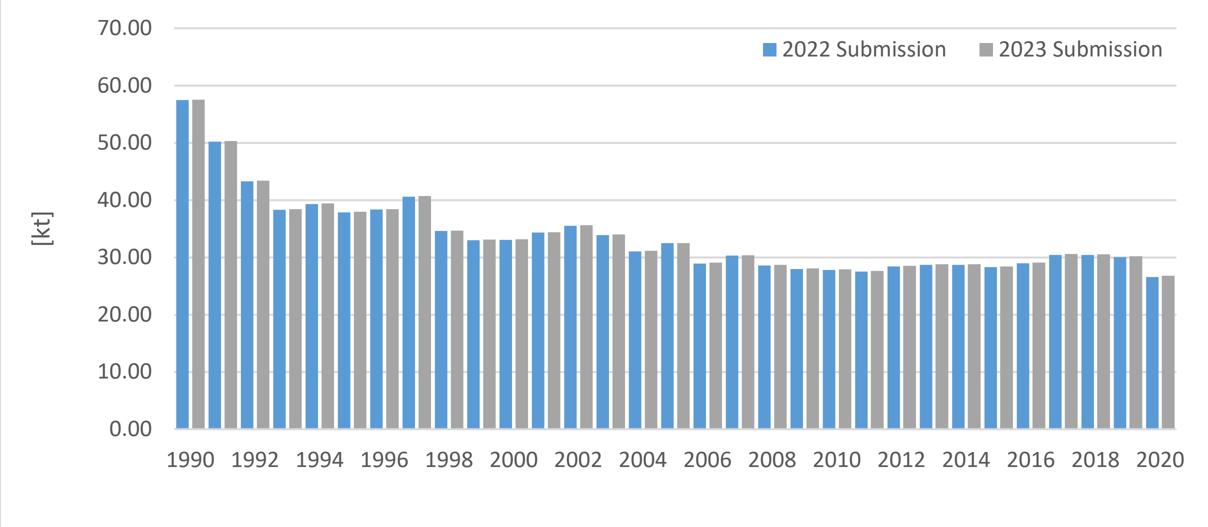
Figure 8.3: *Comparison of SOx emission total between 2022 final submission and 2023 final submission*



8.1.4 NH_3

Emissions increased slightly as a result of recalculation in category **5B1**. The wet weight of composted waste instead of the dry weight was used as activity data.

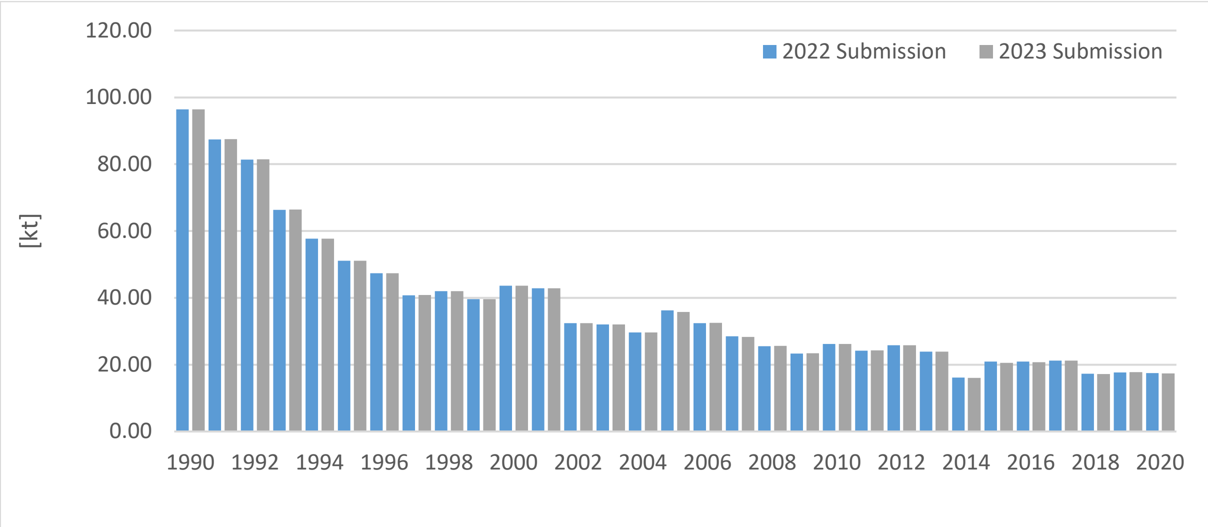
Figure 8.4: *Comparison of NH_3 emission total between 2022 final submission and 2023 final submission*



8.1.5 $PM_{2.5}$

A slight increase in emissions in the whole time series was caused by the implementation of the Tier 2 methodology for category **5A**. The decrease in 2005 and 2007 is the result of the correction of AD in the category **2G**. Slight changes in activity data for **1A4bi** resulted in decreases in 2015 and 2020. An overview of the changes is shown in ***Figure 8.5***.

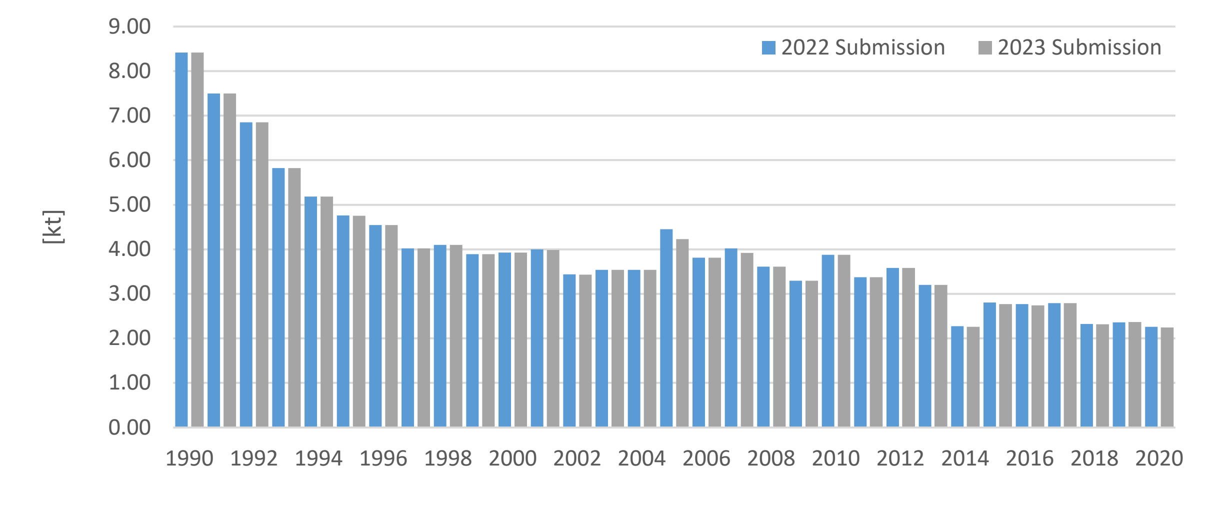
Figure 8.5: *Comparison of $PM_{2.5}$ emission total between 2022 final submission and 2023 final submission*



8.1.6 TSP, PM_{10}, BC

A slight increase in emissions in the whole time series was caused by the implementation of the Tier 2 methodology for category **5A**. The decrease in 2005 and 2007 is the result of the correction of AD in the category **2G**. Slight changes in activity data for **1A4bi** resulted in decreases in 2015 and 2020. An overview of the changes is shown in ***Figure 8.6***.

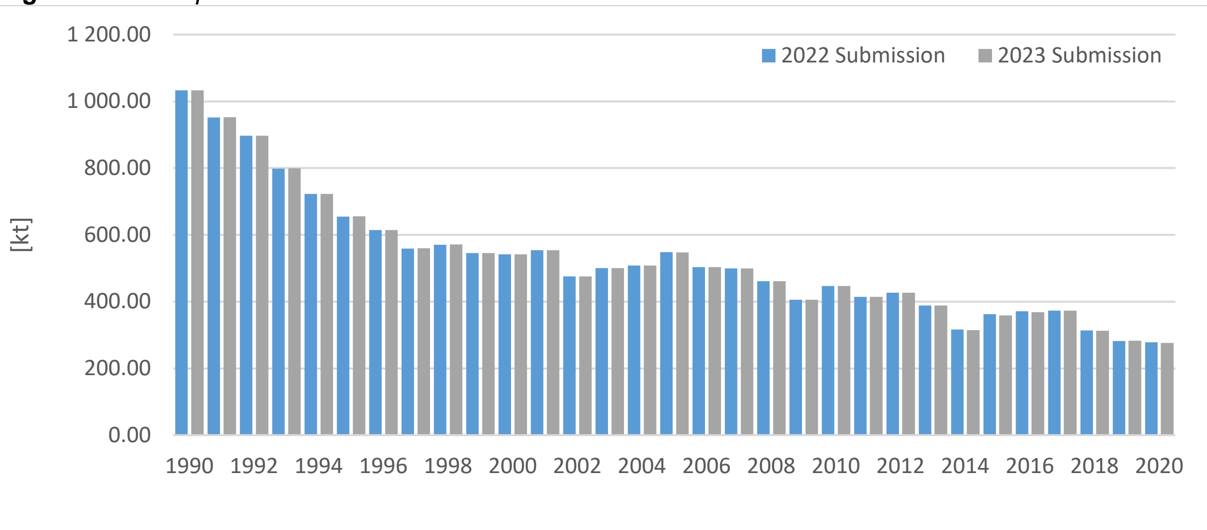
Figure 8.6: *Comparison of BC emission total between 2022 final submission and 2023 final submission*



8.1.7 CO

Minor changes in the period 1990-1999 were caused by the update of IEF calculation for historical years for category **2C1** and in the period 2014-2020 by activity data recalculation in the category ***1A4bi***. An overview of the changes is shown in ***Figure 8.7***.

Figure 8.7: *Comparison of CO emission total between 2022 final submission and 2023 final submission*



8.1.8 Priority heavy metals (Pb, Cd, Hg)

Emissions changed due to the improvement of methodology to the tier 2 level for the categories **1A2a, 1A2d** and **1A2gviii**, changes in activity data and correction of abatement efficiency in the category **1A1a**. (***Figure 8.8*** – ***Figure 8.10***).

Figure 8.8: *Comparison of Pb emission total between 2022 final submission and 2023 final submission*

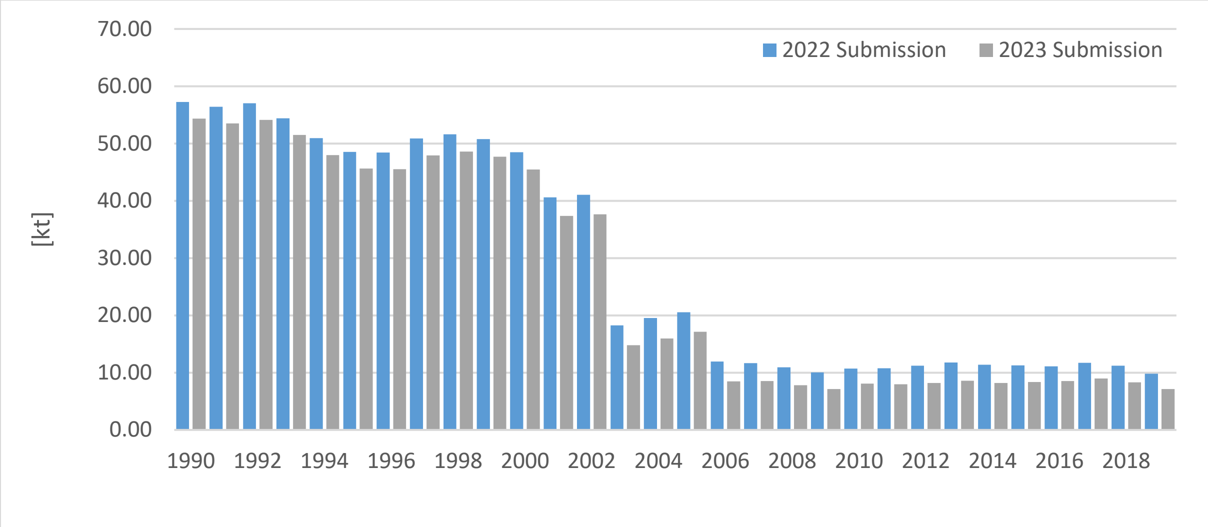


Figure 8.9: *Comparison of Cd emission total between 2022 final submission and 2023 final submission*

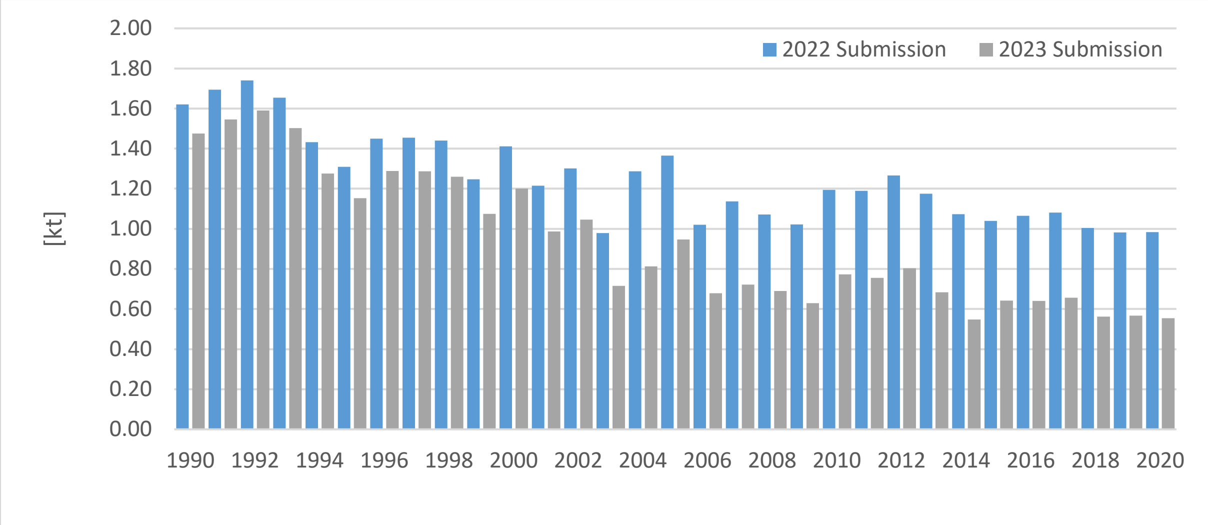
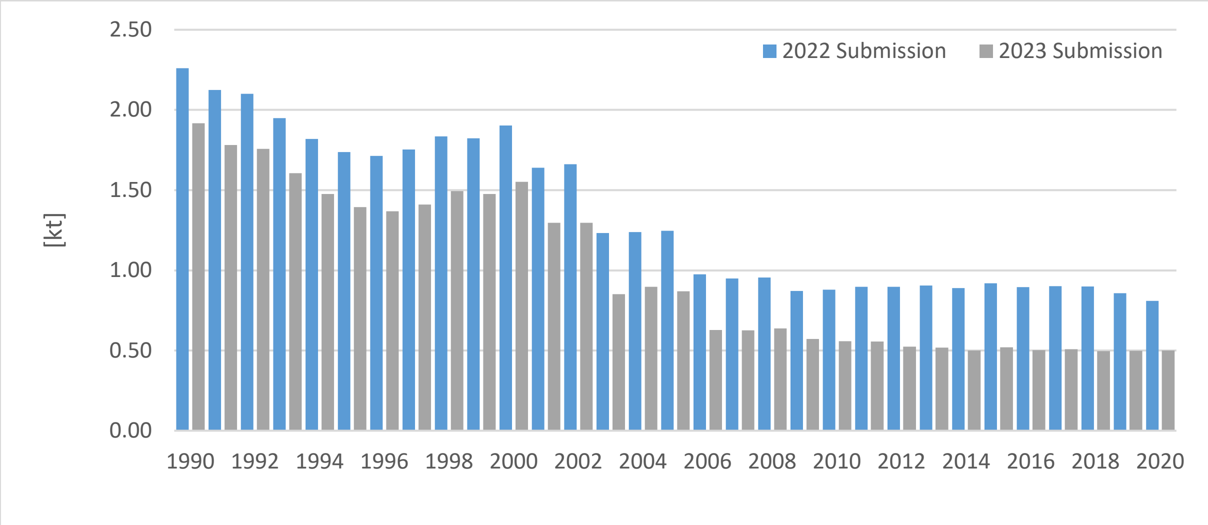


Figure 8.10: *Comparison of Hg emission total between 2022 final submission and 2023 final submission*



8.1.9 POPs

Emissions changed due to the improvement of methodology to the tier 2 level for the categories **1A2a, 1A2d** and **1A2gviii**, changes in activity data and correction of abatement efficiency in the category **1A1a**.

Figure 8.11: *Comparison of PCDD/F emission total between 2022 final submission and 2023 final submission*

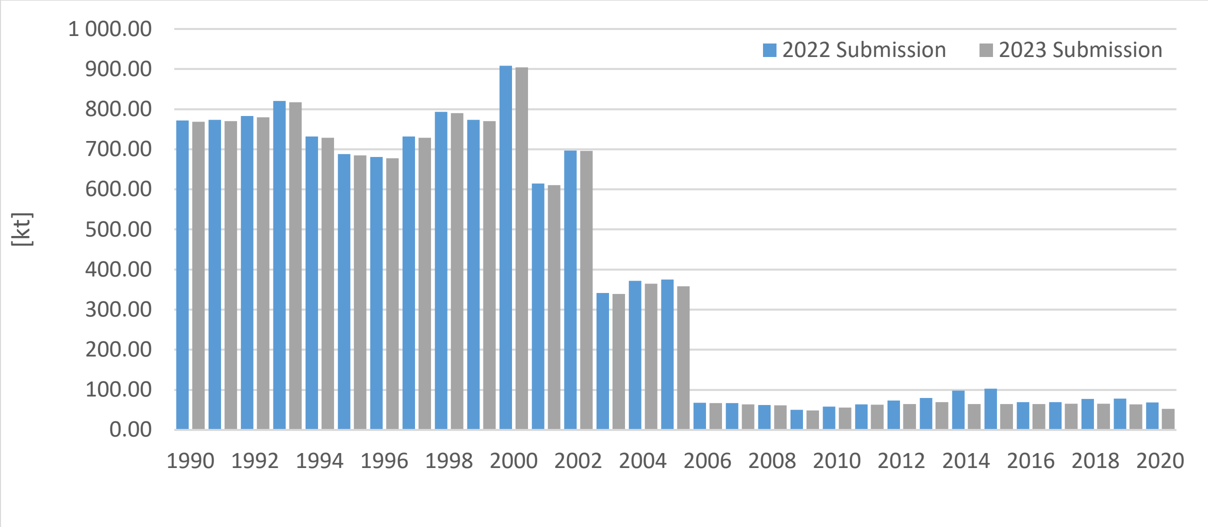


Figure 8.12: *Comparison of PAHs emission total between 2022 final submission and 2023 final submission*

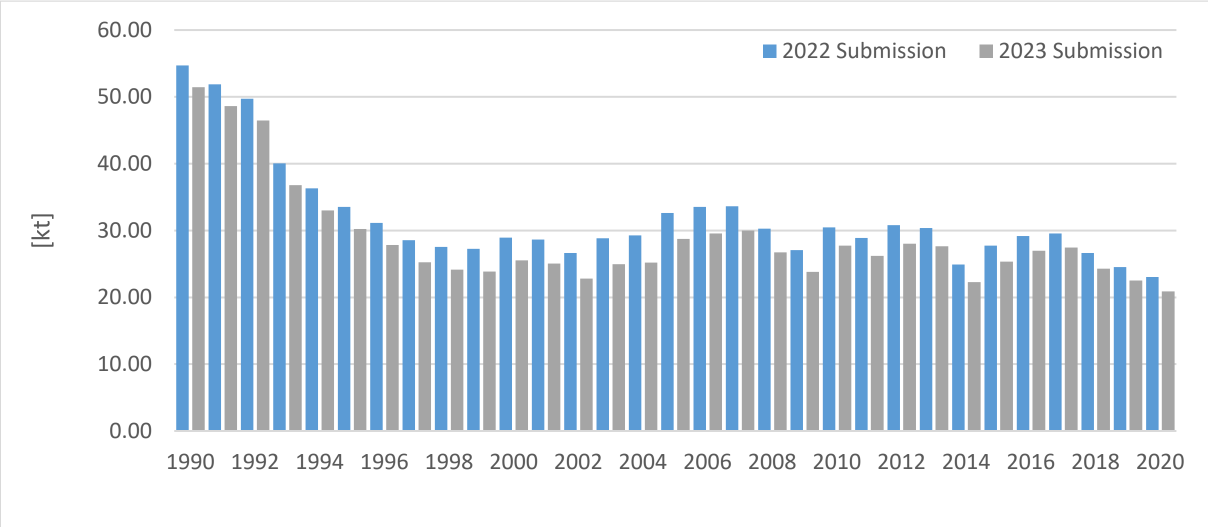


Figure 8.13: Comparison of HCB emission total between 2022 final submission and 2023 final submission

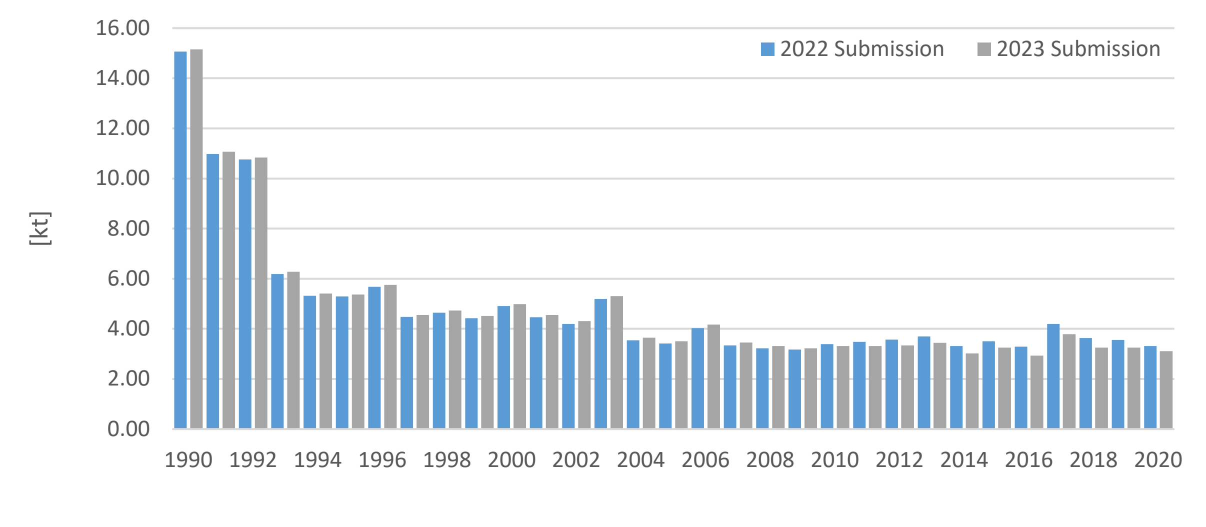
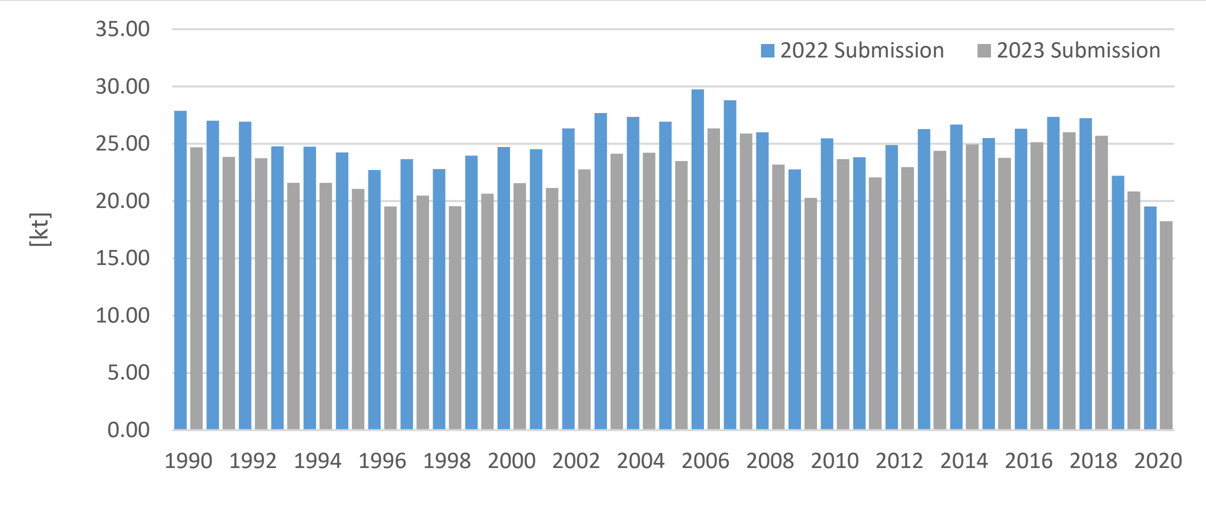


Figure 8.14: Comparison of PCBs emission total between 2022 final submission and 2023 final submission



8.2 RECALCULATIONS BETWEEN 1ST AND FINAL VERSION OF NATIONAL INVENTORY

Some calculation error corrections have occurred after submitting the first version of the inventory. These changes are shown in ***Table 8.15***.

Table 8.15: *Recalculations between 1st and final version of national inventory 2021 – main pollutants*

YEAR/POLLUTANT	2023_V1	2023_V2	CHANGE %
PM_{10}			
1990	107.9407	107.9407	-
1991	98.4371	98.4371	-
1992	91.8301	91.8301	-
1993	76.3737	76.3737	-
1994	67.8552	67.8552	0.00%
1995	61.2086	61.2086	-
1996	58.5845	58.5845	-
1997	50.7617	50.7617	-
1998	53.5834	53.5834	-
1999	49.7490	49.7490	-
2000	54.1738	54.1738	-
2001	53.2431	53.2431	-
2002	42.7995	42.7995	-
2003	41.8858	41.8858	-
2004	39.1618	39.1618	-
2005	44.8351	44.8351	-
2006	41.3193	41.3193	-
2007	36.3646	36.3646	-
2008	33.5585	33.5585	-
2009	31.0803	31.0803	-
2010	33.1920	33.1920	-
2011	30.9841	30.9841	-
2012	32.4308	32.4308	-
2013	30.5786	30.5786	-
2014	22.4106	22.4106	-
2015	28.5326	28.5326	-
2016	27.2082	27.2082	-
2017	28.0171	28.0171	-
2018	23.4197	23.4197	-
2019	24.0981	24.0981	-
2020	24.0238	24.0238	-
2021	24.7717	24.7717	-
TSP			
1990	135.6361	135.6361	-
1991	123.5578	123.5578	-
1992	114.5835	114.5835	-
1993	97.8144	97.8144	-
1994	88.2786	88.2786	0.00%
1995	80.6658	80.6658	-
1996	80.1452	80.1452	-
1997	68.8986	68.8986	-
1998	75.8081	75.8081	-
1999	68.1919	68.1919	-
2000	74.5461	74.5461	-
2001	73.2681	73.2681	-
2002	62.5757	62.5757	-
2003	59.5050	59.5050	-
2004	53.6685	53.6685	-

YEAR/POLLUTANT	2023_V1	2023_V2	CHANGE %
2005	61.2251	61.2251	-
2006	57.5300	57.5300	-
2007	47.8926	47.8926	-
2008	44.3278	44.3278	-
2009	41.2152	41.2152	-
2010	42.7080	42.7080	-
2011	40.0363	40.0363	-
2012	40.5829	40.5829	-
2013	39.5965	39.5965	-
2014	30.8121	30.8121	-
2015	40.8964	40.8964	-
2016	35.2634	35.2634	-
2017	37.4593	37.4593	-
2018	30.9141	30.9141	-
2019	30.9613	30.9613	-
2020	31.6783	31.6783	-
2021	31.9213	31.9213	-
BC			
1990	8.4188	8.4188	-
1991	7.4992	7.4992	-
1992	6.8488	6.8488	-
1993	5.8249	5.8249	-
1994	5.1867	5.1867	-
1995	4.7568	4.7568	-
1996	4.5423	4.5423	-
1997	4.0184	4.0184	-
1998	4.0989	4.0989	-
1999	3.8925	3.8925	-
2000	3.9291	3.9291	-
2001	3.9862	3.9862	-
2002	3.4289	3.4289	-
2003	3.5369	3.5369	-
2004	3.5362	3.5362	-
2005	4.2287	4.2287	-
2006	3.8151	3.8151	-
2007	3.9218	3.9218	-
2008	3.6075	3.6075	-
2009	3.2960	3.2960	-
2010	3.8771	3.8770	0.00%
2011	3.3721	3.3721	0.00%
2012	3.5801	3.5801	0.00%
2013	3.1989	3.1989	0.00%
2014	2.2588	2.2588	0.00%
2015	2.7700	2.7700	0.00%
2016	2.7439	2.7439	0.00%
2017	2.7947	2.7946	0.00%
2018	2.3169	2.3168	0.00%
2019	2.3669	2.3669	0.00%
2020	2.2463	2.2463	0.00%
2021	2.4194	2.4194	-

CHAPTER 9: PROJECTIONS OF EMISSIONS

Last Update: 15.3.2021

The complexity and dynamic changes of the economic development in recent years have significantly complicated the preparation of projections of air pollutant emissions, particularly concerning continual changes of estimated development of macro-economic indicators for the near future. Comprehensiveness is a very important part of projections calculation and therefore joint GHG and air pollutant emission projections were used. The modelling of emission projections was provided consistent with the GHG emission projections reported on 15th March 2021 under Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on Energy Union Governance and Climate Action. Actualized emissions projections of air pollutants were prepared in line with national air pollution control programmes.

The year 2018 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 2021. Actualization was based on efforts to improve the methodology. Changes were driven by the new data and information about future development and also by changes in methodology. Important changes were also applied to the base of updated policies and measures or new information from stakeholders.

Table 9.1: *Main parameters applied in emission projections*

ITEM	UNITS	2015	2020	2025	2030	2035	2040
Gross domestic product: Constant prices	EUR million	76 734	89 328	102 290	117 033	127 854	134 921
Population	1000 People	5 447	5 450	5 462	5 430	5 364	5 281
EU ETS carbon price	EUR/EUA	7.5	15.0	22.5	33.5	42.0	50.0
International coal import prices	EUR/MWh	2.0	1.8	2.7	2.9	13.5	14.1
International oil import prices	EUR/MWh	8.3	6.6	11.8	14	61.0	64.6
International gas import prices	EUR/MWh	6.7	3.5	5.7	6	37.8	39.1

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. The decision 406/2009/EC on effort sharing in the sectors not included in the emission trading plays an important role.

9.1 TOOLS AND METHODS

The general approach in emissions projections calculation is based on the use of the same methodology as in the emission inventory with projected parameters, as much as possible. There were some changes in methodology. The intention is to create a methodology that is best suited for the estimation of emission projections.

The emission modelling was prepared by software model TIMES + model CPS - *Compact PRIMES for Slovakia* (energy + industry)[1],[2] software COPERT (transport)[3],[4] as well as the specific calculations in MS EXCEL environment (energy, agriculture, waste, industry).

[1] https://iea-etsap.org/index.php/etsap-tools/model-generators/times
[2] https://iea-etsap.org/index.php/documentation
[3] https://www.emisia.com/utilities/copert/documentation/

Energy and Industry

Model MESSAGE used in previous years was replaced and not used anymore. The new methodology in the energy sector should be based on the combination of the model TIMES with the CPS model. But for this version of emission projections reporting was model TIMES not fully set and used only for the power generation sector.

TIMES - (The Integrated MARKAL-EFOM System) model generator was developed as part of the IEA-ETSAP's methodology for energy scenarios to conduct in-depth energy and environmental analyses (Loulou et al., 2004). The TIMES model generator combines two different, and complementary approaches to modelling energy: a technical engineering approach and an economic approach. In a nutshell, TIMES is used for, "the exploration of possible energy futures based on contrasted scenarios" (Loulou et al., 2005).

CPS – COMPACT PRIMES for SLOVAKIA is a mathematical system implemented in the General Algebraic Modelling System (GAMS), a high-level modelling tool for mathematical programming. CPS is designed to support energy strategy making including assessment of policy instruments, energy demand and supply planning and evaluation of climate change mitigation policies. The model includes key energy sector metrics at a detailed level: demand for energy by sector and fuel, modelling of energy efficiency possibilities, capacities of technologies, power generation mix, cogeneration and other energy supply technologies, fuel prices and system costs, investment by sector and energy-related CO_2 emissions.

An energy model for Slovakia captures the details of energy supply and demand that are critical to designing a low carbon path. A country-level energy model named the Compact-PRIMES for Slovakia (CPS), provides a bottom-up technology-rich analysis of the key elements of the energy sector and has been designed to evaluate low carbon options for the energy sector. The CPS model is a single-country partial equilibrium model of the energy sector, which balances energy supply and demand. As a hybrid model with technology and engineering detail together with micro-and macroeconomic interactions and dynamics, the CPS' sectoral decisions consider technology and costs. Electricity and heat supply and biomass supply are captured on the supply side while energy demand modelling includes separate treatment of the industrial sector (and 10 subsectors), transport, and other demand. The design of the CPS model is appropriate for the quantification of long-term energy planning and policies reducing energy-related greenhouse gas emissions.

Also, the macroeconomic model, named the ENVISAGE-Slovakia applied general equilibrium (Slovak-CGE) model, has been customized to reflect the particular features of the Slovak economy. A macroeconomic model for Slovakia complements the energy model, using the detailed energy system results from the CPS model and assessing economy-wide impacts. Importantly, demand for energy commodities across households and firms is price sensitive, and various electricity generation options are captured. Emissions are explicitly modelled. A variety of mitigation policies can be analysed using the Slovak-CGE model. By comparison with the CPS energy model, the Slovak-CGE model aims to simulate the broader economic effects of moving towards a low carbon economy.

The detailed description is provided in the Final Project Report here[4]

The modelling of emission projections in the Energy sector was based on sectoral trends and development from the CPS model and actualization was made by taking into account results of model TIMES in the category public electricity and heat production. Emission from households combustion was modelled separately in MS Excel factsheet model, where was taken into account improving efficiency, equipment status and structure and good practice.

Transport

COPERT is the EU standard vehicle emissions calculator. It uses vehicle population, mileage, speed and other data such as ambient temperature and calculates emissions and energy consumption for a specific country or region. Also, COPERT is a technologically advanced, transparent and internationally recognised research tool.

Methodology, key assumptions and trends: The fleet database for emission projections consists of two main parts. The historical time series, which is based on the Information System of Vehicle Registration of the Police Presidium of the Slovak Republic (IS EVO) and future modelled estimates of the development of the vehicle fleet. The data of the historical time series are prepared annually for the needs of emission inventories of Slovakia according to COPERT (version 5) model. The development of the time series until 2050 is projected according to the methodology based on the Sybil model and calculated in COPERT.

Estimates up to 2050 are made on the knowledge of historical time-series, newly registered vehicles, annually scrapped vehicles and the survival rate of vehicles within individual vehicle segments. The assumption is that there will be no vehicle older than 30 years. Thanks to these data, it is possible to create a general matrix of the age structure of the vehicle fleet and apply and adapt it to any development of the vehicle fleet within Slovakia. Creating an age structure for each year until 2050 is the most important part of model preparation.

The basic development of the vehicle fleet according to the methodology mentioned above forms a baseline for the WEM scenario. If the baseline is applied directly to the calculation of the model, can be obtained projections for the emission with existing measures (WEM scenario). The baseline for the WEM scenario is shown in figure 1. The total of the vehicle fleet is not changing in the WAM, but only the technological structure according to implemented measures.

Methodology: The methodology for the calculation of the projections is based on COPERT calculation. The most important data for calculations are:

1. Development of the national vehicle fleet
2. Development of annual mileage for each vehicle category
3. Technology changes
4. Science-based expert judgment of new technology emission factors

The calculation itself is done by the model COPERT through CLI (Command-line interface), which allows introducing into the model any new vehicle category and technology. It is necessary to implement all the basic data for these categories as emission factors, energy consumption and circulation data. After input, the model calculates the consumption and emissions the same way as for the emission inventories. The outcome emissions are afterwards recalculated by the technological efficiency factor. This factor indicates the technological evolution of vehicles until 2050. This factor also reduces the emission factor as required by legislation.

Agriculture

Activity data: Research Institute of Agriculture and Food Economics in Bratislava prepared parameters for emission projections in the exponential balancing model - SAS 9.3 for the period 2018–2040 (NPPC-VÚEPP) (NPPC, 2017). Projections of input parameters such as livestock numbers and amounts of applied organic and mineral fertilizers were subsequently calculated at the Slovak Hydrometeorological Institute (SHMÚ) by 2050 using the exponential balancing function MS Excel, in the Forecast tool.

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.

Emission calculation: The Slovak Hydrometeorological Institute compiles an annual emissions balance and uses emission factors according to the EMEP/EEA GB_{2019}.

The NH_3, NOx emission projections were estimated according to the EMEP/EEA GB_{2019} Guidebook methodologies, the Slovak Republic did not use the specific model for forecasting emissions. NH_3, NOx emission projections were modelled following the Tier 2 approach based on analysing the nitrogen cycle. The algorithm in the system Python was developed, which is an automated version of the N-Tool, developed following the methodology EMEP/EEA GB_{2019}. The nitrogen flow as an available national parameter was taken into account for more accurate emissions estimations. During the preparation of projected emissions of ammonia were considered the same input data and policies and measures, as in the preparation of projected emissions of N_2O. 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_{10}, $PM_{2.5}$, emissions from manure management and agricultural soils were calculated using the default Tier 1 emissions factors for each category of farm animals. The same emissions factors were used for all years. 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_{2019}. NMVOC emissions from other animal categories were calculated using the Tier 1 methodology and emission factors outlined in the EMEP/EEA GB_{2019}. NMVOC emissions from Agricultural soils were calculated using the Tier 1 methodology and emission factors outlined in EMEP/EEA GB_{2019}.

Waste

MUNICIPAL WASTE MODEL

The waste amounts model is derived from statistical data on municipal waste published by ŠÚ SR and waste composition analysis published by Benešová[5]. Total generated waste is estimated from demographic projections and waste per capita. Generated waste is divided into mixed municipal waste, a group of separately collected fractions covered by waste composition analysis and a group of other separately collected fractions not covered by waste composition analysis. The same division is applied for landfilled waste. Total landfilled waste is estimated as a difference between total generated waste and the sum of recovered waste as material and incinerated. The model uses amounts of separated fractions as input variables, from which is estimated the amount of mixed/residual waste and also changes in waste composition.

[5] Benešová, Kotoulova, Černík: Základní charakteristiky komunálních odpadů
http://www.mnisek.cz/e_download.php?file=data/editor/234cs_2.pdf&original=STANOVEN%C3%8D+PRODUKCE+ODPAD%C5%AE-P%C5%98%C3%8DLOHA.pdf

9.2 KEY CHANGES IN UPDATED PROJECTIONS

Residential heating – Probably the most crucial sector cover most of the $PM_{2.5}$ emissions and a considerable amount of NOx and NMVOC emissions. New information was obtained from the second questionnaire survey, new implemented and planned measures. Based on this information datasets were improved together with estimations of natural improvement in the structure of households, heating equipment was implemented. Compared to the last submission these scenarios was included measures that would force improving energy efficiency, equipment changes and improvement of good practices in households heating.

Energy efficiency – Energy efficiency was taken into account based on data from the CPS model

Transport – Actualization based on new methodology with model COPERT using new assumptions and data from the CPS model.

Industry – Changes in the Industry was driven by the trend of historical emission in the last years and assumed slow technology improvement, new estimated sectoral demand from CPS and based on information from producers.

Energy – Actualization was similar to in the industry sector. However, there is a significant decrease in emissions caused by planned measures by key producers. Significant impact has planned phase-out of fossil fuel power plants and fuel switch to natural gas, RES and biomass.

Agriculture – Changes were driven by the improvement of methodology

The most important improvement WAM scenario was included in 2021. Published policies and measures after 2018 from the national strategies were considered in the **WAM** scenario. The list of applied policies and measures were taken at the National Air Pollution Control Program[6] and the Low-carbon Development Strategy of the Slovak Republic[7].

9.3 POLICIES AND MEASURES

Projections of air pollutant emissions were prepared for the years 2020-2050 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 2020).

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.

List of Policies and measures which have been taken into account in the scenario with measures (WEM):

ENERGY

Integrated National Energy and Climate Plan of Slovakia (NECP)

Energy efficiency improvement

National Renewable Energy Action Plan - Impact renewable energy sources in heat and electricity generation. Increase of the share of electricity production from renewable energy sources in the power system. Increase biomass consumption for electricity and heat production.

[6] **MŽP SR. 2020.**The National Air Pollution Control Program.

[7] **MŽP SR,2019.** *Low-Carbon Development Strategy of the Slovak Republic until 2030 with a View to 2050*

Emission trading, the new allocation - The ETS stimulates the use of the biomass in the fuel mix of energy units

Specific emissions limits and specific technical conditions for MCP and LCP - Setting limits on concentration for specific air pollutants for particular combustion plants.

National Emission Reduction Program (NAPCP) – sectoral measures in 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 (eg 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 Novaky and Vojany Coal power plants

TRANSPORT

The RED directive cap for 2020 and further - This directive is transposed to the Slovak legislation in Act no. 309/2018, amending Act no. 309/2009 Coll. on the promotion of renewable energy sources and high-efficiency cogeneration. This measure sets the share of the biofuels in fuels.

Action plan for the development of electromobility in Slovakia - Slow rise and grants for electromobility. Temporarily rise of the numbers of new EV (PHEV, EV) in particular years. It is assumed that the increasing trend, based on their survival rate and a lifetime of EVs, will last until 2050 and no other new measures will be introduced.

National Emission Reduction Program (NAPCP)

Strategic Plan for the development of transport in Slovakia until 2030

Integrated National Energy and Climate Plan of Slovakia (NECP)

Revision and updating of the National Policy Framework for the Development of the Alternative Fuels Market

INDUSTRY

Use of BAT level technologies in Industry

Energy efficiency improvement

AGRICULTURE

The list of applied policies and measures was taken from the National Program for Reducing Pollutant Emissions (EC, 2019), from the Low Carbon Strategy of the Slovak Republic (MŽP SR, 2020) and the strategic document " Farm to Fork Strategy" (EC, 2020). 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 are set for the entire European Union, the Slovak Republic does not set binding reduction resulting from the Farm to Fork Strategy.

The Low Carbon Strategy 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 (MŽP SR, 2020) 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 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. These measures 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 have different often synergistic ý 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 2020. 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. 410/2012 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 **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.

Emissions of NOx and NH_3 from manure and manure storage in the WAM scenario were modelled taking into account the measure of introducing requirements to reduce emissions from livestock farms classified as a medium source of emissions to air. This measure was proposed in the National Program for Emission Reduction (MŽP SR, 2020) and implemented into the calculation of NH_3 and NOx emissions by implementing low-emission systems for manure and manure storage. This measure has an impact on category 3B Manure and slurry management.

Another implemented measure (MŽP SR, 2020), which has an impact on NH_3 and NOx emissions in category 3B 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 NO_X from the application of inorganic nitrogen fertilizers (category 3D Agricultural soils) were modelled in the **WAM** scenario based on a measure implemented from the Low Carbon Strategy of the Slovak Republic (MŽP SR, 2020). This measure recommends the transition or legislative restriction on the application of nitrogen fertilizers to urea bases. The implementation of this measure has an impact on 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 the reduction of the total consumption of inorganic fertilizers in the resulting consumption summary.

The last implemented measure was taken from the European Green Agreement 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 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 9.2***.

Table 9.2: *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 Emission Reduction Program Low carbon strategy Decree of the Ministry of the Environment of the Slovak Republic no. 410/201 2 Coll.	WEM	NH_3, NOx- storage of manure and manure	Efficient storage of animal waste, specifical 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
National Air Pollution Control Programme	WAM	NH_3,NOx - agricultural land	Obligation to comply with measures to reduce ammonia emissions even at medium sources of pollution	synergistic
Low carbon strategy	WAM	NH_3, NOx - storage of manure and manure	Effectively process animal waste and use biogas, especially as a local energy source	synergistic
Low carbon strategy	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 - agricultural land	Reduction of inorganic nitrogen fertilizers by 20 % compared to 2030	synergistic

WASTE

Act on waste introduces the emphasis on the separation of packaging and recyclables

Waste Management Program of the Slovak Republic for 2016-2020. This document states that the previous plan for 2011-2015 did not achieve planned objectives and states that the objective for 2013 to reduce the disposal of biodegradable waste to 50% of 1995 level was not achieved, neither the objective to recycle 35% of municipal waste by 2015. The plan for the period 2021-2025 is not yet available.

The Waste Prevention Programme 2019–2025 evaluates specific targets from the programme for the period 2014–2018 and concludes that the majority of them were not achieved. This new WPP 2019 – 2025 defines the following quantified targets for municipal waste:

- Reduction of residual municipal waste to 50% of the 2016 level by 2025
- Reduction of biodegradable waste in residual municipal waste by 60% not later than 2025
- Reduction of landfilling to 10% of total municipal waste by 2035

It is assumed, that to achieve the targets above, the two incinerators will continually increase operation to their full capacity of 285 kt/yr (Košice 70+80kt/yr and Bratislava 135 kt/tr). Also, additional incinerators and MBT capacity of 560 kt/yr need to be developed.

In this scenario, the recovery of landfill gas is assumed from all landfills developed after 1993 because these had to establish landfill gas collection systems.

List of Policies and measures which have been taken into account in the scenario with additional measures (WAM):

ENERGY

Support for the replacement of old solid fuel boilers with low-emission ones - More effective replacement of old non-ecological solid fuel boilers with new ones

The transition of households using solid fuel for heating to another low-emission heat source (eg natural gas, heat pumps, solar energy…) - Stronger measure, which supports the transition to low-emission methods of household heating. Greater penetration of new technologies.

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 of 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. Fuel switch of all power plants from fossil solid fuels.

Further increase of Energy efficiency and use of RES – for Energy and industry

TRANSPORT

Continuity of direct support for the use of low-emission vehicles – based on the Action plan for the development of electromobility in Slovakia.

Long term financial mechanism to support the development of charging infrastructure - based on the Action plan for the development of electromobility in Slovakia.

Setting stricter requirements for regular technical inspections

Tax for purchasing ICE vehicles with high CO2 g/km - Decreasing numbers of old vehicles.

Setting stricter requirements for periodical technical controls – Stricter checks on NOx emissions during the vehicle inspection.

The modal shift in passenger and freight transport - Strategic Plan for Development of the Transport Infrastructure

Introduction and promotion of Fuel cell electric vehicles (FCEV) - European Hydrogen Strategy

Information campaign

9.4 GENERAL RESULTS AND COMMITMENTS

The actualization of the emission projection led to some changes in comparison with previously reported projections. In the table below are presented national totals of air pollutant emissions and a comparison to the absolute values of emission targets.

***Table 9.3**: WEM scenario emission projection trends and targets*

TOTAL EMISSIONS OF SLOVAKIA (kt)	2005	2015	2020	2025	2030	*TARGET 2020*	*TARGET 2030*
NOx	104.5	73.2	62.68	54.67	48.47	66.88	52.25

TOTAL EMISSIONS OF SLOVAKIA (kt)	2005	2015	2020	2025	2030	*TARGET 2020*	*TARGET 2030*
NMVOC	149.7	112.0	100.29	92.96	85.25	122.73	101.78
SOx	86.2	66.8	17.59	16.28	15.53	37.07	15.52
NH_3	32.6	29.7	33.22	33.04	33.52	27.72	22.83
$PM_{2.5}$	36.1	20.7	17.81	15.75	13.89	23.11	18.42

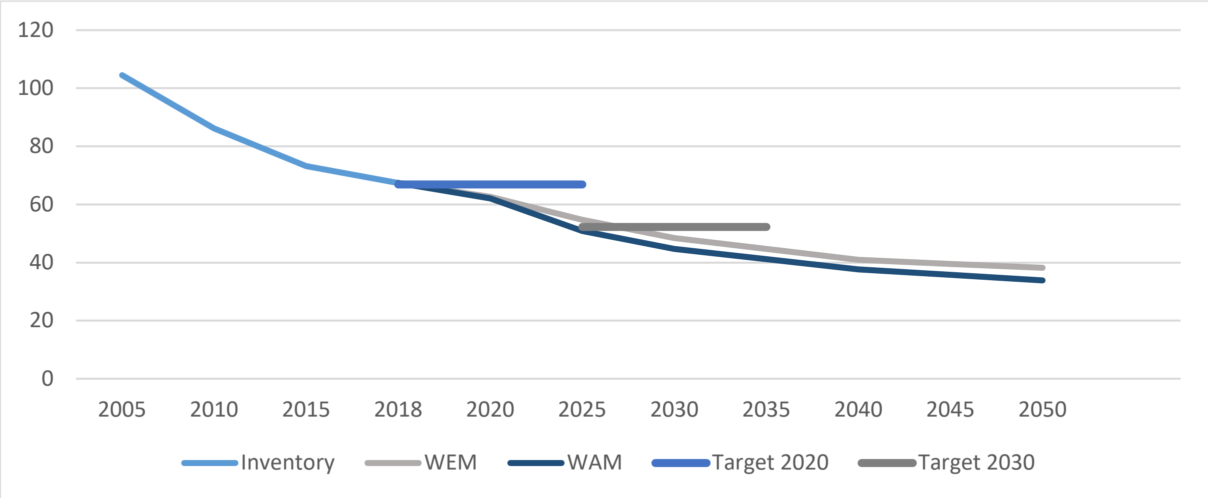
***Table 9.4**: WAM scenario emission projection trends and targets*

TOTAL EMISSIONS OF SLOVAKIA (kt)	2005	2015	2020	2025	2030	*TARGET 2020*	*TARGET 2030*
NOx	104.5	73.2	62.07	50.80	44.66	66.88	52.25
NMVOC	149.7	112.0	98.39	89.01	81.60	122.73	101.78
SOx	86.2	66.8	17.48	15.71	13.70	37.07	15.52
NH_3	32.6	29.7	23.64	23.44	27.40	27.72	22.83
$PM_{2.5}$	36.1	20.7	17.67	14.96	12.49	23.11	18.42

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 achieving the 2030 target will be very tight even in the WAM scenario.

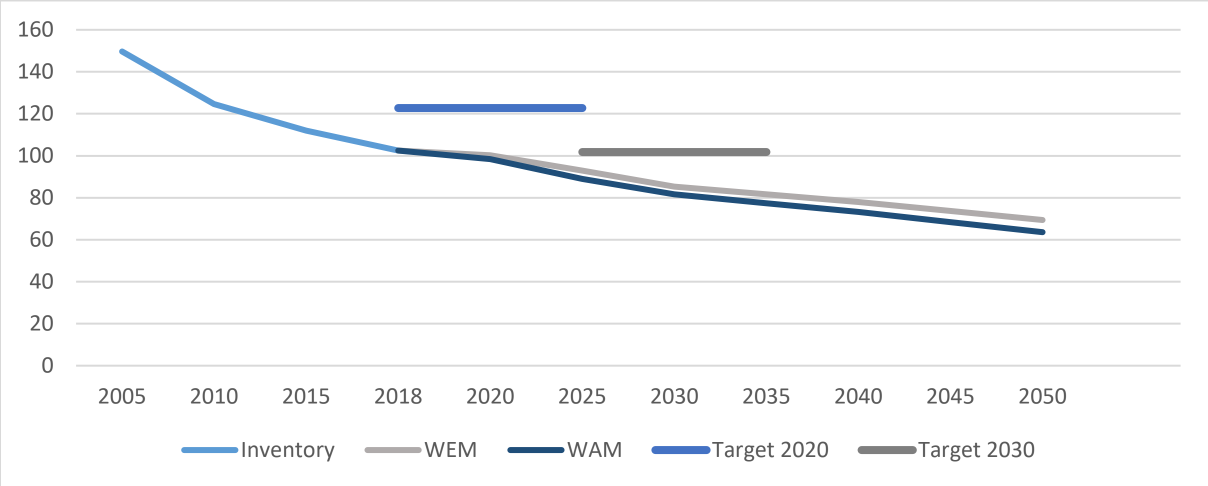
***Figure 9.1**: Emission projections trends for pollutant NOx*



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.

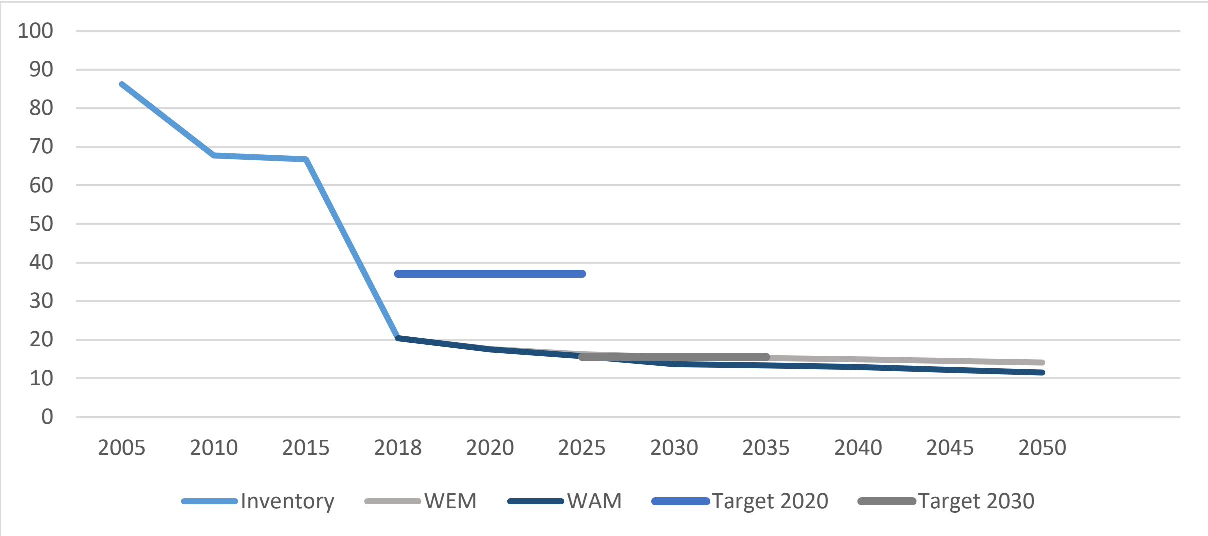
Figure 9.2*: Emission projections trends for pollutant NMVOC*



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.

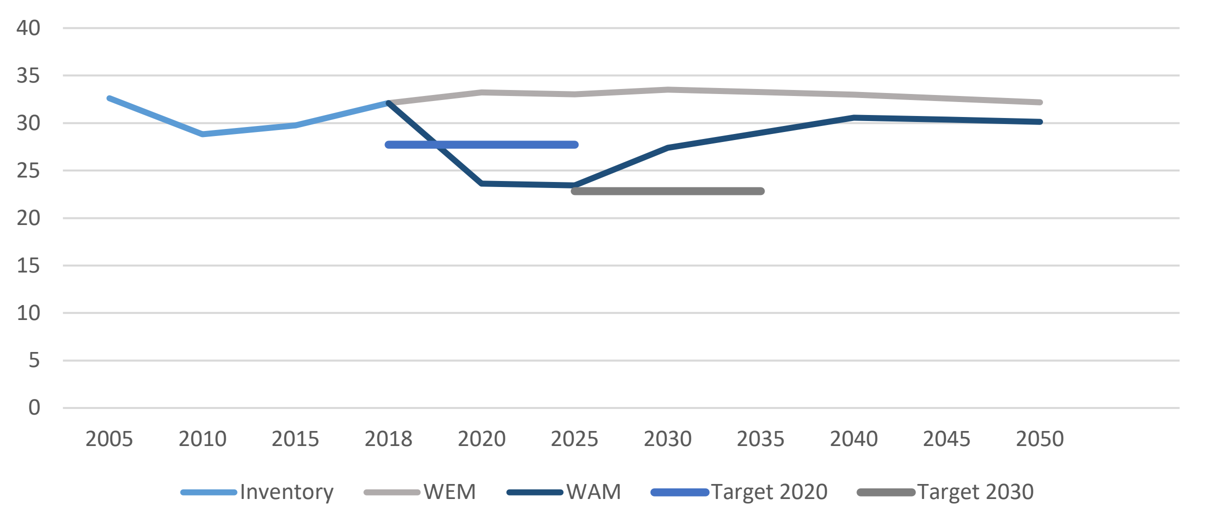
Figure 9.3*: Emission projections trends for pollutant SOx*



NH_3 emissions

Figure 9.4 shows a different trend between WEM and WAM scenarios. According to the measures contained in both scenarios will be very hard to achieve the 2030 target. The increase of NH_3 emissions in the WAM scenario is caused by extensive use of LNG and CNG in the Transport sector.

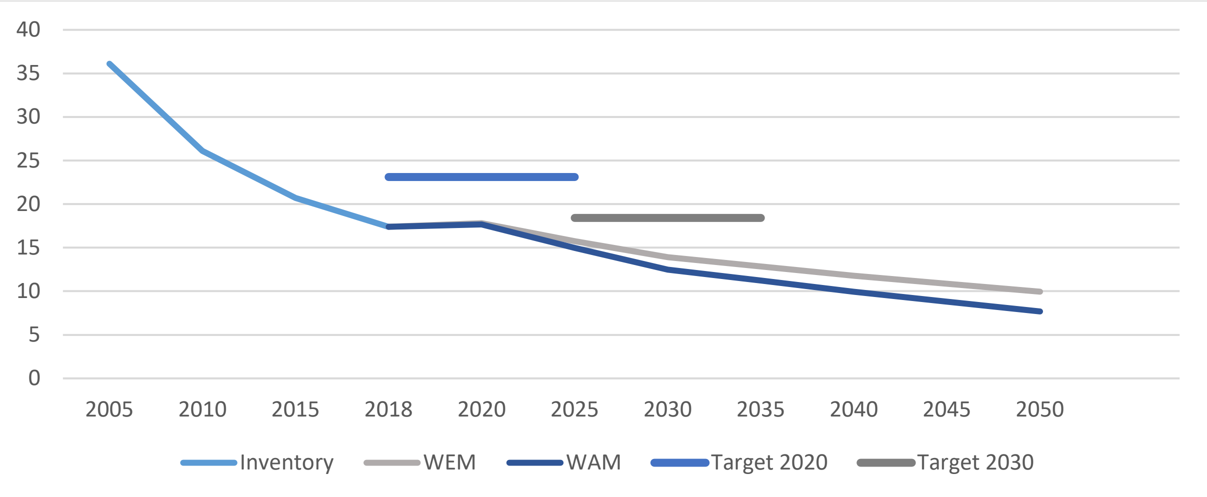
Figure 9.4*: Emission projections trends for pollutant NH_3*



$PM_{2.5}$ 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 seems to be in the margin of target 2030.

Figure 9.5*: Emission projections trends for pollutant $PM_{2.5}$*



9.5 SECTORAL RESULTS – ENERGY

The modelling of emission projections in the Energy sector was based on sectoral trends and development from the CPS model and actualization was made by taking into account results of model TIMES in the category Public electricity and heat production (**1A1a**). 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*

WEM	2005	2010	2015	2020	2025	2030
1A1	19.10	13.04	8.49	5.09	3.54	3.48

WEM	2005	2010	2015	2020	2025	2030
1A2	14.88	11.31	11.90	8.19	8.10	7.93
1A4	8.79	8.54	8.65	8.60	8.04	7.60
1A5	0.20	0.13	0.48	0.67	0.68	0.69
1B	0.00	0.00	0.00	0.00	0.00	0.00
1 Energy	**42.97**	**33.02**	**29.53**	**22.56**	**20.35**	**19.70**

WAM	2005	2010	2015	2020	2025	2030
1A1	19.10	13.04	8.49	5.09	3.52	2.67
1A2	14.88	11.31	11.90	8.13	7.16	6.74
1A4	8.79	8.54	8.65	8.59	7.84	7.49
1A5	0.20	0.13	0.48	0.67	0.68	0.69
1B	0.00	0.00	0.00	0.00	0.00	0.00
1 Energy	**42.97**	**33.02**	**29.53**	**22.49**	**19.20**	**17.59**

NMVOC emissions

Table 9.6*: NMVOC emissions in sector Energy*

WEM	2005	2010	2015	2020	2025	2030
1A1	2.68	1.92	1.83	1.47	1.45	1.42
1A2	5.24	4.82	5.81	6.54	6.69	6.74
1A4	49.47	47.79	38.22	34.08	29.69	25.75
1A5	0.47	0.57	0.82	0.91	0.91	0.91
1B	20.71	19.69	17.66	16.94	15.38	13.43
1 Energy	**78.577**	**74.784**	**64.335**	**59.933**	**54.126**	**48.255**

WAM	2005	2010	2015	2020	2025	2030
1A1	2.68	1.92	1.83	1.48	1.46	1.43
1A2	5.24	4.82	5.81	6.43	6.48	6.54
1A4	49.47	47.79	38.22	33.95	28.39	23.11
1A5	0.47	0.57	0.82	0.91	0.92	0.92
1B	20.71	19.69	17.66	15.47	13.40	13.24
1 Energy	**78.577**	**74.784**	**64.335**	**58.243**	**50.655**	**45.244**

SO_X emissions

Table 9.7*: SOx emissions in sector Energy*

WEM	2005	2010	2015	2020	2025	2030
1A1	60.819	52.747	52.038	4.561	3.343	3.320
1A2	10.010	4.938	3.295	1.449	1.419	1.380
1A4	3.404	2.342	1.938	1.583	1.587	1.355
1A5	0.318	0.101	0.212	0.325	0.361	0.276
1B	0.000	0.000	0.000	0.000	0.000	0.000
1 Energy	74.551	60.128	57.482	7.919	6.709	6.330
WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A1	60.819	52.747	52.038	4.561	3.269	2.153
1A2	10.010	4.938	3.295	1.444	1.194	1.097
1A4	3.404	2.342	1.938	1.563	1.587	1.134
1A5	0.318	0.101	0.212	0.326	0.361	0.276
1B	0.000	0.000	0.000	0.000	0.000	0.000
1 Energy	74.551	60.128	57.482	7.894	6.411	4.661

NH_3 emissions

***Table 9.8**: NH_3 emissions in sector Energy*

WEM	2005	2010	2015	2020	2025	2030
1A1	0.077	0.032	0.047	0.031	0.030	0.029
1A2	0.015	0.018	0.035	0.062	0.063	0.063
1A4	2.064	2.092	1.629	1.536	1.360	1.196
1A5	0.004	0.002	0.002	0.002	0.002	0.002
1B	0.006	0.006	0.006	0.006	0.003	0.001
1 Energy	2.167	2.150	1.719	1.636	1.458	1.291
WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A1	0.077	0.032	0.047	0.031	0.031	0.029
1A2	0.015	0.018	0.035	0.062	0.062	0.063
1A4	2.064	2.092	1.629	1.534	1.327	1.103
1A5	0.004	0.002	0.002	0.002	0.002	0.002
1B	0.006	0.006	0.006	0.004	0.001	0.001
1 Energy	2.167	2.150	1.719	1.633	1.423	1.197

$PM_{2.5}$ emissions

Households (**1A4**) are a dominant contributor to $PM_{2.5}$ emissions.

***Table 9.9**: $PM_{2.5}$ emissions in sector Energy*

WEM	2005	2010	2015	2020	2025	2030
1A1	8.08	0.89	0.67	0.36	0.36	0.35
1A2	0.69	0.38	0.29	0.25	0.25	0.23
1A4	22.41	20.95	16.43	14.58	12.69	10.95
1A5	0.02	0.01	0.02	0.02	0.02	0.02
1B	0.21	0.19	0.17	0.16	0.09	0.02
1 Energy	31.41	22.43	17.58	15.38	13.40	11.58
WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A1	8.08	0.89	0.67	0.36	0.37	0.35
1A2	0.69	0.38	0.29	0.25	0.24	0.23
1A4	22.41	20.95	16.43	14.51	12.02	9.66
1A5	0.02	0.01	0.02	0.02	0.02	0.02
1B	0.21	0.19	0.17	0.11	0.02	0.02
1 Energy	31.41	22.43	17.58	15.25	12.67	10.27

9.6 SECTORAL RESULTS – TRANSPORT

NOx emissions

***Table 9.10**: NOx emissions in sector Transport*

WEM	2005	2010	2015	2020	2025	2030
1A3b road	43.281	36.844	27.568	22.209	16.358	10.998
1A3acde non-road	5.821	4.711	2.684	2.226	2.236	2.299
1A3	49.102	41.556	30.252	24.435	18.594	13.297

WAM	2005	2010	2015	2020	2025	2030
1A3b road	43.281	36.844	27.568	21.994	15.329	10.842
WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3acde non-road	5.821	4.711	2.684	2.226	2.236	2.299

1A3	49.102	41.556	30.252	24.220	17.565	13.141

NMVOC emissions

Table 9.11: *NMVOC emissions in sector Transport*

WEM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	19.830	11.787	5.733	3.328	3.186	2.808
1A3acde non-road	0.395	0.357	0.397	0.159	0.163	0.169
1A3	20.225	12.144	6.130	3.487	3.349	2.977

WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	19.830	11.787	5.733	3.346	3.108	2.681
1A3acde non-road	0.395	0.357	0.397	0.159	0.163	0.169
1A3	20.225	12.144	6.130	3.505	3.271	2.850

SOx emissions

Table 9.12: *SOx emissions in sector Transport*

WEM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	0.526	0.470	0.370	0.290	0.369	0.418
1A3acde non-road	0.000	0.000	0.000	0.000	0.000	0.000
1A3	**0.526**	**0.470**	**0.371**	**0.291**	**0.369**	**0.418**

WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	0.526	0.470	0.370	0.307	0.798	4.957
1A3acde non-road	0.000	0.000	0.000	0.000	0.000	0.000
1A3	**0.526**	**0.470**	**0.371**	**0.307**	**0.799**	**4.957**

NH_3 emissions

Table 9.13: *NH_3 emissions in sector Transport*

WEM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	0.194	0.029	0.031	0.017	0.021	0.024
1A3acde non-road	0.012	0.221	0.186	0.181	0.153	0.135
1A3	0.206	0.250	0.217	0.198	0.174	0.159

WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	0.194	0.029	0.031	0.016	0.020	0.020
1A3acde non-road	0.012	0.221	0.186	0.181	0.153	0.135
1A3	0.206	0.250	0.217	0.197	0.172	0.155

$PM_{2.5}$ emissions

Table 9.14: *$PM_{2.5}$ emissions in sector Transport*

WEM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	2.241	2.178	1.423	1.155	1.066	1.047
1A3acde non road	0.048	0.098	0.083	0.054	0.055	0.056
1A3	2.289	2.276	1.506	1.209	1.121	1.103

WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
1A3b road	2.241	2.178	1.423	1.137	1.011	0.960
1A3acde non road	0.048	0.098	0.083	0.054	0.055	0.056
1A3	2.289	2.276	1.506	1.192	1.066	1.016

9.7 SECTORAL RESULTS – INDUSTRY

NOx emissions

***Table 9.15**: NOx emissions in sector Industry*

WEM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	6.701	5.907	6.483	7.642	7.706	7.699
2D, 2G	0.045	0.016	0.016	0.015	0.014	0.013
2 Industry	6.75	5.92	6.50	7.66	7.72	7.71

WAM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	6.701	5.907	6.483	7.555	7.532	7.441
2D, 2G	0.045	0.016	0.016	0.015	0.014	0.013
WAM	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
2 Industry	6.75	5.92	6.50	7.57	7.55	7.45

NMVOC emissions

***Table 9.16**: NMVOC emissions in sector Industry*

WEM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	7.315	5.323	6.230	6.317	6.492	6.600
2D, 2G	31.632	22.459	25.684	23.376	21.914	20.403
2 Industry	38.95	27.78	31.91	29.69	28.41	27.00

WAM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	7.315	5.323	6.230	6.197	6.311	6.392
2D, 2G	31.632	22.459	25.684	23.259	21.695	20.099
2 Industry	38.95	27.78	31.91	29.46	28.01	26.49

SOx emissions

***Table 9.17**: SOx emissions in sector Industry*

WEM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	11.430	7.303	9.055	9.437	9.356	9.010
2D, 2G	0.025	0.027	0.033	0.035	0.032	0.029
2 Industry	11.45	7.33	9.09	9.47	9.39	9.04

WAM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	11.430	7.303	9.055	9.351	9.090	8.850
2D, 2G	0.025	0.027	0.033	0.035	0.032	0.029
2 Industry	11.45	7.33	9.09	9.39	9.12	8.88

NH_3 emissions

***Table 9.18**: NH_3 emissions in sector Industry*

WEM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	0.240	0.085	0.131	0.201	0.205	0.210
2D, 2G	0.103	0.037	0.035	0.035	0.032	0.029
2 Industry	0.34	0.12	0.17	0.24	0.24	0.24

WAM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	0.240	0.085	0.131	0.201	0.205	0.203

WAM	2005	2010	2015	2020	2025	2030
2D, 2G	0.103	0.037	0.035	0.035	0.032	0.029
2 Industry	0.34	0.12	0.17	0.24	0.24	0.23

$PM_{2.5}$ emissions

***Table 9.19**: $PM_{2.5}$ emissions in sector Industry*

WEM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	1.296	0.713	0.949	0.636	0.649	0.654
2D, 2G	0.671	0.242	0.229	0.228	0.209	0.189
2 Industry	1.97	0.95	1.18	0.86	0.86	0.84

WAM	2005	2010	2015	2020	2025	2030
2A,B,C,H,I,J,K,L	1.296	0.713	0.949	0.631	0.639	0.641
2D, 2G	0.671	0.242	0.229	0.228	0.209	0.189
2 Industry	1.97	0.95	1.18	0.86	0.85	0.83

9.8 SECTORAL RESULTS – AGRICULTURE

Sector agriculture is a dominant contributor to NH_3 emissions and also a significant contributor to NOx and NMVOC emissions.

NMVOC emissions

NMVOC emission projections were prepared using the WEM scenario. 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. Predictions by the WEM scenario were following the Ordinance of the Government of the Slovak Republic No 410/2012 Coll.

***Figure 9.6**: Emission projections trends for pollutant NMVOC in sector Agriculture*

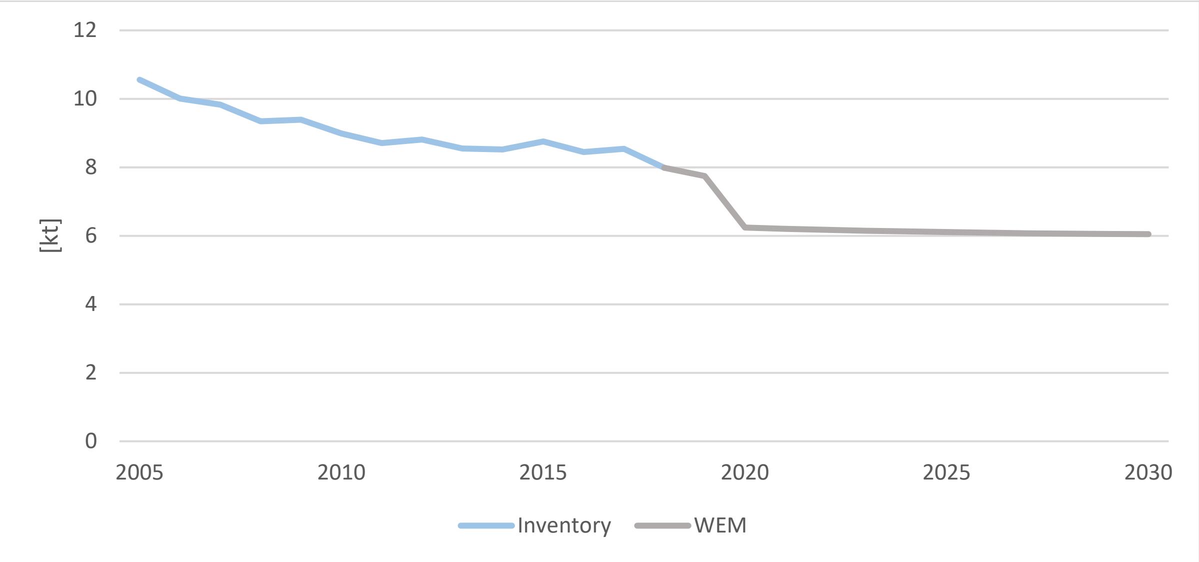


***Table 9.20**: NMVOC emissions in sector Agriculture*

WEM	2005	2010	2015	2020	2025	2030	2035	2040
3B	10.438	8.861	8.629	5.792	5.629	5.554	5.258	5.225
3D	0.120	0.130	0.130	0.445	0.481	0.495	0.494	0.495
3 Agriculture	**10.558**	**8.992**	**8.759**	**6.237**	**6.110**	**6.049**	**5.752**	**5.720**

WAM	2005	2010	2015	2020	2025	2030	2035	2040
3B	10.438	8.861	8.629	5.792	5.629	5.554	5.258	5.225
3D	0.120	0.130	0.130	0.445	0.481	0.495	0.494	0.495
3 Agriculture	**10.558**	**8.992**	**8.759**	**6.237**	**6.110**	**6.049**	**5.752**	**5.720**

NH_3 emissions, 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 3D 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, 24 hours, deep injection of manure), followed by the category Inorganic N-fertilizers representing approximately 20% of the total NH_3 emissions, there no abatements were implemented, due to missing policies. Emissions from 3B1 Cattle, 3B3 Swine and 3B2 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 identical to the WEM scenario for NH_3 and NOx emission projections. The WEM scenario is conservative and does not envisage further measures to reduce emissions. The emission trend is relatively stable (***Figure 9.7***).

Figure 9.7*: Emission projections trends for pollutant NH_3 in sector Agriculture*

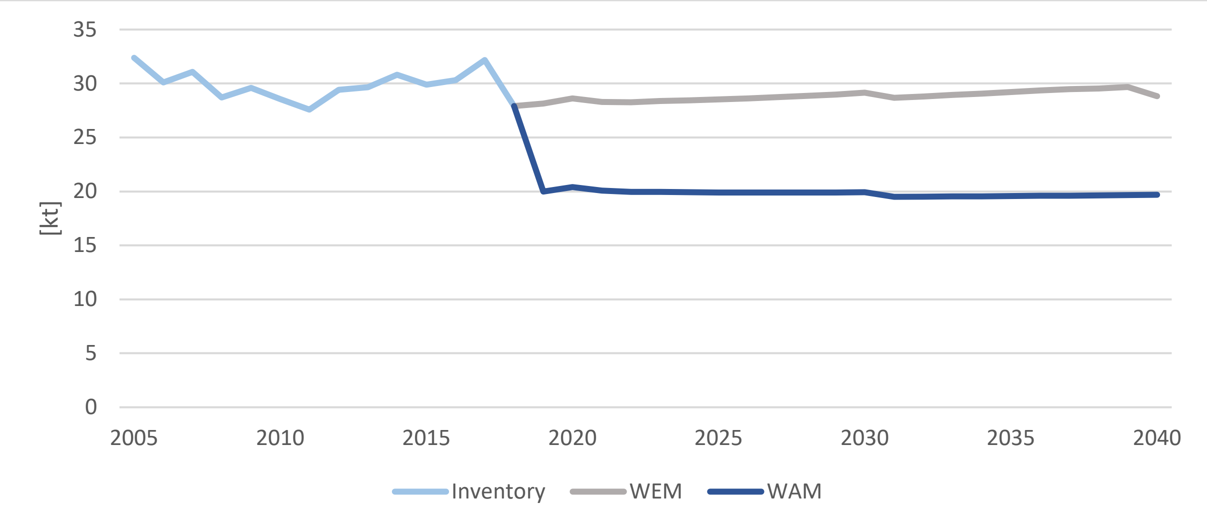


Table 9.21*: NH_3 emissions in sector Agriculture*

WEM	2005	2010	2015	2020	2025	2030	2035	2040
3B	11.42	9.73	9.45	7.17	6.86	6.83	6.72	6.64
3D	20.96	18.83	20.45	21.45	21.67	22.32	22.49	22.18
3 Agriculture	**32.38**	**28.57**	**29.90**	**28.63**	**28.53**	**29.15**	**29.20**	**28.82**

WAM	2005	2010	2015	2020	2025	2030	2035	2040
3B	11.42	9.73	9.45	6.33	6.05	6.02	5.94	5.95
3D	20.96	18.83	20.45	14.07	13.85	13.92	13.63	13.74
3 Agriculture	**32.38**	**28.57**	**29.90**	**20.39**	**19.91**	**19.94**	**19.57**	**19.69**

Agricultural NOx emissions have increased. The NOx emissions from the 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 9.8 *Emission projections trends for pollutant NOx in sector Agriculture*

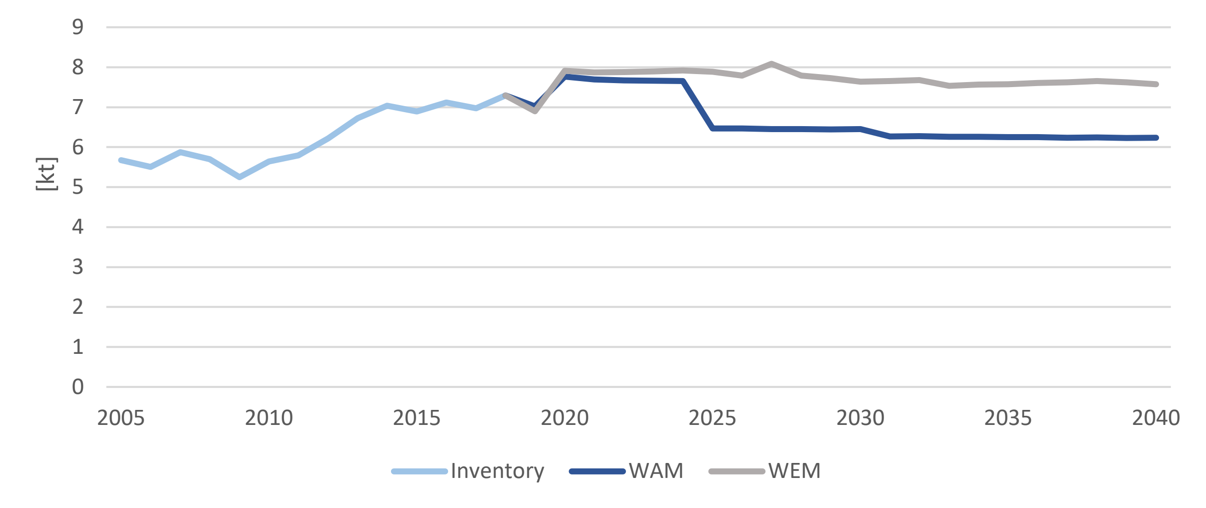


Table 9.22*: NOx emissions in sector Agriculture*

WEM	2005	2010	2015	2020	2025	2030	2035	2040
3B	0.176	0.150	0.146	0.099	0.096	0.096	0.09	0.09
3D	5.497	5.491	6.750	7.907	7.888	7.638	7.57	7.58
3 Agriculture	**5.673**	**5.641**	**6.896**	**8.006**	**7.984**	**7.734**	**7.67**	**7.67**

WAM	2005	2010	2015	2020	2025	2030	2035	2040
3B	0.176	0.150	0.146	7.745	6.451	6.429	0.00	0.00
3D	5.497	5.491	6.750	0.000	0.000	0.000	0.02	0.02
3 Agriculture	**5.673**	**5.641**	**6.896**	**7.745**	**6.451**	**6.429**	**6.45**	**6.43**

Table 9.23: *Proportion of farms (in %) used mitigation on all farms*

YEAR	MITIGATION	A	B	C	D	E	F	G	H	I
						%				
2019	fixed hatch or roof	5.4	5.1	0.3	1.4	0.0	6.5	11.1	14.8	2.6
	covering the surface with peat, straw, oil or other material	1.0	1.2	1.9	0.7	1.9	0.0	0.9	2.0	0.0

A Cattle - dairy cows, **B** Cattle - other cattle, **C** Poultry - broilers, **D** Poultry - laying hens, **E** Poultry - other poultry, **F** Horses, **G** Pigs - sows, **H** Pigs - fattening, **I** Sheep

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%.

The WAM scenario was prepared based on the National Air Pollution Program with the inclusion of measures from the program Introduction of requirements for the reduction of NH_3 emissions from livestock for medium farms (application of the Code of Best Agricultural Practice). The measure includes a set of techniques (***Table 9.23***) to reduce the release of ammonia emissions from agricultural activities during the storage of organic waste from animal production (manure, slurry). The measure aims to extend the obligation to comply with the requirements concerning the reduction of ammonia emissions from large sources to medium sources set out in the Decree of the Ministry of the Environment of the Slovak Republic No. 410/2012 Coll. The trend of NH_3 and NOx projections emissions in the WAM scenario has a decreasing and a sharp decrease is visible especially after 2019 due to implementing the measures. The WAM scenario contains two mitigation measures that have a synergistic effect. 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. Detailed information on when the legislative framework should apply was not available, so an expert estimate 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 Farm to Table strategy was also considered in the WAM scenario. The Strategy aims to reduce the use of pesticides, fertilizers, antibiotics in agriculture and mitigate the environmental and climate footprint of the European food system. Within the WAM scenario, the goal of reducing the consumption of nitrogen fertilizers by 20% by 2030 was implemented. A transitional period was implemented in the emission projections, which is in line with the transitional period for limiting urea (2020-2025). It is probable that the Slovak Republic will negotiate its percentage reduction in fertilizer consumption and will claim a transitional period, which will also be enshrined in legislation. Following the legislative process, it will be necessary to adjust the emission projections in line with the future valid state strategy.

The WAM scenario also contains the measures of increase 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 pigs would be recovered in biogas plants. Cattle and pigs are key categories of animals with the highest emission recovery potential, the 10% potential was chosen as expert judgement. Biogas from stations is a promising source of renewable electricity and heat, which can be used at the local level. The decrease in emissions by 2040 in the WAM scenario compared to 1990 is at the level of -68% and then decrease by 39% compared to 2005. $PM_{2.5}$ emissions

3D sector is the main contributor to PMs emissions in Agriculture. During the preparation of PMs projections from agricultural land management, policies for forecasting sowing areas were unavailable. Therefore, since 2018, consistent sowing areas were used except for wheat which areas were available by 2020. Agriculture is not a significant $PM_{2.5}$ emission category. After 2019, the trend has stagnated character.

Table 9.25*: $PM_{2.5}$ emissions in sector Agriculture*

WEM	2005	2010	2015	2020	2025	2030	2035	2040
3B	0.150	0.129	0.121	0.112	0.109	0.108	0.108	0.108
3D	0.143	0.124	0.128	0.080	0.086	0.089	0.088	0.091
3 Agriculture	0.293	0.253	0.249	0.191	0.195	0.197	0.196	0.198

WAM	2005	2010	2015	2020	2025	2030	2035	2040
3B	0.150	0.129	0.121	0.112	0.109	0.108	0.108	0.108
3D	0.143	0.124	0.128	0.080	0.086	0.089	0.088	0.091
3 Agriculture	0.293	0.253	0.249	0.191	0.195	0.197	0.196	0.198

9.9 SECTORAL RESULTS – WASTE

Emissions from the Waste sector have not a key impact on overall emissions. Projection emissions are estimated by simply methodology, which needs to be updated in the future.

NOx emissions

***Table 9.26**: NOx emissions in sector Waste (kt)*

WEM	2005	2010	2015	2020	2025	2030
5 Waste	0.020	0.022	0.022	0.023	0.023	0.023

NMVOC emissions

***Table 9.27**: NMVOC emissions in sector Waste (kt)*

WEM	2005	2010	2015	2020	2025	2030
5 Waste	1.368	0.909	0.668	0.945	0.971	0.966

SOx emissions

***Table 9.28**: SOx emissions in sector Waste (kt)*

WEM	2005	2010	2015	2020	2025	2030
5 Waste	0.005	0.004	0.006	0.005	0.005	0.005

NH_3 emissions

***Table 9.29**: NH_3 emissions in sector Waste (kt)*

WEM	2005	2010	2015	2020	2025	2030
5 Waste	1.213	1.074	1.077	1.067	1.073	1.075

$PM_{2.5}$ emissions

***Table 9.30**: $PM_{2.5}$ emissions in sector Waste (kt)*

WEM	2005	2010	2015	2020	2025	2030
5 Waste	0.152	0.180	0.189	0.174	0.174	0.174

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 National PRTR. The 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 EMISSIONS 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, 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 reporting 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 is 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: *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 NECD review 2020:

GNFR sector C_OtherStationaryComb

The most emissions in sector C_OtherStationaryComb comes from combustion in households for heating and hot water. Emissions from national inventory in the households sector were spatially distributed based on data from 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) using is higher in lowlands and in the west 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 distribution of NH_3 emissions was used tier 1 methodology was recommended in 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.

REFERENCES

Aalde, H., Gonzalez, P., Gytarsky, M. et al. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Agriculture, Forestry and Other Land Use. [Online] 2006. [Dátum: 21. 11 2018.] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf.

Annual Report of Slovak Railway 2021, p. 14. [Online] https://www.zsr.sk/files/o-nas/vyrocne-spravy/vyrocnasprava2021.pdf

BRESTENSKÝ, V., Straty hmotnosti dusíka pri manipulácií s maštalným hnojom. Národná poľnohospodárske a potravinárske centrum. [Online] [Dátum: 27. January 2016.] http://www.cvzv.sk/index.php/sk/poradcovia-cvzv-nitra/148-ing-vojtech-brestensky-csc.

EEA. 2016. 3.D Crop production and agricultural soils. European Environment Agency. [Online] 7. March 2016. [Dátum: 5. November 2015.] http://www.eea.europa.eu/publications/emep-eea-guidebook-2016.

EEA. 2016. Agriculture, 3B Manure managment. European Environment Agency. [Online] March. 7 2016. [Dátum: 29. Október 2015.] http://www.eea.europa.eu/publications/emep-eea-guidebook-2016.

Guideline for sewage sludge application (In Slovak): http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

Horváth, J. and Tonhauzer, K. 2022, How to rebuild Slovak Agriculture and Transport to a sustainable future?. Utrecht : s.n., 2022.

Horváth, J. et al. 2021, Improving the allocation of road transport emissions in AEA module and coherence between AEA and PEFA modules.. 2021. Bratislava : KongresStudio, spol. sr.o., 2021. Ochrana Ovzdušia 2021 - Zborník. pp. 80-86. ISBN 978-82-89565-50-4.

Horváth, J, et al. 2022, Results of the EUROSTAT project: New methodology for allocation of Emissions from transport. 2022. Bratislava : Kongres Studio spol. s r.o., 2022. ISBN 987-80-89565-55-9.

Horváth, J,, Szemesová, J, and Zetochová, L. 2022, Roadmap to zero carbon road transport. Graz : Joint Research Centre, 2022. ISBN 978-92-76-43803-8.

Horváth, J. et al. 2022, Výsledky projektu EUROSTAT: Nová metodika pre alokáci emisií z dopravy. 2022. Bratislava : Kongres Studio spol. s r. o.,. ISBN 978-80-89565-56-6.

Jonáček, Z. and col. 2022, Informative Inventory Report 2022, Slovak Republic. Bratislava : Slovak Hydrometeorological Institute, 2022. ISBN 978-80-99929-34-1.

Klimont, Z., Cofala, J., Bertok, I., Amann, M., Heyes, C., Gyarfas, F. 2002. 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

LIFE Integrated Project: Implementation of Air Quality Plan for Małopolska Region – Małopolska in a healthy atmosphere [Online] https://powietrze.malopolska.pl/en/life-project/

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

Most, P. F. J. van der Veldt, C. 1992. Emission factors manual PARCOM-ATMOS : emission factors for air pollutants 1992. Netherlands : TNO Institute of Environmental and Energy Technology, 1992.

National Forest Centre in Zvolen. 2015. Forest portal. [Online] 2015. http://www.forestportal.sk/lesne-hospodarstvo/ochrana-lesa/poziare/Stranky/kategorie-a-priciny-poziarov.aspx.

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

SHMU, ECOSYS: Návrh výpočtu tuhých znečisťujúcich látok s aerodynamickým priemerom menších ako 10 a 2.5 μm (PM10 a PM2.5), Bratislava, August 2008, Interim report.

Statistical Office of the Slovak Republic. 2002-2020. Waste in Slovak republic in 2002-2017. Bratislava: Statistical Office of Slovak Republic, 2002-2020.

Szemesová, J. et al., National Inventory Report 2022, Slovak Republic. Bratislava: Slovak Hydrometeorological Institute, 2022. ISBN 978-80-99929-32-7.

Šťastný, P., et al. 2015. Climate Altlas of Slovakia. Bratislava : Slovak Hdrometeorological Institute, 2015. ISBN 978-8-88907-91-6.

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

Tonhauzer, K., Szemesová, J. 2018. Implementácia mitigačných opatrení a ich potenciál pre znižovanie emisií v poľnohospodárstve. Bratislava : Slovenský hydrometeorologický ústav, 2018. ISSN 1335-339X.

ÚEOS - Komercia, a.s. 2018. Slovak Construction Yearbook 2018. [Online] June 2018. [Dátum: 4. January 2019.] https://www.mindop.sk/ministerstvo-1/vystavba-5/stavebnictvo/dokumenty-a-materialy/rocenky-stavebnictva/rocenky-stavebnictva-2018.

ÚEOS - Komercia, a.s. 2017. Slovak Construction Yearbook 2018. [Online] June 2018. [Dátum: 4. January 2019.] https://www.mindop.sk/ministerstvo-1/vystavba-5/stavebnictvo/dokumenty-a-materialy/rocenky-stavebnictva/rocenky-stavebnictva-2017.

U.S. Dept. of Health and Human Services. 1981. The Health Consequences of Smoking: The Changing Cigarette. 1981. s. 59.

Vestnik" (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

Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

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 for the first time. 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 2021 in %(cumulative total at least 80%)*

NOx	3Da1 (28)	1A3bi (11)	1A4cii (10)	3Da2a (5)	3Da3 (4)	1A3bii (4)	1A3c (3)	1A4di(ii) (2)	1A2f (2)	2C1 (2)		
NMVOC	1B2av (26)	1B2b (11)	1B1a (10)	1A4bi (10)	2H2 (8)	1B2ai (6)	3B1a (3)	3B1b (3)	2D3d (3)	1A3bv (2)		
SOx	2C1 (21)	2C3 (13)	1A1a (11)	1A1b (7)	2B10a (7)	1A2a (4)	2C7c (4)	1A4bi (4)	1A2f (3)	2A6 (2)	1A4ai (2)	1A2gviii (2)
NH_3	3Da2a (49)	3B4gii (9)	3Da3 (7)	3B1b (6)	3B1a (6)	3B3 (6)						
$PM_{2.5}$	1A4bi (59)	1A3bvi (3)	1A3bi (3)	3Dc (2)	1B1a (2)	3B1b (2)	1A3bvii (2)	1B1b (2)	3B1a (2)	1A4cii (2)	5E (1)	
PM_{10}	1A4bi (26)	3Dc (22)	2A5b (9)	1B1a (6)	3B4gii (4)	3B4gi (4)	1A3bvi (3)	1B1b (2)	3B3 (2)	1A3bvii (2)	3B1b (2)	
TSP	2A5b (16)	1A4bi (15)	3B4gi (11)	3Dc (10)	3B3 (8)	1B1a (8)	3B4gii (5)	1B1b (3)	1A3bvi (3)	1A3bvii (2)		
BC	1A4bi (44)	1A3bi (14)	1A4cii (6)	1A3bii (5)	2G (4)	1A2gviii (3)	1A3bvi (2)	1A3biii (2)				
CO	1A4bi (56)	2C1 (9)	1A4bii (8)	1A3bi (4)	1A2gvii (2)	1A1c (2)						
Pb	1A3bvi (46)	2C1 (25)	1B1b (7)	2G (6)								
Cd	1A4ai (26)	1A4bi (26)	2G (8)	1A2a (6)	2C1 (3)	1B2aiv (3)	1B1b (3)	1A5a (3)	1A3bvi (2)			
Hg	1A2f (25)	2K (18)	5C1bv (16)	1A2a (11)	1A2d (7)	1A3bi (5)						
As	2C1 (30)	1B1b (9)	1A2f (8)	1A2d (8)	1A3bvi (8)	1A4ai (5)	1B2aiv (4)	1A3di(ii) (3)	1A4bi (3)	1A2a (3)	1A1a (2)	
Cr	1A3bvi (44)	2C7a (18)	1A4ai (7)	2C1 (5)	1B1b (5)	1A4bi (4)						
Cu	1A3bvi (93)											
Ni	1A3di(ii) (36)	1A3dii (12)	1A3bvi (11)	2C1 (10)	1B1b (7)	1A2f (6)						
Se	2C1 (34)	1A2a (15)	1B1b (14)	1A1a (7)	1A2f (7)	1A3bvi (6)						
Zn	2D3i (41)	2C1 (25)	1A3bvi (17)									
PCDD/F	1A2f (79)	1A1b (8)										
PAHs	2C1 (55)	1B1b (22)	1A4bi (8)									
HCB	1A1a (56)	1A4bi (13)	2C1 (12)									
PCB	2C1 (71)	1A3c (8)	1A1a (7)									

Table A1.2: *Trend assessment of the key categories analysis with uncertainty of air pollutants in the Slovak Republic in 2021 in % (cumulative total at least 80%)*

NOx	1A4cii (16)	1A3biii (13)	3Da1 (11)	1A3bi (9)	1Agvii (6)	1A1a (5)	1A3dii (5)	1Adi(ii) (4)	1A3c (3)	1A3bii (2)	2C1(2)	1A4bi (2)	3Da2a (2)	1A2f (2)
NMVOC	1B2av (28)	1A4bi (24)	2H2 (9)	1A3bi (6)	3B1b (3)	1B1a (2)	1B2ai (2)	1A2gviii (2)	1B2b (2)	2D3d (1)	3B1a (1)			
SOx	1A1a (22)	1A4bi (20)	2C1 (13)	2C3 (10)	1A2d (6)	2B10a (5)	2C7c (3)	2A6 (2)	1A2f (2)					
NH_3	3Da2a (46)	3B3 (19)	3B1b (9)	3B4gii (7)										
$PM_{2.5}$	1A4bi(69)	1A3bvii (3)	1A1a (2)	3Dc (2)	1A3bvii (1)	1A3biii (1)	1A3bi (1)	1A2a (1)						
PM_{10}	1A4bi (44)	3Dc (17)	2A5b (8)	3B4gii (3)	1A3bvi (3)	1B1a (2)	1A3bvii (2)	1B1b (2)	1A1a (2)					
TSP	1A4bi (33)	2A5b (17)	3Dc (9)	3B4gi (5)	3B4gii (5)	1A3bvi (3)	1B1b (3)	3B3 (3)	1A3bvii (2)	1B1a (2)				
BC	1A4bi (54)	1A3biii (7)	1A3bi (7)	2G (4)	1A2gvii (3)	1A3bii (2)	1A4cii (2)	1A3bvi (2)						
CO	1A4bi (57)	1A3bi (9)	1A4cii (5)	1A4bii (5)	2C1 (4)									
Pb	1A3bi (29)	1A3bvi (21)	1A1a (14)	2C1 (15)										
Cd	1A1a (24)	1A4bi (18)	1A4ai (16)	2G (6)	2C7a (5)	1A2a (4)	1A2d (3)	1A5a (2)	2C1 (1)					
Hg	1A2f (17)	1A1a (14)	1A2a (14)	5C1bv (13)	2K (12)	1A2d (6)	1A3bi (4)							
As	1A1a (21)	2C1 (16)	1A4bi (9)	1A3bvi (6)	1A2d (6)	1A2f (5)	2C7a (4)	1B1b (4)	1A4ai (3)	1B2aiv (2)	1A3di(ii) (2)	1A2a (2)		
Cr	1A3bvi (31)	2C7a (19)	1A4bi (13)	1A1a (8)	1A4ai (6)	1A3biii (2)	2C1 (1)							
Cu	1A3bvi (54)	1A3biii (11)	2C1 (10)	1A3bi (8)										
Ni	1A3di(ii) (32)	1A1a (12)	1A3bvi (9)	1A3dii (8)	1A2f (5)	1B1b (5)	1A2a (4)	2C1 (3)	1A2d (3)					
Se	1A1a (33)	2C1 (23)	1A2a (11)	1B1b (7)	1A2f (4)	1A3bvi (4)								
Zn	2D3i (34)	1A3bvi (15)	2C1 (7)	1A3biii (6)	1A1a (4)	1A4ai (4)	1A4bi (3)	1A3biv (2)	1A3cii (2)					
PCDD/F	1A2f (75)	1B1b (6)												
PAHs	2C1 (49)	1A4bi (24)	1B1b (10)											
HCB	1A1a (51)	1A4bi (14)	2C1 (9)	5C1biii (5)	1A4ai (2)									
PCB	1A3c (51)	2C1 (22)	1A2c (4)	1A1a (3)										

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 including and yellow cells exclude condensable components. Grey cells represent categories with notation keys and red cells categories are unknown of 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*

NFR	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			

NFR	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
1A4bi	Residential: Stationary			Unknown - 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_{2016}
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_{2016}
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)			

NFR	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
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]
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_{2016}
3Dd	Off-farm storage, handling and transport of bulk agricultural products			
3De	Cultivated crops			
3Df	Use of pesticides			

NFR	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
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
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 theSlovak Republic in 2021 inTJ*

	Anthra-cite	*Coking Coal*	*Other Bituminous Coal*	*Brown Coal and Lignite*	*Hard Coal Coke*	*Brown Coal and Peat Briquettes*	*Patent Fuel*	*Coal Tar*	*Coke Oven Gas*	*Blast Furnace Gas*	*Oxygen Steel Furnace Gas*
Primary Production	-	-	-	12 019	-	-	-	-	-	-	-
Import	3 307	80 216	13 390	2 619	4 715	1 035	196	-	-	-	-
Export	-	-	-	-	28	-	-	1 842	-	-	-
Stock Changes	625	865	3 072	-22	-1 875	-	-	-	-	-	-
Gross Inland Consumption	**3 932**	**81 081**	**16 462**	**14 616**	**2 812**	**1 035**	**196**	**-1 842**	**-**	**-**	**-**
Transformation Input	**1 302**	**81 081**	**5 592**	**13 765**	**45 800**	**-**	**-**	**-**	**743**	**1 570**	**424**
Electricity Production - Thermal Equipment	1 302	-	5 592	13 720	-	-	-	-	743	1 563	412
of which: Public	1 302	-	3 859	13 720	-	-	-	-	-	-	-
Autoproducers	-	-	1 733	-	-	-	-	-	743	1 563	412
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	63 129	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	17 952	-	-	45 772	-	-	-	-	-	-
Refineries	-	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	45	28	-	-	-	-	7	12
Transformation Output	**-**	**-**	-	**-**	**46 197**	**-**	**-**	**1 842**	**11 353**	**20 428**	**3 470**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	46 197	-	-	1 842	11 353	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	20 428	3 470
Refineries	-	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-**	**-**	-	-	-	**-**	**-**	**-**	-	-	-
Product Transferred	**-**	**-**	-	-	-	-	-	-	-	-	-
Backflows from Petrochemical Sector	**-**	**-**	-	-	-	-	-	-	-	-	-
Consumption of the Energy Sector	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4 081**	**10 525**	**-**
Distribution Losses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**121**	**1 266**	**659**

1st continuation

	Anthra-cite	*Coking Coal*	*Other Bituminous Coal*	*Brown Coal and Lignite*	*Hard Coal Coke*	*Brown Coal and Peat Briquettes*	*Patent Fuel*	*Coal Tar*	*Coke Oven Gas*	*Blast Furnace Gas*	*Oxygen Steel Furnace Gas*
Final Consumption	**2 630**	**-**	**10 870**	**851**	**3 209**	**1 035**	**196**	**-**	**6 408**	**7 067**	**2 387**
Final Non - Energy Consumption	**1 172**	**-**	**-**	**-**	**994**	**-**	**-**	**-**	**-**	**-**	**-**
of which: Chemical Industry	-	-	-	-	-	-	-	-	-	-	-
Final Energy Consumption	**1 458**	**-**	**10 870**	**851**	**2 215**	**1 035**	**196**	**-**	**6 408**	**7 067**	**2 387**
Industry	**1 458**	**-**	**7 536**	**101**	**2 158**	**-**	**-**	**-**	**6 408**	**7 067**	**2 387**
of which: Iron and steel	1 354	-	6 092	-	1 051	-	-	-	6 404	7 067	2 387
Non - ferrous metals	-	-	-	-	142	-	-	-	-	-	-
Chemical	-	-	-	-	28	-	-	-	-	-	-
Non - metallic minerals	104	-	1 444	34	852	-	-	-	4	-	-
Mining and quarrying	-	-	-	-	-	-	-	-	-	-	-
Food, beverages and tobacco	-	-	-	-	85	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-	-
Pulp, paper and print	-	-	-	-	-	-	-	-	-	-	-
Mach. and transport equipment	-	-	-	67	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Other Sectors	**-**	**-**	**3 334**	**750**	**57**	**1 035**	**196**	**-**	**-**	**-**	**-**
of which: Households	-	-	1 050	448	57	776	-	-	-	-	-
Agriculture	-	-	-	11	-	-	-	-	-	-	-
Commercial and public services	-	-	2 284	291	-	259	196	-	-	-	-

2nd continuation

	Natural Gas	*Crude Oil and NGL*	*Refinery Feedstock[1/]*	*Refinery Gas*	*LPG*	*Naphta*	*Gasoline*	*Kerosene*
Primary Production	2 044	294	8 509	-	-	-	-	-
Import	178 759	229 625	965	-	2 162	1 320	8 258	87
Export	47 208	210	-	-	414	1 892	35 713	736
Stock Changes	56 948	1 680	-	-	-46	220	-351	-
Gross Inland Consumption	**190 543**	**231 389**	**9 474**	**-**	**1 702**	**-352**	**-27 806**	**-649**
Transformation Input	**46 915**	**231 389**	**33 019**	**167**	**-**	**-**	**-**	**-**
Electricity Production - Thermal Equipment	37 636	-	-	167	-	-	-	-
of which: Public	35 940	-	-	-	-	-	-	-
Autoproducers	1 696	-	-	167	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-
Refineries	-	231 389	33 019	-	-	-	-	-
Heat Production	9 279	-	-	-	-	-	-	-
Transformation Output	**-**	**-**	**-**	**15 512**	**5 934**	**25 696**	**51 615**	**1 602**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-
Refineries	-	-	-	15 512	5 934	25 696	51 615	1 602
Heat Production	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-6 974**	**-**	**23 545**	**-**	**-2 714**	**-6 160**	**-**	**-**
Product Transferred	-6 974	-	14 671	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	8 874	-	-2 714	-6 160	-	-
Consumption of the Energy Sector	**4 999**	**-**	**-**	**11 634**	**-**	**-**	**-**	**-**
Distribution Losses	**3 922**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3rd continuation

	Natural Gas	*Crude Oil and NGL*	*Refinery Feedstock[1/]*	*Refinery Gas*	*LPG*	*Naphta*	*Gasoline*	*Kerosene*
Final Consumption	**127 733**	**-**	**-**	**3 711**	**4 922**	**19 184**	**23 809**	**953**
Final Non - Energy Consumption	**17 010**	**-**	**-**	**-**	**2 530**	**19 184**	**-**	**-**
of which: Chemical Industry	17 010	-	-	-	2 530	19 184	-	-
Final Energy Consumption	**110 723**	**-**	**-**	**3 711**	**2 392**	**-**	**23 809**	**953**
Industry	**34 817**	**-**	**-**	**3 711**	**184**	**-**	**44**	**-**
of which: Iron and steel	6 412	-	-	-	-	-	-	-
Non - ferrous metals	1 726	-	-	-	-	-	-	-
Chemical	4 438	-	-	3 711	-	-	-	-
Non - metallic minerals	4 601	-	-	-	92	-	-	-
Mining and quarrying	1 722	-	-	-	-	-	-	-
Food, beverages and tobacco	3 752	-	-	-	-	-	-	-
Textile and leather	434	-	-	-	-	-	-	-
Pulp, paper and print	1 992	-	-	-	-	-	-	-
Mach. and transport equipment	6 370	-	-	-	46	-	44	-
Not elsewhere specified	3 370	-	-	-	46	-	-	-
Transport	**306**	**-**	**-**	**-**	**1 564**	**-**	**23 765**	**953**
Other Sectors	**75 600**	**-**	**-**	**-**	**644**	**-**	**-**	**-**
of which: Households	51 433	-	-	-	368	-	-	-
Agriculture	1 102	-	-	-	184	-	-	-
Commercial and public services	23 065	-	-	-	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	35 648	528	2 182	283	344	2 188	6 582	173	4 576	4 519
Export	72 895	2 152	4 243	11 757	301	715	818	-	-	14 318
Stock Changes	337	81	283	404	-	-	-	-	-35	-169
Gross Inland Consumption	**-36 910**	**-1 543**	**-1 778**	**-11 070**	**43**	**1 473**	**5 764**	**173**	**4 541**	**-9 968**
Transformation Input	**42**	-	**40**	**2 505**	**-**	**-**	**-**	**-**	**-**	**-**
Electricity Production - Thermal Equipment	42	-	40	2 505	-	-	-	-	-	-
of which: Public	-	-	40	-	-	-	-	-	-	-
Autoproducers	42	-	-	2 505	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	-
Refineries	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	-
Transformation Output	**119 190**	**2 233**	**1 858**	**19 958**	**-**	**-**	**-**	**-**	**1 872**	**12 671**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	-
Refineries	119 190	2 233	1 858	19 958	-	-	-	-	1 872	12 671
Heat Production	-	-	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Product Transferred	-	-	-	-	-	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-
Consumption of the Energy Sector	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1 872**	**-**
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	**82 238**	**690**	**40**	**6 383**	**43**	**1 473**	**5 764**	**173**	**4 541**	**2 703**
Final Non - Energy Consumption	**-**	**568**	**-**	**-**	**43**	**1 473**	**5 764**	**173**	**2 288**	**2 703**
of which: Chemical Industry	-	568	-	-	-	-	-	-	-	2 703
Final Energy Consumption	**82 238**	**122**	**40**	**6 383**	**-**	**-**	**-**	**-**	**2 253**	**-**
Industry	**547**	**-**	**40**	**6 383**	**-**	**-**	**-**	**-**	**2 253**	**-**
of which: Iron and steel	-	-	40	-	-	-	-	-	-	-
Non - ferrous metals	-	-	-	-	-	-	-	-	-	-
Chemical	-	-	-	6 383	-	-	-	-	-	-
Non - metallic minerals	42	-	-	-	-	-	-	-	2 253	-
Mining and quarrying	168	-	-	-	-	-	-	-	-	-
Food, beverages and tobacco	-	-	-	-	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-
Pulp, paper and print	-	-	-	-	-	-	-	-	-	-
Mach. and transport equipment	42	-	-	-	-	-	-	-	-	-
Not elsewhere specified	295	-	-	-	-	-	-	-	-	-
Transport	**79 502**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Other Sectors	**2 189**	**122**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
of which: Households	-	-	-	-	-	-	-	-	-	-
Agriculture	2 189	-	-	-	-	-	-	-	-	-
Commercial and public services	-	122	-	-	-	-	-	-	-	-

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	165 004	365	302	2 887	-	62 634	3 003	5 472	7 894	18	15 329	2 416	-	7 390	295 580
Import	-	-	-	-	74	72	-	-	623	-	-	-	49 982	4 256	638 684
Export	-	-	-	-	-	631	-	-	-	-	-	-	47 196	3 968	247 037
Stock Changes	-	-	-	-	-	101	-	-	12	-	-	-	-	19	62 149
Gross Inland Consumption	**165 004**	**365**	**302**	**2 887**	**74**	**62 176**	**3 003**	**5 472**	**8 529**	**18**	15 329	2 416	**2 786**	**7 697**	**749 376**
Transformation Input	**162 995**	**-**	**272**	**-**	**-**	**19 262**	**1 541**	**4 427**	**1 367**	**-**	**-**	**-**	**-**	**-**	**654 218**
Electricity Production - Thermal Equipment	-	-	-	-	-	16 333	1 541	4 354	1 260	-	-	-	-	-	87 210
of which: Public	-	-	-	-	-	8 744	-	1 549	1 253	-	-	-	-	-	66 407
Autoproducers	-	-	-	-	-	7 589	1 541	2 805	7	-	-	-	-	-	20 803
Nuclear Plants	162 995	-	-	-	-	-	-	-	-	-	-	-	-	-	162 995
Coke Ovens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63 129
Blast Furnaces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63 724
Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	264 408
Heat Production	-	-	272	-	-	2 929	-	73	107	-	-	-	-	-	12 752
Transformation Output	**-**	**-**	**-**	**-**	**30 458**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**89 236**	**-**	**461 125**
Electricity Production - Thermal Equipment	-	-	-	-	19 393	-	-	-	-	-	-	-	32 609	-	52 002
of which: Public	-	-	-	-	16 798	-	-	-	-	-	-	-	22 929	-	39 727
Autoproducers	-	-	-	-	2 595	-	-	-	-	-	-	-	9 680	-	12 275
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-	-	56 627	-	56 627
Coke Ovens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59 392
Blast Furnaces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23 898
Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	258 141
Heat Production	-	-	-	-	11 065	-	-	-	-	-	-	-	-	-	11 065
Exchanges and Transfers, Backflows	**-2 009**	**-2**	**-**	**-2 887**	**4 898**	**-**	**-**	**-**	**-**	**-18**	-15 329	**-2 416**	**17 763**	**-7 697**	**0**
Product Transferred	-2 009	-2	-	-2 887	4 898	-	-	-	-	-18	-15 329	-2 416	17 763	-7 697	0
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Consumption of the Energy Sector	**-**	**5**	**-**	**-**	**3 747**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**12 949**	**-**	**49 812**
Distribution Losses	**-**	**-**	**-**	**-**	**4 177**	**24**	**-**	**-**	**-**	**-**	**-**	**-**	**4 860**	**-**	**15 029**

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	**-**	**358**	**30**	**-**	**27 506**	**42 890**	**1 462**	**1 045**	**7 162**	**-**	**-**	**-**	**91 976**	**-**	**491 442**
Final Non - Energy Consumption	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**53 902**
of which: Chemical Industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41 995
Final Energy Consumption	**-**	**358**	**30**	**-**	**27 506**	**42 890**	**1 462**	**1 045**	**7 162**	**-**	**-**	**-**	**91 976**	**-**	**437 540**
Industry	**-**	**-**	**-**	**-**	**2 902**	**13 770**	**-**	**3**	**7 162**	**-**	**-**	**-**	**41 789**	**-**	**140 720**
of which: Iron and steel	-	-	-	-	31	321	-	-	-	-	-	-	6 109	-	37 268
Non - ferrous metals	-	-	-	-	96	-	-	-	-	-	-	-	9 112	-	11 076
Chemical	-	-	-	-	432	5	-	-	873	-	-	-	4 302	-	20 172
Non - metallic minerals	-	-	-	-	196	6	-	-	6 234	-	-	-	2 959	-	18 821
Mining and quarrying	-	-	-	-	5	-	-	-	-	-	-	-	202	-	2 097
Food, beverages and tobacco	-	-	-	-	233	259	-	-	-	-	-	-	1 786	-	6 115
Textile and leather	-	-	-	-	33	1	-	-	-	-	-	-	360	-	828
Pulp, paper and print	-	-	-	-	1295	11 645	-	3	-	-	-	-	3 172	-	18 107
Mach. and transport equipment	-	-	-	-	397	183	-	-	55	-	-	-	9 121	-	16 325
Not elsewhere specified	-	-	-	-	184	1 350	-	-	-	-	-	-	4 666	-	9 911
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2 110**	**-**	**108 200**
Other Sectors	**-**	**358**	**30**	**-**	**24 604**	**29 120**	**1462**	**1042**	**-**	**-**	**-**	**-**	**48 077**	**-**	**188 620**
of which: Households	-	326	-	-	19 544	28 709	-	-	-	-	-	-	21 485	-	124 196
Agriculture	-	-	30	-	32	346	-	765	-	-	-	-	810	-	5 469
Commercial and public services	-	32	-	-	5 028	65	1462	277	-	-	-	-	25 782	-	58 955

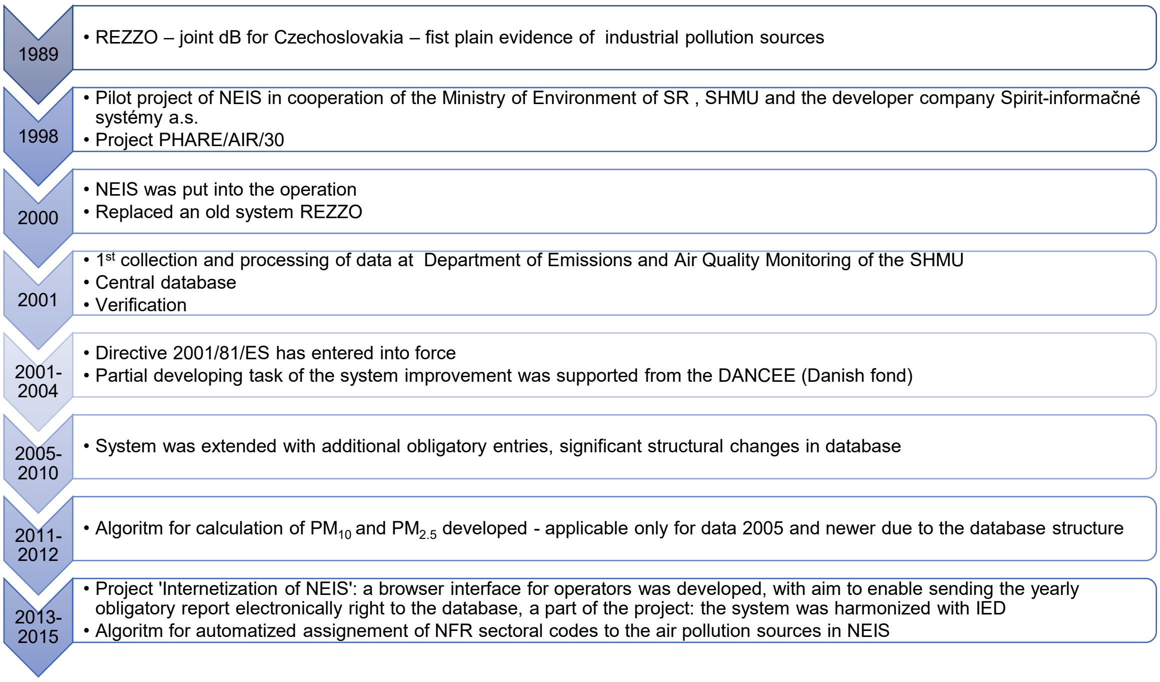
ANNEX IV: ADDITIONAL INFORMATION ON METHODOLOGY

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 pollutants 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.

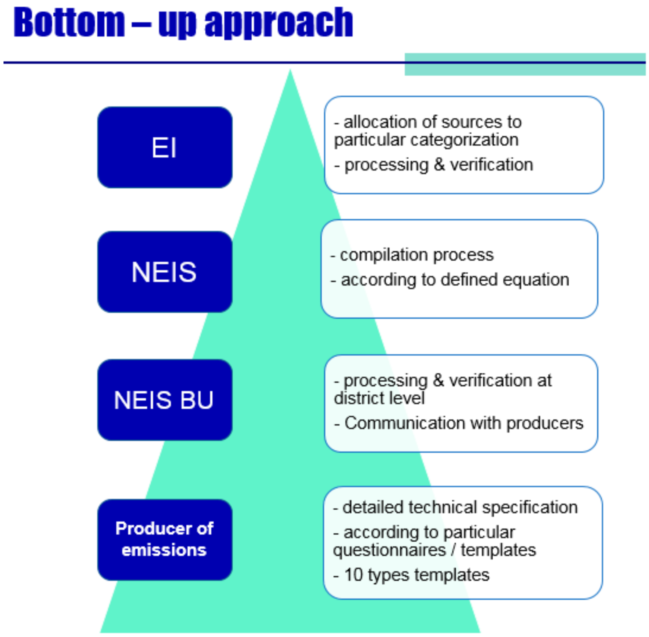
The last changes within the improvement of the NEIS were carried out from December 2013 until August 2015. Within the scope of the recent Project ‘Internetization of NEIS, a browser interface was developed. The aim was to enable sending the yearly obligatory report electronically right to the database 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 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 requires 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 2000–2021 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

FORM TYPE	NAME	CONTENT
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
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

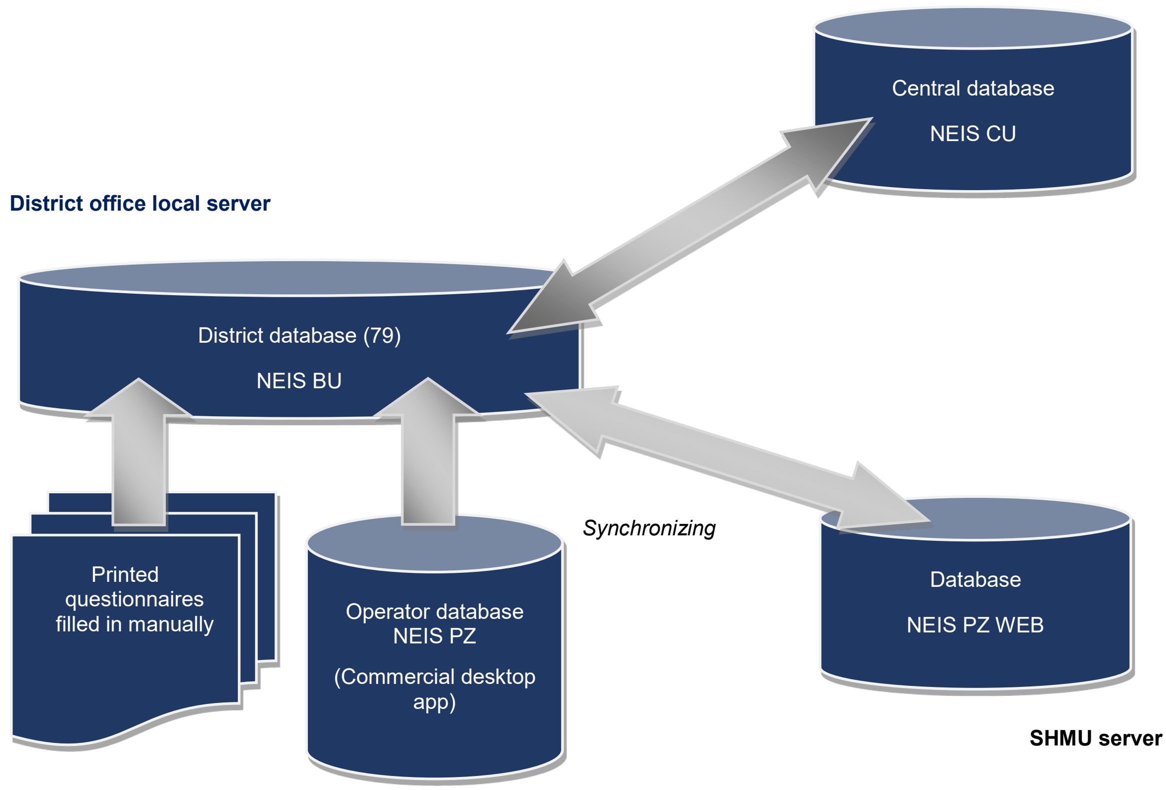
Database NEIS includes about 13000 sources of air pollution per year. The sources are categorized by activity and projected capacity as large or medium (Decree No 410/2012 Coll.) as follow:

- 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 137/2010 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 technology. 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[8],
- 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.

[8] General relations, as well as default EF, are published in Bulletin of the Ministry of the Environment No 410/2012 Coll.

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 (2000-2020) was revised: emissions from individual air pollution sources were reallocated according to revised sectoral codes.

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, compare 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

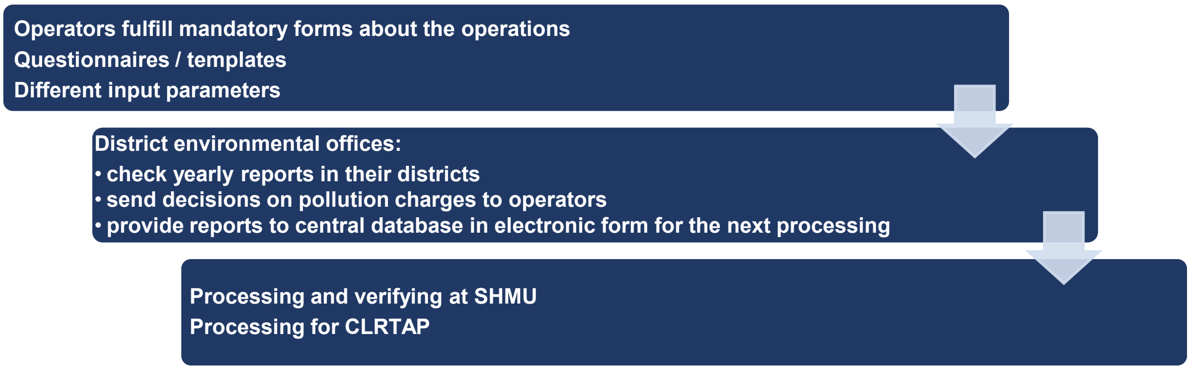
The sources below 0.3 MW (category **1A4bi** – Residential: Stationary plants) are defined as small sources. These are not registered as individual point sources. The emission balance is being processed centrally (NEIS CU - central unit) and it is based on:

- 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*



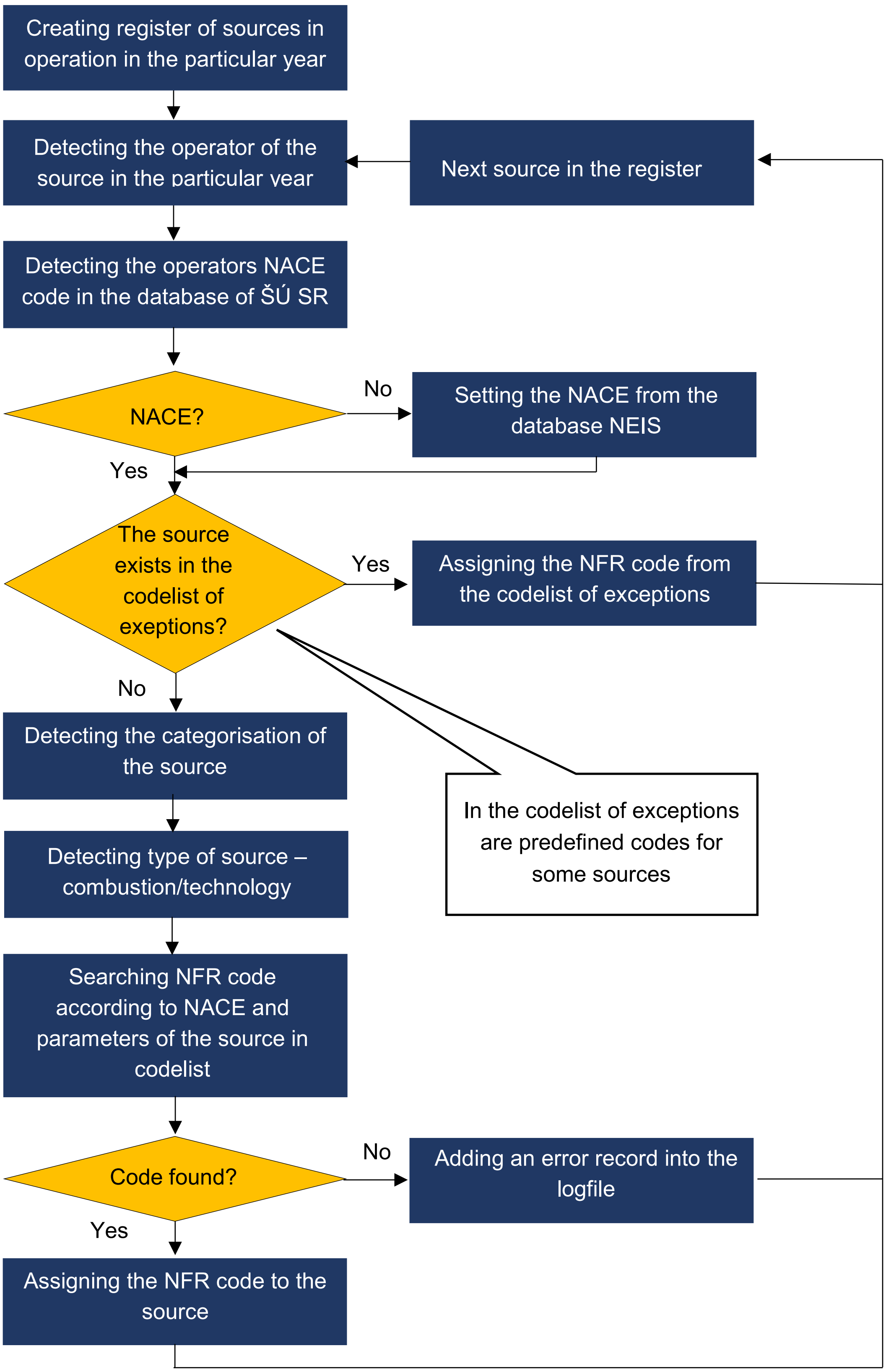
A4.4 VERIFICATION PROCESS OF NEIS DATA

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 NFR 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). Emission inventory of PM_{10} and $PM_{2.5}$ for the Slovak Republic are 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 methodology is based on IIASA's report[9].

Automated calculation of emissions PM_{10} and $PM_{2.5}$ was technically implemented in 2011[10] in db. NEIS according to the study[11]. Emissions PM_{10} and $PM_{2.5}$ were processed with certain sectoral default indicators. In respect of that on the EU level were defined emission ceiling for 2020 based on 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 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.

Table A4.2: *General relations and default EF published in Bulletin of the Ministry of the Environment*

FUEL	input	TZL	SO_2	NO_x as NO_2	CO	VOC	TOC
FURNACE/COMB. UNIT TYPE	**MWt**	**EF in kg/t of fuel, resp. kg/mil.m³ gaseous fuel**					
BR.COAL / LIGNITE							
Dry Bottom Boiler							
pásový rošt		$1.7.A^r$	$17.5.S^r$	3	6	0.055	0.045
pásový rošt s pohadzovačom		$4.0.A^r$	$17.5.S^r$	3	10	0.055	0.045
presuvný vratný rošt ***Combine - Dry and Wet Bottom Boiler*** rošt-olej rošt-plyn		$1,7.A^r$	$17.5.S^r$	3	6	0.055	0.045
Dry Bottom Boiler							
pevný rošt		$1.A^r$	$12.5.S^r$	3	45	7.5	6.15
Granular combined; prášok - rošt; prášok - olej; prášok - plyn							
a) stena		$7.5.A^r$	$17.5.S^r$	4	0,5	0.06	0.05
b) tangenc.		$7.5.A^r$	$17.5.S^r$	4	0,5	0.06	0.05
Fluid Combustion							
circulating layer		$3.A^r$	$12.5.S^r$	2	5	0.055	0.045
static layer		$1.6.A^r$	$12.5.S^r$	3	2.5	0.055	0.045
Cyclone combustion		$3.4.A^r$	$17.5.S^r$	6	0.5	0.06	0.049
WOOD							
		15	-	3	16	0.11	0.09
HARD COAL AND COKE							
Dry Bottom Boiler							
pásový rošt		$1.5.A^r$	$19.S_r$	5.5	3	0.055	0.045

[9] hhttp://www.iiasa.ac.at/web/home/research/researchPrograms/air/ir-02-076.pdf
[10] Správa k riešeniu úlohy „Systém pre prepočet emisií TZL na emisie PM10 a PM2.5, SPIRIT informačné systémy
[11] 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

FUEL	input	TZL	SO_2	NO_x as NO_2	CO	VOC	TOC
FURNACE/COMB. UNIT TYPE	**MWt**	**EF in kg/t of fuel, resp. kg/mil.m³ gaseous fuel**					
pásový rošt s pohadzovačom		$4.A^r$	$19.S^r$	7	2.5	0.055	0.045
presuvný vratný rošt ***Combine - Dry and Wet Bottom Boiler*** rošt-olej rošt-plyn		$1.3.A^r$	$19.S^r$	5.5	3	0.055	0.045
Dry Bottom Boiler							
pevný rošt		$1.A^r$	$15.5.S^r$	5.5	45	7.5	6.15
Granular combined; prášok - rošt; prášok - olej; prášok - plyn							
a) stena		$7.5.A^r$	$19.S^r$	9	0.5	0.06	0.05
b) tangenc.		$7.5.A^r$	$19.S^r$	9	0.5	0.06	0.05
Fluid Combustion							
circulating layer		$2.2.A^r$	$12.5.S^r$	2	5	0.055	0.045
static layer		$1.6.A^r$	$12.5.S^r$	5.5	2.5	0.055	0.045
Cyclone combustion		$1.A^r$	$19.S^r$	17	0.5	0.06	0.049
Melting		$5.A^r$	$19.S^r$	15	0.5	0.045	0.037
LIQUID AND GASEOUS FUELS							
Heavy Fuel Oil	<3	2.9	20xS	8.5	0.65	0.202	0.166
	3-100	2.9	20xS	8.5	0.65	0.146	0.120
	>100	2.9	20xS	8.5	0.65	0.131	0.170
Diesel Oil and Other Liquid Fuels	<3	0.1	20xS	8.5	0.65	0.139	0.114
	3-100	1.1	20xS	8.5	0.65	0.087	0.071
	>100	2.1	20xS	8.5	0.65	0.075	0.062
Naphtha	<3	1.42	20xS	5	0.8	0.139	0.114
	3-100	2.42	20xS	5	0.8	0.087	0.071
	>100	3.42	20xS	5	0.8	0.075	0.062
Propane - Butane		0.45	20xS (0.004)	4.7	0.8	0.132	0.108
Natural Gas	<3.5	80	9.6	1560	630	128	105
	3.5-115	80	9.6	1760	590	92	75
	>115	80	9.6	1760	590	28	23
Blast Furnace Gas	<3.5	302	2.S	1920	320	128	105
	3.5-115	290	2.S	3700	270	92	75
	>115	240	2.S	9600	270	28	23
			(150)				
Coke Oven Gas	<3.5	302	2.S	1920	320	128	105
	3.5-115	290	2.S	3700	270	92	75
	>115	240	2.S	9600	270	28	23
			(9500)				
Other Gas	<3.5	302	2.S	1920	320	128	105
	3.5-115	290	2.S	3700	270	92	75
	>115	240	2.S	9600	270	28	23
			(85)				

A^r = content of ashes in original fuel in % of weight
S^r = content of sulphur in original fuel in % of weight
S = for liquid fuels is sulphur content in % of weight
S = for gaseous fuels is sulphur content in mg/m³
S = for Propane – Butane is sulphur content in mg/100g

A4.7 ABATEMENT TECHNOLOGIES

Table A4.3: *List Abatement technologies reported to NEIS database*

TYPE OF SEPARATOR	NAME
F - textile	F - Textile hose

TYPE OF SEPARATOR	NAME
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
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

TYPE OF SEPARATOR	NAME
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
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	XX																	
synthetic airborne	XX		X															
synthetic burning			XX								XX							
epoxid			XX								XX							
polyurethane			XX				XX								XX			
polymerate				XX			XX	XX							XX			
cellulose			XX	XX		XX	XX		XX	XX		XX						XX
asphalt	XX		XX															
estermid			XX											XX		X		
resole			XX								XX							
PAINTS																		
oil and varnish	XX																	
synthetic airborne	XX		XX															
synthetic burning			XX	XX							XX							
polyurethane 2 K			XX				XX								XX			
polyurethane 1 K			X				XX								XX			
acrylic			XX				XX				XX							
cellulose		XX	XX	XX		XX	XX			XX		XX						
resole			XX			XX	XX				XX							
epoxide			XX								XX							
high solid paints	XX		XX															
chlorine rubber paints			XX				XX											
for print				XX		XX	XX	XX		XX								
THINNERS																		
synthetic	XX		XX															
polyurethane			XX				XX								XX			
cellulose				XX		XX	XX		XX	XX		XX						
other			XX	XX		XX	XX		XX	XX	XX	XX			XX			
solvent adhesives		XX		XX		XX							XX					XX
RESINS																		
unsaturated polyester					XX													
alkyde resins	XX		XX															
akryl resins			XX				XX				XX							
other resins											XX	XX						
COATING REMOVERS																		
old cover removers				XX				XX	XX	XX							XX	

XX-Confidential data

ANNEX V: NECD RECOMMENDATIONS

The Slovak Republic has prioritised its effort to implement the recommendations of the 2022 Comprehensive Technical Review of the National Emission Inventories that might have an impact on the emission estimates as far as possible in the 2023 submission. Recommendations that have been addressed are shaded in grey in ***Table A5.1***. The remaining recommendations are mainly related to transparency and will be implemented in future submissions when resources are available.

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-0A-2020-0002	Final review report, Chapter V, p. 12	Completeness	No	No	Very High	**0A National Total - National total for the entire territory - Based on fuel sold/fuel used, SO2, NH3, NMVOC, PM2.5, BaP, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, PM10, CO, BC, 1990 – 2018:** The TERT noted that the recommendation to carry out a complete uncertainty analysis for all sectors and pollutants, which was first raised during the 2020 review, has been partially implemented. A detailed uncertainty assessment has been carried out for the energy, industry and waste sectors using the uncertainty tool, see section 1.7 and Annex IX of the IIR. Slovakia further stated in its IIR (page 466) that an uncertainty analysis with detailed data for the sectors of agriculture, transport and residential heating is planned for the submissions 2023/2024. The TERT recommends that Slovakia carry out a complete uncertainty analysis for all sectors and pollutants as part of their 2023 submission./**Implemented, Chapter 1.7**
SK-1A2-2022-0001	Final review report 2022. Chapter V., p.13	Transparency	No	No	High	**1A2 Stationary Combustion in Manufacturing Industries and Construction, NH3, 2005,2018,2019,2020:** For subcategories of 1A2 Stationary Combustion in Manufacturing Industries and Construction, solid biomass, NH_3 and selected years (1A2a: 2020, 1A2c: 2005,2018-2020, 1A2d: 2005), the TERT noted that NH_3 emissions are not reported whilst a Tier 1 method is available in the 2019 EMEP/EEA Guidebook. In response to a question raised during the review, Slovakia explained that facility operators report emissions of NH_3 as zero. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Slovakia include a description in the IIR stating that NH_3 emissions from solid biomass combustion are reported as 'NO' because measurements show that NH_3 is not relevant, or that Slovakia estimate NH_3 emissions by using a Tier 1 method of the EMEP/EEA Guidebook./**Implemented, Chapter 3.5.1.**

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA1	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-1A4ai-2022-0001	Final review report 2022. Chapter V., p.13	Transparency	No	No	High	**1A4ai Commercial/Institutional: Stationary, NH_3, 2005:** For 1A4ai Commercial/Institutional: Stationary, solid biomass, NH_3 and 2005, the TERT noted that NH_3 emissions are not reported whilst a Tier 1 method is available in the 2019 EMEP/EEA Guidebook. In response to a question raised during the review, Slovakia explained that facility operators report emissions of NH_3 as zero. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Slovakia include a description in the IIR stating that NH_3 emissions from solid biomass combustion are reported as 'NO' because measurements show that NH_3 is not relevant, or that Slovakia estimate NH_3 emissions by using a Tier 1 method of the EMEP/EEA Guidebook./**Implemented, Chapter 3.7.2.2.**
SK-1A4ci-2022-0001	Final review report 2022. Chapter V., p.13	Transparency	No	No	High	**1A4ci Agriculture/Forestry/Fishing: Stationary, NH_3, 2005, 2018-2020:** For 1A4ci Agriculture/Forestry/Fishing: Stationary, solid biomass, NH_3 and 2005 and 2018-2020, the TERT noted that NH_3 emissions are not reported whilst a Tier 1 method is available in the 2019 EMEP/EEA Guidebook. In response to a question raised during the review, Slovakia provided an emission estimate and explained that the estimate would be reported in the next submission. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Slovakia estimate NH_3 emissions from solid biomass combustion in the submission 2023. /**Implemented, Chapter 3.7.6.2.**

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA1	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-2G-2022-0001	Final review report 2022, Chapter V, page. 14	Transparency	No	No	High	**2G Other Product Use, NOX, NH_3, NMVOC, $PM_{2.5}$, 2005:** For 2G Other Product Use for NH_3, NMVOC, NOX and $PM_{2.5}$ for 2005, the TERT noted that there is a lack of transparency regarding emissions being statistically greater than emissions between 2000-2010. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Slovakia explained that in 2005 a high amount of tobacco products was imported to the Slovak Republic. The TERT is of the view that export data for 2005 are possibly incorrect or that for 2005 and subsequent years some tobacco products were possibly kept in stock. The TERT recommends that Slovakia check the export data and possibility of stock, and in case of errors correct estimates for 2005 and subsequent years in its next submission./**Implemented, Chapter 4.7.10.4.**
SK-3B4h-2022-0001	Final review report 2022, Chapter V., p. 14	Completeness	No	No	High	**3B4h Manure Management - Other Animals, NOX, NH_3, NMVOC, $PM_{2.5}$, PM_{10}, 1990-2020:** For category 3B4h Manure Management - Other Animals for the years 1990-2020 and pollutants: NOX, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, the TERT noted that the notation key 'NA' (not applicable) is used whilst a Tier 1 method is available in the 2019 EMEP/EEA Guidebook. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Slovakia explained that it does not have any activity data on category 3B4h. For the benefit of the review, they provided an estimated based on FAOSTAT, which confirmed that the issue is indeed below the threshold of significance. The TERT recommends that Slovakia calculate the emissions for this NFR code in future submissions to improve completeness of its inventory./**Not implemented. More information isavailable in Chapter 5.3**

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA1	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-5B1-2022-000	Final review Report 2022, Chapter V., p. 12	Accuracy	No	Yes	High	**5B1 Biological Treatment of Waste - Composting, NH_3, 2005-2020:** For 5B1 Biological Treatment of Waste - Composting, NH_3 emissions and all years, the TERT noted that the performed recalculations resulted in a substantial decrease in NH_3 emissions. The explanation for this recalculation was that weight of waste has been amended so that dry weight instead of wet weight is used. Although this is not explicitly stated in the 2019 EMEP/EEA Guidebook, the TERT compared this method with other countries and studies and concluded that activity data for 5B1 should be used as wet weight. In response to a question raised during the review, Slovakia accepted the interpretation by the TERT and provided a revised estimate. This means that the default emission factor is applied to organic waste in wet weight. Slovakia provided a revised estimate for NH_3 emissions for year 1990-2020 and stated that it would be included in the next submission. The TERT agreed with the revised estimate provided by Slovakia. The TERT recommends that Slovakia include the revised estimate in its 2023 NFR and IIR submission./**Implemented, Chapter 6.5.2.**
SK-5C2-2022-0001	Final review Report 2022, Chapter V., p. 14	Transparency	No	No	High	**5C2 Open Burning of Waste, SO2, NOX, NMVOC, $PM_{2.5}$, PM_{10}, 2005-2020:** For 5C2 Open Burning of Waste and all main pollutants, the TERT noted that there is a lack of transparency regarding the use of a notation key (NO) and its explanation. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Slovakia referred to waste legislation from 2015 and 2001 prohibiting the burning of agricultural waste. The TERT recommends that Slovakia include this information and some further explanation if this legislation relates to crop and/or forestry and/or orchard burning to increase transparency and completeness. /**Implemented, Chapter 6.6.5**.

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA1	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-5D1-2022-0001	Final review Report 2022, Chapter V., p. 15	Transparency	No	No	High	**5D1 Domestic Wastewater Handling, $PM_{2.5}$, PM_{10}, 1990-2020:** For 5D1 Domestic Wastewater Handling, the TERT noted that there is a lack of transparency regarding an explanation why PM_{10} emissions are equal to $PM_{2.5}$ emissions resulting from flaring of biogas. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Slovakia explained that emission factors for $PM_{2.5}$ and PM_{10} are determined in the Decree 363/2010 Coll., which had been set by evaluating the results of available measurements in installations which flare biogas. A comparison was made with other similar foreign materials, especially with the methodology and factors issued by the Ministry of the Environment of Czechia, factors issued by the US EPA, Corinair Inventory, which were also used as a basis for determining emission factors for some technologies. The TERT recommends that Slovakia include a description of the calculation of PM emissions from category 5D1 in its next submission. /**Implemented, Chapter 6.7.2**.
SK-5D2-2022-0003	Final review Report 2022, Chapter V., p. 15	Transparency	No	No	High	**5D2 Industrial Wastewater Handling, $PM_{2.5}$, PM_{10}, 1990-2020:** For 5D2 Industrial Wastewater Handling, PM emissions, the TERT noted that there is a lack of transparency regarding the documentation of the methodology to calculate $PM_{2.5}$ and PM_{10} emissions. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Slovakia explained that PM emissions are based on implied emission factors, derived from facility data which flare biogas, and are quality checked with other national and international data sources. The TERT recommends that Slovakia include in its 2023 IIR documentation of how PM emissions have been calculated and what the data sources are. /**Implemented, Chapter 6.7.3**.

Serial No.	Review report/ Chapter/Page	Priority criteria TCCCA1	Priority criteria Key category	Priority criteria over emission 2%	Priority level (Very high, High, Low)	Review Recommendation
SK-5D2-2022-0004	Final review Report 2022, Chapter V., p. 12	Accuracy	Yes	Yes	High	**5D2 Industrial Wastewater Handling, NMVOC, 2005-2020:** For 5D2 Industrial Wastewater Handling, NMVOC emissions and all years, the TERT noted that the emission values are about 400 times higher than average emissions of other countries and was not sure if a Tier 2 methodology has been applied for this key category. In response to a question raised during the review, Slovakia stated that a unit conversion error resulted in emissions that are 1000 times too high and provided further information on the technologies applied, including the flaring of biogas resulting in additional emissions from 5D2. Slovakia provided a revised estimate for NMVOC emissions for year 1990-2020 and stated that it would be included in the next submission. The TERT agreed with the revised estimate provided by Slovakia. The TERT recommends that Slovakia include the revised estimate in its 2023 NFR and IIR submission. / **Implemented, Chapter 6.7.3**.

ANNEX VI: IMPLEMENTATION OF MITIGATION MEASURES FOR AMMONIA EMISSIONS REDUCTION IN AGRICULTURE

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 the 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[12] Coll. on air and Decree of the Ministry of the Environment of the Slovak Republic No 410/2012 Coll[13]. 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 pollutions and pollution charges into the relevant district in the prescribed forms, or a portable electronic medium. NEIS has information on livestock number 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 into the emissions inventory for quality control purposes.

12 Act of the Ministry of the Environment of the Slovak Republic no.137/2010 Coll. Of 3 March 2010
13 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

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[14]. The ŠU SR 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.

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, 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*** provides a share of the abatements per farm. There 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 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 tier 3 approach was accepted of 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 into 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 put together as a single well mixed system with weighted-average emission factors. Abated emission factors were calculated separately and implemented into 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:

$\mathbf{Ef_{average}}$ = 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*

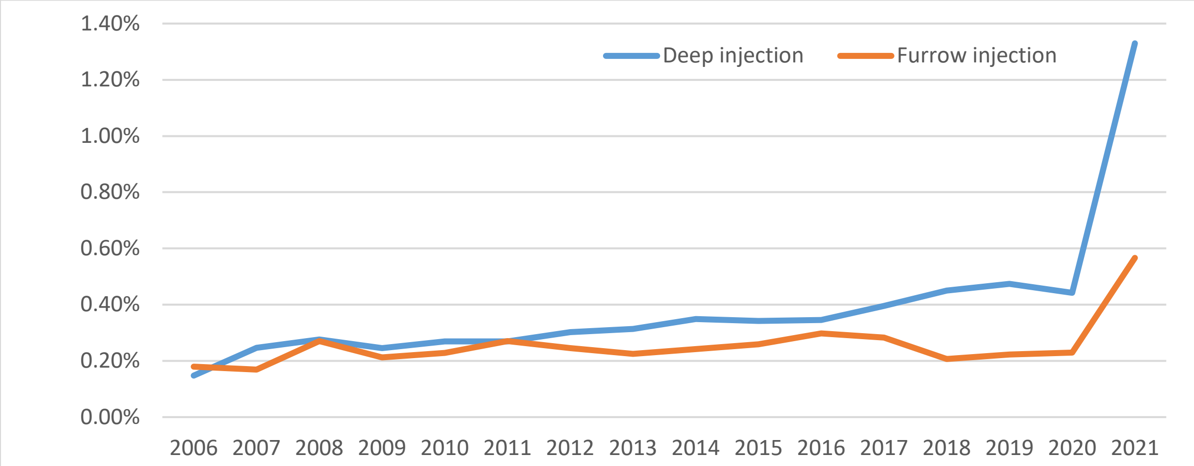


Figure A6.2: *Development of abatements since 2006*

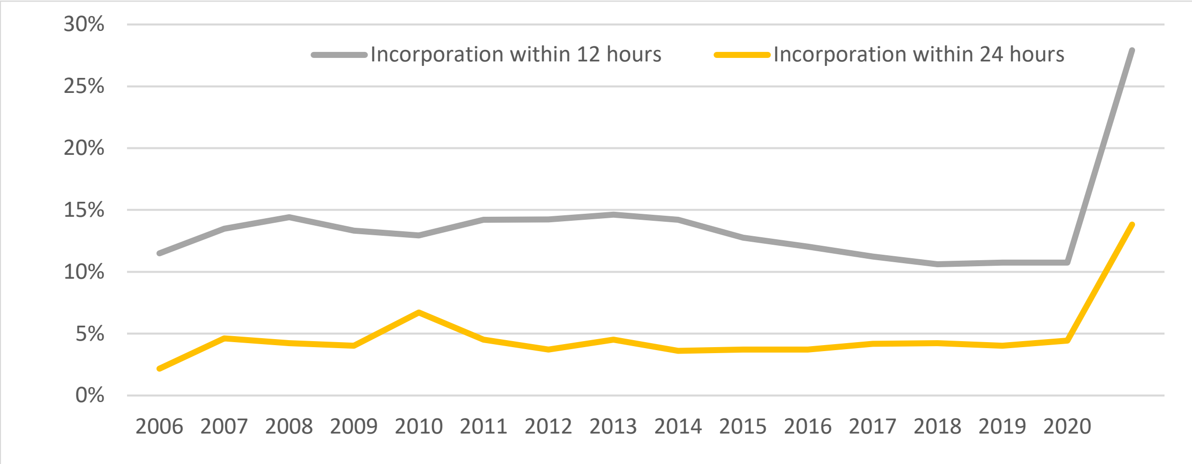


Figure A6.3: *Development of abatements since 2006*

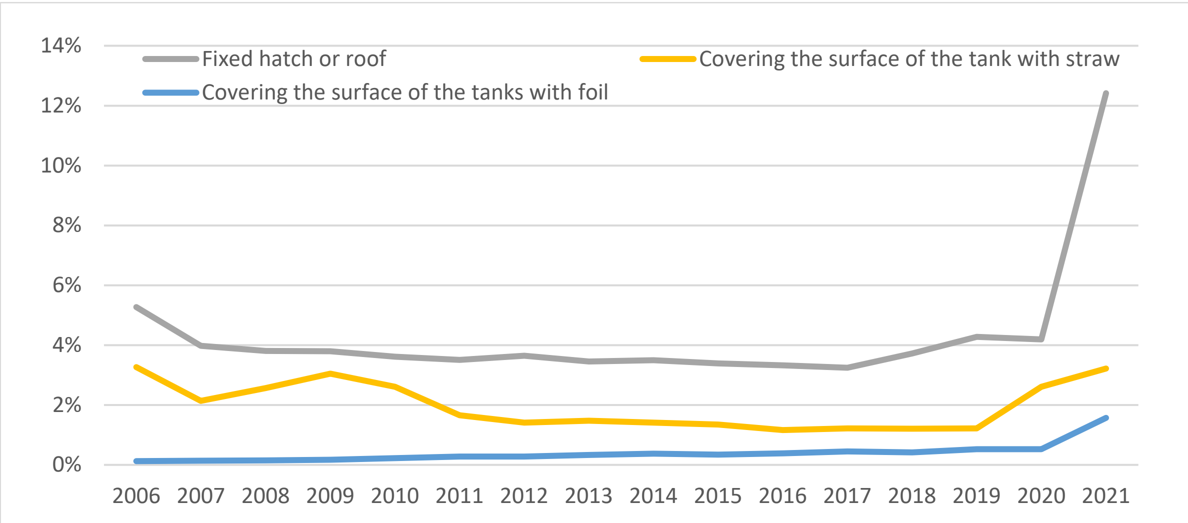


Table A6.2: *Penetration of storage abatement measure – fixed hatch or roof*

FIXED HATCH OR ROOF											
CATEGORY	**DAIRY CATTLE**	**NON-DAIRY CATTLE**	**BROILERS**	**LAYING HENS**	**GEESE**	**TURKEYS**	**DUCKS**	**HORSES**	**BREEDING SWINE**	**FATTENING SWINE**	**SHEEP**
2006	7%	7%	1%	0%	5%	5%	5%	0%	13%	16%	0%
2007	6%	7%	1%	2%	0%	0%	0%	0%	13%	14%	1%

FIXED HATCH OR ROOF											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2008	7%	7%	1%	2%	0%	0%	0%	0%	11%	14%	1%
2009	6%	7%	1%	2%	0%	0%	0%	0%	11%	14%	1%
2010	6%	6%	1%	3%	0%	0%	0%	0%	10%	13%	1%
2011	5%	5%	1%	3%	0%	0%	0%	0%	11%	14%	0%
2012	6%	5%	1%	3%	0%	0%	0%	0%	11%	15%	0%
2013	6%	5%	1%	3%	0%	0%	0%	0%	11%	13%	0%
2014	6%	5%	1%	2%	0%	0%	0%	0%	11%	14%	0%
2015	6%	5%	1%	1%	0%	0%	0%	0%	11%	14%	0%
2016	5%	5%	0%	1%	0%	0%	0%	0%	11%	13%	0%
2017	5%	5%	0%	1%	0%	0%	0%	0%	10%	13%	0%
2018	5%	5%	0%	1%	0%	0%	0%	3%	12%	14%	0%
2019	5%	5%	0%	1%	0%	0%	0%	6%	11%	15%	3%
2020	6%	5%	0%	1%	0%	0%	0%	6%	11%	14%	2%
2021	16%	15%	1%	4%	0%	0%	0%	20%	31%	38%	11%

Table A6.3: *Penetration of storage abatement measure – covering the surface of the tank with straw*

COVERING THE SURFACE OF THE TANK WITH STRAW											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2006	1%	1%	1%	2%	10%	10%	10%	0%	1%	1%	0%
2007	1%	1%	2%	1%	6%	6%	6%	0%	1%	1%	0%
2008	1%	2%	2%	1%	7%	7%	7%	0%	1%	1%	0%
2009	2%	2%	2%	1%	8%	8%	8%	0%	1%	1%	0%
2010	2%	2%	2%	1%	7%	7%	7%	0%	1%	2%	0%
2011	2%	2%	2%	1%	3%	3%	3%	0%	1%	2%	0%
2012	1%	1%	2%	1%	3%	3%	3%	0%	1%	1%	0%
2013	1%	1%	1%	1%	3%	3%	3%	0%	1%	1%	0%
2014	1%	1%	2%	1%	3%	3%	3%	0%	1%	1%	0%
2015	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2016	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2017	1%	1%	2%	1%	2%	2%	2%	0%	1%	1%	0%
2018	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2019	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2020	2%	2%	2%	1%	7%	7%	7%	0%	1%	2%	0%
2021	3%	4%	4%	1%	5%	5%	5%	0%	3%	5%	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											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2006	1%	1%	1%	2%	10%	10%	10%	0%	1%	1%	0%
2007	1%	1%	2%	1%	6%	6%	6%	0%	1%	1%	0%
2008	1%	2%	2%	1%	7%	7%	7%	0%	1%	1%	0%
2009	2%	2%	2%	1%	8%	8%	8%	0%	1%	1%	0%
2010	2%	2%	2%	1%	7%	7%	7%	0%	1%	2%	0%
2011	2%	2%	2%	1%	3%	3%	3%	0%	1%	2%	0%
2012	1%	1%	2%	1%	3%	3%	3%	0%	1%	1%	0%
2013	1%	1%	1%	1%	3%	3%	3%	0%	1%	1%	0%
2014	1%	1%	2%	1%	3%	3%	3%	0%	1%	1%	0%
2015	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%

COVERING THE SURFACE OF THE TANKS WITH FOIL											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2016	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2017	1%	1%	2%	1%	2%	2%	2%	0%	1%	1%	0%
2018	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2019	1%	1%	2%	1%	2%	2%	2%	0%	1%	2%	0%
2020	2%	2%	2%	1%	7%	7%	7%	0%	1%	2%	0%
2021	3%	2%	0%	0%	0%	0%	0%	0%	6%	7%	0%

Table A6.5: *Penetration of storage abatement measure - Slurry/liquid with natural crust cover*

SLURRY/LIQUID WITH NATURAL CRUST COVER											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2009	2%	2%	2%	1%	8%	8%	8%	0%	1%	2%	0%
2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2011	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2012	13%	14%	4%	4%	9%	9%	9%	4%	12%	10%	1%
2013	11%	12%	3%	3%	6%	6%	6%	4%	10%	7%	1%
2014	40%	11%	12%	2%	1%	5%	5%	5%	0%	11%	8%
2015	12%	12%	2%	1%	2%	2%	2%	3%	11%	8%	0%
2016	12%	12%	2%	1%	2%	2%	2%	3%	12%	8%	0%
2017	12%	12%	2%	0%	2%	2%	2%	4%	13%	8%	1%
2018	12%	13%	2%	0%	2%	2%	2%	6%	13%	8%	4%
2019	12%	13%	2%	1%	2%	2%	2%	6%	12%	7%	4%
2020	12%	13%	2%	1%	2%	2%	2%	6%	11%	7%	5%
2021	35%	38%	8%	2%	5%	5%	5%	20%	31%	20%	16%

Table A6.6: *Penetration of application abatement measure – furrow injection*

FURROW INJECTION											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2006	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2007	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2008	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%
2011	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	0%
2012	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2013	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2014	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2015	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	0%
2016	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	0%
2017	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2018	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2019	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2020	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2021	1%	0%	0%	0%	0%	0%	0%	0%	3%	2%	0%

Table A6.7: *Penetration of application abatement – deep injection*

DEEP INJECTION											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2006	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2007	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2008	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2009	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2010	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2011	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2012	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2013	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2014	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2015	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2016	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2017	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
2018	1%	0%	0%	0%	0%	0%	0%	0%	2%	2%	0%
2019	1%	0%	0%	0%	0%	0%	0%	0%	2%	2%	0%
2020	1%	0%	0%	0%	0%	0%	0%	0%	1%	2%	0%
2021	4%	1%	0%	0%	0%	0%	0%	0%	4%	5%	0%

Table A6.8: *Penetration of application abatement - incorporation within 12 hours*

INCORPORATION WITHIN 12 HOURS											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2006	18%	18%	8%	4%	14%	14%	14%	0%	17%	17%	0%
2007	17%	18%	6%	4%	11%	11%	11%	21%	16%	16%	16%
2008	19%	19%	6%	4%	13%	13%	13%	21%	17%	17%	16%
2009	19%	19%	6%	4%	8%	8%	8%	21%	18%	18%	16%
2010	19%	19%	6%	3%	7%	7%	7%	20%	20%	18%	18%
2011	18%	18%	5%	5%	10%	10%	10%	22%	20%	18%	19%
2012	18%	18%	6%	5%	8%	8%	8%	25%	20%	18%	23%
2013	18%	18%	6%	7%	9%	9%	9%	27%	19%	17%	22%
2014	18%	18%	6%	7%	8%	8%	8%	29%	18%	16%	23%
2015	17%	17%	5%	5%	5%	5%	5%	28%	18%	15%	22%
2016	17%	17%	5%	4%	4%	4%	4%	26%	17%	15%	21%
2017	16%	16%	5%	4%	4%	4%	4%	20%	16%	14%	20%
2018	15%	16%	5%	4%	4%	4%	4%	16%	16%	15%	18%
2019	15%	15%	5%	3%	7%	7%	7%	13%	16%	15%	16%
2020	15%	15%	5%	3%	7%	7%	7%	13%	16%	15%	16%
2021	41%	42%	14%	9%	21%	21%	21%	18%	42%	42%	41%

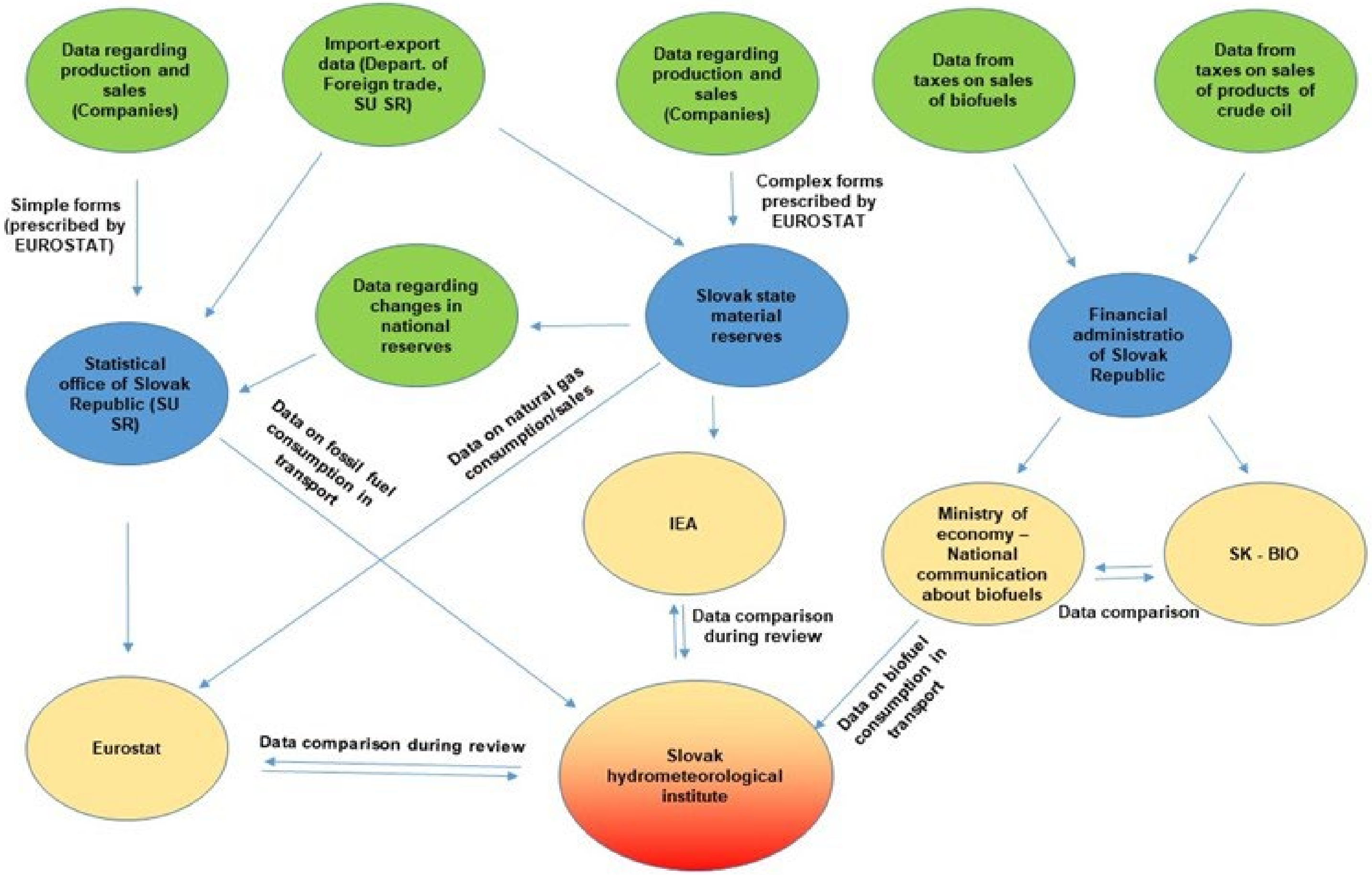
Table A6.9: *Penetration of application abatement - incorporation within 24 hours*

INCORPORATION WITHIN 24 HOURS											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2009	5%	5%	5%	2%	0%	0%	0%	4%	4%	0%	0%
2010	6%	6%	4%	2%	0%	0%	0%	14%	5%	4%	11%
2011	6%	5%	2%	1%	0%	0%	0%	14%	5%	3%	10%
2012	6%	5%	2%	1%	0%	0%	0%	14%	5%	3%	8%
2013	6%	6%	2%	2%	7%	7%	7%	20%	4%	4%	10%
2014	6%	6%	2%	1%	0%	0%	0%	17%	4%	3%	10%
2015	6%	6%	2%	2%	0%	0%	0%	10%	4%	3%	8%

INCORPORATION WITHIN 24 HOURS											
CATEG ORY	DAIRY CATTLE	NON-DAIRY CATTLE	BROIL ERS	LAYING HENS	GEE SE	TURK EYS	DUC KS	HOR SES	BREEDING SWINE	FATTENING SWINE	SHE EP
2016	6%	6%	3%	3%	3%	3%	3%	8%	4%	3%	8%
2017	6%	7%	2%	2%	0%	0%	0%	8%	4%	4%	7%
2018	7%	7%	2%	1%	0%	0%	0%	10%	4%	4%	6%
2019	7%	7%	2%	1%	0%	0%	0%	10%	4%	4%	6%
2020	8%	8%	2%	1%	0%	0%	0%	12%	4%	4%	8%
2021	22%	23%	8%	2%	0%	0%	0%	45%	13%	14%	25%

ANNEX VII: DATA FLOW OF FUE

Figure A7.1: *Flowchart of data reporting and utilisation (green – original data, blue – primary users, yellow – secondary users, red – tertiary users)*



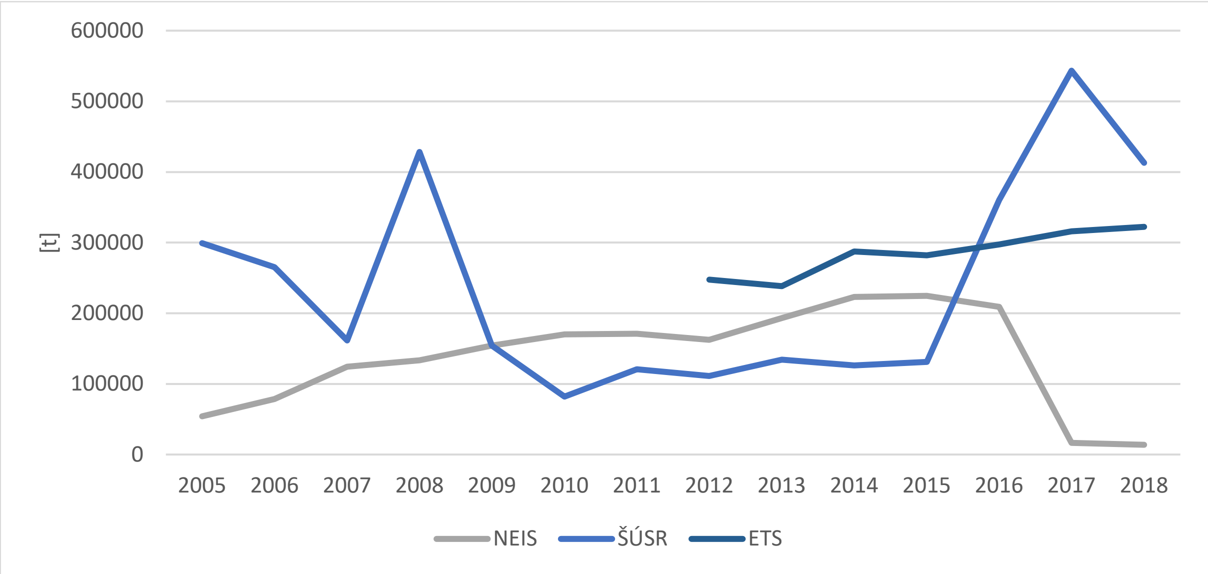
ANNEX VIII: JUSTIFICATION OF THE ACTIVITY DATA SOURCE FOR WASTE INCINERATION

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 (MoE SR) on a yearly basis. According to information provided by MoE 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.

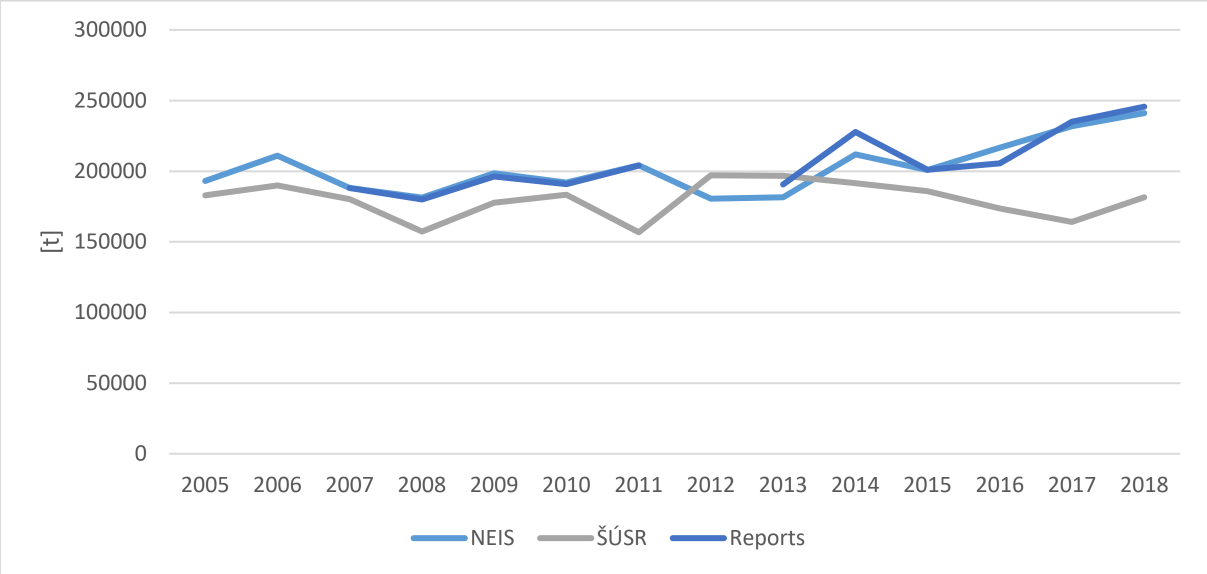
By comparison of the statistical, NEIS and ETS data for the incineration of waste with energy recovery (co-incineration in cement and lime production plants), significant differences were recorded. The amounts of industrial waste incinerated according to statistical data are much higher compared to ETS 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*

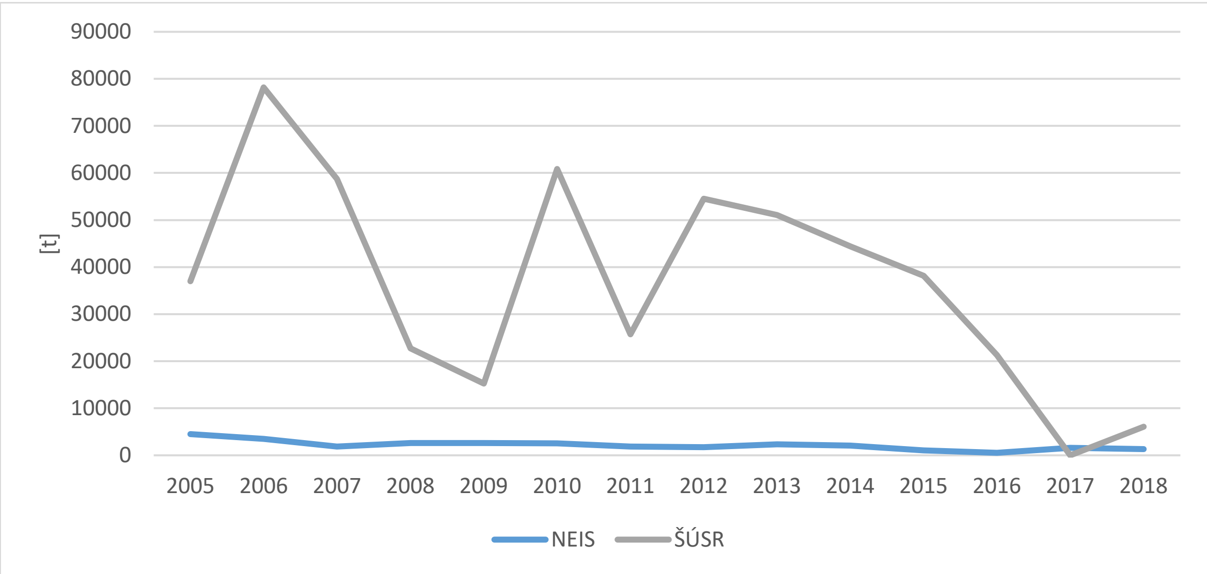
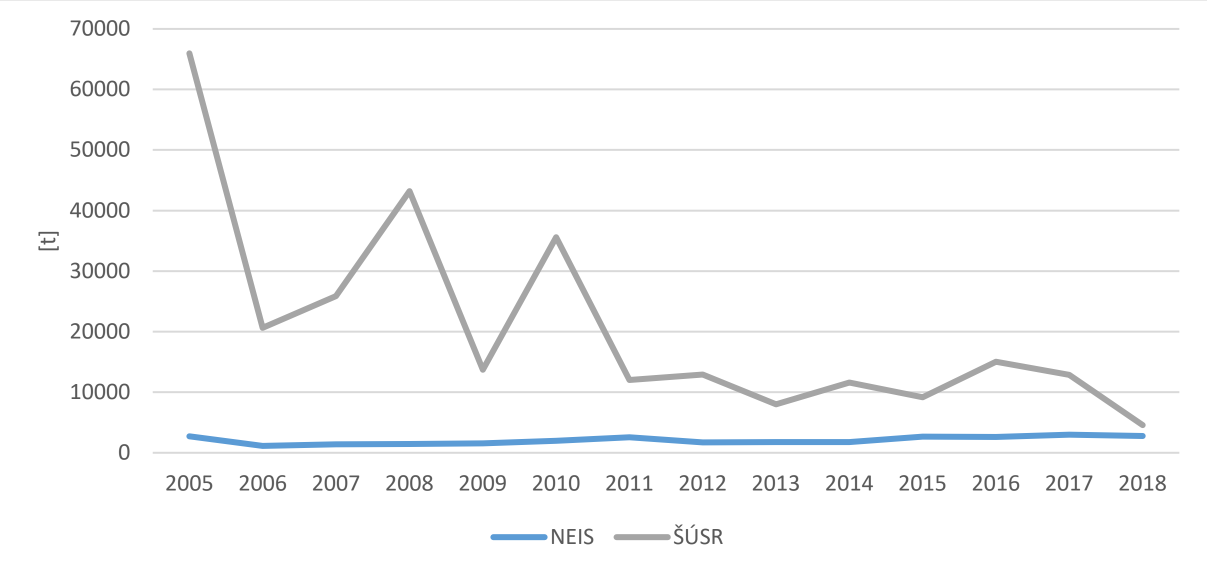


Figure A8.4: *Comparison of data of clinical waste incinerated (without energy recovery) from ŠÚ SR and NEIS database*



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_{2019} were calculated and used for the calculation.

For the sector of residential heating, the value of uncertainty was obtained from the VEC VŠB[15].

Emission factors and measurement uncertainty for emissions from the NEIS database (main pollutants) were established by Decree 410/2012 Coll[16].

The table below represents example of the uncertainty analysis calculation.

---

15 https://powietrze.malopolska.pl/en/life-project/

16 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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	Underrfire 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 improvement of the key categories*

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 2022	**To be implemented**
Uncertainty analysis with detailed data for sectors agriculture, transport and residential heating	Uncertainty analysis on tier 1	Submission 2024/2025	**To be implemented**
Improvement of priority categories to Tier 2	Emissions of priority key categories reported using Tier 2	Submission 2024/2025	**To be implemented**
Further analysis of available sources of methodology/Activity data	Emissions of non-priority key categories using Tier 2	Submission 2024/2025	**To be implemented**