SLOVAK REPUBLIC

INFORMATIVE INVENTORY REPORT 2018

Submission under the LRTAP Convention and under the NEC Directive

Slovak Hydrometeorological Institute

Ministry of Environment of the Slovak Republic

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PREFACE

TITLE OF REPORT	INFORMATIVE INVENTORY REPORT 2018. SLOVAK REPUBLIC. AIR POLLUTANT EMISSIONS 1990-2017.
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The Slovak Republic Informative Inventory Report (SK IIR) is an official document accompanying the emission inventory submission of the Slovak Republic under the Convention on Long-Range Transboundary Air Pollution (LRTAP Convention). Since the Directive (EU) 2016/2284[1] on the reduction of national emissions of certain atmospheric pollutants (NECD) was adopted, this report represents also the official document as required in new NEC Directive.

SK IIR is annually prepared by Slovak Hydrometeorological Institute (SHMÚ) at 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 a technical and methodological support for the emission information presented in common template for LRTAP Convention submission and NECD. The report bring sufficiently detailed information that allows transparent view onto emission preparation process of the Slovak emission inventory.

The structure of document is in line with general recommendations and presents institutional background information and arrangement, trends of pollutants, 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 has 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
CW	Clinical waste
EP and Council	European Parliament and the Council
EC	European Commission
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
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
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
VÚVZ	Výskumný ústav výživy zvierat Research Institute for Animal Production
WI	Waste incineration

EXECUTIVE SUMMARY

ES.1 BACKROUND 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 single national entity regarding emission inventories, compiles 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 inventory of air pollutants of the Slovak Republic for all years from 1990 to 2017, 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 with an aim 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 2018 Recommendations.

One of the main changes in national inventory of air pollutants was improvement of the sector residential heating. In cooperation with EUROSTAT, new methodology based on detailed statistical survey among house households was made. Statistical survey provided information on boilers composition of households using solid fuels for heating, heating habits and humidity of combusted wood[2].

Significant changes were also done in sector Fuel Combustion, where net caloric value of fuels was reconsidered and several fuels were reallocated to another fuel type in comply with EMEP/EEA GB_{2016}. Linear extrapolated historical data were also modified due to possible overestimation and data inconsistency in last submissions.

In sector agriculture, use of abatement technologies was included into emission calculations and category 3B3 Manure management – Swine was recalculated.

[2] http://www.shmu.sk/File/projekty/SK_AEA_Implementation_Report.pdf

In sector waste, new methodology for the category 5C1biii Clinical waste incineration was applied and clinical waste was separated from veterinary waste, which will be since this submission allocated into category 5C1bi Industrial waste incineration.

General model of IIR from the sectoral point of view was introduced and implemented in 2016 in compare to the older SK IIRs, where the pollutant approach was used. In the internal preparation system of LRTAP Convention emission inventory process, the responsibility was partly adapted correspondingly to the sectoral division. In the past, national or external experts were in charge of particular pollutant or pollutants emissions across all categories. According to new circumstances, sectoral liability diversification was set. Current list of team members and their roles is shown in ***Chapter 1.2***.

The document structure of the SR IIR reflects changes mentioned above and previous endeavours to follow 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;
- detailed description of emission trends and key drivers for each category;
- description and more detail explanation of methodology, level of method used, activity data and emission factors used in each category;
- reasoning for notation keys using or explanation for allocated items if needed;
- description of recalculations that have been done covering the time series;
- improvement plan for the next and future submissions.

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 agreement on the mutual cooperation concluded between 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. 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 were re-assessed and it has allowed the enlargements of activity data receiving from ŠÚ SR for inventory usage. Moreover, the shift to regular providing of data via FTP server erase the annual administration and paper work related to official necessary permissions between institutions. In addition, determination of qualified and authorized persons with direct access improve the effectivity of this cooperation.

The essential change was arranged in the field of agriculture in 2016. The cooperation with the Ministry of Agriculture and Rural Development (MPaRV) and the National Agricultural and Food Centre (NPPC) was established, which formally merged with nine delegates of research institutes. For the fourth year, emissions inventories for livestock have been conducted in collaboration with experts from the Animal Welfare Research Institute (VÚVZ). Detailed methodology, results and sector assessment are provided in **Chapter 3 Agriculture** (NFR3).

Since submission 2018, emission estimations in sector waste are calculated using EMEP/EEA Guidebook 2016 (GB_{2016}) methodology, instead of using emissions value reported to the NEIS database by operators.

ES.4 OVERVIEW OF THE EMISSION TRENDS

Following ***Figure ES.1*** to ***Figure ES. 4*** show 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/PCDF, PAHs, HCB, PCBs).

Figure ES.1: *Overall emission trends of Main pollutants in kt*

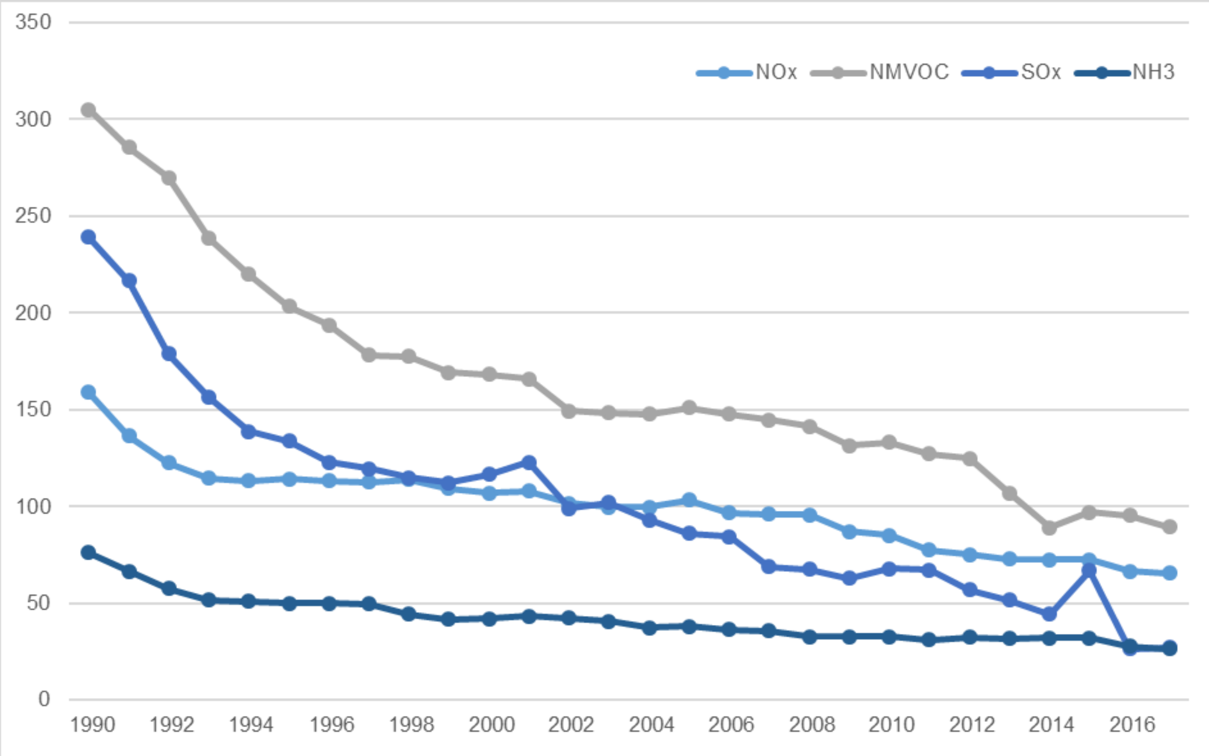


Figure ES.2: *Overall emission trends of the Particulate matter in kt*

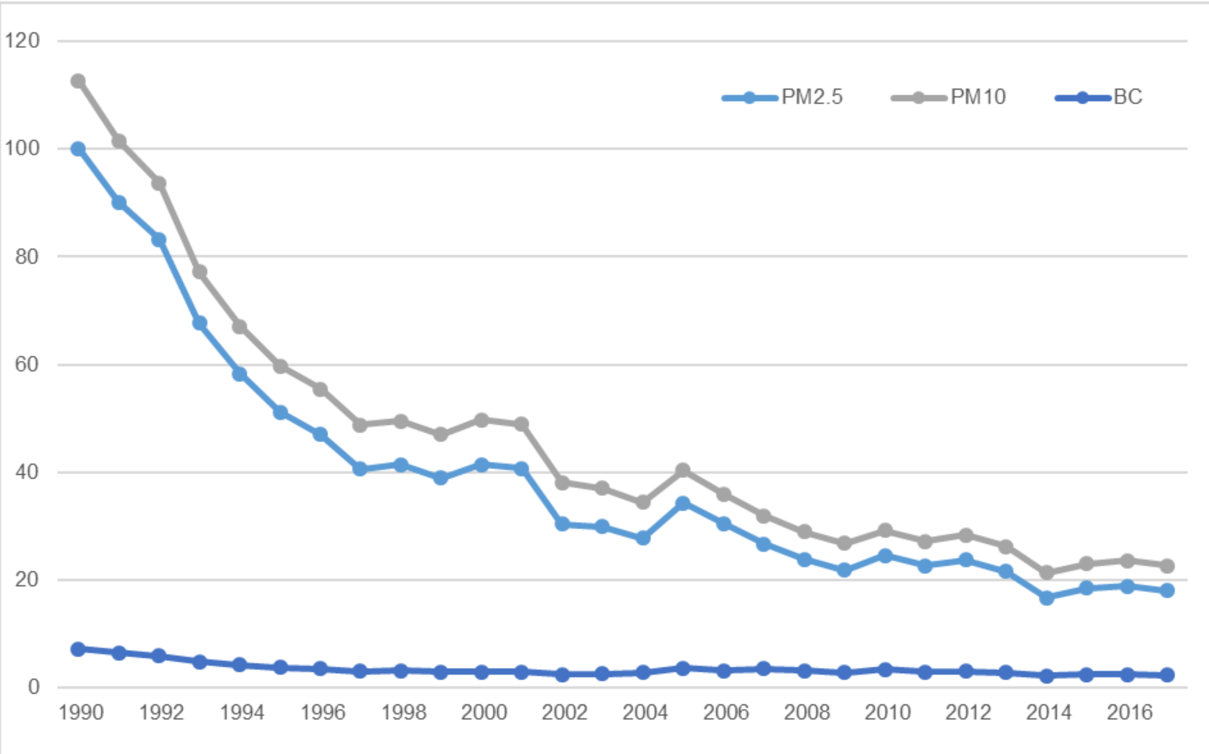


Table ES.3: *Overall emission trends of the Priority heavy metals in t*

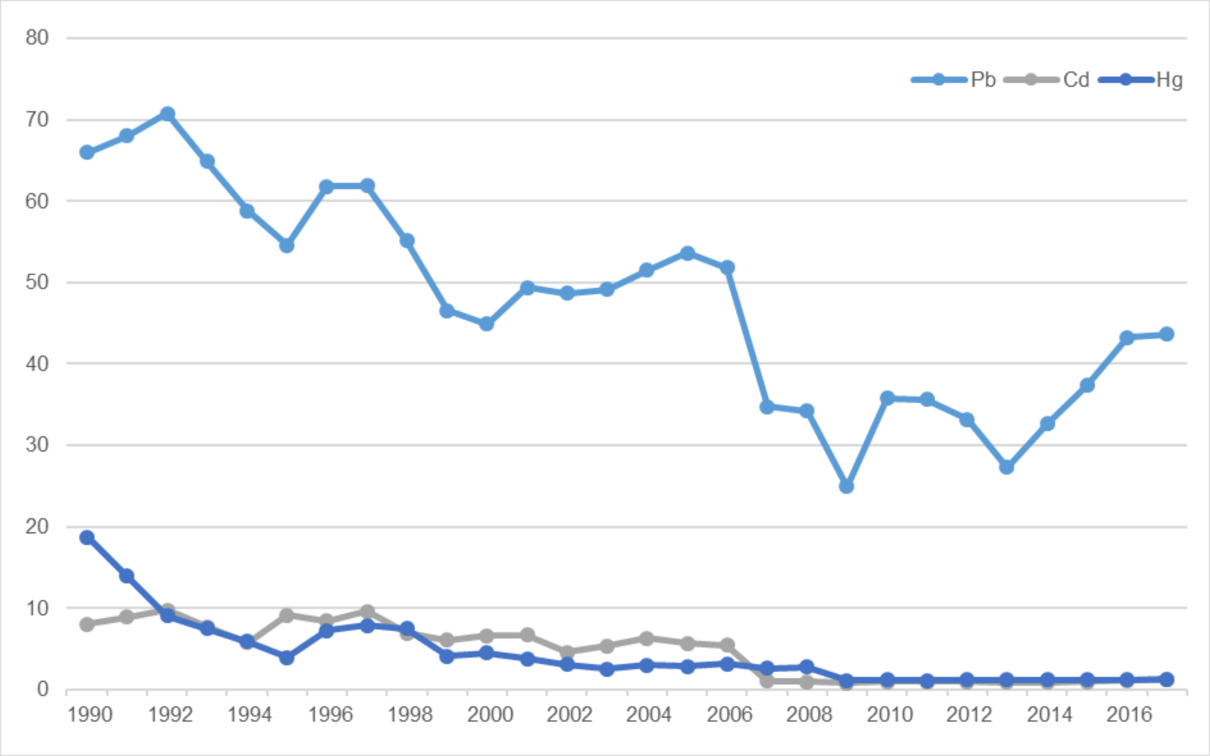
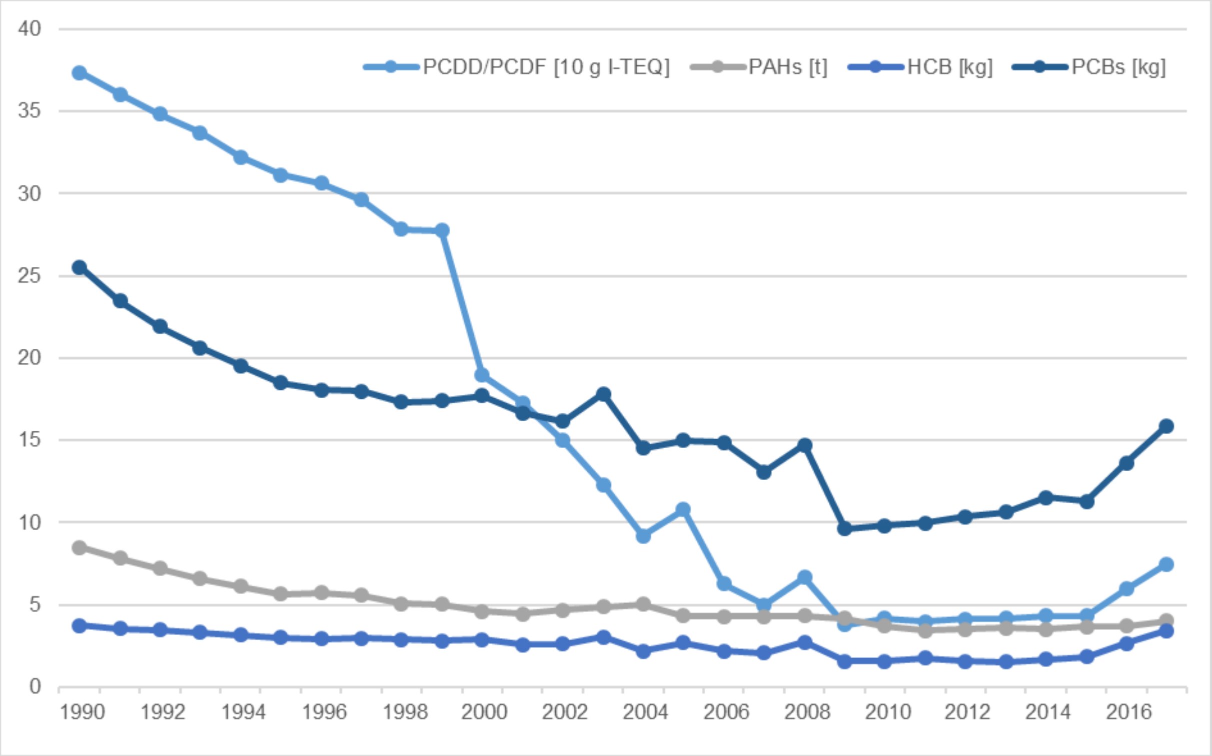


Table ES.4: *Overall emission trend of the Persistent organic pollutants*



ES.5 OVERVIEW OF RECALCULATIONS

Most of the recalculations realized in the 2019 submission were connected with application of the new methodology for residential heating (**1A4bi**). This methodology was developed within the Eurostat grant: *"Quality Improvements of the Air Emission Accounts and Extension of provided Time-Series"[3].* Higher tier methodology for this source was necessary in the Slovak Republic, as residential heating was recorded as the key category for PMs emissions in the last submission. For the first time, emissions of BC and NH_3 were balanced within this category.

Net caloric value of fuels for fuel combustion activities were reconsidered and recalculated in comply with GHG inventory. Also, several fuels were reallocated to another fuel type. This led to significant changes especially in historical years.

Several recalculations were made in Agriculture and Waste sector, too. These are mostly the follow up of the recommendations from the previous review process 2018.

Table ES.1 provide overview of recalculations in the 2019 submission. More detailed data can be found in the particular chapters of this report.

[3] http://www.shmu.sk/File/projekty/SK_AEA_Implementation_Report.pdf

Table ES.1: *Main recalculations and their explanation, % difference for year 2016, 2015, 2015, 2005 between the 2018 and 2019 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 2016 VALUES	UNITS	COMMENT/EXPLANATION
NOx (as NO_2)	-26%	-6%	-8%	-9%	-3%	-0%	kt	Main changes were made in Energy sector. New methodology for residential heating caused slight decrease in emission totals. The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.
NMVOC	81%	39%	41%	49%	40%	49%	kt	New methodology for residential heating caused significant increase of emission totals.
SOx (as SO_2)	-43%	-7%	-3%	-2%	-1	-3%	kt	Main changes were made in Energy sector. New methodology for residential heating caused moderate decrease in emission totals. The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.
NH_3	3%	5%	7%	5%	3%	-9%	kt	Increase in time series (except 2016) was caused by recalculation of the category 3B3 Manure management –Swine and adding of the calculation of NH_3 from residential heating for the first time. Abatement technology efficiencies were added to the calculations in agriculture sector for the years 2016 and 2017 which caused decrease of emissions.
$PM_{2.5}$	-8%	32%	-10%	-12%	-37%	-29%	kt	New methodology for residential heating changed emission overall trend of PMs Emission in this category increased significantly for the historical years, but since 2003 emission are decreasing in comparison to submission 2018. The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.
PM_{10}	-17%	14%	-13%	-16%	-37%	-30%	kt	New methodology for residential heating changed emission overall trend of PMs Emission in this category increased significantly for the historical years, but since 2003 emission are decreasing in comparison to submission 2018. The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.
BC	318%	209%	203%	183%	189%	298%	kt	BC emissions from residential heating were balanced for the first time in 2019 submission in comply with the new methodology, what caused high increase of its emissions.

POLLUTANT	CHANGE FOR 1990 VALUES	CHANGE FOR 2000 VALUES	CHANGE FOR 2005 VALUES	CHANGE FOR 2010 VALUES	CHANGE FOR 2015 VALUES	CHANGE FOR 2016 VALUES	UNITS	COMMENT/EXPLANATION
CO	124%	45%	51%	63%	50%	57%	kt	New methodology for residential heating caused high increase of CO emissions in the 2019 submission.
Pb	-14%	-9%	-9%	-9%	-3%	-3%	t	The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics. New methodology for clinical waste incineration cause significant decrease in the period 2005-2017.
Cd	-6%	-4%	-9%	-24%	-18%	-21%	t	
Hg	-7%	-20%	-48%	-54%	-21%	-31%	t	New methodology for clinical waste incineration caused significant decrease of emission totals.
PCDD/PCDF	18%	49%	-4%	-40%	-32%	-29%	g I-TEQ	Due to new methodology for clinical waste incineration, emission trend was changed to significant increase in period 1990-2000 and decrease in the next period.
PAHs	-57%	-65%	-78%	-80%	-82%	-81%	t	New methodology for residential heating resulted to high decrease of emissions in 2019 submission. Calculations correction in the category 1A5a.
HCB	53%	76%	72%	36%	46%	94%	kg	Increase is a result of correction of emission factor unit for industrial waste incineration with and without energy recovery (1A2gviii and 5C1bi).
PCBs	-61%	-30%	-28%	-43%	-39%	-24%	kg	Decrease of emission due to application of the new methodology for residential heating.

ES.6 IMPROVEMENT PRIORITIES

General and sectoral uncertainty analysis is one of our main future goals. Due to necessity of total approach change in the most of the categories in sectors energy and industry, this cannot be done in short-term. Mentioned approach change is very difficult to provide and must be also approved by competent executives in the MŽP SR. Currently, the approach change is at the stage of analysing of the available options. In short-term, it will be possible to manage several sectoral uncertainty analyses. With this improvement is connected possibility to move on of the key category analysis from current tier 1 to tier 2 methodology.

Next important improvement planned for the next period is to develop new methodology for heavy metals, with priority to key categories due to insufficient tier of methodology used nowadays. Similarly, higher tier methodology development is planned for estimation of POPs emission.

Due to lack of activity data, technology and abatement technology used in the Slovak Republic (especially for the historical data in the period 1990-2004), as well as the lack of capacity, this improvement will not be possible to complete in the next submission.

ES.7 OVERVIEW OF SECTROS 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 sector Transport, which include condensable component into PM 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 sector Agriculture and Waste, estimations were provided using EEA/EMEP GB_{2016} emission factors, which do not include condensable component. Detailed information about methodology used to estimate emissions and inclusion/exclusion of condensable component in PM emission factors of individual categories is described in **ANNEX II** of this report.

CHAPTER 1: INTRODUCTION

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[4] 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: Slovak Republic on 28 May 1993

LRTAP Convention[5] - 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
    - 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
    - Slovak Republic succession on 28 May 1993
- *Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (1991)*
    - Slovak Republic accession on 15 December 1999
- *Oslo Protocol on Further Reduction of Sulphur Emissions (1994)*
    - Slovak Republic ratification on 1 April 1998
- *Aarhus Protocol on Heavy Metals (1998)*
    - Slovak Republic acceptance on 30 December 2002
- *Aarhus Protocol on Persistent Organic Pollutants (POPs)* (1998)
    - Slovak Republic acceptance on 30 December 2002
- *Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999)*
    - Slovak Republic ratification on 28 April 2005

[4] https://www.unece.org/env/lrtap/emep_h1.html
[5] http://www.unece.org/env/lrtap/status/lrtap_s.html

NEC Directive[6] **-** 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[7]

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 matters ($PM_{2.5}$)

The objective is to be achieved by setting a percentage reduction in national emissions between 2020 and 2029 and, after 2030, base year 2005 (***Table 1.2***).

In order 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 are in force 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%

UNFCCC - UN Framework Convention on Climate Change was in 1992 adopted 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 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 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 of GHG emissions since 1992, an urgent need to adopt an additional and efficient instrument that would stimulate mitigation effort has occurred. In 1997, the Parties to 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 former EU Member States ratified the Kyoto Protocol on 31th May 2002.

One of the commitments, resulting from the Convention, was preparation and submission of greenhouse gas emission inventories to the UNFCCC secretariat on annual basis by 15th April each year.

[6] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1491821672988&uri=CELEX:32016L2284
[7] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0081&from=EN

After joining the EU (1st May 2004), 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) repealing Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol and Doha Amendment, the Slovak Republic shall submit the preliminary data on GHG emission inventory for the year X-2 in required scope by January 15th each year (Annual Report) and National Inventory report submits by 15th March each year.

More information on UNFCCC GHG inventory of The Slovak Republic and National Inventory report 2018 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 the environmental policy. The Slovak Republic expressed interest in being a member of the European Union in 1991. However, the fulfilment of this vision disrupted the division of former Czechoslovakia into Czech and Slovak independent states in 1993. On 4 October 1993, the Slovak Republic signed the agreement in Luxembourg, which was ratified in the year 1995. The integration process, when the necessary political, economic and legislative changes had to be made, culminated in the EU's accession 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 in fact already in place in 1991 (in legislation - Act No 17/1992 Coll. on Environment). This strict basis was introduced into the Slovak law, according to the German model. Therefore, there was no room for 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[8]
- Act No 134/1992 Coll. on State Administration of Air Protection as amended[9]
- 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[10]
- Decree of Ministry of the Environment of Slovak republic No 103/1995 Coll. as amended[11]

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

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

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
- 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[12]
- Decree of the Ministry of Environment of the Slovak Republic No 408/2003 Coll. on monitoring of emissions and air quality monitoring[13]
- Decree No 409/2003 Coll. on emission limits, technical requirements and general operational conditions of certain activities and installations, which use organic solvents[14]
- Decree No 706/2002 Coll. on air pollution sources, on emission limits, on technical requirements and general operational conditions, on list of pollutants, on categorization of air pollution sources and on requirements of emission's dispersion as amended[15]

[12] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/478/vyhlasene_znenie.html
[13] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2003/408/vyhlasene_znenie.html
[14] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2003/409/vyhlasene_znenie.html
[15] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/706/vyhlasene_znenie.html

- Decree No 705/2002 Coll. on air quality[16]
- 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[17]
- Decree No60/2003 Coll. on the Specification of maximum volume of discharged pollutants (emission quotas)[18]
- Decree No 144/2000 Coll. on the Requirements for the quality of fuels[19]

Nowadays are these acts/decrees repealed or it is covered by Act on air protection No 137/2010 Coll.[20] 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, 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 to 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 the 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 ensure that Parties are in compliance 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 (http://ghg-inventory.shmu.sk/) has been established and officially announced by 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[21]. 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 on 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

[16] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/705/vyhlasene_znenie.html
[17] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/704/vyhlasene_znenie.html
[18] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2003/60/vyhlasene_znenie.html
[19] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2000/144/20000601.html
[20] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2010/137/20160101
[21] 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 Protoco

was provided 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 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 is 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 Ivana Ďuricová	SHMÚ SHMÚ	monika.jalsovska@shmu.sk ivana.duricova@shmu.sk
Transport	Ján Horváth Jiří Dufek	SHMÚ Motran Research	jan.horvath@shmu.sk Jiri.dufek@motran.info
IPPU	Ivana Ďuricová Ľubomír Polakovič Lýdia Pokorná	SHMÚ VUIS - CESTY VURUP	ivana.duricova@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 Jiří Balajka	SHMÚ Senior consultant	marcel.zemko@shmu.sk
POPs emissions	Marcel Zemko Zuzana Jonáček	SHMÚ SHMÚ	marcel.zemko@shmu.sk zuzana.jonacek@shmu.sk
QA/QC	Lenka Zetochová	SHMÚ	lenka.zetochova@shmu.sk

On the base of the official Agreement between the MŽP SR[22] and ŠÚ SR, the data are annually exchanged via FTP server. Data transfer of individual and confidential data and their protection is ensured by determination of qualified and authorized persons with direct access to server.

In the emissions inventory of the transport, model COPERT IV and V were used. Activity data for 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.

Agricultural sector of emission inventory was performed in the cooperation with the Ministry of Agriculture and Rural Development[23] (MPaRV). The responsibility for data and compilations of 3B Manure management was consequently shifted to the allowance organization - the National Agriculture and Food Centre[24] (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:

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

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

The SHMÚ also provides the technical preparation and compilation of data for Air Environmental Accounts - AEA[25] that are processed by inventory first approach for air pollutants and energy first approach for the GHGs.

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 in consistency with the greenhouse gases (GHG) emission inventory under UNFCCC and the projection requirements of the Decision 280/2004/EC. UNFCCC and the projection requirements of the Regulation (EU) No 525/2013 an Implementing Regulation (EU) No 749/2014.

The National Emissions Inventory is being prepared in accordance with the updated EMEP/EEA GB_{2016} and implements the NFR (reporting nomenclature) and the category. Data are provided between 2001 and 2017[26]. 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. Basic principles of the NEIS are shown in ***Figure 1.1***.

Activity data from the ŠÚ SR are provided to SHMÚ on base of the long-term cooperation in the field of data exchange through agreement on the mutual cooperation concluded between Ministry of Environment of the Slovak Republic (MŽP SR) and the ŠÚ SR. data are provided via FTP server to qualified and authorized persons with direct access improve the effectivity of this cooperation.

Information System NEIS was established in 1998. The database was developed in order to fulfil the national legislation in air quality and the requirements in pollutants fees decisions (Act No. 401/1998 on air pollution charges as amended). Since 2000, when NEIS was set into the operation, the emissions are directly collected in consistent way and verified on more levels. This database replaced an old system REZZO (Emission and Air Pollution Source Inventory).

[25] under the Regulation (EU) No 691/2011 of the EP and of the Council on European environmental economic accounts
[26] http://www.eea.europa.eu/publications/emep-eea-guidebook-2016

Annual data is collected from large and medium sources from sector energy and industry. The collection of annual activity data are 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 range from 2000–2017 were processed in the NEIS CU module by the same way of calculation.

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

NEIS remains a major source of data for inventory in the key categories and sectors (Energy, Industry). Sectoral experts from research institutes or cooperative external experts provide emission inventory studies or material balances studies that are consequently involved in the compilation process.

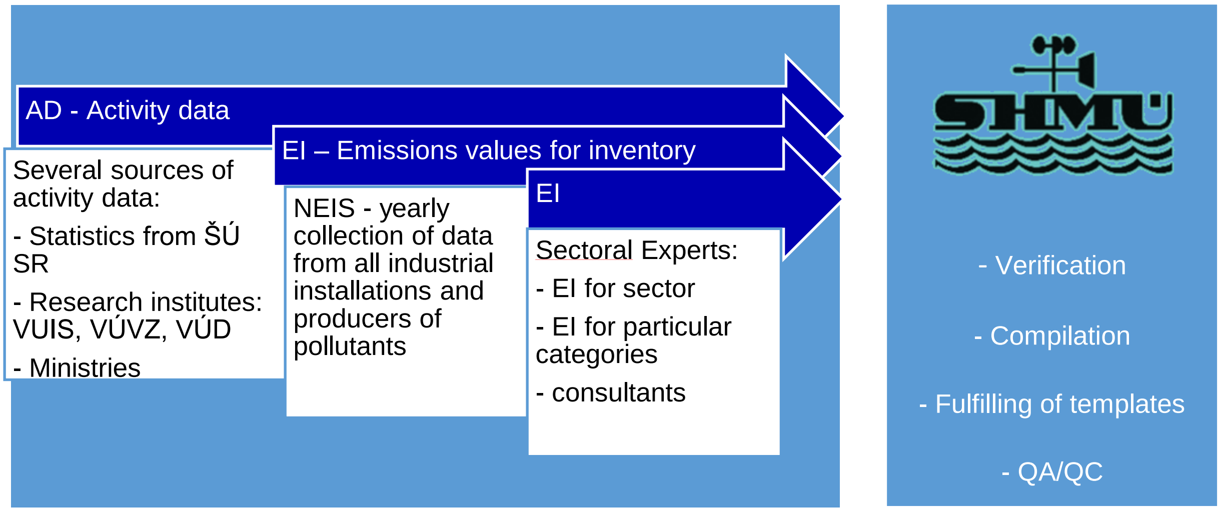
The MŽP SR has mandated the SHMÚ to ensure communication with the producers in order to collect the necessary data, which they are not obliged to provide to NEIS.

The MŽP SR, the MPaRV 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 (in accordance with 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_{2016}, in accordance with the requirements of the relevant UNECE Working Group on Inventory of Emissions and the methodology based on the IIASA report[27].

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: *Scheme of different sources for Emission Inventory of air pollutants and processes performing in SHMÚ*



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

Table 1.4: *Summary of Key Categories of key pollutants for the year 2017 – Contributions per pollutant for Level Assessment (LA) and Trend Assessment (TA) in %*

NFR14	NOx		SOx		NH_3		NMVOC		$PM_{2.5}$		PM_{10}		CO		BC		Pb		Cd		Hg		DIOX		PAHs		HCB		PCB	
	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA
1A1a	6	23	32	11						21		17									5	3						34		
1A1b	2																								8	6				
1A2a	3		6	8						13		9					30	12	24	12	50	21	16	8					32	
1A2b																											20	29		
1A2d		4		14																										27
1A2e																									3					
1A2gviii																			8		4		54	22			54	14	36	28
1A3bi	15	14					3	6	2	6	2	3	7	14	15	24		13												
1A3bii	6	5													7															
1A3biii	17																													
1A3bv							2	2																						
1A3bvi										5	3	6																		
1A3bvii										3		3																		
1A3c	2																													6
1A3ei		10																												
1A4ai	4	4					2	4											9											
1A4bi	5	3	6	13	5	10	45	21	78	11	64	8	43	31	60	36			17	9	12	7								
1A4cii	4	6						2					6	10		8														
1A5a																										10				5
1B1a							6	6																						
1B1b																							6	7	40	17				
2A1	5	4								4		6						12			4									
2A3																	17			50										
2A5b											3	4																		
2A6										5		3																		

NFR14	NOx		SOx		NH_3		NMVOC		$PM_{2.5}$		PM_{10}		CO		BC		Pb		Cd		Hg		DIOX		PAHs		HCB		PCB	
	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA
2B10a			5	9																	4					4				
2B10b							2	2																						
2C1	5		23	6							2		28	25									6	9						14
2C2		4								6		5				6													12	
2C3																									31	44				
2C4																														
2C7a																	38	43	22	13		47								
2C7c			12	22										6																
2D3a							7	11																						
2D3d							12	11																						
2D3e							3																							
2D3g								9																						
2D3h								7																						
2D3i																														
2G										4		2				11														
2K																					4	3								
3B1b						10																								
3B3					5	13																								
3B4gi					8	8																								
3B4gii					5	6																								
3Da1	7	3			23	18																								
3Da2a					37	19																								
3Dc											8	15																		
5C1bi																								7				10		
5C1biii																								33			8			
5E										3																				

1.5 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 – 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 these documents:

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

1.5.1 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 descripted.

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 the inventory principles.

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

- ➢ Timeliness
- ➢ Completeness
- ➢ Consistency
- ➢ Comparability
- ➢ Accuracy
- ➢ Transparency
- ➢ ImprovementQuality Control Procedures (DO)

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 development and modification of the spreadsheets to minimise emission calculation errors. Checks ensure compliance with the established procedures as well as allow detecting 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.

1.5.2 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 to identify areas where improvements could be made. These procedures are in different levels; include basic reviews of the draft report, external peer review, internal audit and EU/UNECE reviews.

Sectoral experts and the members of inventory team during the year are participating 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 of 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 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 check does not provide a clear clue concerning the steps to be taken, the quality control, bilateral discussion between 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 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.

1.5.3 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, the consistency of data are checked regularly. Completeness checks are undertaken, 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 EU28, and analyse its relevance for Slovakia.

1.5.4 INVENTORY IMPROVEMENT (ACT)

The main aim of QA/QC process is 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 this recommendation lists.

The recommendation and improvement plans are updated annually after the regular UNECE and EU compliance reviews takes place. Prioritisation process is based on problems and recommendation raised during reviews and expert's consultations. Results of prioritisation are included in the improvement plans. Detailed recommendation list and improvement plan 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 2017 submission, sources using fuels were all allocated in sector 1A. In this year submission, reallocation of process sources into process categories were provided.

1.6 GENERAL UNCERTIANTY EVALUATION

Uncertainty analysis were not provided in the past due to the insufficient capacities and unavailable data. Nevertheless this important issue was involved in the improvement plan as the item with the high importance.

1.7 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 the 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 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 daily base 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 the 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 of the arranged FTP server, archived electronically at SHMÚ as well as the Statistical yearbook published annually by 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 central archive of the SHMÚ and at the OEaB. The electronic archive have been created for all electronic documents relates to the emission inventories.

1.8 GENERAL ASSESMENT OF COMPLETENESS

Assessment of completeness is one of the elements of quality control procedure in the inventory preparation on general and sectoral level. 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 is performed and the estimation is completed in recent inventory submission (2019). The list of categories reported by the notation keys NE and IE is provided in the ***Table 1.5*** and ***Table 1.6***.

Several categories are reported as not occurring (NO) due to the not existence of the emission source or the source is out of threshold and measurement range. If the methodology does not exist in the EMEP/EEA Guidebook$_{2016}$, the notation key not applicable (NA) was used. The lists of notation keys NA and NO are available in the ***Table 1.7*** and ***Table 1.8***.

Several NE key categories have been reported in 2019 submission for 1990–2017.

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.

1.8.1 SOURCES NOT ESTIMATED

Emissions of sources that are not estimated in the Slovak inventory (reported as NE) are listed in ***Table 1.5***.

Table 1.5: *Explanation to the Notation key NE*

NFR CODE	POLLUTANTS NOT ESTIMATED (NE)	REASON
1A1a, 1A1b, 1A2a, 1A2b, 1A2c, 1A2d, 1A2e, 1A2f, 1A2gviii, 1A3ei, 1A4ai, 1A5a, 2A6, 2B10b, 2H3, 2I, 5C1bv	BC	Only information on total BC emissions is available. Information on the contribution of a particular type of fuel to overall emissions is unavailable, therefore EF cannot be applied.
1A3ai(ii), 1A3aii(ii)	NH_3, Heavy metals, POPs	Emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
1A3bv	Zn, PCDD/F, B(a)P, B(b)F, B(k)F, PCB	Emissions occur, but have not been estimated due to lack of emission factors in methodology
1A3bvi	CO, PCDD/F, PAHs, PCB	
1A3bvii	CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, PCDD/F, PAHs, PCB	
1A3c	Pb, Hg, As	
1A4ci	NH_3, BC	Only information on total BC emissions is available. Information on the contribution of a particular type of fuel to overall emissions is unavailable, therefore EF cannot be applied. NH_3 emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
1A4cii	Pb, PCDD/F, B(K)F, I()P, HCB, PCB	No EF in the methodology.
1B1a	BC, Heavy metals	HMs emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016. Only information on total BC emissions is available. Information on the contribution of a particular type of fuel to overall emissions is unavailable, therefore EF cannot be applied.
1B1b	HCB, PCB	Emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016.
1B2ai, 1B2av, 1B2b	SOx, PCDD/F	
1B2c	BC, CO, Heavy metals, POPs	No EF in the methodology.
1B2d	All pollutants	Geothermal energy is not developed in The Slovak Republic, most of the sources are used for recreational purposes, and are considered as negligible

NFR CODE	POLLUTANTS NOT ESTIMATED (NE)	REASON
2A1	PCDD/F, PAHs, HCB	Emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016.
2A3	PAHs	No EF in the methodology.
2B5	BC **since 1992**, Heavy metals, PCDD/F, PAHs	HMs emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016. Only information on total BC emissions is available. Information on the contribution of a particular type of fuel to overall emissions is unavailable, therefore EF cannot be applied.
2B10a	HCB, PCB	Emissions have not been estimated due to lack of emission factor in national methodology.
2C1	B(b)F, B(K)F, I()P, HCB	
2C2	PAHs	
2C4	BC, PAHs, HCB, PCB	
2C5	NH_3, BC, Hg, Cr, Cu, Ni, Se, PAHs, HCB	Emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016.
2C7a	PAHs, HCB, PCB	Emissions have not been estimated due to lack of emission factor in national methodology.
2C7c	POPs	
2C7d	Pb, Cr, Cu, Ni, Zn	Emissions have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016.
2D3a, 2D3e, 2D3f	$PM_{2.5}$	
2D3b	NOx, SOx, CO, PAHs, HCB	
2D3c	NOx, Pb, Cd, Hg, PCDD/F, PAHs, HCB	
2D3g	NOx, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs	
2D3h	$PM_{2.5}$, BC	
2G	Se, HCB, PCB	
2H1	PAHs, HCB	
2H2	$PM_{2.5}$, PM_{10}, TSP, BC	
3Da4	NH_3	
5A	NH_3, CO, Hg	
5B1	NOx, NMVOC, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO	
5B2	NOx, NMVOC, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, Cr, Zn, POPs	
5C1bi	NH_3, Cr, Cu, Se, Zn	
5C1biii	NH_3, $PM_{2.5}$, PM_{10}, Se, Zn, B(a)P, B(b)F, B(K)F, I()P	
5D1	$PM_{2.5}$, PM_{10}, TSP, BC, Heavy metals	
5D2	NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals	
5E	NOx, NMVOC, SOx, BC, CO, Ni, Se, Zn, PAHs, HCB, PCB	

1.8.2 SOURCES INCLUDED ELSEWHERE

Emissions of sources that are unspecified within the NFR14 disaggregation for a specific sector are reported as IE. ***Table 1.6*** lists all sources included in these categories.

Table 1.6: *Explanation to the Notation key IE*

NFR CODE	POLLUTANTS INCLUDED ELSEWHERE (IE)	ALLOCATION	REASON
1A1b	Heavy metals	1B2aiv	If a Tier 1 approach is adopted for the process emissions (Chapter 1.B.2.a.iv), combustion emissions are already covered and should not be reported again in Chapter 1.A.1.b since this would lead to double counting.
1A2gvii, 1A4aii, 1A4bii	All pollutants except Hg, As	1A4ciii	Disaggregation would lead to negligible amount of emissions in this category.
1A3d(ii)	All pollutants except Pb, Hg, As – **1900-2015**	1A3dii	Missing activity data for the period
1A5b	All pollutants – **1900-2014**	1A4ciii	Disaggregation would lead to negligible amount of emissions in this category.
1B2aiv	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO		If a Tier 1 approach is adopted for the process emissions (Chapter 1.B.2.a.iv), combustion emissions are already covered and should not be reported again in Chapter 1.A.1.b since this would lead to double counting.
1B2c	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP	1A1b, 1A1c	Fugitive emissions from flaring in refinery, technological losses and storage cannot be disaggregated at the current methodology used. These emissions are reported by operators to NEIS database as totals for whole process of refining of oil
2A5c	$PM_{2.5}$, PM_{10}, TSP		Emissions are already included in outputs form individual technologies
2C3	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, PCDD/F, HCB, PCB	2C7c	The Decree 410/2012 defines in general the production and processing of metals, therefore, it is not possible at this time to divide by different types of manufactured metals
2C7a	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, PCDD/F	2C7c	
2C7d	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO	2C7c	
5C1bii	All pollutants	5C1bi	This category will be disaggregated as soon as the methodology for this source will be available.

1.8.3 OTHER NOTATION KEYS

Table 1.7 shows all categories and pollutants, where notation key not available was used. ***Table 1.8*** lists categories and pollutants, which were reported as not occurring.

Table 1.7: *Categories reported as not available*

NFR CODE	POLLUTANTS NOT AVAILABLE (NA)
1A1c, 1A3ai(i), 1A3aii(i), 1A3ai(ii), A3aii(ii), 2A3	HCB, PCB
1A2gvii, 1A4cii	Hg, As
1A3eii, 3B4h, 3Dd, 3Df, 3I	All pollutants
1A3bv	NOx, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, I()P, HCB
1A3bvi	NOx, NMVOC, SOx, NH_3, BC, HCB
1A3bvii	NOx, NMVOC, SOx, NH_3, BC, Zn, HCB
1A3di(ii)	Pb, Hg, As
1A3ei	NH_3, Heavy metals, POPs
1A4aii	Hg, As
1B1a	NOx, SOx, NH_3,CO, POPs

NFR CODE	POLLUTANTS NOT AVAILABLE (NA)
1B2ai	NOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, Zn, PAHs, HCB, PCB
1B2aiv	BC
1B2av, 1B2b	NOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, PAHs, HCB, PCB
2A1	Cu, PCB
2A2	NH_3, Heavy metals, PAHs
2A3	HCB, PCB
2A5a	NH_3, BC, Heavy metals, POPs
2A5b, 2A5c	NOx, NMVOC, SOx, NH_3, BC, CO, Heavy metals, POPs
2A6	Heavy metals, POPs
2B2	NMVOC, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs
2B5	NH_3, PCB
2B10a	Pb, Cd, As, Cr, Cu, Ni, Se, Zn
2B10b, 2H3, 2I	Heavy metals, POPs
2C2	Hg, Se, HCB
2C3	Pb, Hg, As, Cr, Cu, Se
2C4	Se, PCDD/F
2C7a	Cr, Cd – **1900, 1999, 2000**, Se, Zn - **1990, 2000**
2C7c	Cd, Hg, As, Se
2C7d	Cd, Hg, As, Se, POPs
2D3a	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, Pb, Cd, As, Cr, Cu, Ni, Se, Zn, POPs
2D3b	NH_3, Heavy metals, PCB
2D3c	SOx, NH_3, As, Cr, Cu, Ni, Se, Zn, PCB
2D3d	NOx, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs
2D3e, 2D3f	NOx, SOx, NH_3, PM_{10}, TSP, BC, CO, Heavy metals, POPs
2D3h	NOx, SOx, NH_3, PM_{10}, TSP, CO, Heavy metals, POPs
2D3i	NOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, POPs
2H1	Heavy metals, PCDD/F, PCB
2H2	NOx, SOx, NH_3, CO, Heavy metals, POPs
2K	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals except Hg, POPs
3B1a, 3B1b, 3B2, 3B3, 3B4d, 3B4e, 3B4gi, 3B4gii, 3B4giii, 3B4giv, 3Da2a	SOx, BC, CO, Heavy metals, POPs
3Da1	NMVOC. SOx, TSP, BC, CO, Heavy metals, POPs
3Da2a	SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs
3Da2b, 3Da2c	NMVOC, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs
3Da3	SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs
3Da4, 3Db	NOx, NMVOC, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Heavy metals, POPs
3Dc	NOx, NMVOC, SOx, NH_3, BC, CO, Heavy metals, POPs
3De	NOx, SOx, $PM_{2.5}$, PM_{10},TSP, BC, CO, Heavy metals, POPs
5A	NOx, SOx, BC, cd, Hg, As, Cr, Cu, Ni, Se, Zn, POPs
5B1	Heavy metals, POPs
5B2	As, Cu, Ni, Se
5C1bv, 5E	NH_3
5D1, 5D2	NOx, SOx, CO, POPs

Table 1.8: *Categories reported as not occurring*

NFR CODE	POLLUTANTS NOT OCCURING (NO)
1A1a, 1A2a, 1A2b, 1A2c, 1A2f, 2A1, 2B10b, 3Db, 3De	NH_3
1A4ciii, 1B1c, 2B1, 2B3, 2B6, 2B7, 2C6 2C7b, 2J, 2L, 3B4a, 3B4f, 3F, 5C1a, 5C1biv, 5C1bvi, 5C2, 5D3, 6A	All pollutants
3Da1	$PM_{2.5}$, PM_{10}
3Da2c	NOx, NH_3
5B2	NH_3 **1990-2000**
5C1biii	Pb **2008, 2009, 2011-2017**

CHAPTER 2: KEY TRENDS

This chapter is concerned on 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 air pollutants separately and provide explanations of the main changes in the time series.

2.1 TRENDS IN EMISSIONS OF NECD POLLUTANTS

In Europe, the 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.

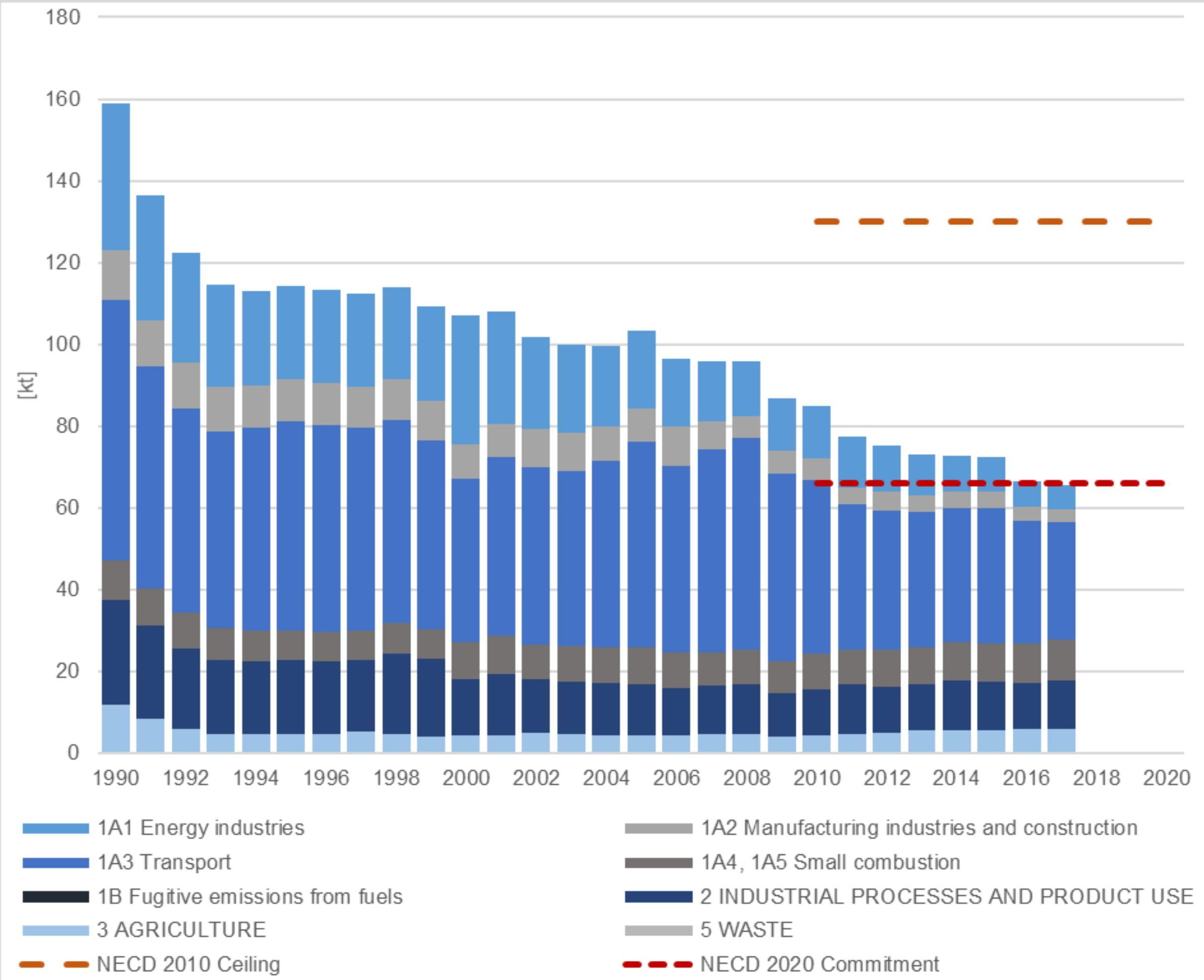
The Directive 2001/81/EC on National emissions ceilings (NEC Directive) sets limit values of emissions of **sulphur dioxide** (SO_2), **nitrogen oxides** (NOx), **volatile organic compounds** (VOCs) and **ammonia** (NH_3).

This Directive was replaced by The **New NEC Directive** 2284/2016, which sets national emission reduction commitments for 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 the ***Figure 2.1*** can be seen that emissions of NOx have constantly decreasing trend and do not exceed the emission ceilings set up in **NEC Directive 2001/81/EC** for 2010. Since the year 2005, emission decreased by 36% that 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 through 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.

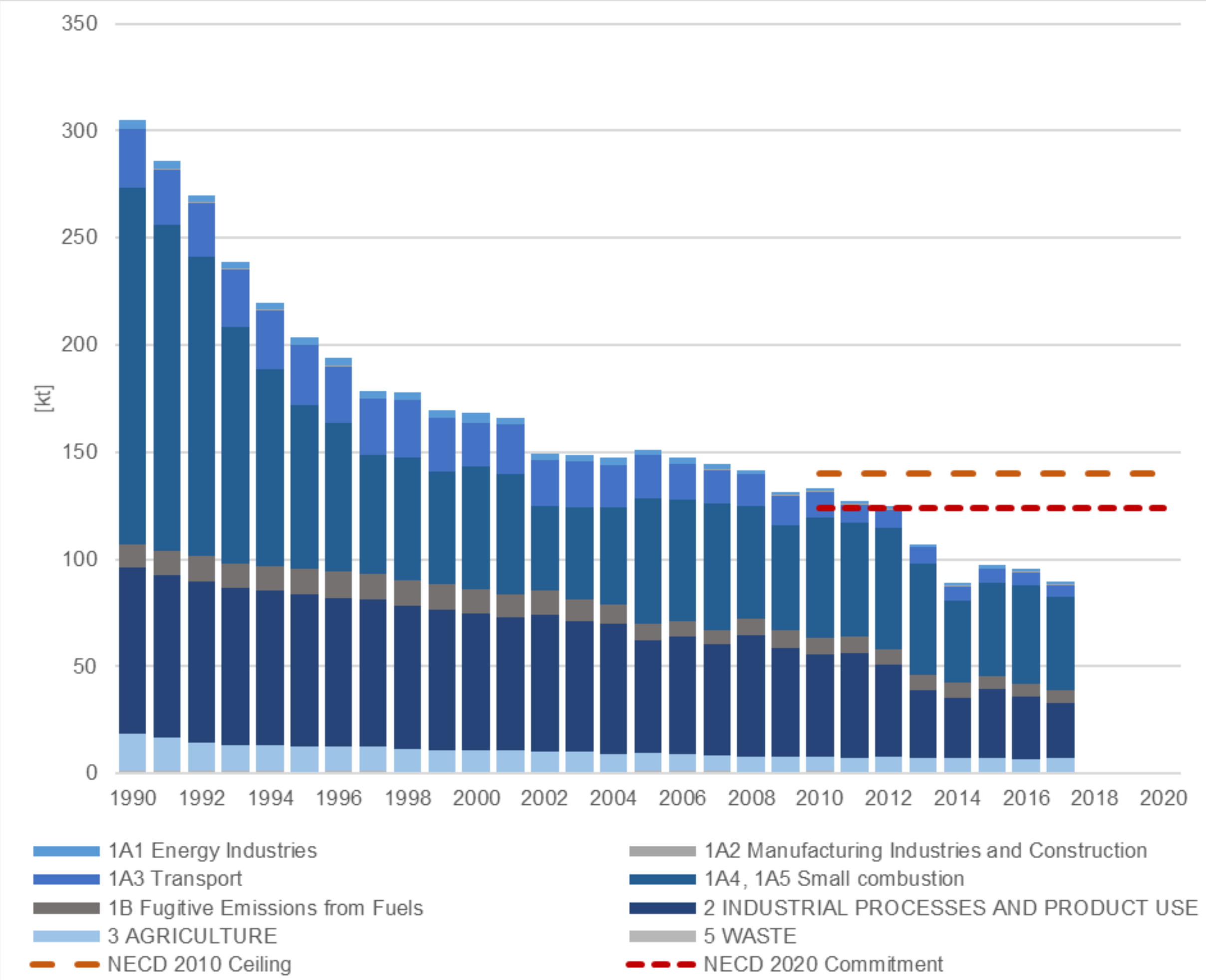
Figure 2.1: *Total NOx Emissions by Sectors*



2.1.2 TRENDS IN EMISSIONS OF NMVOC

Emissions of NMVOC have decreasing trend in whole time-series although the most significant decrease occurred in the period 1990-2000. Main source of NMVOCs in the Slovak Republic are residential heating sources, which produced 49 % of total NMVOCs emission in 2017. Decrease in the period 1990-2000 was caused primarily by decrease of energy demand in the households, which reconstructed their houses and also increase of 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 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

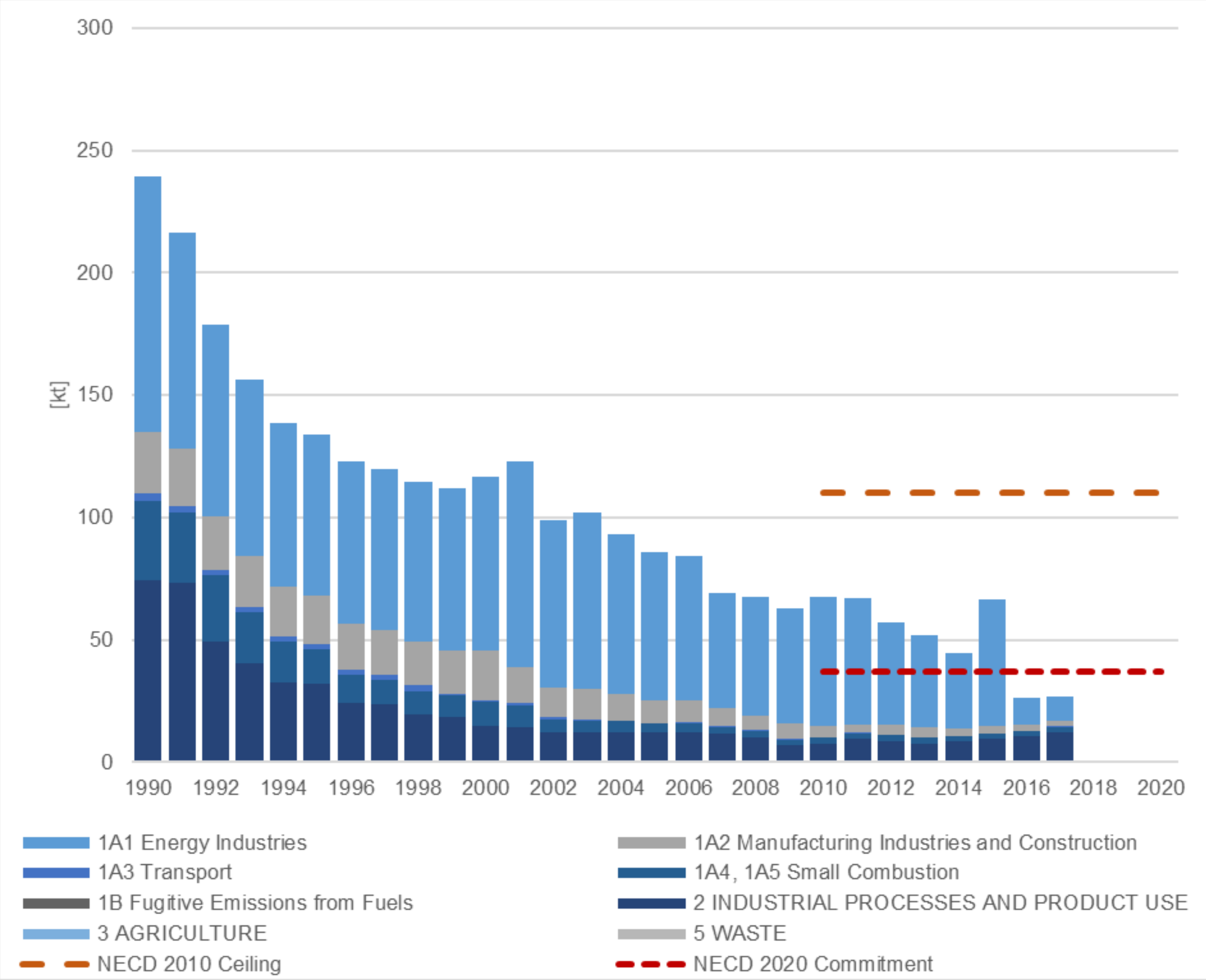
The trends of SOx emission decrease until 2014 continually. Since 1990 SOx emissions have noticed the significant decrease due to strict air protective legislative. Downward trend relates also to the composition of fuel use in all sectors and related legislative limitations.

In 2015, substantial increase was recorded. This emissions originated from the source Slovenské elektrárne (SE). According to records of a database of NEIS, power plant - ENO 0023 B-block 3 and 4 burnt twice the amount of brown coal than 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 time period 1990-2016, in the year 2017 this sector was replaced by Metal production.

Emissions of SOx are in comply with **NEC Directive** (ceiling for the year 2010, national commitment for the period 2020-2029) 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*



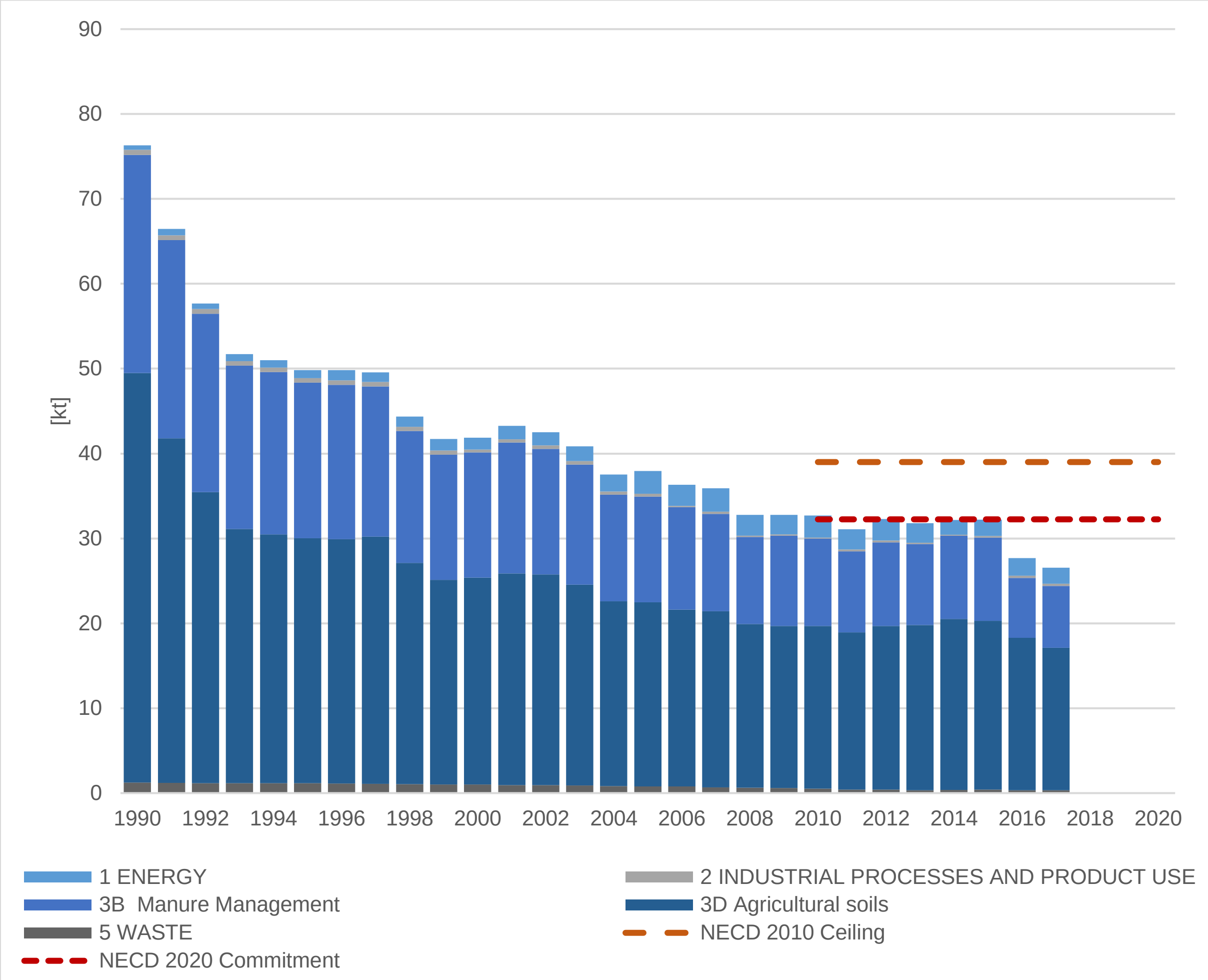
2.1.4 TRENDS IN EMISSIONS OF NH_3

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 slight increase and the major driver for this change was increase of number of animals and application of the inorganic N-fertilized into soils (***Figure 2.4***). Noticeable decrease in the years 2016 and 2017 is a result of inclusion of abatement technologies into emissions calculations.

Animal manure applied to soils is the key category, which emitted more than 37% of all ammonia in the Slovak republic in the year 2017. This category is the main polluter in the whole time-series.

As shown in the ***Figure 2.4***, the Slovak Republic fulfil both 2010 emission ceiling set by **2001/81/EC Directive** and national commitment on emission reduction set by **2016/2284/EU Directive.**

Figure 2.4: *Total NH_3 Emissions by Sectors*



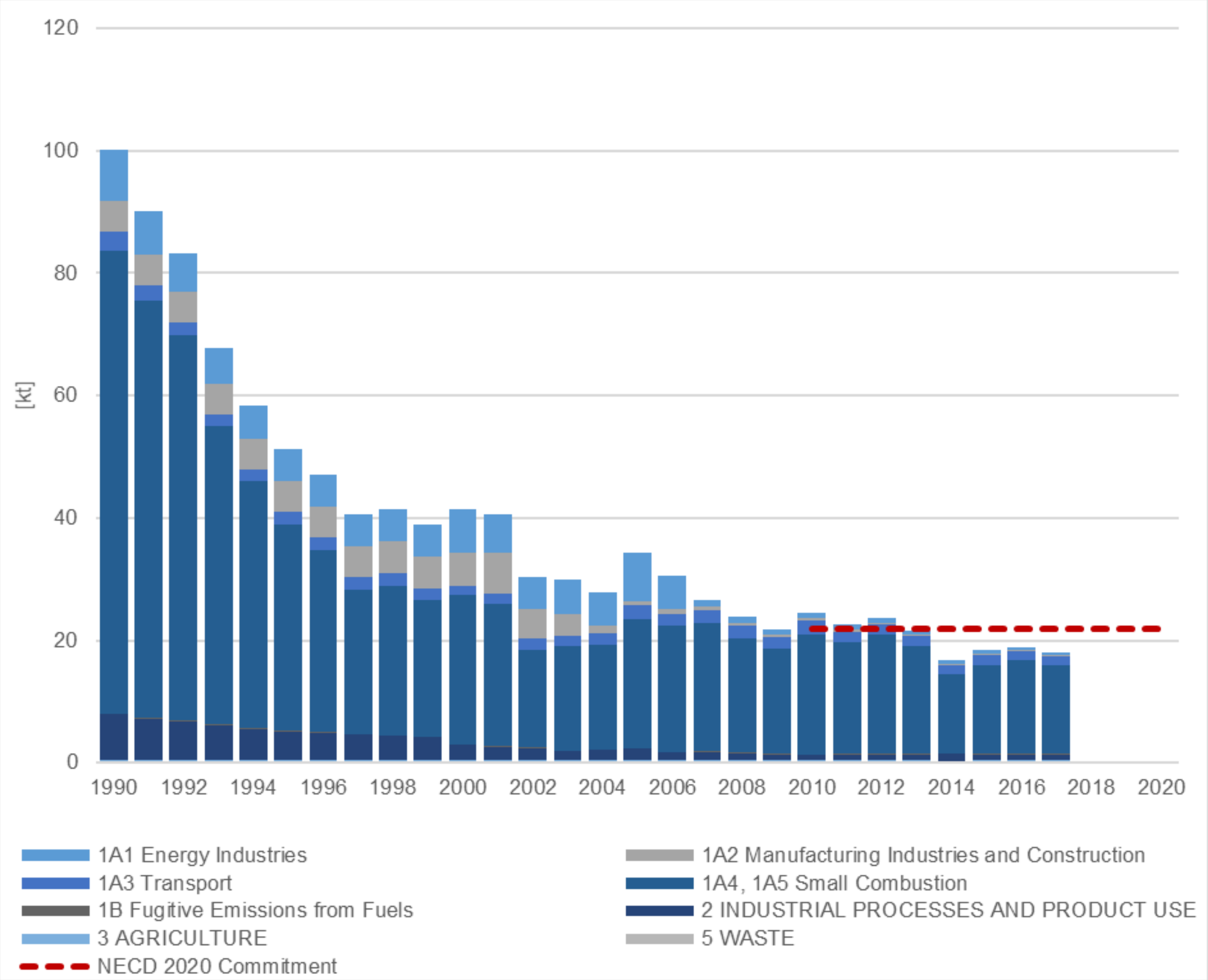
2.1.5 TRENDS IN EMISSIONS OF $PM_{2.5}$

Emission trend of $PM_{2.5}$ is significantly affected by emission trend of the category Residential heating. This category produced more than 80% of total $PM_{2.5}$ emission in the Slovak Republic in the year 2017. Emissions in this category are connected to energy demand of households, which is influenced by several conditions, such as climate factor, reconstruction status of buildings etc.

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

National emission commitment set by **2016/2284/EU Directive** for the period 2020-2029 has 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 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, 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 stable decreasing trend with slight fluctuation in last two decades. These emissions come especially from residential heating, but also transport and industry contribute substantially.

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

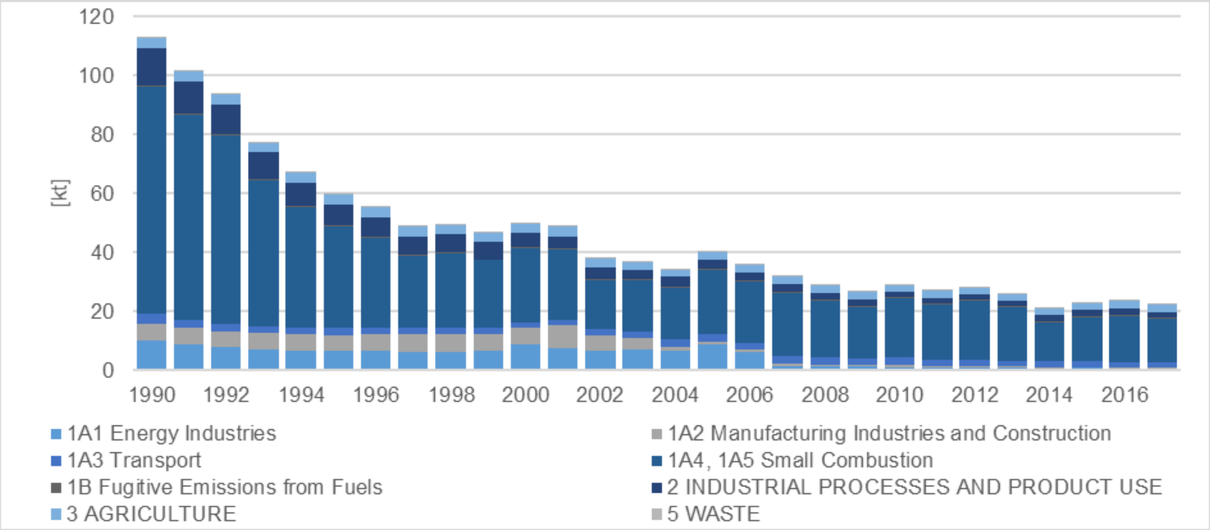


Figure 2.7: *Total BC Emissions by Sectors*

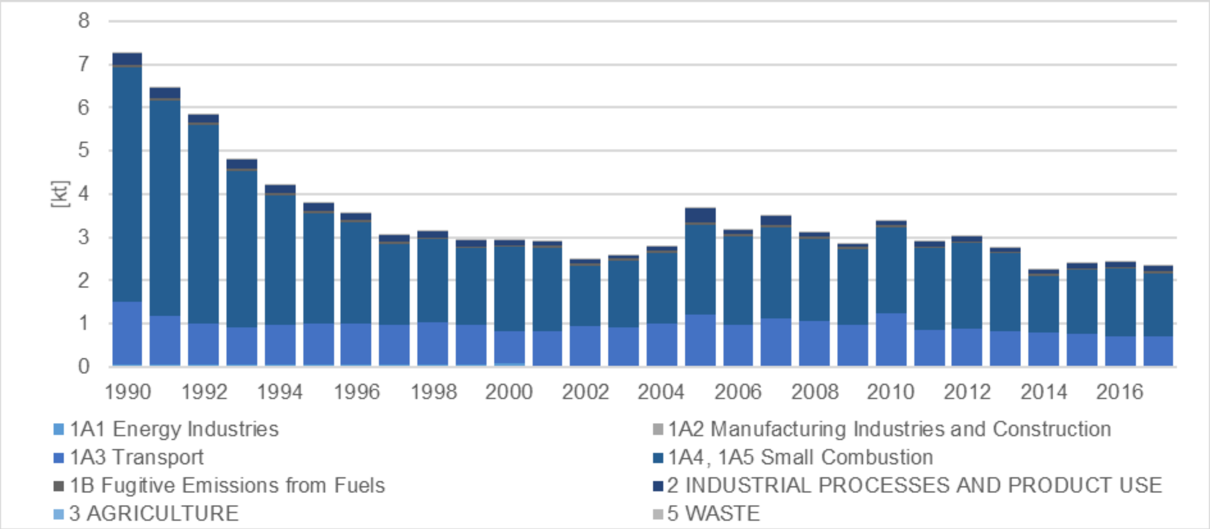
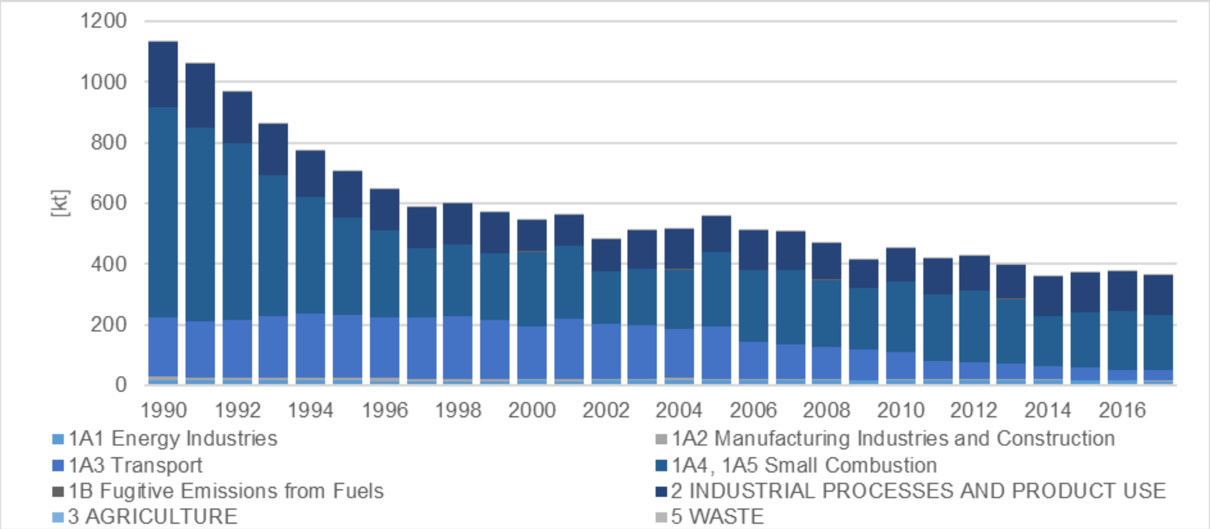


Figure 2.8: *Total CO Emissions by Sectors*



2.5 TRENDS IN EMISSIONS OF HEAVY METALS

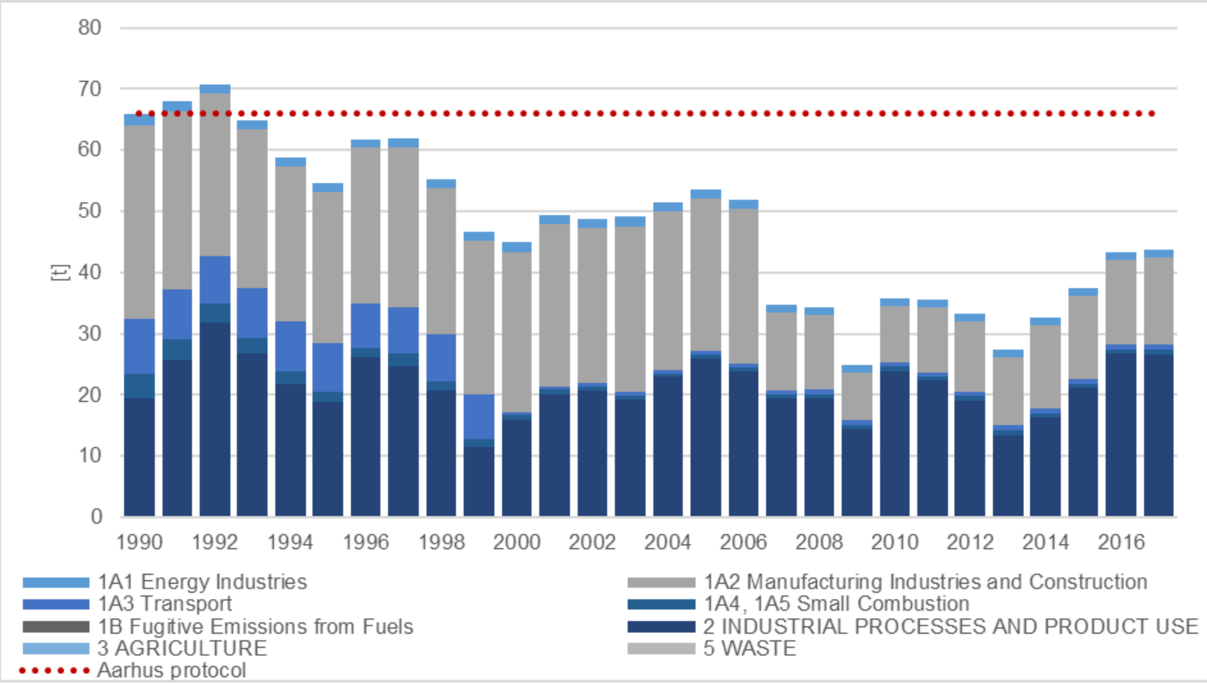
2.5.1 TRENDS IN EMISSIONS OF Pb

In general, the pollutant moderately fluctuating trend. In the year 2000, emissions dropped due to the end of the use of leaded petrol in transport activities. Next significant decrease occurred in 2007 due to stricter legislation and emission limits for large sources. Next dip was recorded in 2009, which is connected to economic crisis.

Main contributor to Pb emissions since 2008 is copper production, previously it was combustion activities in iron and steel production followed by glass 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 exceeded this level in the years 1991 and 1992, since then, emissions did not exceeded this level.

Figure 2.9: *Total Pb Emissions by Sectors*

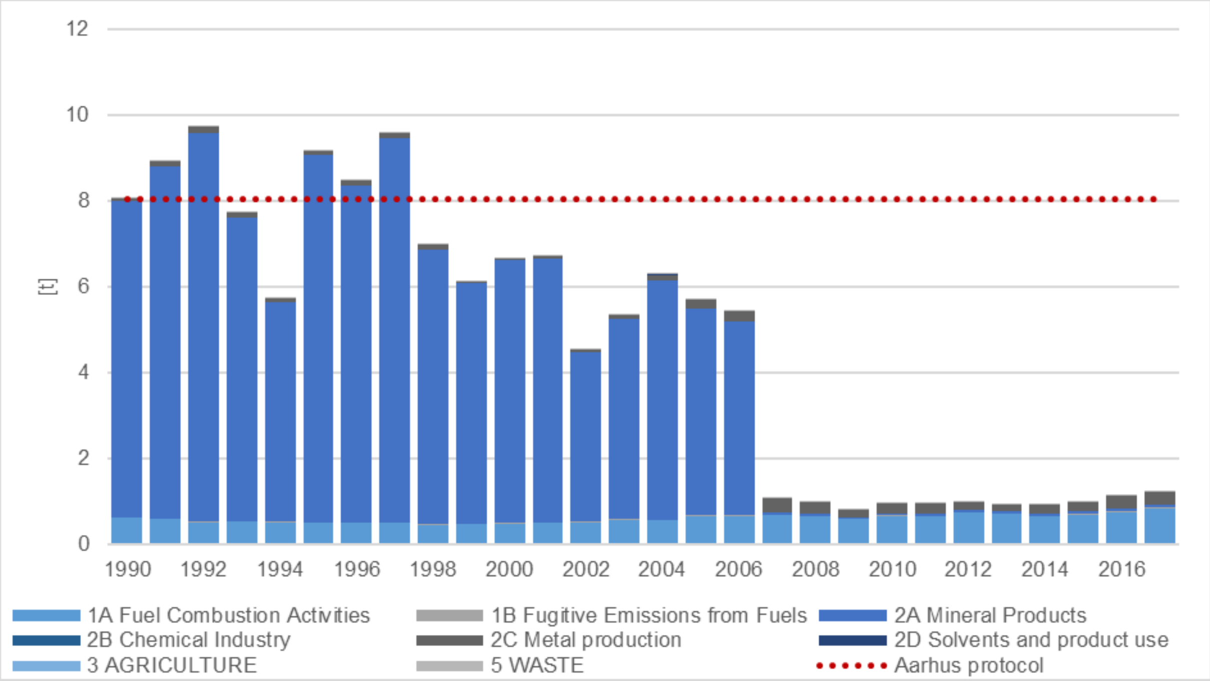


2.5.2 TRENDS IN EMISSIONS OF Cd

As shown in the ***Figure 2.10*** emissions of Cd decreased since 1990. The largest decline occurred in 2007, when main part of Slovak glass operators ceased production. Since then is trend relatively stable or slightly increasing.

There were several exceedances of Aarhus protocols of CLRTAP in the years 1991, 1992 and 1995-1997.

Figure 2.10: *Total Cd Emissions by Sources*

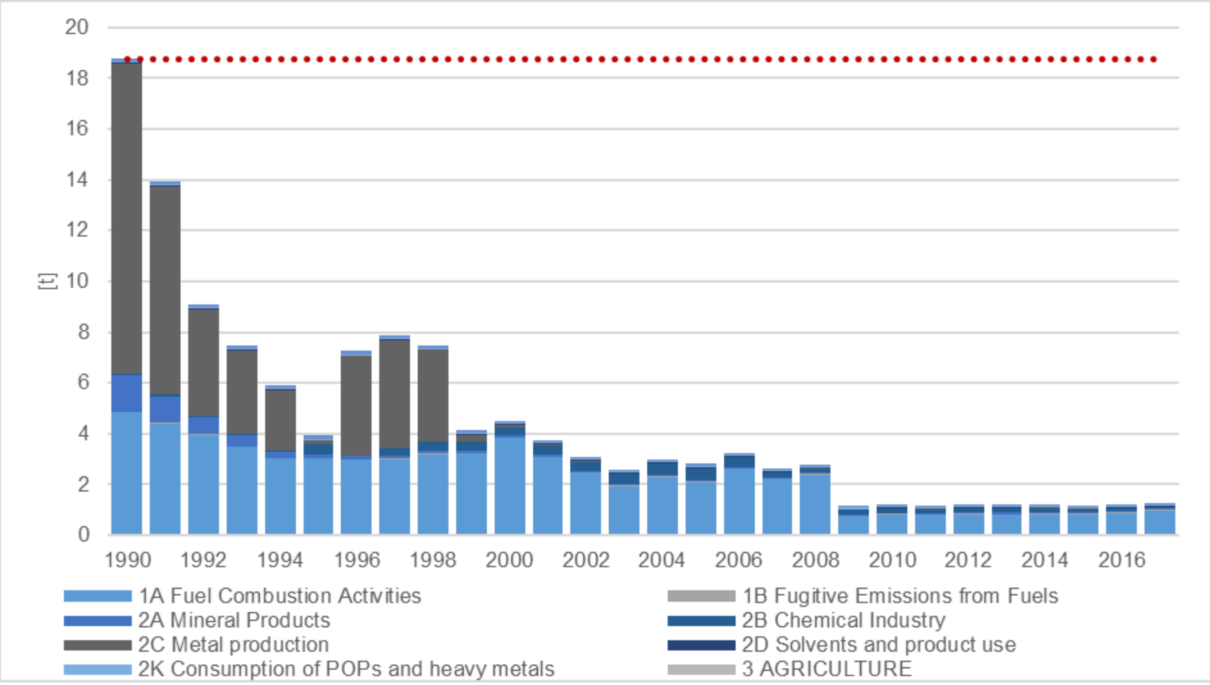


2.5.3 TRENDS IN Hg EMISSIONS

Emissions trend of Hg is decreasing in general (***Figure 2.11***). Several jumps and dips were identified as a reason of economic and political situation in the Slovak Republic, especially in 1995, when the biggest state company producing copper was sold to private sector and in 1999 when the company stopped producing copper using outdated and energy ineffective technology. Since 2009, the emission trend remain stable.

Main contributor to emissions of Hg was copper production in the past. Nowadays, combustion activities in iron and steel manufacturing produce major part of these emissions.

Figure 2.11: *Total Hg Emissions by Sources*



2.6 TREND IN EMISSION OF POPS

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 and in comply with requirements of the respective of working group for emission inventory (UNECE Task Force on Emission Inventory).

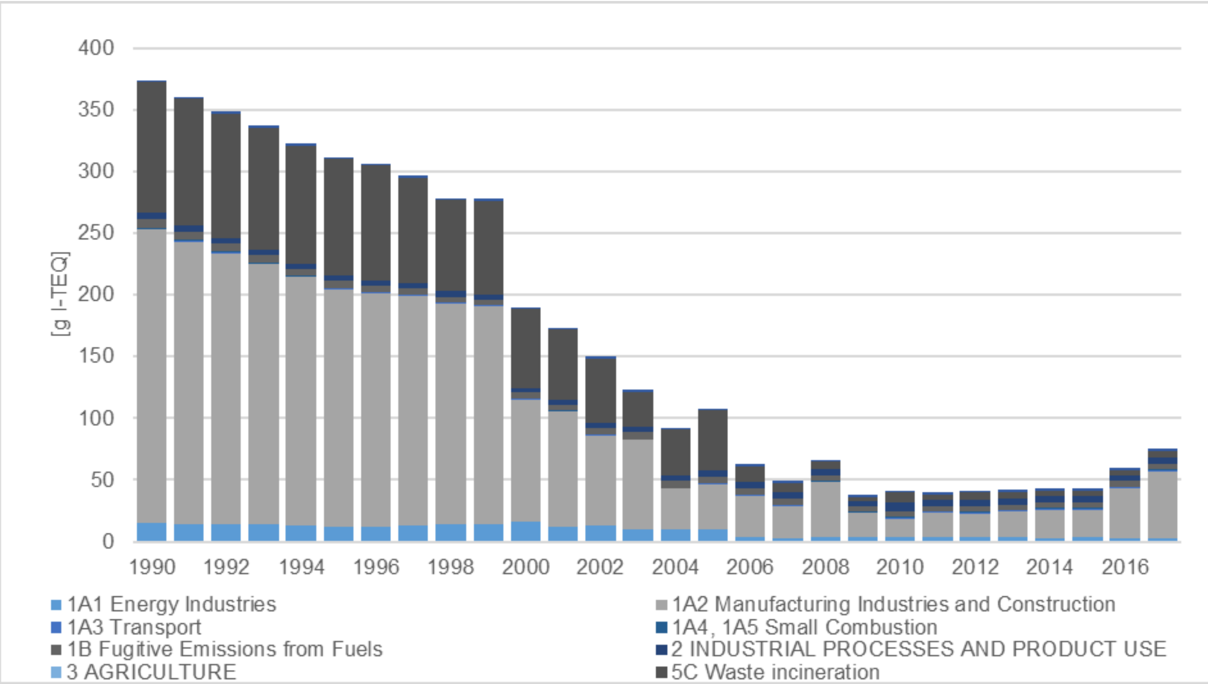
The individual sectors are defined in the sense of the SNAP nomenclature. In the sense of the requirements for the NFR reporting the NFR codes were assigned to the individual sectors upon the base of SNAP nomenclature. Emission factors for the emission estimation have been taken over from literature, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals) and smaller amount comes from the measurements on sources in the SR, Poland and Czech Republic and from EMEP/EEA Air Pollution Emission Inventory Guidebook.

2.6.1 TRENDS IN EMISSIONS OF PCDD/PCDF

Emissions of PCDD/F dropped in 1999 due to technological improvement of facilities which combust industrial waste as a fuel to produce energy (***Figure 2.12***). Moderate increase in 2005 was a result of that many facilities did not comply with the stricter emission limits that came into force in 2006 and therefore used the last year of their operation to burn more waste (with and without energy recovery). Drop in 2009 is caused by economic crisis. Slightly increasing trend since 2010 is a result of waste management politics in the Slovak Republic, which prefer combustion to landfilling of waste.

Main contributors is the 1A2gviii, which include incineration of industrial and clinical waste with energy recovery.

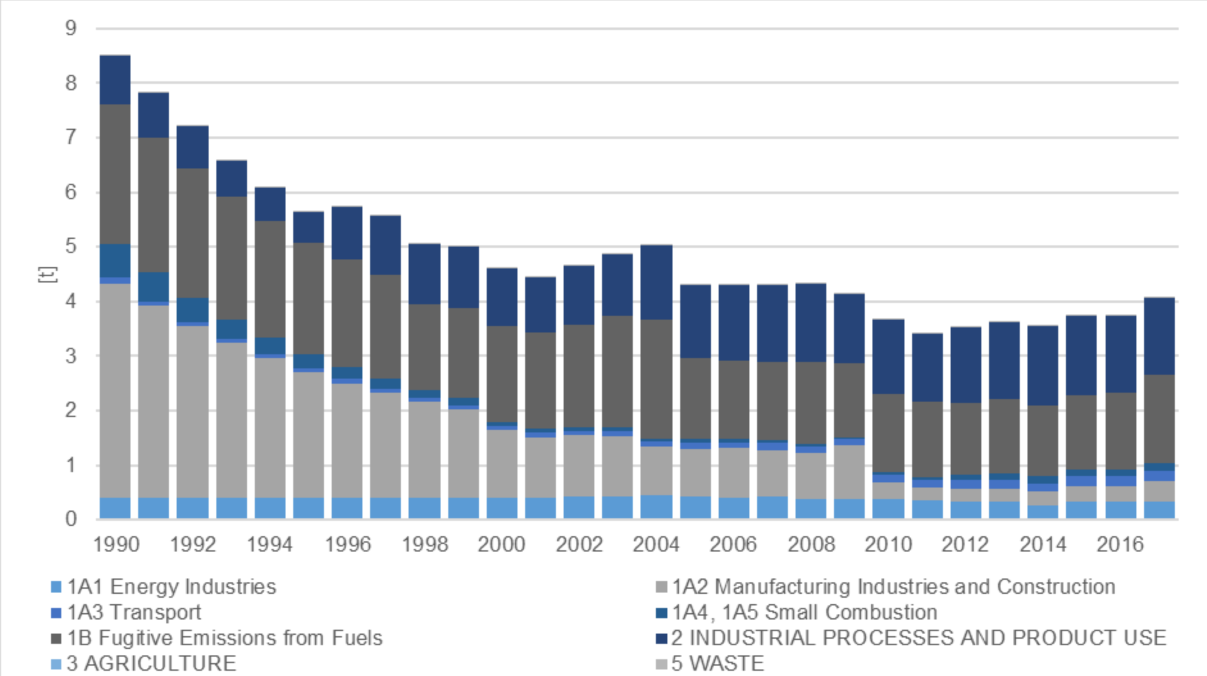
Figure 2.12: *Total PCDD/PCDF Emissions by Sectors*



2.6.2 TRENDS IN EMISSIONS OF PAHS

Decreasing trend of PAHS emission is the most intensive in the period 1990-2000. Since then these emissions fluctuating slightly and in the last years slight increase was recorded. (***Figure 2.13***). Decrease in 2005 was a result of application of new abatement technologies in the largest iron and steel producer in the Slovak Republic. In the year 2010 emissions decreased due to change of fuel base and decrease of using solid fuels of the combustion activities in pulp and paper production.

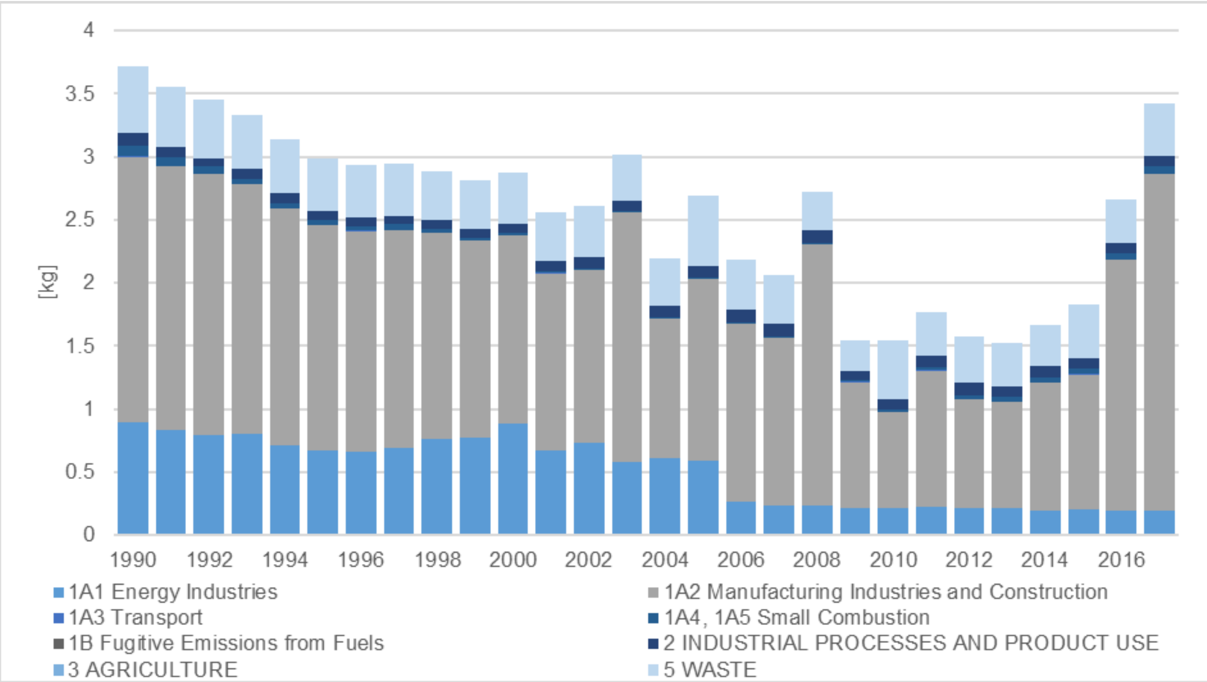
Figure 2.13: *Total PAHs Emissions by Sectors*



2.6.3 TRENDS IN HCB EMISSIONS

Emissions of HCB are connected to energy utilization of industrial waste. The ***Figure 2.14*** shows in general declining trend until 2013 with several jumps in 2003, 2005 and 2008. These are the result of tightening legislation on waste incineration plant. Since the 2014, emissions increasing due to higher use of biomass waste as a fuel in comparison to other fuels in industry.

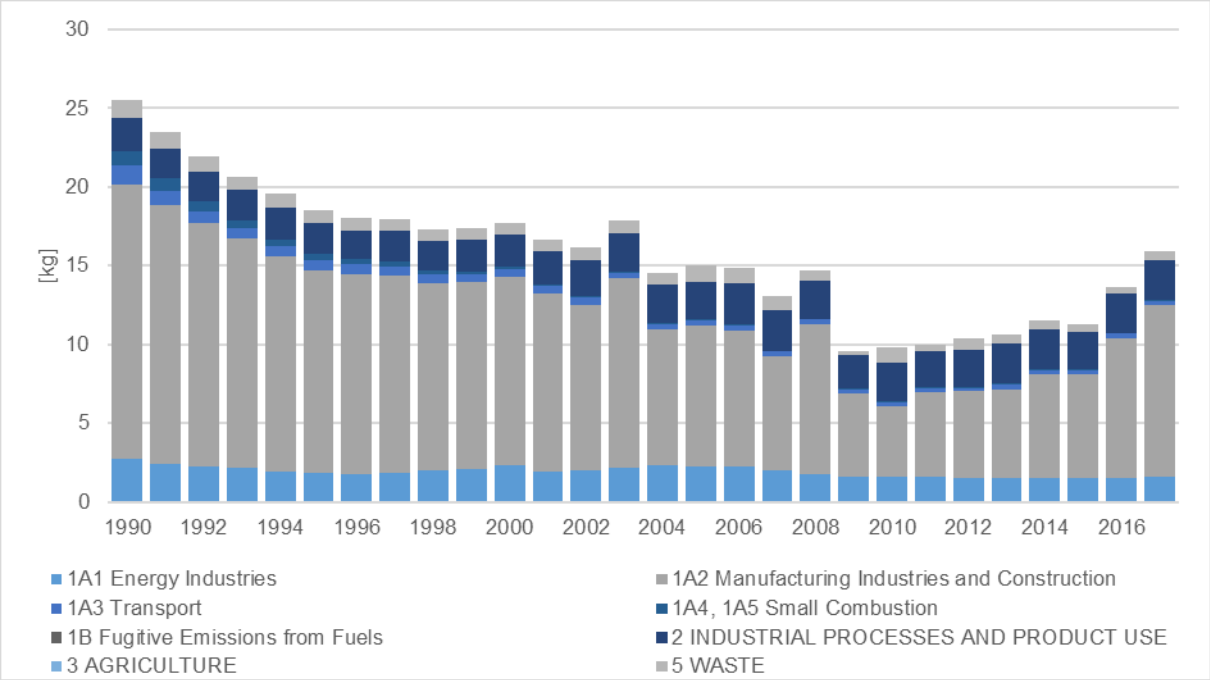
Figure 2.14: *Total HCB Emissions by Sectors*



2.6.4 TRENDS IN PCBs EMISSIONS

Emissions of PCB have the most significant decreasing trend in period 1990-2010, with moderate jumps in 2003 and 2008. Significant decrease in 2009 is a result of the economic crisis which culminated this year. Increasing trend since 2013 is the result of the higher use of biomass waste as a fuel in comparison to other fuels in industry (***Figure 2.15***).

Figure 2.15: *Total PCBs Emissions by Sectors*



CHAPTER 3: ENERGY (NFR 1)

3.1 OVERVIEW OF THE SECTOR

The emissions covered by energy sector originate from fuel combustion (NFR 1A1, 1A2 and 1A3) and fugitive emissions (NFR 1B).

The data sources

a/ NEIS database of stationary large and medium sources providing facility data for nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC) sulphur oxides (SO_X), 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 database is considered as T3 methodology. In year 2016 the system contained 863 (742 of it in operation) large sources and 12 709 (10 504 of it in operation) medium sources.

b/ COPERT 5 model (version 1.1) - This methodology is balancing fifteen different emissions including greenhouse gases from road transport. All data that comes from model is considered as T3 methodology. Detailed description is provided in the **Chapter 3.8.4 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 as T2 or T1. The overview of categories according NFR structure and tier level of inventory is presented in the following ***Table 3.1***.

The inventory of air pollutants except of 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 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, tie or notation key used in energy sector*

NFR		METHODOLOGY / TIER					
	LONGNAME OF CATEGORY	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, NO	T3	NK	T1	T1
1A1b	Petroleum refining	T3	T3	T3	T1	NK	T1
1A1c	Manufacture of solid fuels and other energy industries	T3	T3	T3	T1	T1	T1
	Stationary combustion in manufacturing and construction						
1A2a	Iron and steel	T3	T3, NO	T3	NK	T2	T2
1A2b	Non-ferrous metals	T3	NO	T3	NK	T1	T2, NK
1A2c	Chemicals	T3	NO	T3	NK	T1	T2, NK
1A2d	Pulp, Paper and Print	T3	T3,NO	T3	NK	T1	T2, NK
1A2e	Food processing, beverages and tobacco	T3	T3	T3	NK	T1	T1, NK
1A2f	Non-metallic minerals	T3	NO	T3	NK	T1	T1, NK
1A2gvii	Mobile Combustion	NK	NK	NK	NK	NK	NK
1A2gviii	Other	T3	T3	T3	NK	T1	T2, NK

NFR		METHODOLOGY / TIER					
	LONGNAME OF CATEGORY	NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TSP	BC	HM	POPS
	Transport						
1A3ai(i)	International aviation LTO (civil)	T3	T3	T3	T3	NK	NK
1A3aii(i)	Domestic aviation LTO (civil)	T3	T3	T3	T3	NK	NK
1A3bi	Road transport: Passenger cars	T3	T3	T3	T3	T3	T3
1A3bii	Road transport: Light duty vehicles	T3	T3	T3	T3	T3, NK	T3
1A3biii	Road transport: Heavy duty vehicles and buses	T3	T3	T3	T3	T3, NK	T3
1A3biv	Road transport: Mopeds & motorcycles	T3	T3	T3	T3	T3, NK	T3
1A3bv	Road transport: Gasoline evaporation	T3, NK	NK	NK	NK	NK	NK
1A3bvi	Road transport: Automobile tyre and brake wear	NK	NK	T3	T3	T3	NK
1A3bvii	Road transport: Automobile road abrasion	NK	NK	T3	NK	T3	NK
1A3c	Railways	T1	T1	T1	T1	T1	T1
1A3di(ii)	International inland waterways	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK	T1, NK
1A3dii	National navigation (shipping)	T2	T2	T2	T2	T2	T2
1A3ei	Pipeline transport	T3	NK	T3	NK	NK	NK
1A3eii	Other	NK	NK	NK	NK	NK	NK
	Small combustion						
1A4ai	Commercial/institutional: Stationary	T3	T3	T3	NK	T1	T1
1A4aii	Commercial/institutional: Mobile	NK	NK	NK	NK	NK	NK
1A4bi	Residential: Stationary	T2, T1	NK	T3	NK	T1	T2
1A4bii	Residential: Household and gardening	NK	NK	NK	NK	NK	NK
1A4ci	Agri./Forest./Fish.: Stationary	T3	NK	T3	NK	T1	T1
1A4cii	Agri./Forest./Fish.: Off-road vehicles and other machinery	T3	T3	T3	T3	T3, NK	T3, NK
1A4ciii	Agri./Forest./Fish.: National fishing	NO	NO	NO	NO	NO	NO
	Non-road mobile machinery						
1A5a	Other stationary (including military)	T3	T3	T3	NK	T1	NK
1A5b	Other, Mobile	T2, NK	T2, NK	T2, NK	NK	T2, NK	NK
	Fugitive emissions						
1B1a	from solid fuels: Coal mining and handling	T1,T2,NK	NK	T2	NK	NK	NK
1B1b	from solid fuels: Solid fuel transformation	T1	T1	T1	T1	T1	T3, T1, NK
1B1c	Other fugitive emissions from solid fuels	NO	NO	NO	NO	NO	NO
1B2ai	from oil: Exploration, production, transport	T1+T3, NK	NK	NK	NK	NK	NK
1B2aiv	from oil: Refining / storage	NK	NK	NK	NK	T1	T1, NK
1B2av	Distribution of oil products	T3, NK	NK	NK	NK	NK	NK
1B2b	from natural gas	T1, NK	NK	NK	NK	NK	NK
1B2c	Venting and flaring	NK	NK	NK	NK	NK	NK
1B2d	Other fugitive emissions from energy production	NK	NK	NK	NK	NK	NK

3.2 RECALCULATIONS, IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

Energy sector undertakes continuing improvements. One of these further improvement was check of fuels balances and NCV in all timelines available in registry of NEIS.

The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Net calorific values used for expression in energy units of natural gas has been harmonized in entire timelines with statistics and reference approach of GHG inventory. Propane-butane, which was appeared inconsistently as gaseous fuel as well as liquid in annual dataset in database, was harmonized to liquid fuel due to the majority of data and check with GHG inventory. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.

Representation of fuel shares in total balance is shown on the ***Figure 3.1***. Absolute values are provided in the ***Table 3.2***.

Figure 3.1: *Trend in fuel consumption in TJ*

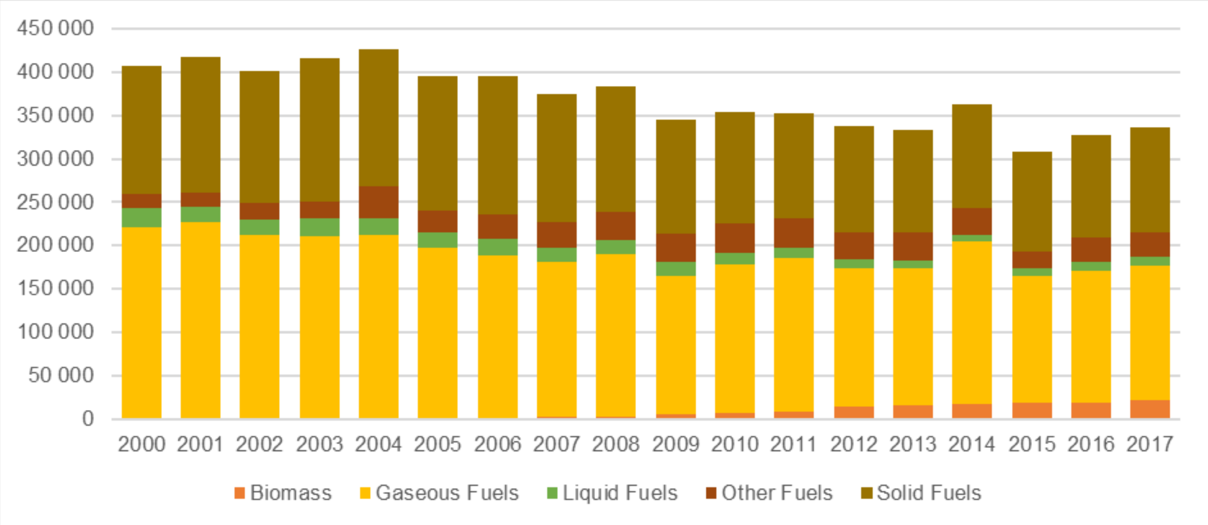


Table 3.2: *Overview of fuel in NEIS in TJ (transport is not included).*

THE NEIS - FUELS 2019						
	LIQUID FUELS TJ	NCV - NG	SOLID FUELS TJ	GASEOUS FUELS TJ	BIOMASS TJ	OTHER FUELS
2000	21 613	34.23	148 262	220 852	552	16 090
2001	18 770	34.18	156 234	225 615	665	16 387
2002	18 864	34.23	152 919	210 693	965	18 694
2003	20 694	34.26	165 590	209 794	642	19 626
2004	19 912	34.26	159 053	210 957	835	36 480
2005	18 669	34.20	154 822	195 991	1 244	24 891
2006	19 061	34.31	159 492	186 972	1 448	28 207
2007	16 630	34.27	147 053	177 704	2 937	30 593
2008	16 529	34.28	145 114	186 362	3 103	33 064
2009	16 379	34.40	131 267	160 416	4 851	32 404
2010	13 832	34.42	128 627	170 451	7 331	33 875
2011	12 403	34.51	120 734	176 222	8 710	34 120
2012	11 355	34.56	122 941	159 015	14 734	30 196
2013	9 670	34.64	117 948	157 382	16 203	32 001
2014	7 208	34.80	119 488	188 455	16 837	30 841
2015	9 164	34.95	115 761	146 889	18 745	18 686
2016	10 466	35.00	118 371	151 388	18 936	28 608
2017	9 785	34.92	120 885	155 683	21 477	28 814

The overview of NEIS fuels categorization and the match of different fuels to the state is listed in the following tables. The tables present complete list of fuel types, marking if particular type is in the registry of db. NEIS during entire time range 2000-2017 and tables provide the average net calorific value for each fuel in registry for year 2017 as well as the average for all years.

Table 3.3: *Overview of liquid fuels and average values of NCV in energy balance*

	CODE	FUEL NAME	REGISTRY	AV. NCV GJ/t	AV. NCV 2017
LIQUID FUELS	**20100**	Crude Oil	-	-	-
	20301	Heavy Fuel Oil Low Sulphur (<1%)	X	40.64	40.16
	20304	Heavy Fuel Oil Medium Sulphur (<1%)	X	40.53	40.83
	20305	Heavy Fuel Oil High Sulphur (>=1%)	X	40.35	40.60
	20306	Medium Fuel Oil (sulphur <1%) Medium Fuel Oil	X	40.43	-
	20307	Refinery - Tar	-	-	-
	20400	Light Fuel Oil	X	41.26	42.48
	20405	Secondary Liquid Fuel (regenerated fuel oil and other secondary liquid fuels), which meets the fuel quality requirements of Annex no. 3a to Decree No. 228/2014	-	-	-
	20600	Kerosene Other	-	-	-
	20601	Kerosene Other	-	-	-
	20700	Kerosene for jet engines (Jet A1 or Jet A)	-	-	-
	20701	Gasoline for jet engines (Jet B) - Jet Fuel	-	-	-
	20800	Gasoline	X	43.54	-
	20900	Kerosene (AvGas)	X	42.03	42.80
	20901	Naphtha	-	-	-
	20902	White Spirit SBP	-	-	-
	20903	Gasoline	-	-	-
	20904	Lubricants	-	-	-
	20905	Refinery Feedstock	-	-	-
	20906	Refinery - Additive and Oxygenates	-	-	-
	20907	Refinery - Other Hydrocarbons	-	-	-
	20908	Refinery - Benzene	-	-	-
	20909	Refinery - Other Refinery Products	-	-	-
	20990	Other Liquid Fuels	X	42.36	42.43
	21000	Diesel Oil	X	43.76	43.69

Table 3.4: *Overview of biomass and average values of NCV in energy balance*

	CODE	FUEL NAME	REGISTRY	AV. NCV GJ/t	AV. NCV 2017
BIOMASS	**11160**	Biomass - Wood and Wooden chips	X	12.47	12.05
	11161	Biomass - Wooden Briquettes and Pellets	X	16.44	16.44
	11170	Biomass - Other Biomass Matter (e.g. Straw)	X	13.98	14.07
	11180	Biomass - Waste according to § 8, par. (2) (i) no. 410/2012 as amended, for which specific requirements for combustion / co-incineration of waste are not applicable	X	13.96	13.82
	11190	Secondary fuel produced from waste wood, which meets the fuel quality requirements of Annex no. 3a to Decree No. 228/2014 as amended.	-	-	-
	11191	Secondary solid fuel other (excluding fuel 11190)	-	-	-
	11200	Charcoal	-	-	-
	11301	Peat Briquettes	X	14.55	14.50

Table 3.5: *Overview of solid fuels and average values of NCV in energy balance*

	CODE	FUEL NAME	REGISTRY	AV. NCV GJ/t	AV. NCV 2017
SOLID FUELS	**10100**	Anthracite	X	25.84	23.93
	10205	Hard Coal CZ	X	28.03	27.20
	10206	Hard Coal PL	X	26.36	25.25
	10210	Hard Coal UA	-	-	-
	10211	Other Bituminous Coal	X	26.52	-
	10305	Coking Coal	-	-	-
	10306	Hard Coal Briquettes	X	22.59	-
	10307	Sub-Bituminous Coal	-	-	-
	10308	Other Sub-Bituminous Coal	-	-	-
	10400	Patent fuel	X	24.42	-
	10501	Brown Coal CZ	X	17.52	17.17
	10507	Brown Coal SK	X	15.84	15.11
	10510	Lignite	X	13.33	11.85
	10518	Brown Coal UA	X	17.40	17.26
	10520	Brown Coal Other	X	15.75	-
	10600	Brown Coal Briquettes	X	19.78	22.80
	10700	Hard Coal Coke	X	27.17	27.14
	10701	Petroleum Coke	X	32.91	-
	10900	Gas coke	-	-	-
	11901	Coal Tar	-	-	-
	11902	Bitumens	-	-	-
	11903	Paraffin Waxes	-	-	-
	11990	Other solid Fuels (exclud. Waste)	X	16.02	-

Table 3.6: *Overview of gaseous fuels and average values of NCV in energy balance*

	CODE	FUEL NAME	REGISTRY	AV. NCV GJ/t.m^3	AV. NCV 2017
GASEOUS FUELS	**30100**	Natural Gas	X	34.47	34.92
	30201	Liquid Hydrocarbons from Natural Gas	-	-	-
	30202	Liquefied Petroleum Gas (LPG)	X	46.00	-
	30301	Propane - Butane	X	45.16	44.91
	30400	Coke Oven Gas - Mining	X	16.72	16.25
	30401	Coke Oven Gas - Metallurgical	-	-	-
	30405	Secondary Gas Fuel that meets the fuel quality requirements of Annex 1. 3a to Decree No. 228/2014 as amended	-	-	-
	30500	Blast Furnace Gas	X	3.31	3.16
	30800	Refinery Gas Non-Condensed	-	43.87	44.01
	30900	Biogas from Excrements	X	21.83	21.46
	30901	Biogas from Waste Water Treatment Plant	X	21.98	22.02
	30902	Biogas from Food Waste	-	-	-
	31000	Biogas from Landfills	X	19.11	18.95
	31001	Biogas Other	X	21.31	21.08
	31200	Generator Gas	X	6.00	6.00
	31300	Oxygen Steel Furnace Gas	X	8.35	8.32
	31500	Ethane	-		-
	31600	Other Gas	-	9.94	9.68
	31990	Other Gaseous Fuels	X	16.92	16.07

__Table 3.7:__ Overview of other fuels and average values of NCV in energy balance

	CODE	FUEL NAME	REGISTRY	AV. NCV GJ/t	AV. NCV 2017
OTHER FUELS	**40101**	Wastes resulting from exploration, mining, treatment and further processing of minerals and stones	-	**-**	**-**
	40102	Hazardous wastes resulting from exploration, mining, treatment and further processing of minerals and stones	-	-	-
	40201	Wastes from agriculture, horticulture, forestry, hunting and fishing, hydroponics and food production and processing	X	13.46	16.09
	40202	Hazardous wastes from agriculture, horticulture, forestry, hunting and fishing, hydroponics and food production and processing	X	16.38	19.00
	40301	Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture	X	32.78	14.61
	40302	Hazardous wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture	X	19.40	24.00
	40401	Wastes from the leather, fur and textile industries	X	10.46	11.17
	40402	Hazardous wastes from the leather, fur and textile industries	X	22.00	-
	40501	Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal	X	34.31	18.00
	40502	Hazardous wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal	X	14.33	24.00
	40601	Wastes from inorganic chemical processes	-	-	-
	40602	Hazardous wastes from inorganic chemical processes	X	18.33	24.00
	40701	Wastes from organic chemical processes	X	16.23	17.31
	40702	Hazardous wastes from organic chemical processes	X	20.43	21.30
	40801	Wastes from production, distribution and use of coatings, adhesives, sealants and printing inks	X	16.84	24.00
	40802	Hazardous wastes from production, distribution and use of coatings, adhesives, sealants and printing inks	X	18.54	21.71
	40901	Wastes from the photographic industry	X	12.22	12.59
	40902	Hazardous wastes from the photographic industry	X	17.25	-
	41001	Wastes from thermal processes	X	11.70	-
	41002	Hazardous wastes from thermal processes	X	24.00	-
	41101	Wastes from chemical surface treatment and coating of metals and other materials, wastes from hydrometallurgy of non-ferrous metals	-	-	-
	41102	Hazardous wastes from chemical surface treatment and coating of metals and other materials, wastes from hydrometallurgy of non-ferrous metals	X	15.00	-
	41201	Wastes from shaping, physical and mechanical surface treatment of metals and plastics	X	12.77	17.59
	41202	Hazardous wastes from shaping, physical and mechanical surface treatment of metals and plastics	X	19.47	21.00
	41302	Hazardous wastes from oil and liquid fuels	X	30.09	31.16
	41402	Hazardous wastes from organic solvents, refrigerants and propellants	X	18.72	21.20
	41501	Waste packaging, absorbents, cloths, filter materials and protective clothing	X	13.91	20.02
	41502	Hazardous waste packaging, absorbents, cloths, filter materials and protective clothing	X	16.32	18.43
	41601	Wastes not otherwise specified in the list	X	18.29	21.75
	41602	Hazardous wastes not otherwise specified in the list	X	18.43	21.66
	41701	Wastes from construction and demolition	X	13.95	19.72
	41702	Hazardous wastes from construction and demolition	X	16.77	24.00
	41801	Wastes from human or animal health care or related research	X	16.07	16.83

	CODE	FUEL NAME	REGISTRY	AV. NCV GJ/t	AV. NCV 2017
	41802	Hazardous wastes from human or animal health care or related research	X	15.37	14.42
	41901	Wastes from waste management facilities, waste water treatment plants and treatment of drinking water, and industrial water	X	17.45	20.67
	41902	Hazardous wastes from waste management facilities, waste water treatment plants and treatment of drinking water, and industrial water	X	18.27	20.88
	42001	Municipal waste (from household and similar waste from trade, industry and institutions)	X	10.91	16.47
	42002	Hazardous municipal wastes (from household and similar waste from trade, industry and institutions)	X	17.91	19.71
	49901	A mixture of wastes, which cannot be clearly identified for the year in question according to the categories mentioned	X	17.00	-
	49902	A mixture of hazardous wastes, which cannot be clearly identified for the year in question according to the categories mentioned	X	19.50	-

The focus of NECD Review 2018 was on heavy metals and POPs. Raised issues on HM in energy sector will be in detail reviewed and implemented during the next reporting cycle.

3.3 OVERALL TREND IN THE ENERGY SECTOR

The processing for energy sector NFR 1A currently covers only energy sources defined according to the Annex No 6 of Decree No 410/2012 Coll. as amended, see ***Table 8***. The rest of sources, classified as technological or combine sources were processed into other NFR process categories. (There are some exceptions for instance the allocation of combustion of municipal waste with energy recovery included in 1A or clearly identified combustion etc. which are allocated manually).

Table 3.8: *General definition of sources included in 1A according to national categorization*

1	THE FUEL-ENERGY INDUSTRY
1.1	Technological units containing combustion plants , including gas turbines and stationary piston engines, with an installed total rated thermal input in MW
1.2	Sorting and treatment of coal, briquette production with projected output in t/h
1.3	Production of coke
1.4	Facilities for fuel gasification or liquefaction of a) coal b) other fuels except for biogas plants and thermal treatment of waste in cat. 5. 7 with a total rated thermal input in MW 7
1.5	Biogas production with projected production capacity: quantity of processed raw material or biological waste in t/d

3.3.1 EMISSIONS

Since 1990 the emissions of air pollutants have significantly declined as shown on following figures (***Figure 3.2***, ***Figure 3.3*** and ***Figure 3.4***). The current share of national totals for NOX is 75%, for NMVOC is 43%, for SOx is 61%, for NH_3 is 2%, for $PM_{2.5}$ is 95% and CO is 45%, for Pb is 40%, for Hg is 46%, Cd is 82% and for PAH is 93%, HCB is 95%, PCB is 84%. The share of individual air pollutants in 2017 is presented on the ***Figure 3.5***.

Figure 3.2: *Trend in emissions for NFR 1*

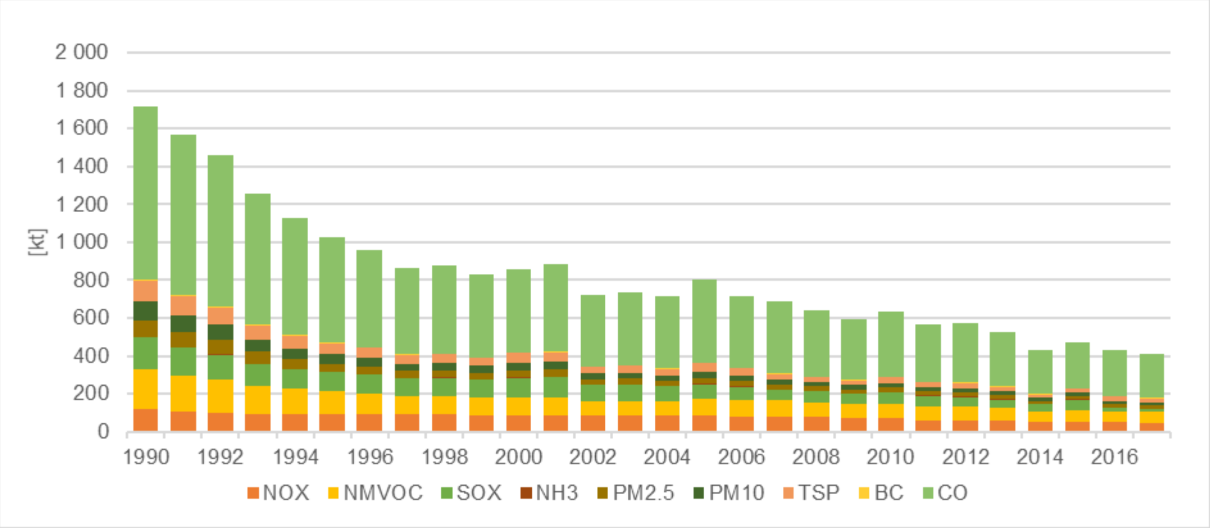


Figure 3.3: *Trend in emissions of energy sector 1A*

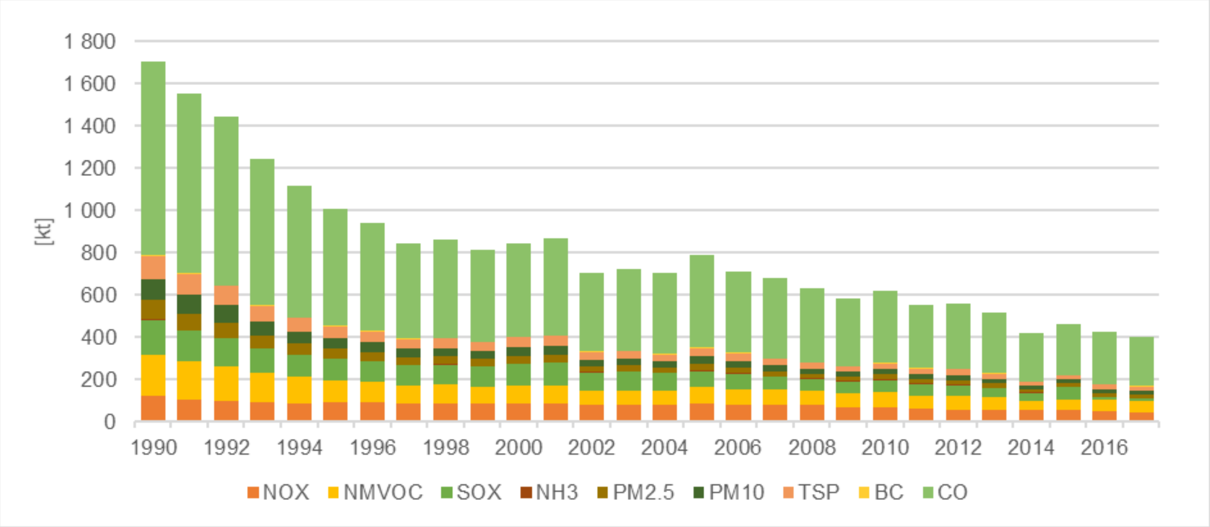
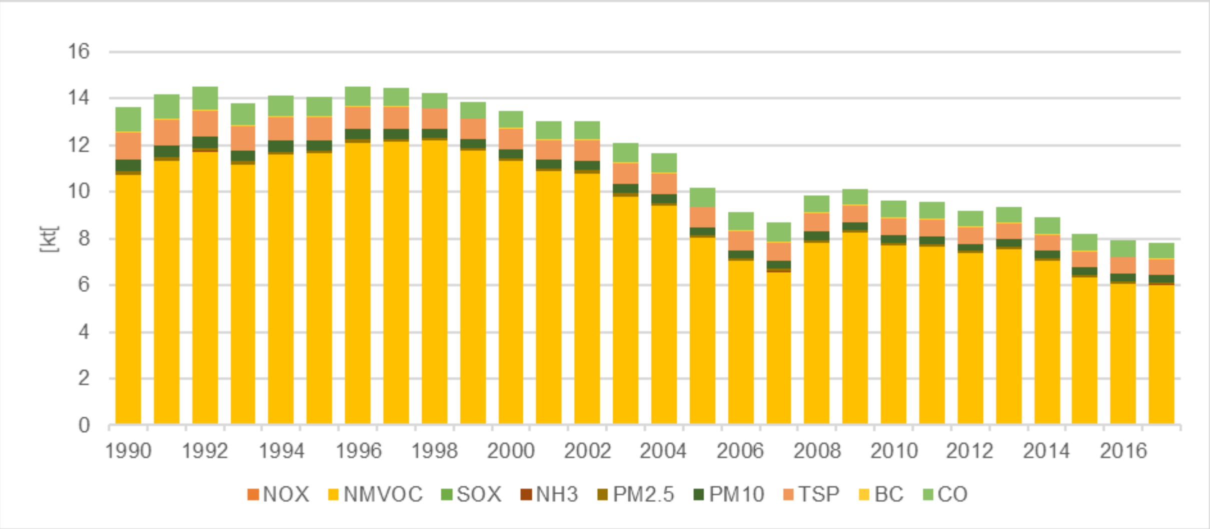


Figure 3.4: *Trend in emissions of energy sector 1B*



The strict air protection legislation alongside the advancements and progress of abatement systems lead to reduction of air pollutants. The reduction of SO_2 emissions has taken place in all sectors due to reduced sulphur content in fuels. Downward trend relates to the composition of fuel use in all sectors and related legislative limitations. The reduction of NO_X was most significant in 1A1 and 1A2 and 1A3 subsectors. Emissions of NMVOC and CO have been reduced mainly due to reductions in transport emissions.

Figure 3.5: *The share in 2017 of individual air pollutants for energy sector*

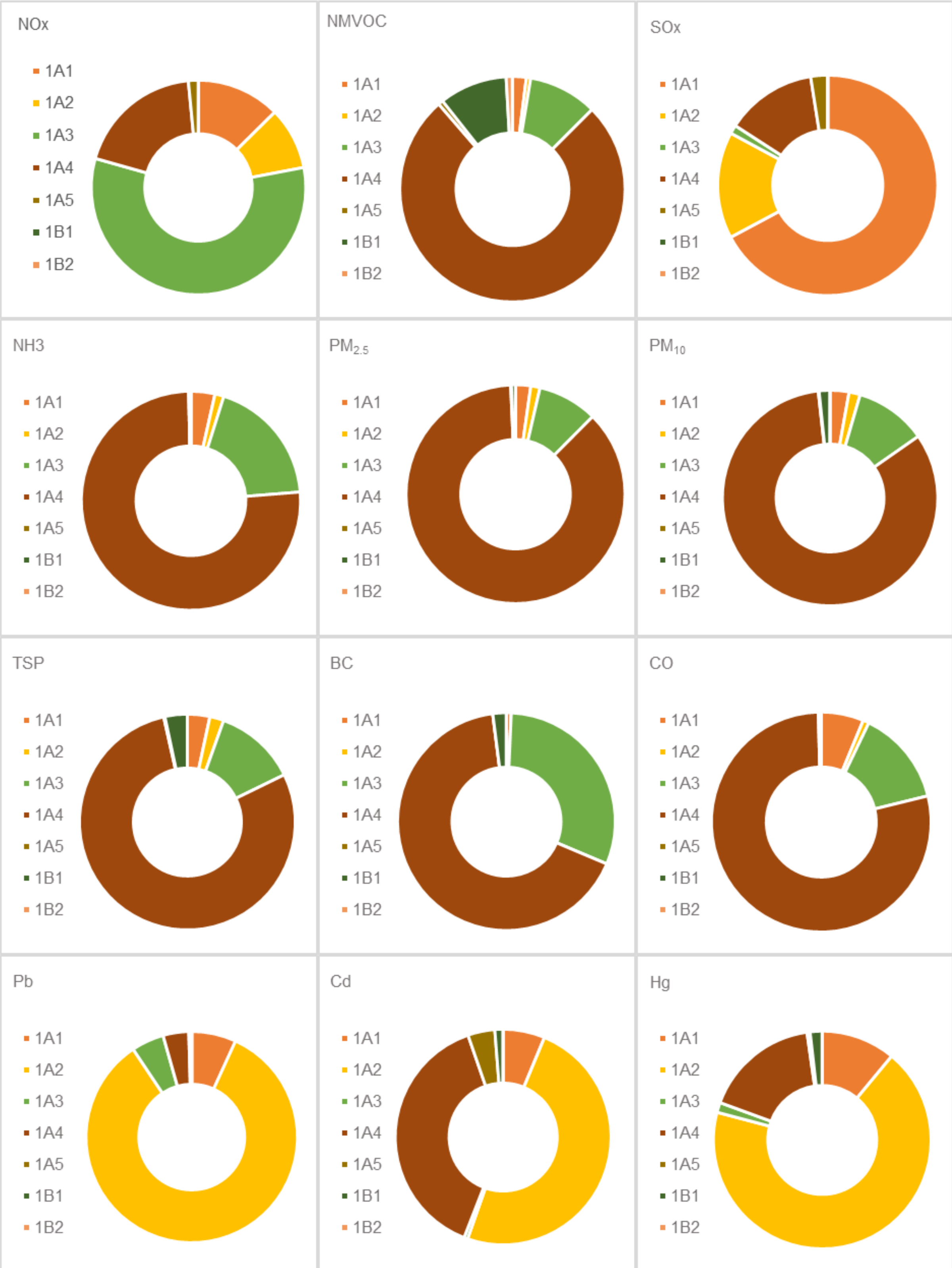
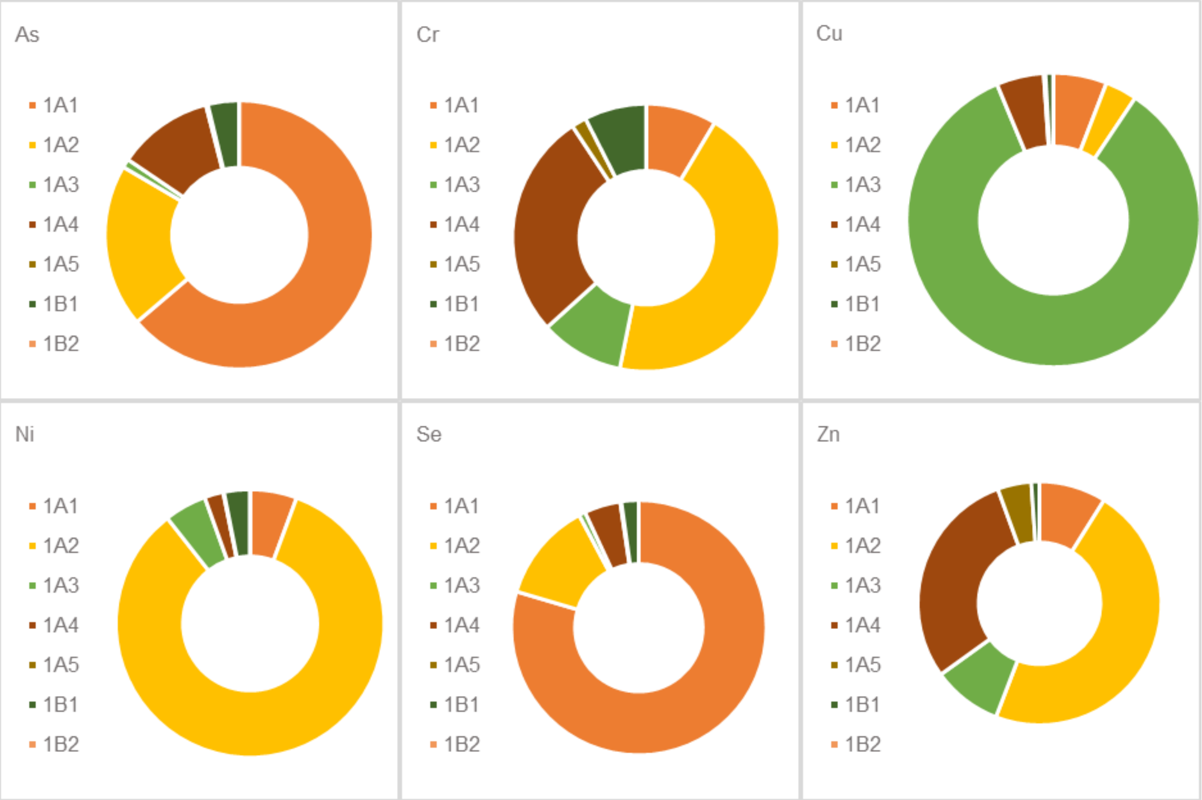


Figure 3.5: *The share in 2017 of individual air pollutants for energy sector - continuation*



3.4 UNCERTAINTY ANALYSIS

Legislation in Slovakia requires monitoring of emissions by the operator as transposed from the IED and MCPD (and previous directives), covering the all significant installations and plants, except the minor ones. In this meaning continuous or periodic measurements shall be applied. Sampling and analysis of polluting substances and measurements of process parameters as well as any alternatives shall be based on methods enabling reliable, representative and comparable results. Methods complying with harmonised EN standards shall be presumed to satisfy this requirement.

3.5 METHODS AND DATA SOURCES

3.5.1 NEIS DATABASE

The emissions of air pollutants (NO_X, SO_X, NMVOC, NH_3, TSP, PMi and HM) are recorded and calculated on yearly bases in NEIS database. Since 2000, when NEIS was set into the operation, the emissions are directly collected in consistent way and verified on more levels. The data collection of air pollutants and emission inventory preparation is performed by standardized procedure. For the purposes of the international emission inventory requirements the bottom-up approach has been introduced for the basic pollutants. For detailed information see **ANNEX IV*.***

3.5.1.1 Data collection

Annual data is collected from energy and industry sources in accordance with Act on air protection No. 137/2010 Coll. as amended and related regulations.

The used term *source* according to the national Act on air protection No. 137/2010 is defined as: „stationary source, as a technological unit, fuel yard, stock of raw materials or products, landfill, quarry or other area with the possibility to steam, burn, or causing dust outlet, or other building, object and activity, which is air polluting or may be air polluting“. Source is „determined as a complex of all parts, components and activities within a functional unit and a spatial unit“.

In connection with the IED, the entity *source* can overlap the *installation* defined in Chapter I, Art. 3(3). (But in some cases *source* can representing an installation's part or a group of more installations). However, the capacity/output threshold values for the *sources* are much lower, compared with IED activities. In addition the number of activity categories is higher compared with IED. Therefore, the national "source records" managed in the NEIS have a far wider range as IED or E-PRTR.

For detailed information see **ANNEX IV*.***

All annual data 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 range from 2000–2017 were processed in the NEIS CU module by the same way of calculation.

3.5.1.2 Completeness

As the estimation of energy subsectors 1A1a, 1A1b, 1A1c, 1A2a, 1A2b, 1A2c, 1A2d, 1A2e, 1A2f, 1A2gviii, 1A3e, 1A4ai, 1A4ci, 1A4cii, 1A5a (bottom up approach) is based on detailed data in the NEIS, all the relevant air pollution sources with installed thermal input ≥ 0.3 MW are included in respective subsector. The balance is completed by transport sector, which is based on statistical data and processed by model COPERT and data on fuels from households which is partly in registry of NEIS completed by statistics.

3.5.1.3 Methodological issues

The sources, having the national categorization, included in energy sector are linked to NFR according to system of NFR code assignment (see **ANNEX IV**):

However, this definition for energy units is wider and insufficient. For distinguishing into individual NFR is used also the specification according to NACE.

The collected data are processed in order to calculate definite emissions for particular year for each source in registry. NEIS is highly variable for determination of emissions according to approved permission on operation and technical condition of installation. There are several manners for compilation of combustion emissions.

Emission compilations for energy in NEIS:

1.	Continuous measurement
2.	Calculation using representative concentration and volume of flue gas

$$Em\ [t] = (1-\eta/100) * c\ [mg/m^3] * V\ [tis.m^{-3}] * 10^{-6}$$

Where

η = Effectiveness of abatement technology or separator

c = concentration of air pollutant

V = quantity/volume of released waste gas

3.	Calculation using representative individual mass flow and number of operating hours

$$Em\ [t] = (1-\eta/100) * q\ [kg/hod] * t\ [hod] * 10^{-3}$$

Where

η = Effectiveness of abatement technology or separator

q = mass flow

t = number of operational hours for related year

4.	Calculation using emission factor and amount of fuel

$$Em\ [t] = (1-\eta/100) * EF\ kg/t * AD\ t * 10^{-3}$$

$$Em\ [t] = (1-\eta/100) * EF\ kg/mil.m^3 * AD\ tis.m^3 * 10^{-6}$$

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

$$Em\ [t] = (1-\eta/100) * EF\ kg/GJ * AD\ GJ * 10^{-3}$$

$$Em\ [t] = (1-\eta/100) * EF\ kg/kWh * AD\ kWh * 10^{-3}$$

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 content of AP in fuel and amount of fuel

$$Em\ [t] = (1-\eta/100) * EF\ kg/t * AP\ \% * AD\ t * 10^{-3}$$

$$Em\ [t] = (1-\eta/100) * EF\ kg/mil.m^3 * AP\ \% * AD\ tis.m^3 * 10^{-6}$$

$$Em\ [t] = (1-\eta/100) * EF\ kg/t * AP\ mg/kg * AD\ t * 10^{-9}$$

$$Em\ [t] = (1-\eta/100) * EF\ kg/mil.m^3 * AP\ mg/kg * AD\ tis.m^3 * 10^{-12}$$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of Air Pollutant expressed as 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-η/100) * EF kg/t * AP % in dry matter * 1-W/100 * 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 percentage

W = humidity of material

AD = Quantity of fuel

8.	Calculation using emission factor related to calorific value

*Em [t] = (1-η/100) * EF kg/GJ * NCV GJ/t * AD t * 10*$^{-3}$

*Em [t] = (1-η/100) * EF kg/GJ * NCV GJ/tis.m*^{3} ** AD tis.m*^{3} ** 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-η/100) * EF kg/GJ * AP % * NCV GJ/t * AD t * 10*$^{-3}$

*Em [t] = (1-η/100) * EF kg/GJ * AP % * NCV GJ/tis.m*^{3} ** AD tis.m*^{3} ** 10*$^{-6}$

*Em [t] = (1-η/100) * EF kg/GJ * AP mg/kg * NCV GJ/t * AD t * 10*$^{-9}$

*Em [t] = (1-η/100) * EF kg/GJ * AP mg/kg * NCV GJ/tis.m*^{3} ** AD tis.m*^{3} ** 10*$^{-12}$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of Air Pollutant expressed as 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] = (1-η/100) * EF kg/GJ * AP % * 1-W/100 * NCV GJ/t * AD t * 10*$^{-3}$

Where

η = Effectiveness of abatement technology or separator

EF = Emission Factor

AP = Content of ash and sulphur in dry matter expressed as percentage

W = humidity of material

AD = Quantity of fuel

99.	Other manner of determination

In data processing is taken specific information on abatement technologies and their effectiveness in compilation of final emissions. (**ANNEX IV, Chapter A4.7**).

3.5.1.4 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 comply 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_{2016} and in comply with requirements of the respective of working group for emission inventory (UN ECE Task Force on Emission inventory) and methodology is based on IIASA's report[1].

Automated calculation of emissions PM_{10} and $PM_{2.5}$ was technically implemented in 2011[2] in db. NEIS according the study[3] . 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 methodology of calculation inventory of PM_{10} and $PM_{2.5}$. National inventory is base to 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. 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 separator, the calculation of total emissions PM_{10} and $PM_{2.5}$ is taken to NFR tables

Emissions are distinguish into three fractions: fine ($PM_{2.5}$), coarse (PM_{10} -$PM_{2.5}$) and big (PM>10 μm)

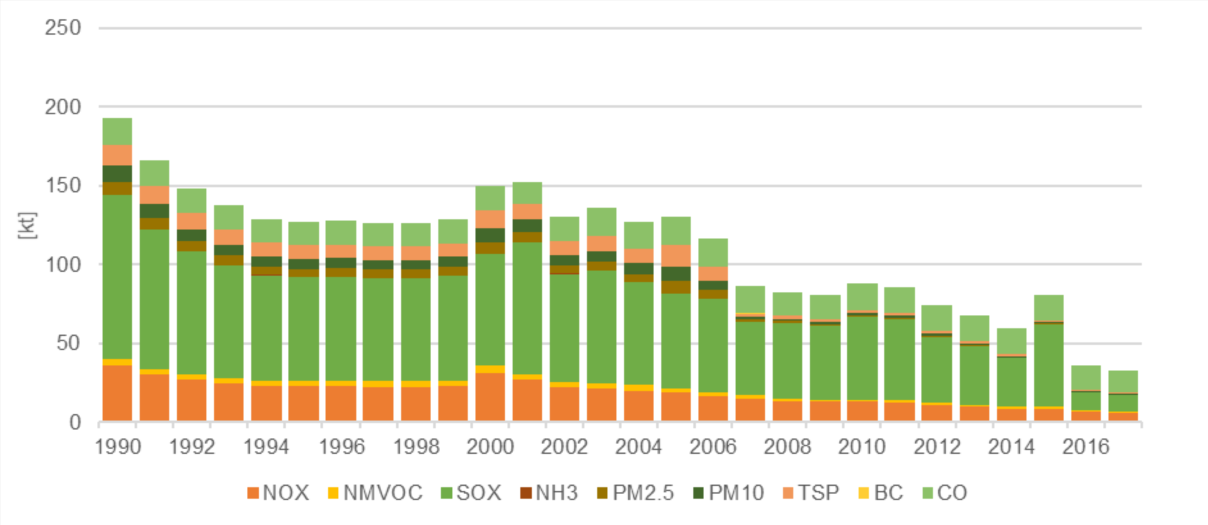
Final emissions are calculated: $PM_{10} = PM_{fine} + PM_{coars}$

3.6 ENERGY INDUSTRIES (NFR 1A1)

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 following chapters.

[1] hhttp://www.iiasa.ac.at/web/home/research/researchPrograms/air/ir-02-076.pdf
[2] Správa k riešeniu úlohy „Systém pre prepočet emisií TZL na emisie PM10 a PM2.5, SPIRIT informačné systémy
[3] 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

Figure 3.6: Trend of air emissions pollutans in energy industry



3.6.1 PUBLIC ELECTRICITY AND HEAT PRODUCTION (NFR 1A1a)

3.6.1.1 Overview

This activity covers emissions from combustion plant 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.

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

Table 3.9: Activities according to national categorization included in 1A1a

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW + specification according to NACE: LARGE SOURCES 35.1; 35.2; 35.3
5.1. Waste incineration plants (with 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

Figure 3.7: Trends in emissions of air pollutants in 1A1a

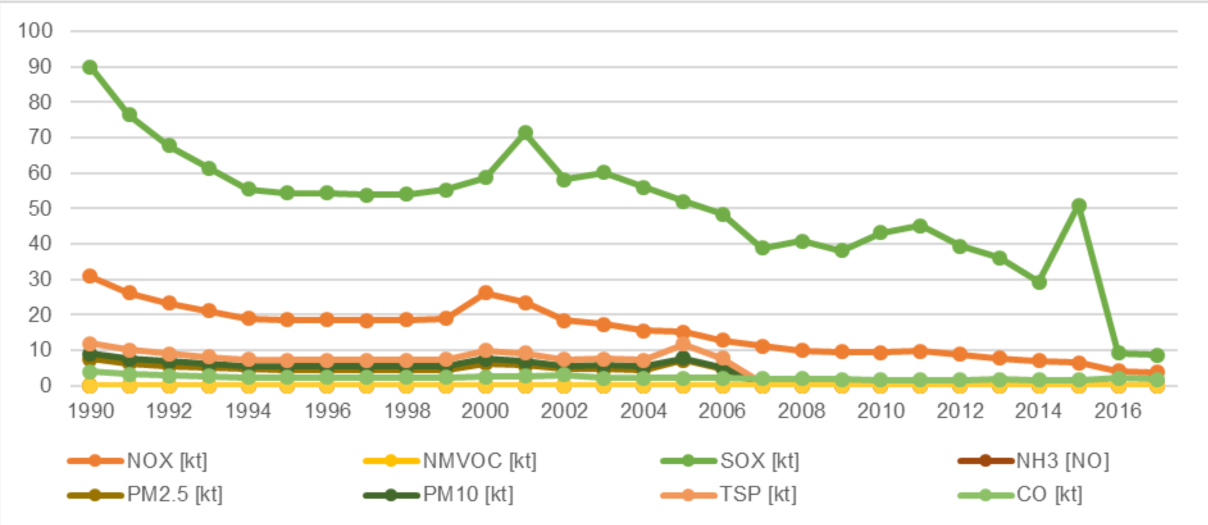


Figure 3.8: *Trends in emissions of heavy metals in 1A1a*

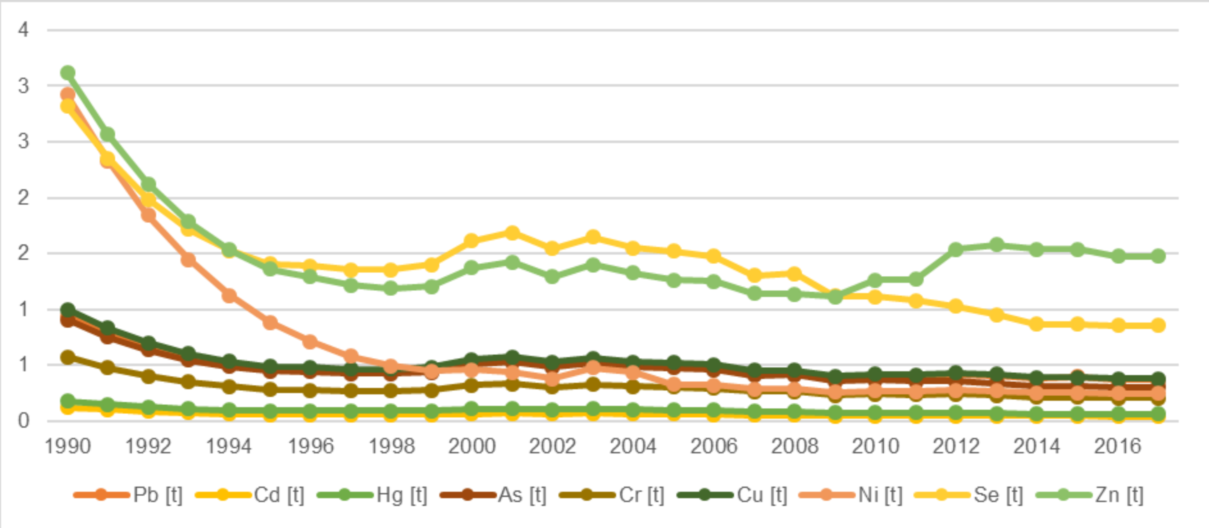
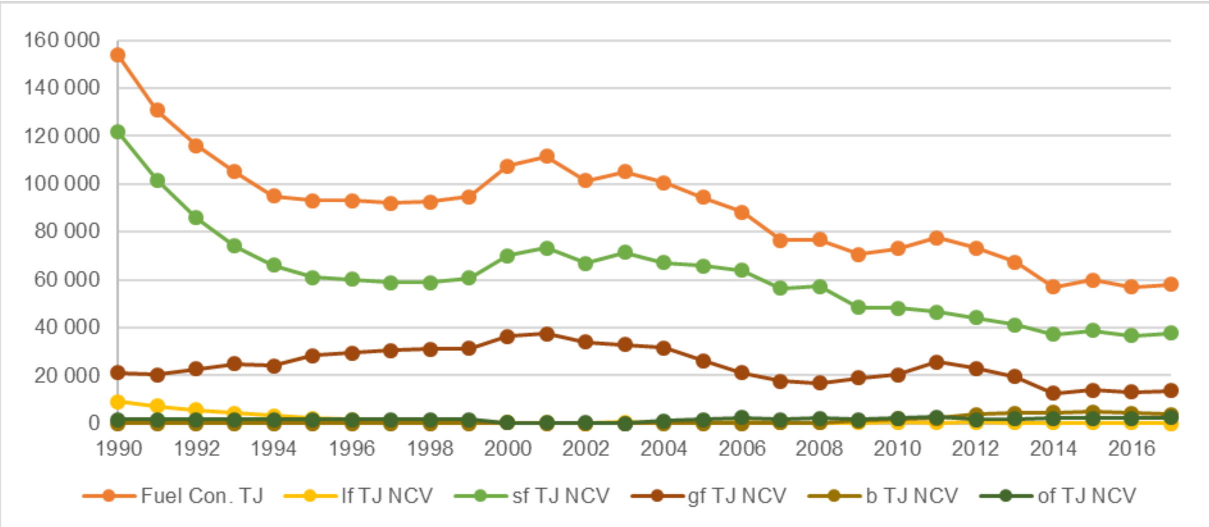


Figure 3.9: *The fuel consumption of NFR 1A1a in TJ*



The emission data of air pollutants in ***Table 3.10*** are calculated in Tier 3 level. The share of allocated emissions from MWI for individual air pollutants are presented in table below.

Table 3.10: *The overview of emissions of AP in Public electricity and heat production in division on 1A1a and allocated emissions MWI with energy recovery in kt.*

NFR / Y	NO_x kt		NMVOC kt		SO_x kt		CO kt	
	1A1a	MWI	1A1a	MWI	1A1a	MWI	1A1a	MWI
2005	15.072	0.2224	0.152	0.0016	51.954	0.0385	2.258	0.0479
2006	12.670	0.1638	0.142	0.0012	48.418	0.0043	2.266	0.0177
2007	11.036	0.1348	0.133	0.0009	38.778	0.0034	1.999	0.0087
2008	9.837	0.1233	0.141	0.0007	40.915	0.0036	2.006	0.0083
2009	9.476	0.1373	0.140	0.0011	38.124	0.0057	1.860	0.0086
2010	9.389	0.1384	0.159	0.0018	43.148	0.0066	1.684	0.0096
2011	9.637	0.1631	0.166	0.0018	45.187	0.0069	1.612	0.0084
2012	8.816	0.1578	0.178	0.0020	39.343	0.0063	1.750	0.0076
2013	7.729	0.1399	0.174	0.0026	36.165	0.0075	1.854	0.0082
2014	6.906	0.1504	0.166	0.0023	29.243	0.0109	1.669	0.0173
2015	6.415	0.1240	0.168	0.0021	50.892	0.0067	1.666	0.0083
2016	4.058	0.1426	0.151	0.0016	9.228	0.0087	2.163	0.0088

NFR / Y	NO_X kt		NMVOC kt		SO_X kt		CO kt	
	1A1a	MWI	1A1a	MWI	1A1a	MWI	1A1a	MWI
2017	3.724	0.1465	0.149	0.0016	8.639	0.0097	1.764	0.0141

From emission data is visible increase in 2015 and drop in 2016, the most significant in SO_X. This annual fluctuation caused the one source of Slovak power plants. This increase was in ENO A K1, K2- granul. 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 brow 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 be in comply with national legislation, so the expected significant reduction in SO_X emissions was visible in 2016 emissions. The decline was continuing during 2017.

Table 3.11: *The overview of emissions of AP in Public electricity and heat production in division on 1A1a and allocated emissions from MWI with energy recovery in kt*

NFR / Y	$PM_{2.5}$ kt		PM_{10} kt		TSP kt	
	1A1a	MWI	1A1a	MWI	1A1a	MWI
2005	7.255	0.0083	7.802	0.0083	11.724	0.0110
2006	4.901	0.0013	5.259	0.0013	7.736	0.0018
2007	0.678	0.0013	0.815	0.0013	1.032	0.0018
2008	0.532	0.0006	0.667	0.0006	0.926	0.0008
2009	0.467	0.0005	0.597	0.0005	0.835	0.0007
2010	0.431	0.0010	0.516	0.0010	0.656	0.0013
2011	0.505	0.0007	0.596	0.0007	0.721	0.0009
2012	0.459	0.0013	0.572	0.0013	0.700	0.0017
2013	0.371	0.0012	0.467	0.0012	0.644	0.0016
2014	0.349	0.0018	0.426	0.0018	0.552	0.0023
2015	0.460	0.0012	0.563	0.0012	0.703	0.0016
2016	0.206	0.0012	0.248	0.001	0.300	0.0016
2017	0.148	0.0016	0.178	0.002	0.226	0.0021

Table 3.12: *The overview of emissions of heavy metals in Public electricity and heat production in division on 1A1a and allocated emission from MWI with energy recovery in kt*

NFR / Y	Pb		Cd		Hg		As		Cr	
	1A1a	MWI	1A1a	MWI	1A1a	MWI	1A1a	MWI	1A1a	MWI
2005	0.483	0.011	0.060	0.001	0.095	0.003	0.472	0.001	0.298	0.003
2006	0.472	0.011	0.058	0.001	0.092	0.004	0.459	0.001	0.290	0.003
2007	0.421	0.010	0.052	0.001	0.081	0.003	0.407	0.001	0.258	0.003
2008	0.424	0.009	0.052	0.001	0.082	0.003	0.411	0.001	0.260	0.003
2009	0.376	0.010	0.046	0.001	0.071	0.003	0.356	0.001	0.228	0.003
2010	0.393	0.011	0.047	0.001	0.072	0.003	0.363	0.001	0.235	0.003
2011	0.385	0.011	0.046	0.001	0.071	0.003	0.355	0.001	0.230	0.003
2012	0.404	0.010	0.047	0.001	0.070	0.003	0.354	0.001	0.235	0.003
2013	0.392	0.010	0.045	0.001	0.066	0.003	0.337	0.001	0.226	0.003
2014	0.367	0.011	0.042	0.001	0.060	0.003	0.310	0.001	0.210	0.003
2015	0.387	0.011	0.044	0.001	0.063	0.004	0.325	0.001	0.220	0.003
2016	0.358	0.011	0.041	0.001	0.059	0.004	0.303	0.001	0.205	0.003
2017	0.356	0.011	0.041	0.001	0.060	0.004	0.307	0.001	0.206	0.003

Table 3.12: *The overview of emissions of heavy metals in Public electricity and heat production in division on 1A1a and allocated emission from MWI with energy recovery in kt - continuation*

NFR / Y	Cu		Ni		Se		Zn	
	1A1a	MWI	1A1a	MWI	1A1a	MWI	1A1a	MWI
2005	0.517	0.003	0.324	0.004	1.518	0.002	1.256	0.004
2006	0.505	0.003	0.316	0.004	1.472	0.002	1.246	0.005
2007	0.450	0.002	0.282	0.004	1.300	0.002	1.140	0.004
2008	0.453	0.002	0.284	0.003	1.315	0.002	1.132	0.004
2009	0.401	0.002	0.252	0.004	1.114	0.002	1.109	0.004
2010	0.418	0.003	0.264	0.004	1.111	0.002	1.260	0.004
2011	0.410	0.003	0.259	0.004	1.077	0.002	1.261	0.005
2012	0.429	0.002	0.272	0.004	1.023	0.002	1.536	0.004
2013	0.415	0.002	0.265	0.004	0.953	0.002	1.577	0.004
2014	0.389	0.003	0.248	0.004	0.865	0.002	1.536	0.005
2015	0.409	0.003	0.261	0.004	0.898	0.002	1.640	0.005
2016	0.378	0.003	0.241	0.004	0.851	0.002	1.471	0.005
2017	0.377	0.003	0.241	0.004	0.875	0.002	1.420	0.005

3.6.1.2 Methodological issues

Emission data is compiled in the NEIS as presented in **Chapter 3.5.1.3**, therefore the individual specific EF could be used for sources recorded in database. Otherwise general EFs of the Bulletin of Ministry of Environment are presented in **ANNEX IV, Chapter A4.6.** For detailed methodology please see **ANNEX IV**. The following ***Table 3.13*** presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Due to the high share of using plant specific data or EF, in ***Table 3.14*** it is provided only the *implied emission factors related to overall volume of fuel consumed* for 2017 in category and *weighted IEF related to overall volume of fuel consumed* for years 2000–2017. The refined estimation of historical emissions are done by the *weighted IEF* related to period 2000-2003.

For PMi are provided in the percentage share of PMi from TSP due to the integrated way of compilation in the NEIS. The shares were calculated for PMi in available years from 2005 to 2017. Their average was used for calculations of historical data due to the absence of historical data in db. NEIS. Emissions of NH_3 are recorded only for last two year. Emission presence is linked with the usage of DENOX abatements technologies.

Table 3.13: *The overview of share of used calculation type for category 1A1a in the NEIS*

1A1A	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	30%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	13%
4	Calculation using emission factor and amount of fuel	18%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.1%
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	38%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

Table 3.14: *Implied emission factors for air pollutants for 2017 in 1A1a*

IEF g/GJ	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	CO
2017	66.78	2.60	149.23	0.34	65.61%	78.87%	3.93	30.68
W-IEF g/GJ	**NO_X**	**NMVOC**	**SO_X**	**NH_3**	**$PM_{2.5\ \%TSP}$**	**$PM_{10\ \%TSP}$**	**TSP**	**CO**
2000-2003	201.00	1.64	584.32	-	62.80%	75.39%	78.20	25.64
2000-2016	178.39	1.70	159.96	0.31	62.90%	75.45%	48.86	25.79

Heavy metals are calculated as Tier 1 level. Emission factors used for calculation of heavy metals are default EF from EMEP/EEA GB_{2016}.

Table 3.15: *Emission factor for heavy metals in 1A1a*

T1	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	INCINERATED M. WASTE
Unit	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ
Pb	4.56	7.3	0.0015	20.6	58
Cd	1.2	0.9	0.00025	1.76	4.6
Hg	0.341	1.4	0.1	1.51	18.8
As	3.98	7.1	0.12	9.46	6.2
Cr	2.55	4.5	0.00076	9.03	16.4
Cu	5.31	7.8	0.000076	21.1	13.7
Ni	255	4.9	0.0051	14.2	21.6
Se	2.06	23	0.0112	1.2	11.7
Zn	87.8	19	0.0015	181	24.5

POPs were balance on base of country specific emission factors, which originate from the study "*Inventarizácia emisií POPs do ovzdušia*" (*Inventory of emissions of POPs into the air*) (Matejovičová, 2006). Emission factors are showed in the ***Table 3.16***.

Table 3.16: *Emission factor for POPs in 1A1a*

	HARD COAL	WOOD	BROWN COAL	FUEL OIL	NATURAL GAS	MSW, GOOD AP	MSW, VERY GOOD APC
Unit	mg/t	mg/t	mg/t	mg/t	mg/th.m^3	mg/t	mg/t
DIOX	0.0002	0.001	0.001	0.0001	0.00002	0.06	0.0004
B(a)P	0.004	0.095	0.004	4.68	-	0.7	0.7
B(b)F	0.007	19	0.007	20.3	-	19	19
B(k)F	0.007	19	0.007	3.98	-	19	19
I()P	0.00703	0.17	0.00703	7.57	-	0.17	0.17
PAHs	0.025	38.265	0.02519	36.53	-	38.87	38.87
HCB	0.074	0.043	0.048	0.128	-	3	0.1
PCBs	0.791	0.049	0.052	0.612	-	5.2	5.25

3.6.1.3 Completeness

Emissions are well covered.

3.6.2 PETROLEUM REFINING (NFR 1A1b)

3.6.2.1 Overview

This activity covers emissions released from production and combustion processes within a refinery. Combustion processes include the heating of crude and petroleum products without contact between flame and products.

The emissions from the refineries are allocated in 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 the petroleum refining, classified by the code 1A1b, concern all combustion activities required to support the refining of petroleum products. ***Figure 3.10*** provides the overview of the trend in emissions. Heavy metals are reported as NE. POPs are balanced using country specific emission factors (Matejovičová, 2006).

Table 3.17: *Activities according to the national categorization included in 1A1b*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
1.1. Technological units containing combustion plants, including gas turbines and stationary piston engines, with an installed total rated thermal input in MW *+ specification according to NACE: LARGE SOURCES 19*
4.3. Refineries (combustion)

Figure 3.10: *Trends in emissions of air pollutants in 1A1b*

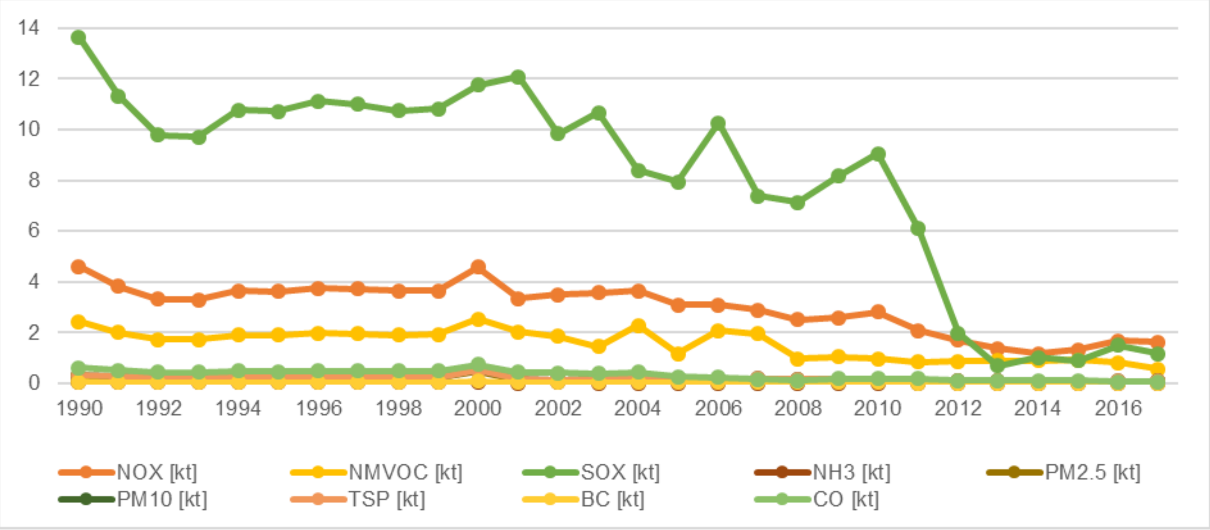
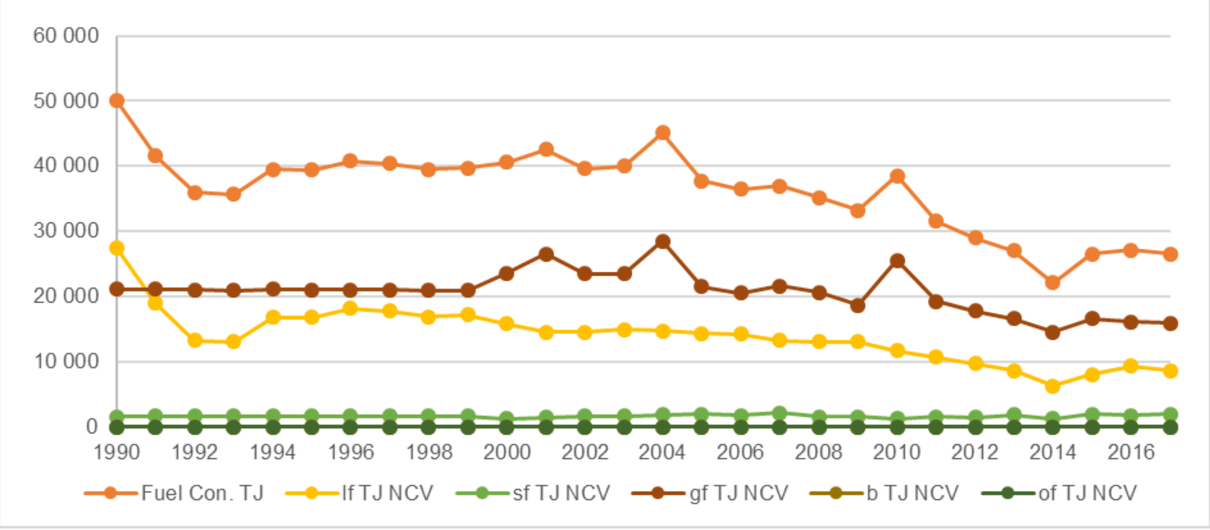


Figure 3.11: *The fuel consumption of NFR 1A1b in TJ*



3.6.2.2 Methodological issues

Emission data is compiled in the NEIS as presented in **Chapter 3.5.1.3**, therefore the individual specific EF could be used for sources recorded in database. Otherwise general EFs of the Bulletin of Ministry of Environment are presented in **ANNEX IV, Chapter A4.6.** For detailed methodology please see **ANNEX IV**. The following ***Table 3.18*** presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Historical data 1990-1999 are not covered by NEIS, therefore the estimations are done on base of development of IEF. HM emissions are allocated in the category 1B2aiv because if using of Tier 1 approach adopted for the process emissions, combustion emissions are already covered and should not be reported again in Chapter 1A1b since this would lead to double counting. This action was taken due to recommendation No ***SK-1A1b-2018-0001***. POPs are balanced using emission factors from EMEP/EEA GB_{2016}.

Table 3.18: *The overview of share of used calculation type for category 1A1b in NEIS*

1A1b	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	70%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	20%
4	Calculation using emission factor and amount of fuel	1%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.01%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	9%

Due to the high share of using plant specific data or individual authorized measures, in ***Table 3.19*** it is provided only the *implied emission factors related to overall volume of fuel consumed* for 2017 in category and *weighted IEF related to overall volume of fuel consumed* for years 2000–2017. The refined estimation of historical emissions are done by the *weighted IEF* related to period 2000-2003.

Table 3.19: *Implied emission factors for air pollutants of 1A1b*

IEF g/GJ	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	CO
2017	61.03	20.98	44.37	0.62	91.85%	99.61%	3.29	2.02
W-IEF g/GJ	**NO_X**	**NMVOC**	**SO_X**	**NH_3**	**$PM_{2.5\ \%TSP}$**	**$PM_{10\ \%TSP}$**	**TSP**	**CO**
2000-2003	92.09	48.33	272.51	0.56	91.17%	99.58%	6.13	12.04
2000-2016	76.21	39.96	195.04	0.28	91.17%	99.58%	4.54	7.13

For PMi are provided in the percentage share of PMi from TSP due to the integrated way of compilation in the NEIS. The shares were calculated for PMi in available years from 2005 to 2017. The average were used for calculations of historical data due to the absence of historical data in db. NEIS.

Emission factor of POPs are displayed in the ***Table 3.20***.

Table 3.20: *Emission factor for POPs in 1A1b*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	µg/GJ	µg/GJ	µg/GJ	µg/GJ	µg/GJ	µg/GJ	ng WHO-TEQ/GJ	ng WHO-TEQ/GJ
Heavy fuel oil	2.5	-	4.5	4.5	6.92	15.92	-	-
Natural gas	0.5	0.56	0.84	0.84	0.84	3.08	-	-
Hard coal	10	0.7	37	29	1.1	67.8	6.7	3.3
Refinery gas	-	0.669	1.14	0.631	0.631	3.071	-	-

3.6.2.3 Completeness

Emissions are well covered.

3.6.3 MANUFACTURE OF SOLID FUELS AND OTHER ENERGY INDUSTRIES (NFR 1A1c)

3.6.3.1 Overview

The activity covers coke production and emissions associated with combustion in the coke oven. The category covers the activities included in 1A1c is shown in ***Table 3.21*** and trend of emissions are presented on ***Figure 12*** – ***Figure 3.14*** and fuels in ***Figure 15***.

Table 3.21: *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

Figure 3.12: *Trends in emissions of air pollutants in 1A1c*

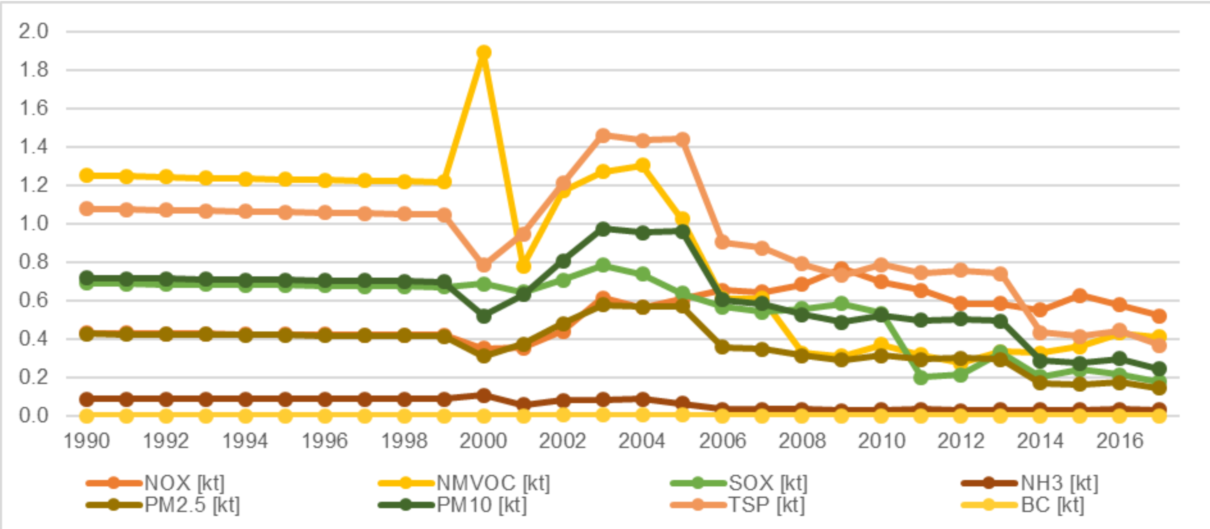


Figure 3.13: *Trend in emissions of CO in 1A1c*

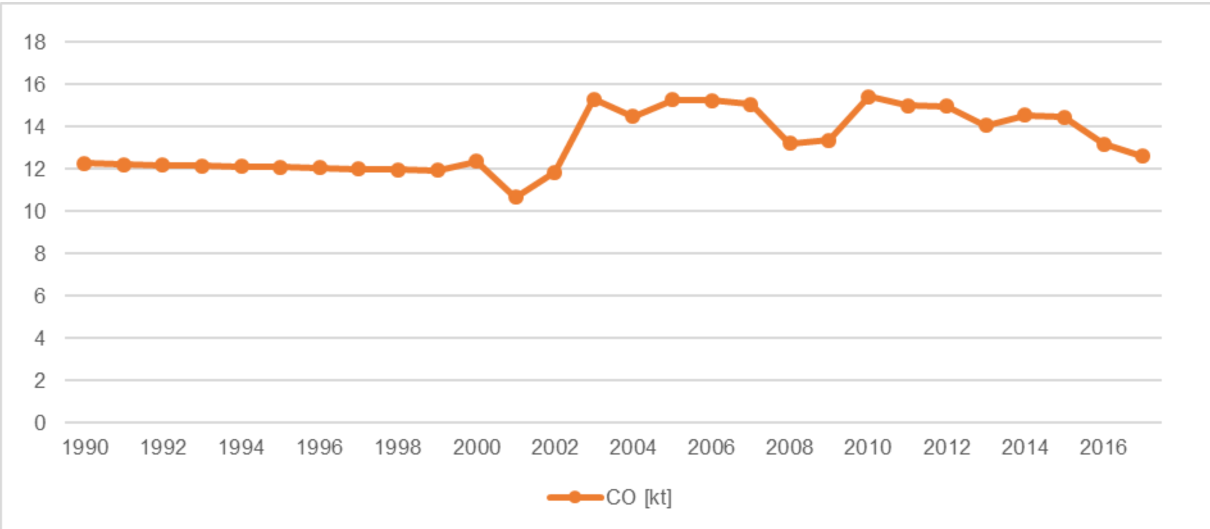


Figure 3.14: Trends in emissions of heavy metals in 1A1c

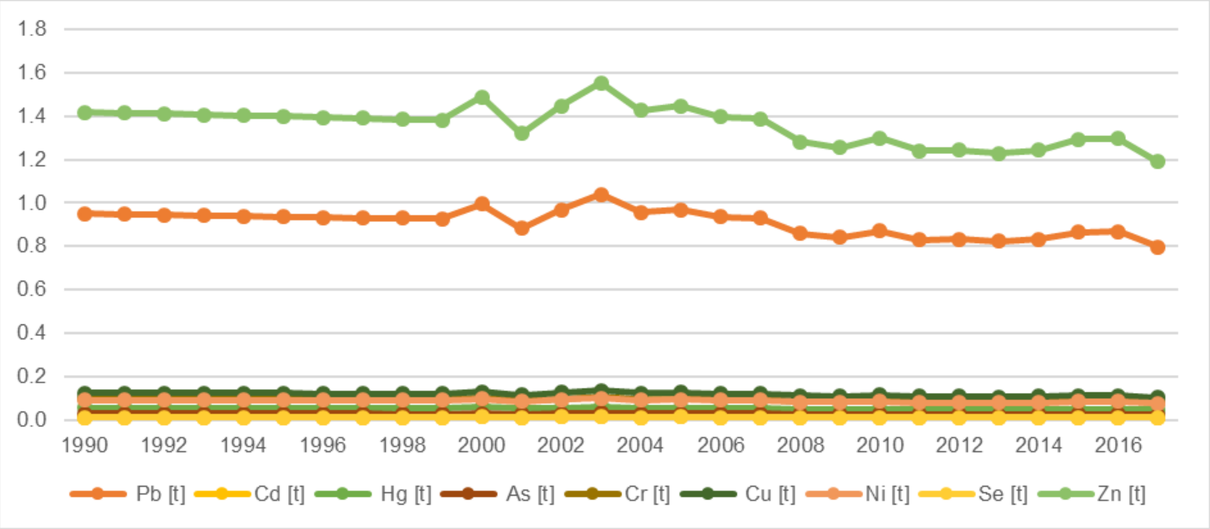
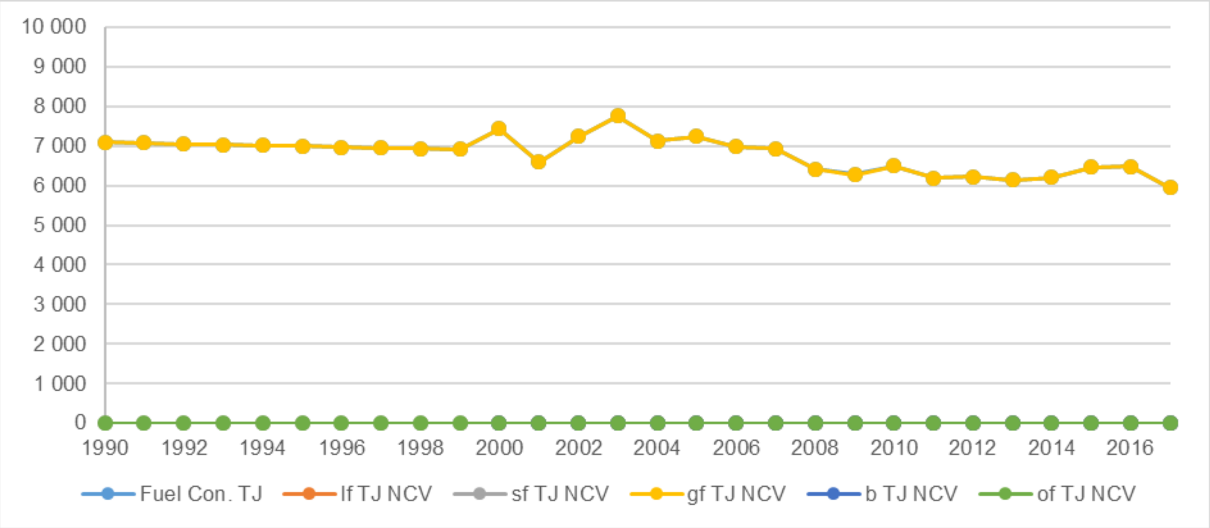


Figure 3.15: The fuel consumption of NFR 1A1c in TJ



3.6.3.2 Methodological issues

Emission data is compiled in the NEIS as presented in **Chapter 3.5.1.3**, therefore the individual specific F could be used for sources recorded in database. Otherwise general EFs of the Bulletin of Ministry of Environment are presented in **ANNEX IV, Chapter A4.6.** For detailed methodology please see **ANNEX IV**. The following ***Table 3.22*** presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Table 3.22: The overview of share of used calculation type for category 1A1c in NEIS

1A1c	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	94%
3	Calculation using representative individual mass flow and number of operating hours	0.4%
4	Calculation using emission factor and amount of fuel	1%
5	Calculation using emission factor and amount of related quantity other than fuel	2%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%

1A1c	TYPE OF EMISSION COMPILATION/CALCULATION	%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	3%

Due to the high share of using plant specific data, in ***Table 3.23*** it is provided only the implied emission factors related to overall volume of fuel consumed for 2017 in category and weighted IEF related to overall volume of fuel consumed for years 2000–2016. The refined estimation of historical emissions are done by the weighted IEF related to period 2000-2003.

EMEP/EEA GB_{2016} emission factors were used for POPs (***Table 3.24***).

Table 3.23: *Implied emission factors for air pollutants of 1A1c*

IEF g/GJ	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$
2017	87.70	68.96	30.03	4.60	39.40%	66.45%
W-IEF g/GJ	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$
2000-2003	60.68	176.23	97.21	12.50	39.58%	66.62%
2000-2016	87.21	102.63	73.43	7.35	39.58%	66.62%

Table 3.24: *Implied emission factors for POPs of 1A1c*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs
Unit	ng/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ
Coal	26	0.29	0.003	0.001	0.001	0.295

3.6.3.3 Completeness

Emissions are well covered.

3.7 MANUFACTURING INDUSTRIES AND CONSTRUCTION (NFR 1A2)

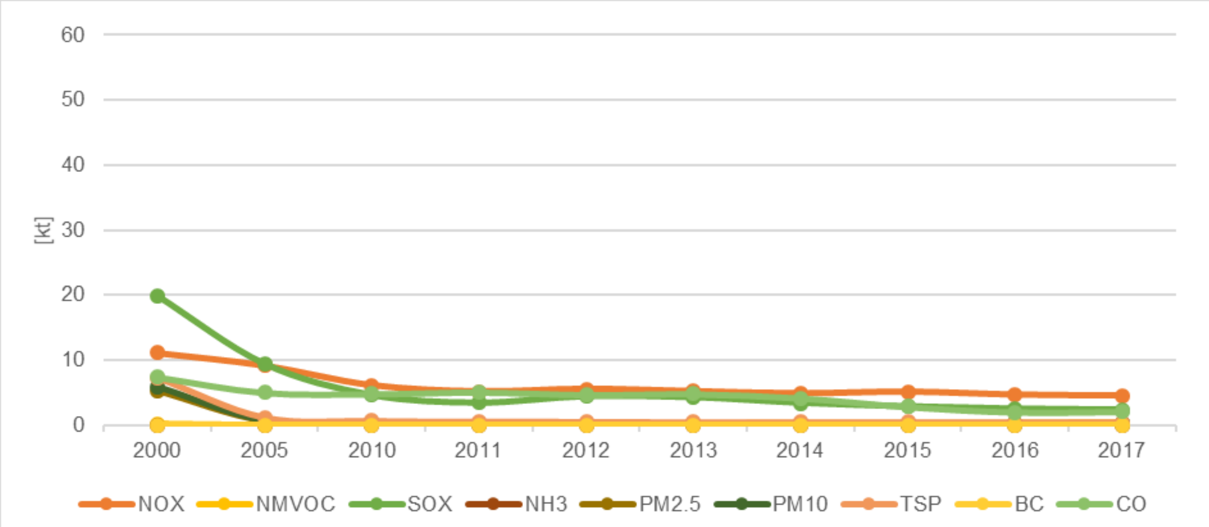
3.7.1 OVERVIEW

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). Emissions from the category 1A2 were recalculated as a consequence of the implementation of the recommendations from review (for details and explanation, please see ***Chapter 3.2***). For better transparency, in these categories only energy sources are included. Combine sources (plants where emission cannot be clearly separate) are in industrial processes.

The emissions will depend on the 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).

The overall emission trend strongly decreased (***Figure 3.16***) before the Slovakia entered to the European Union in 2004 due to the legislation and market changes in that period. The subcategories are further described in following chapters.

__Figure 3.16:__ Trend of air emissions pollutants in manufacturing and construction industry



Calculation of heavy metals in manufacturing industries and construction were performed according to T1 method EMEP/EEA GB_{2016}. Exception is the Iron and steel production.

__Table 3.25:__ Emission factor for heavy metals in 1A2

T1	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
Unit	mg/GJ	mg/GJ	mg/GJ	mg/GJ
Pb	0.8	134	0.011	27
Cd	0.006	1.8	0.0009	13
Hg	0.12	7.9	0.54	0.56
As	0.03	4	0.1	0.19
Cr	0.2	13.5	0.013	23
Cu	0.22	17.5	0.002600	6
Ni	0.008	13	0.013	2
Se	0.11	1.8	0.058	0.5
Zn	29	200	0.73	512

3.7.1 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: IRON AND STEEL (NFR 1A2a)

3.7.1.1 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 company in the Slovak Republic (U.S. Steel). Total volume of fuels allocated in 1A2a expressed in energy units represented 21 992 TJ in 2017. Data is in Tier 3 method – facility data from operator. The overview of trends in emissions are presented in following ***Figures 3.17, 3.18*** and fuels on ***Figure 3.19***.

The sources included in 1A2a is shown in ***Table 3.26***. Data of fuel consumption is in registry of NEIS since 2000.

__Table 3.26:__ 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

Figure 3.17: *Trends in emissions of air pollutants in 1A2a*

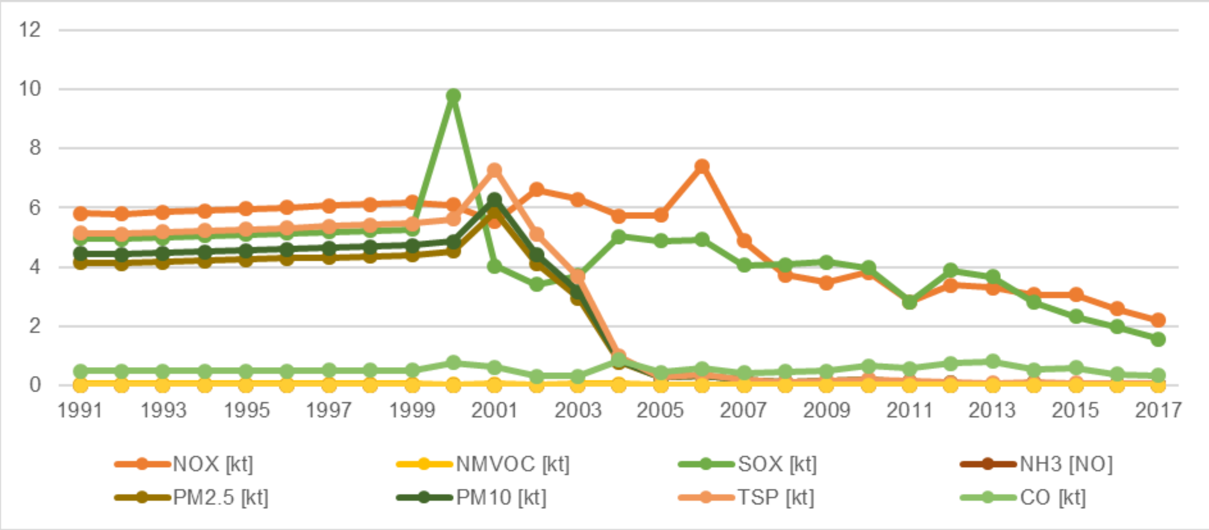


Figure 3.18: *Trends in emissions of heavy metals in 1A2a*

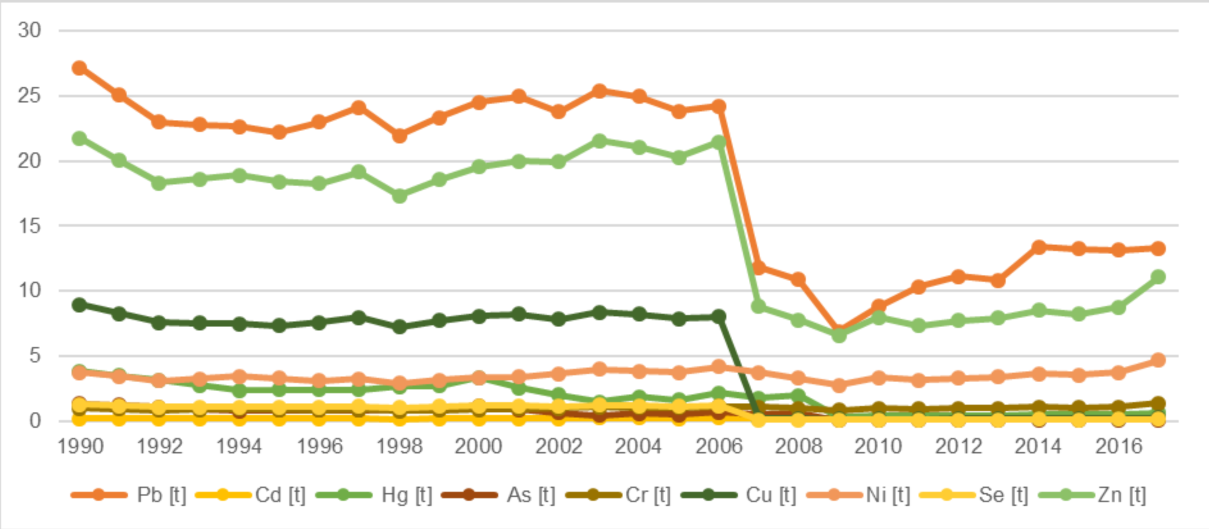
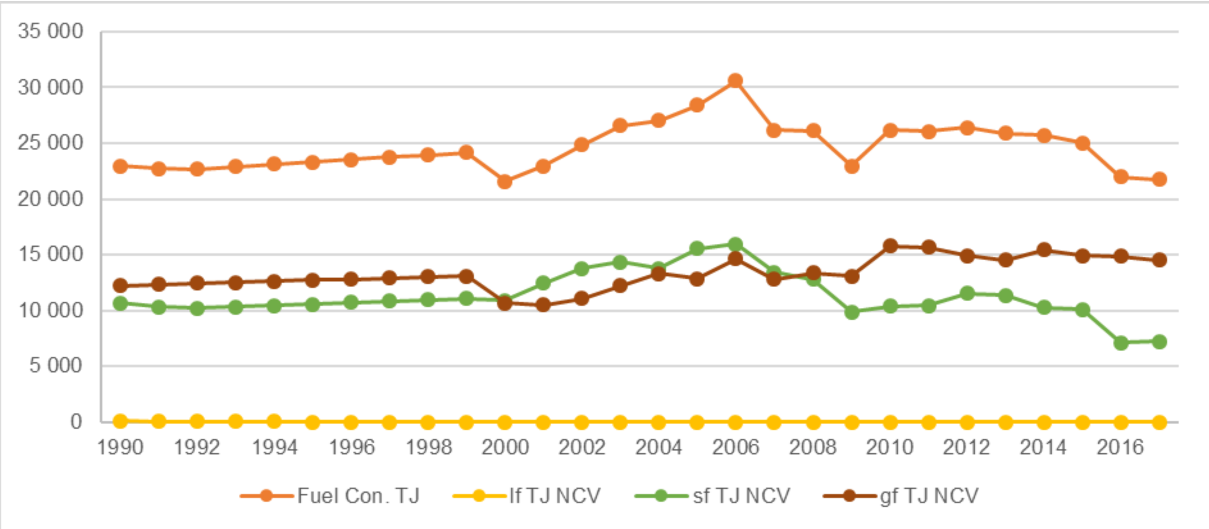


Figure 3.19: *The fuel consumption of NFR 1A2a in TJ*



3.7.1.2 Methodological issues

Emission data is compiled in the NEIS. For detailed methodology please see **ANNEX IV**.

Table 3.27: *The overview of share of used calculation type for category 1A2a in NEIS*

1A2a	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	95%
2	Calculation using representative concentration and volume of flue gas	0.004%
3	Calculation using representative individual mass flow and number of operating hours	1%
4	Calculation using emission factor and amount of fuel	4%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

From the table is visible that only 5% of emissions are determined other way than by continuous measurements. Due to the high share of using plant specific data, in ***Table 3.28*** is provided only the implied emission factors related to overall volume of fuel consumed for 2017 in category and weighted IEF related to overall volume of fuel consumed for years 2000–2017. The refined estimation of historical emissions are done by the weighted IEF related to period 2000-2003.

Table 3.28: *Implied emission factors for air pollutants of 1A2a*

IEF g/GJ	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	BC $_{\%PM2.5}$	CO
2017	100.76	1.56	72.29	0.001	62.18%	74.79%	2.21	NE	14.89
W-IEF g/GJ	**NO_X**	**NMVOC**	**SO_X**	**NH_3**	**$PM_{2.5\ \%TSP}$**	**$PM_{10\ \%TSP}$**	**TSP**	**BC $_{\%PM2.5}$**	**CO**
2000-2003	255.38	1.80	218.28	NO	80.57%	86.40%	226.02	NE	20.93
2000-2016	178.39	1.70	159.96	15.76	80.57%	86.40%	56.34	NE	21.79

The calculation of emissions of heavy metals in 1A2a are based on national EF related to products and particular activity - ore agglomeration from two plants. Even though the method and allocation of sources for air pollutants were recalculated, the emissions of HM were not relocated and the method for heavy metals was partly updated. EMEP/EEA GB_{2016} reports NE for emissions of heavy metals in chapter 1A2a.

POPs emission factors are country specific (Matejovičová, 2006) (***Table 3.30***).

Table 3.29: *Implied emission factor for sinter production in 1A2a*

EF g/t product	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
I - before 2007	6.785	0.004	0.016	0.01	0.022	2.23	0.171	0.315	3.55
I - after 2008	3.5	0.004	0.049	0.018	0.016	0.033	0.09	0.02	0.06

Table 3.30: *POPs emission factor for sinter production in 1A2a*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Iron ore agglomeration 1990-2001	0.013	1.2	4.35	4.35	1.77	11.67	0.032	1.3
Iron ore agglomeration 2002	0.01	1.2	4.35	4.35	1.77	11.67	0.032	1.1
Iron ore agglomeration 2003	0.007	1.2	4.35	4.35	1.77	11.67	0.032	1.1
Iron ore agglomeration since 2004	0.003	1.2	4.35	4.35	1.77	11.67	0.032	1.1
Production of pellets	0.000057	-	-	-	-	-	-	-
Iron production	0.002	0.058	0.103	0.103	0.052	0.316	-	0.383
Cast iron production	0.0001	17	-	-	-	-	-	0.03

3.7.1.3 Completeness

Emissions are well covered.

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

3.7.2.1 Overview

The category is focused on combustion processes in production of non-ferrous metals. The emissions trends are presented in following figures with distinguish on air pollutants and heavy metals because of the different scale reported emissions. The category covers the combustion activities of sources defined in table below in comply with the definitions of sources in national legislations. POPs (except of HCB and PCBs) are reported as NE in the period 1990-1996 due to missing activity data for aluminium production.

Figure 3.20: *Trends in emissions of air pollutants in 1A2b*

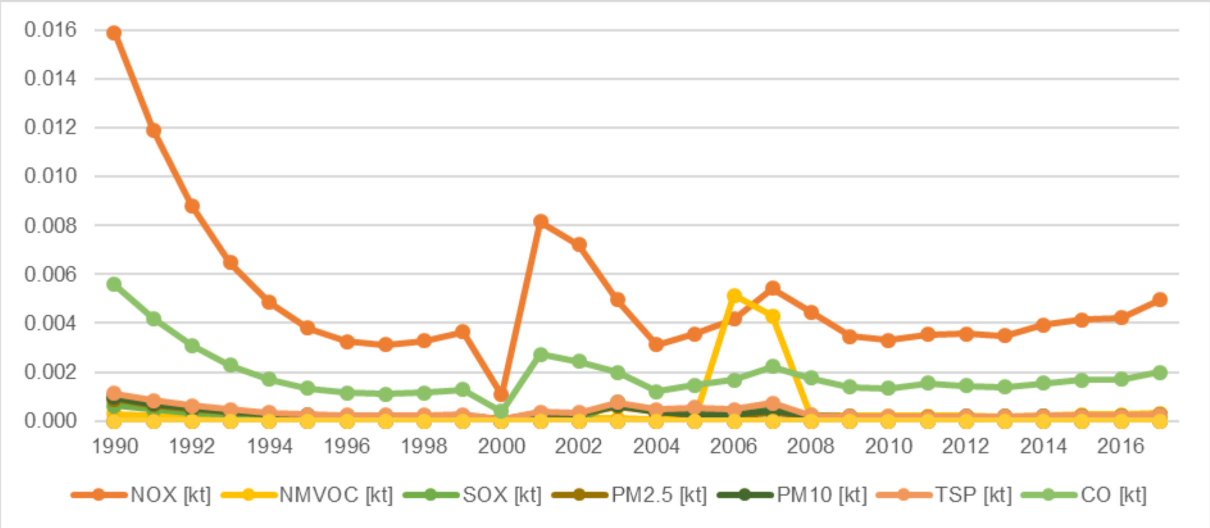


Figure 3.21: *Trends in emissions of heavy metals in 1A2*

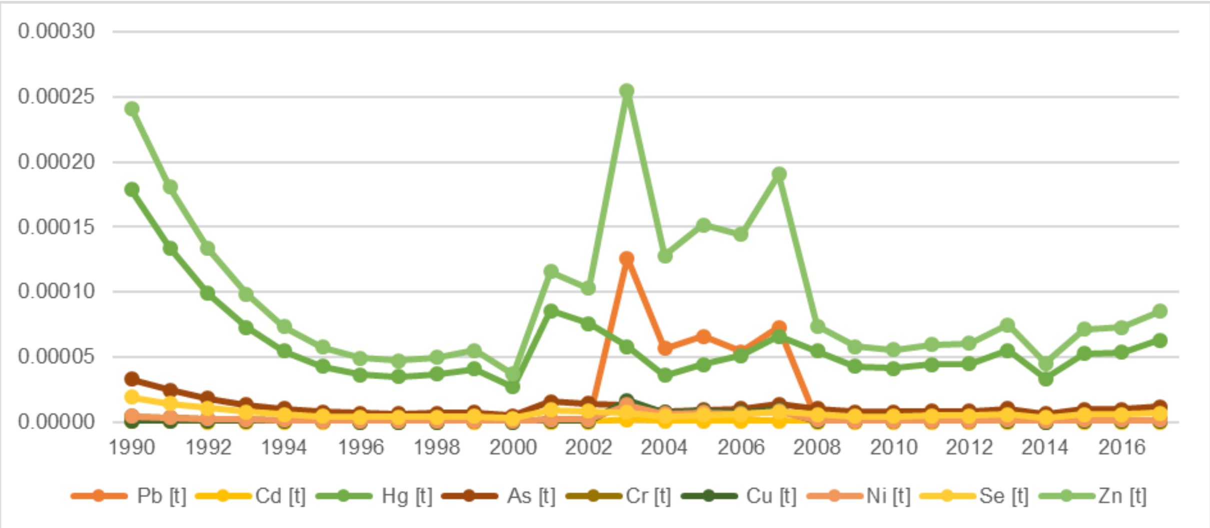


Figure 3.22: *The fuel consumption of NFR 1A2b in TJ*

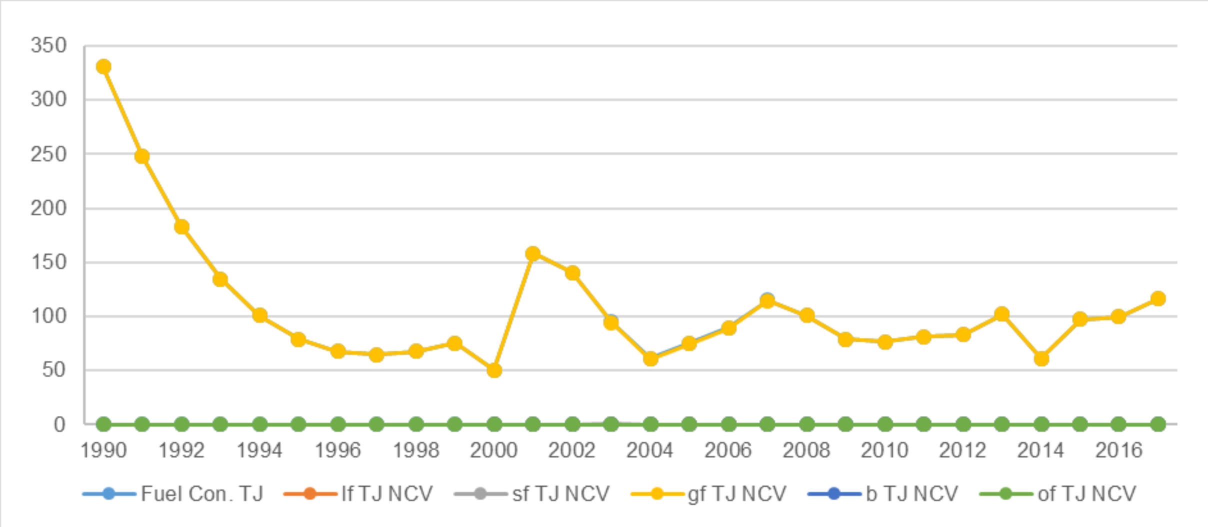


Table 3.31: *Activities according to national categorization included in 1A2b*

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

3.7.2.2 Methodological issues

Emission data is compiled in the NEIS. For detailed methodology please see **ANNEX IV**. According to recommendation ***SK-1A2b-2018-0001***, historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.

Table 3.32: *The overview of share of used calculation type for category 1A2b in NEIS*

1A2b	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	0%
4	Calculation using emission factor and amount of fuel	100%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

The emissions were balanced in comply with general EF of the Bulletin of Ministry of Environment. These emissions factors are presented in **ANNEX IV, Chapter A4.6**.

Table 3.33: Implied emission factors for air pollutants of 1A2b

IEF g/GJ	NOx	NMVOC	SOx	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	$BC_{\%PM2.5}$	CO
2017	42.57	2.57	0.26	NO	87.86%	95.81%	2.18	NE	17.15
W-IEF g/GJ	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5\ \%TSP}$**	**$PM_{10\ \%TSP}$**	**TSP**	**$BC_{\%PM2.5}$**	**CO**
2000-2003	48.12	0.90	1.92	NO	78.26%	84.83%	3.41	NE	16.93
2000-2016	45.79	7.67	1.68	NO	78.26%	84.83%	3.48	NE	17.79

Calculation of heavy metals in manufacturing industries and construction were performed according to T1 method EMEP/EEA GB_{2016}.

POPs emission factors are country specific (Matejovičová, 2006) (***Table 3.34***)

Table 3.34: POPs emission factor for sinter production in 1A2b

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Secondary aluminium production	0.05	-	-	-	-	-	39	2.6
Secondary copper production	0.1	0.135	1.513	1.513	0.103	3.264	-	16.652

3.7.2.3 Completeness

POPs (except of HCB and PCBs) are reported as NE in the period 1990-1996 due to missing activity data for aluminium production.

3.7.3 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: CHEMICALS (NFR 1A2c)

3.7.3.1 Overview

Combustion in the chemicals sector ranges from conventional fuels in boiler plant and recovery of process by-products using thermal oxidisers to process-specific combustion activities.

The category includes emissions from fuel combustion in chemical industry. The production in chemical industry is very wide and all sources with mixed emissions were allocated into 2B10a. Total volume of fuels expressed in energy units allocated in this subcategory was 4 328 TJ in 2017.

Figure 3.23: Trends in emissions of air pollutants in 1A2c

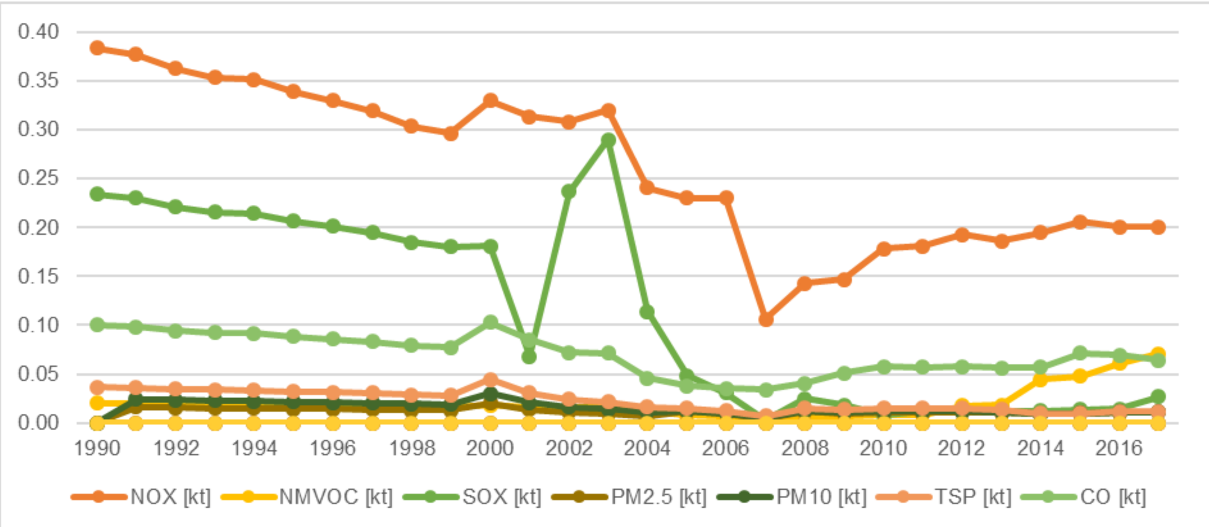


Figure 3.24: Trends in emissions of heavy metals in 1A2c

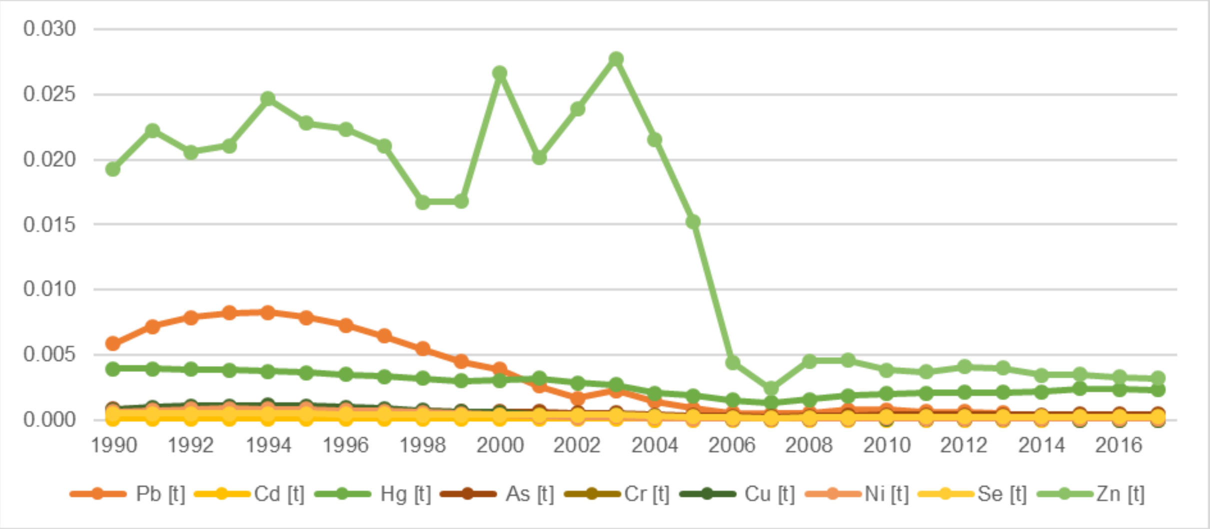
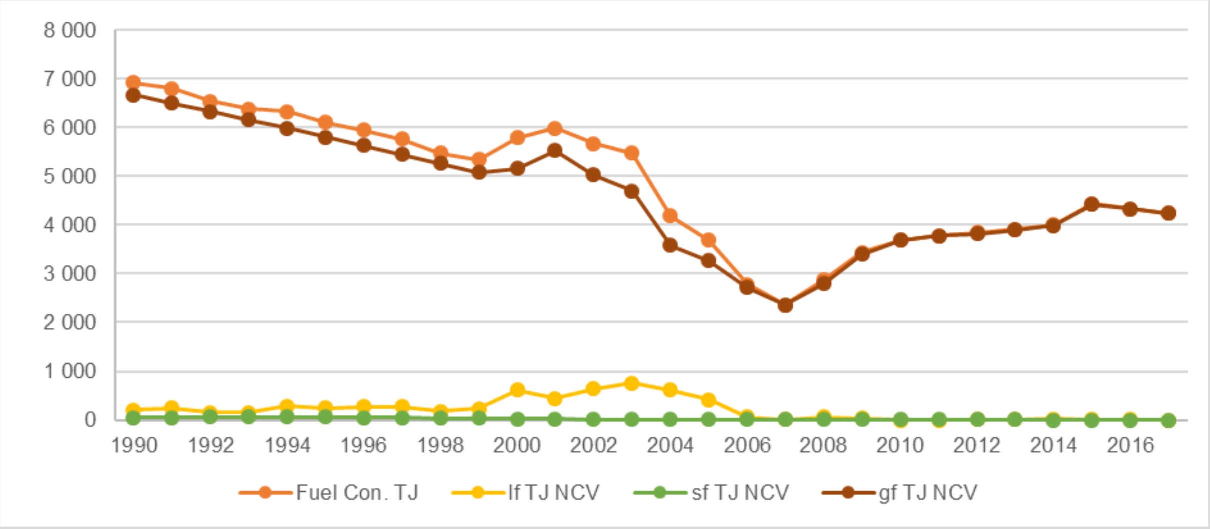


Figure 3.25: The fuel consumption of NFR 1A2c in TJ



Activities are included in 1A2c according to national categorization.

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

3.7.3.2 Methodological issues

Emission data is compiled in the NEIS. Detailed methodology is descripted **ANNEX IV**.

Table 3.36: The overview of share of used calculation type for category 1A2c in NEIS

1A2c	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	11%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	16%
4	Calculation using emission factor and amount of fuel	72%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%

1A2c	TYPE OF EMISSION COMPILATION/CALCULATION	%
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	0.03%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

The emissions were balanced in comply with general EF of the Bulletin of Ministry of Environment. These emissions factors are presented in **ANNEX IV, Chapter A4.6**. Calculation of heavy metals and POPs this category were performed according to T1 method EMEP/EEA GB_{2016}.

EMEP/EEA GB_{2016} tier 1emission factors were used for the calculations in this category.

Table 3.37: *Implied emission factors for air pollutants of 1A2c*

IEF g/GJ	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %PM2.5	CO
2017	47.39	16.75	6.39	NO	90.48%	95.28%	2.81	NE	15.20
W-IEF g/GJ	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
2000-2003	55.45	2.89	33.80	NO	45.26%	67.25%	5.29	NO	14.46
2000-2016	52.78	4.53	15.64	NO	76.64%	81.83%	4.14	NO	14.27

Table 3.38: *Emission factors for POPs of 1A2c*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	ng I-TEQ/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	µg/GJ	µg/GJ
Liquid f.	1.4	1.9	15	1.7	1.5	20.1	NE	NE
Solid f.	203	45.5	58.9	23.7	18.5	146.6	0.62	170
Gaseous f.	0.52	0.72	2.9	1.1	1.08	5.8	NE	NE
Biomass f.	100	10	16	5	4	35	5	0.06

3.7.3.3 Completeness

Emissions are well covered.

3.7.4 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: PULP, PAPER AND PRINT (NFR 1A2d)

3.7.4.1 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.

The category includes emissions from fuel combustion in paper industry. The trends in emissions are provided in following figures.

Figure 3.26: Trends in emissions of air pollutants in 1A2d

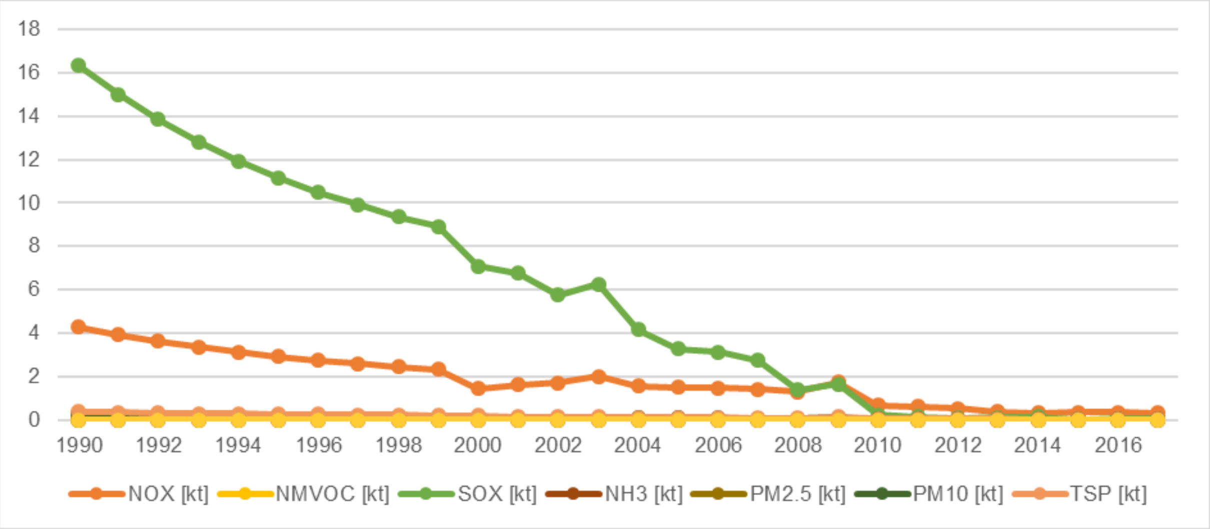


Figure 3.27: Trends in emissions of heavy metals in 1A2d

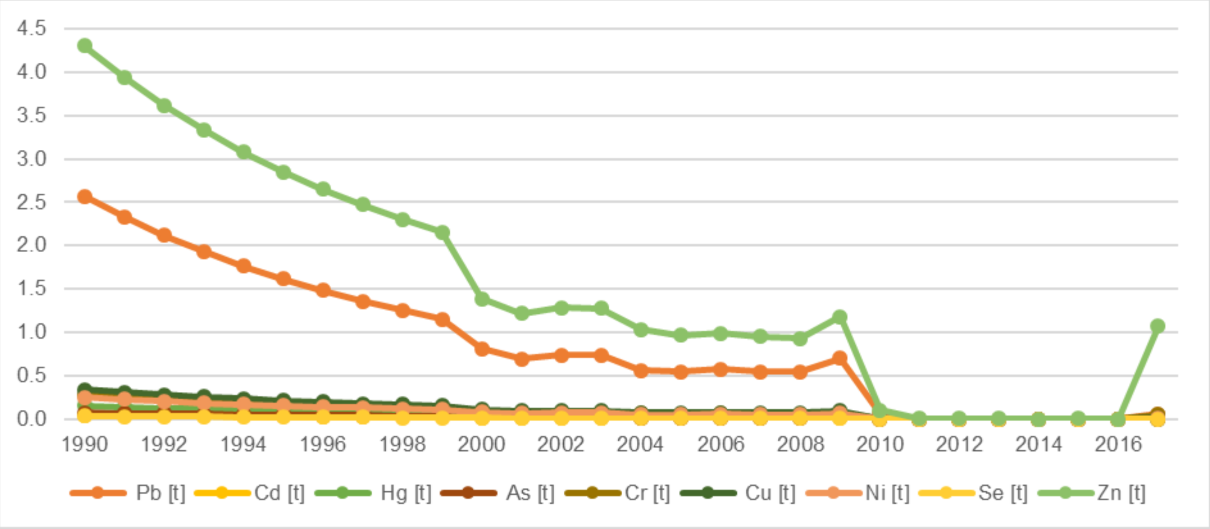
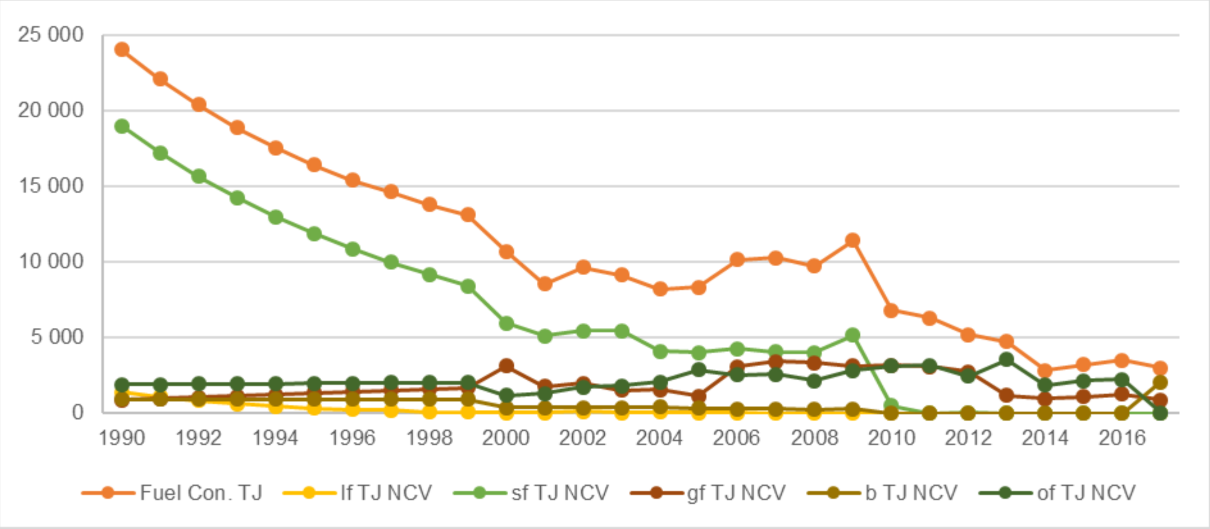


Figure 3.28: The fuel consumption of NFR 1A2d in TJ



3.7.4.2 Methodological issues

The category represents the emissions from the activities included in ***Table 3.39***.

Table 3.39: *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

During the review the issue for 1A2d was raised. Slovakia explained the reasons of inconsistencies.

NUMBER	NFR, POLLUTANT(S), YEAR(S)	BRIEF DESCRIPTION
SK-1A2d-2017-0001	1A2d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print, SO2, 2005,2010,2015	1A2d - SOX emissions decrease by 90% between 2005 and 2010, but activity data does not indicate such strong decrease

The major change has been caused by one of the biggest company in this industry. Decrease in 2005-2007 was not significant and the emissions are following the downward trend in fuel consumption of the company. SO_2 emissions were calculated on the base of mass flow measurement multiplied by operation hours per year. The reason for drop of SO_2 emissions is the change in the used type of fuels in years 2008 and 2009 (permit according to IED in 2008 and 2 in 2009). In these permissions is officially recorded the change of fuel basement. The permits declare that the maximum content of sulphur is 1%.

After 2010, the source has undergone the change and also the NACE classification has changed onto production of electricity and heat. Thus the emissions of source has been allocated according to the general rules of matching sources into NRF categorisation from 1A2d to 1A1a in the NEIS. AD were synchronized with the GHG inventory and probably not all sources are similarly categorized in both inventories (GHG and NECD). This issue was consider as important for next submission. The actions taken to provide more suitable activity data the fuel compilation was performed from the NEIS according to consumption of fuels related to the NFR (please see chapter Recalculations, improvements and implementation of recommendations).

Table 3.40: *The overview of share of used calculation type for category 1A2d in NEIS*

1A2d	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	91%
2	Calculation using representative concentration and volume of flue gas	0.39%
3	Calculation using representative individual mass flow and number of operating hours	0%
4	Calculation using emission factor and amount of fuel	9%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

From the table is visible that majority of emission are determined by continuous measurements. Due to the high share of using plant specific data, in ***Table 3.41*** is provided the implied emission factors related to overall volume of fuel consumed for 2017 in category and weighted IEF related to overall volume of fuel consumed for years 2000–2017. The refined estimation of historical emissions are done by the weighted IEF related to period 2000-2003.

EMEP/EEA GB_{2016} tier 1emission factors were used for the calculations in this category (***Table 3.42***).

Table 3.41: Implied emission factors for air pollutants of 1A2d

IEF g/GJ	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %PM2.5	CO
2017	105.41	9.06	14.65	2.41	97.78%	99.24%	4.08	NE	35.85
W-IEF g/GJ	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
2000-2003	178.17	1.73	679.85	0.48	66.43%	75.03%	16.09	NE	298.57
2000-2016	147.52	1.34	333.96	0.48	66.43%	75.03%	11.53	NE	255.67

EMEP/EEA GB_{2016} tier 1emission factors were used for the calculations in this category (***Table 3.44***).

Table 3.42: Emission factors for POPs of 1A2d

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	ng I-TEQ/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	µg/GJ	µg/GJ
Liquid f.	1.4	1.9	15	1.7	1.5	20.1	NE	NE
Solid f.	203	45.5	58.9	23.7	18.5	146.6	0.62	170
Gaseous f.	0.52	0.72	2.9	1.1	1.08	5.8	NE	NE
Biomass f.	100	10	16	5	4	35	5	0.06

3.7.4.3 Completeness

Emissions are well covered.

3.7.5 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: FOOD PROCESSING, BEVERAGES AND TOBACCO (NFR 1A2e)

3.7.5.1 Overview

Food processing can require considerable amounts of heat, steam and power. Many food 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 food industry were clearly identified as combustion emissions. Therefore the industrial categories of national classification according to the following ***Table 3.43*** were included here.

The development in emission and fuels are shown on ***Figures 3.29*** – ***3.31***.

Figure 3.29: Trends in emissions of air pollutants in 1A2e

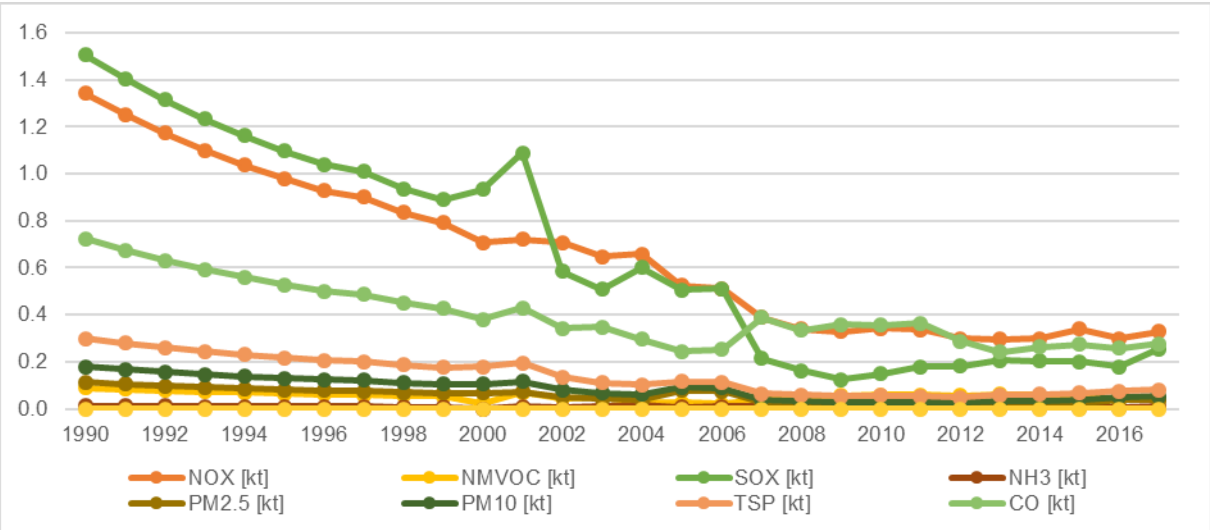


Figure 3.30: *Trends in emissions of heavy metals in 1A2e*

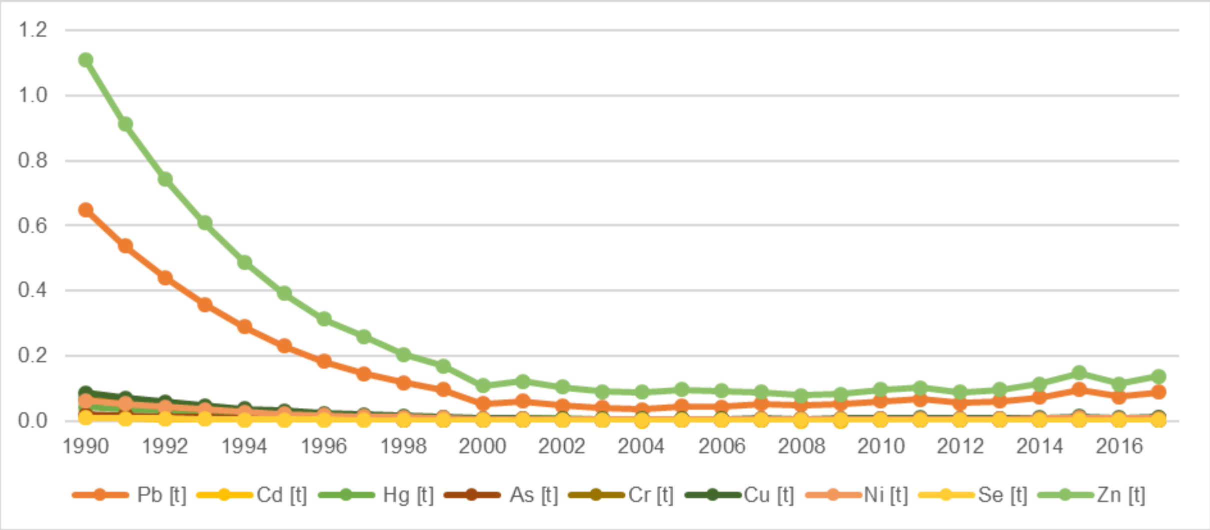
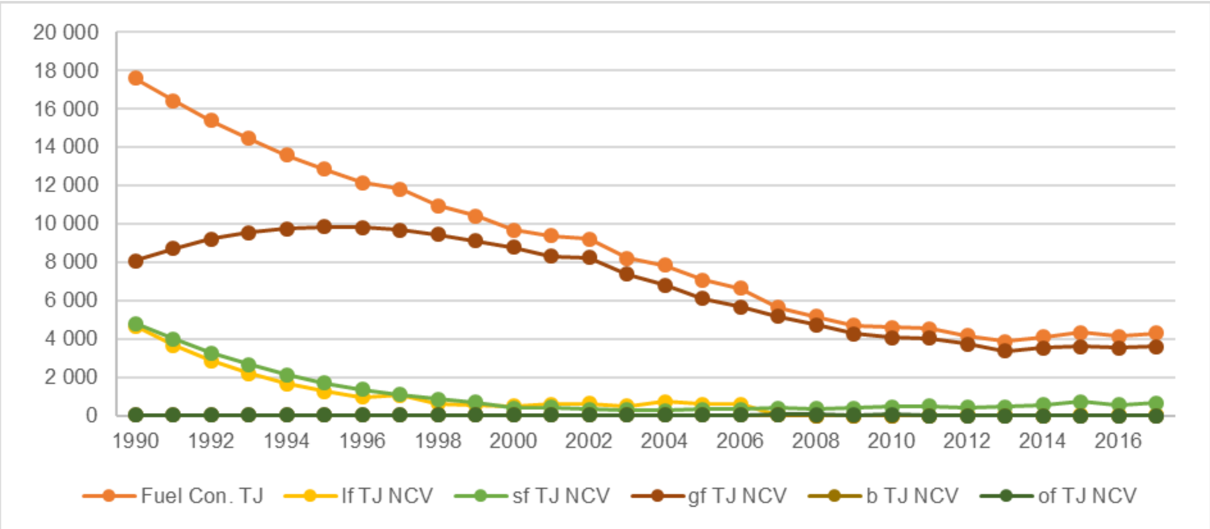


Figure 3.31: *The fuel consumption of NFR 1A2e in TJ*



3.7.5.2 Methodological issues

The 50% of emissions were balanced in comply with general EF of the Bulletin of Ministry of Environment. These emissions factors are presented in **ANNEX IV, Chapter A4.6**.

Table 3.43: *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 (eg. 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

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
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

Table 3.44: *The overview of share of used calculation type for category 1A2e in NEIS*

1A2e	Type of emission compilation/calculation	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0.0001%
3	Calculation using representative individual mass flow and number of operating hours	29%
4	Calculation using emission factor and amount of fuel	50%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	22%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0.02%

In ***Table 3.45*** it is provided the implied emission factors related to overall volume of fuel consumed for 2016 in category and weighted IEF related to overall volume of fuel consumed for years 2000–2076. The refined estimation of historical emissions are done by the weighted IEF related to period 2000-2003.

Table 3.45: *Implied emission factors for air pollutants of 1A2e*

IEF g/GJ	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %PM2.5	CO
2017	76.71	9.91	59.49	2.24	48.14%	68.16%	18.51	NE	64.52
W-IEF g/GJ	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
2000-2003	76.18	5.08	85.39	0.73	37.52%	59.90%	16.96	NE	41.08
2000-2016	74.93	7.77	63.23	1.09	37.52%	59.90%	14.97	NE	52.43

EMEP/EEA GB_{2016} tier 1emission factors were used for the calculations in this category (***Table 3.46***).

Table 3.46: *Emission factors for POPs of 1A2e*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	ng I-TEQ/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	μg/GJ	μg/GJ
Liquid f.	1.4	1.9	15	1.7	1.5	20.1	NE	NE
Solid f.	203	45.5	58.9	23.7	18.5	146.6	0.62	170
Gaseous f.	0.52	0.72	2.9	1.1	1.08	5.8	NE	NE
Biomass f.	100	10	16	5	4	35	5	0.06

3.7.5.3 Completeness

Emissions are well covered.

3.7.6 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: NON-METALLIC MINERALS (NFR 1A2f)

3.7.6.1 Overview

Majority of emission in non-metallic industry are measured or determined together (combustion and process emissions). After the correction and methodology changes in 2017 (please, see **IIR 2018 recalculation chapter Recalculations, improvements and implementation of recommendations**) in automated processing of source allocation, the majority of emission are in industrial NFR in related category. The involved sources in 1A2f are define according the ***Table 3.49***.

Development of emissions is showed in the ***Figure 3.32*** and ***Figure 3.33***.

Figure 3.32: *Trends in emissions of air pollutants in 1A2f*

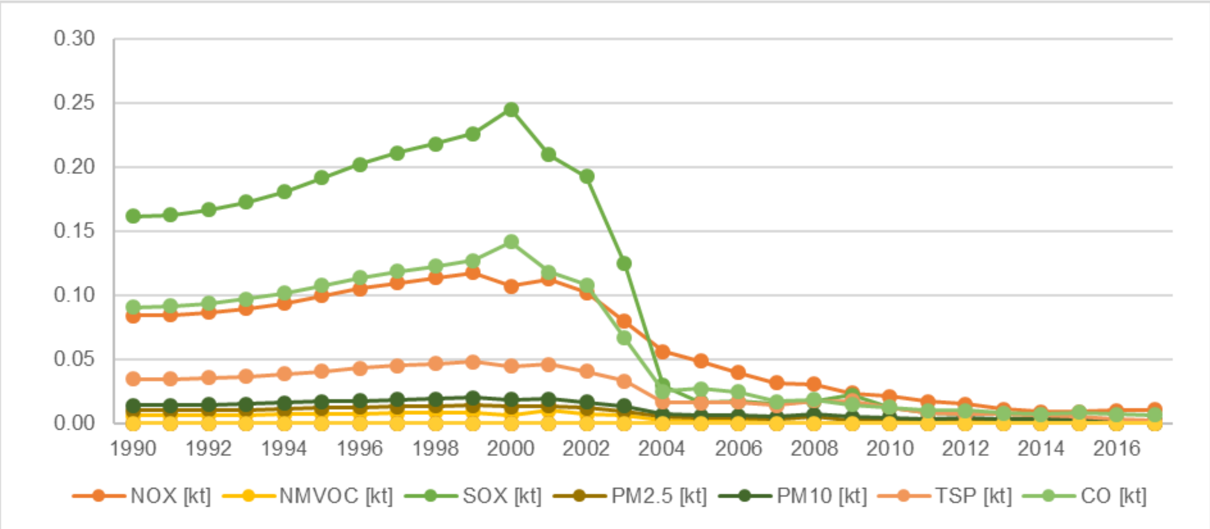


Figure 3.33: *Trends in emissions of heavy metals in 1A2f*

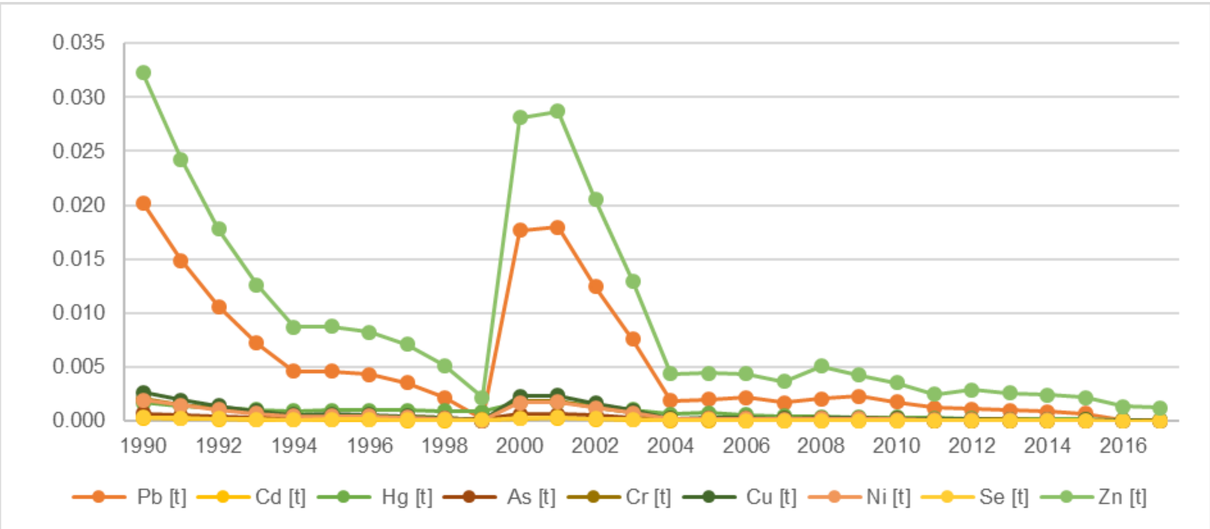
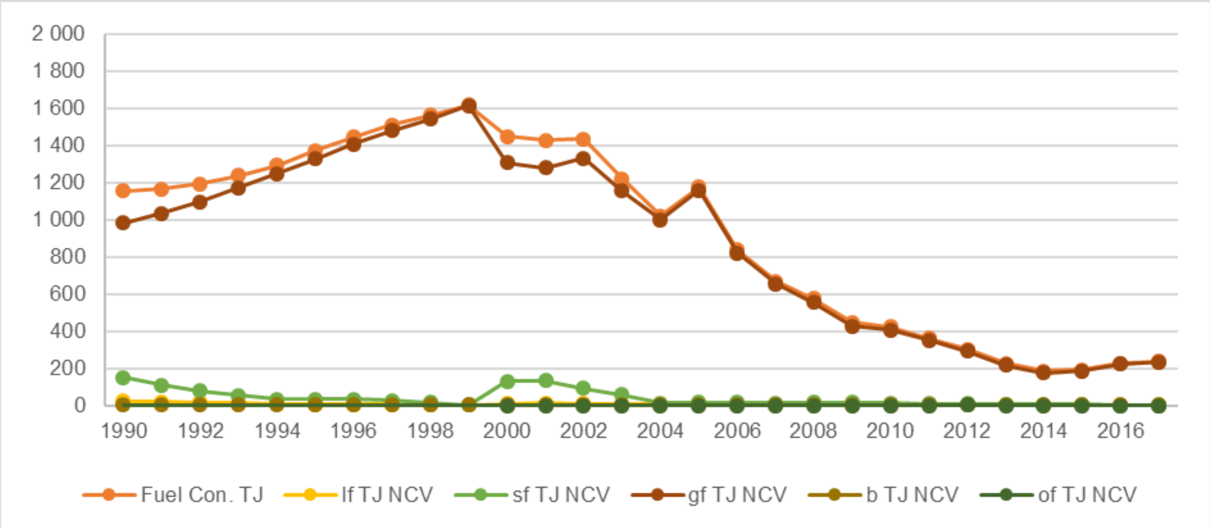


Figure 3.34: The fuel consumption of NFR 1A2f in TJ



3.7.6.2 Methodological issues

Calculation of annual emissions are performed in the NEIS. The emissions were balanced in comply with general EF of the Bulletin of Ministry of Environment. These emissions factors are presented in **ANNEX IV, Chapter A4.6**.

Table 3.48: 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

Table 3.48: Implied emission factors for air pollutants of 1A2f

IEF g/GJ	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %PM2.5	CO
2017	45.66	2.46	0.26	NO	73.87%	84.03%	8.35	NE	27.15
W-IEF g/GJ	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
2000-2003	72.71	5.43	139.96	NO	29.40%	41.39%	29.83	NE	78.71
2000-2016	59.65	3.47	77.18	NO	29.40%	41.39%	25.96	NE	51.53

EMEP/EEA GB_{2016} Tier 1 emission factors were used for the calculations in this category (***Table 3.49***).

Table 3.49: Emission factors for POPs of 1A2f

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	ng I-TEQ/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	µg/GJ	µg/GJ
Liquid f.	1.4	1.9	15	1.7	1.5	20.1	NE	NE
Solid f.	203	45.5	58.9	23.7	18.5	146.6	0.62	170
Gaseous f.	0.52	0.72	2.9	1.1	1.08	5.8	NE	NE
Biomass f.	100	10	16	5	4	35	5	0.06

3.7.6.3 Completeness

Emissions are well covered.

3.7.7 MOBILE COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION (NFR 1A2gvii)

3.7.7.1 Overview

The category is reported with the notation key IE because all emission are included in 1A4cii Off-road vehicles and other machinery.

3.7.8 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: OTHER (NFR 1A2gviii)

3.7.8.1 Overview

The category covers the sources that cannot be clearly identified to particular activity but generally it is the combustion process. The definition of sources are provided in ***Table 3.52***.

Emission trends are shown in the ***Figure 3.35*** – ***Figure 3.37***. Significant increase of heavy metals and POPs emissions since 2016 was connected with increasing amounts of industrial waste used as a fuel.

Figure 3.35: *Trends in emissions of air pollutants in 1A2gviii*

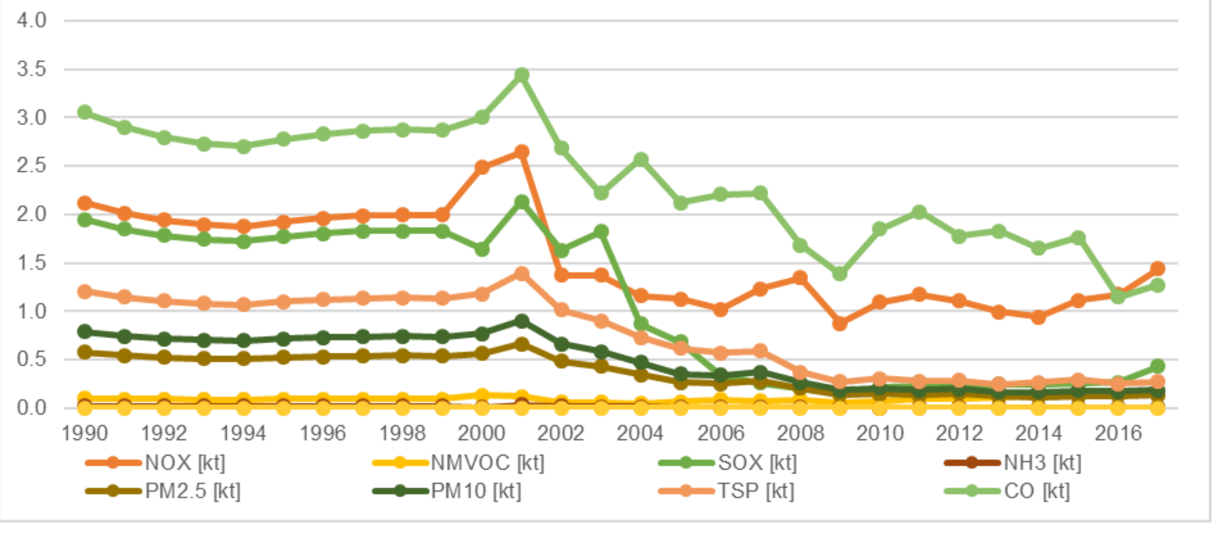


Figure 3.36: *Trends in emissions of heavy metals in 1A2gviii*

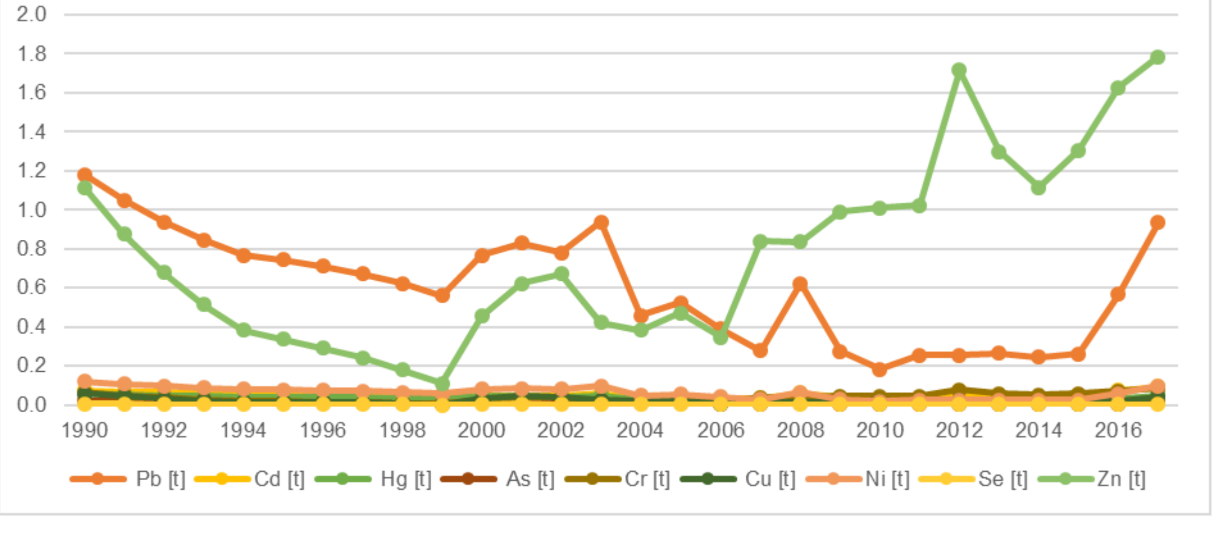


Figure 3.37: *Trends in emissions of POPS in 1A2gviii*

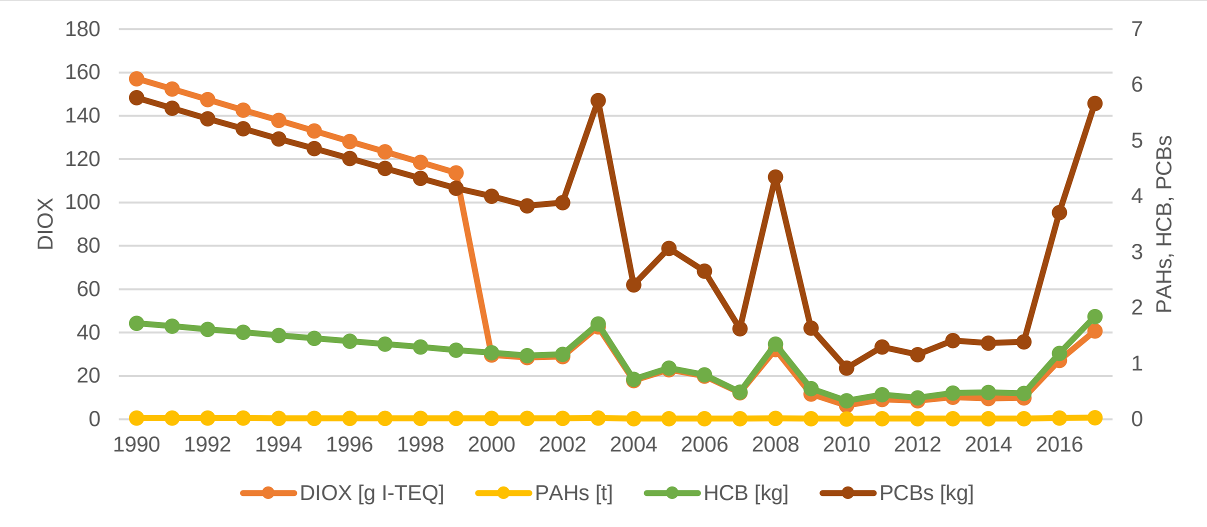
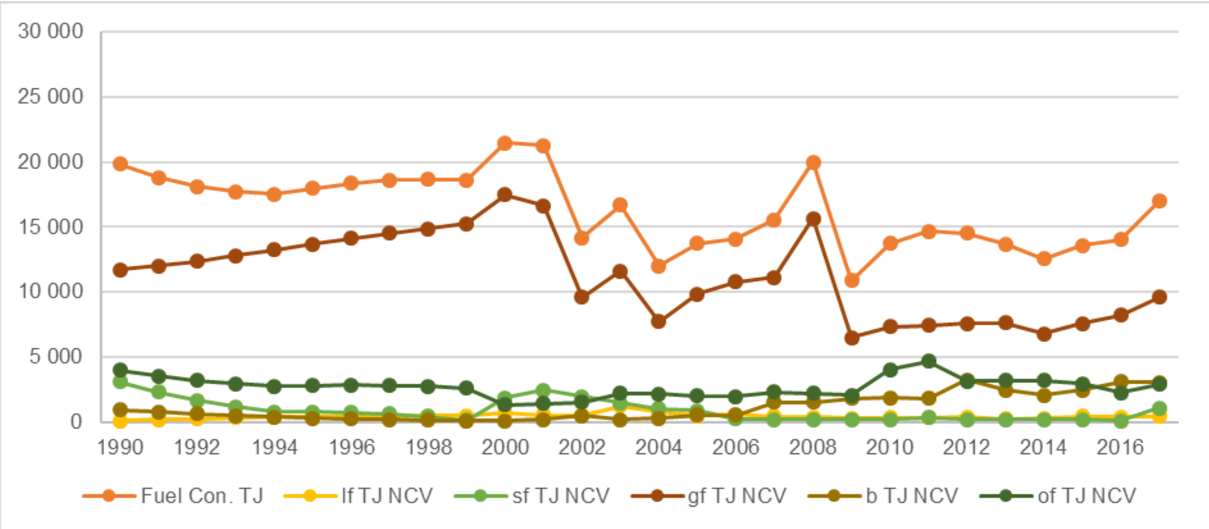


Figure 3.38: *The fuel consumption of NFR 1A2gviii in TJ*



3.7.8.2 Methodological issues

Main air pollutants, CO and PMi emissions were taken from the NEIS. Heavy metals and POPs emissions were balanced with T1 methodology.

POPs emission factors for waste incineration (same emission factors as for waste incineration without energy recovery used) originate from EMEP/EEA GB_{2016} (***Table 3.52***). Emission factors for thermal processes in industry originate from the study of Magulová (2003). For emissions calculation methodology of clinical waste incineration with energy recovery, please see **Chapter 6.7.4.2**.

Table 3.50: *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

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:	SPECIFICATION FOR SOURCES
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

Industrial and clinical waste incineration with energy recovery is also included in this category. Amounts of incinerated waste are shown in the ***Table 3.51***. Clinical waste has been incinerated with energy recovery since the year 2008.

Table 3.51: *Industrial and clinical waste incinerated with energy recovery*

YEAR	INDUSTRIAL WASTE IN kt	CLINICALL WASTE IN kt
1990	571.18	NO
1995	483.69	NO
2000	396.20	NO
2005	304.00	NO
2010	83.42	0.7
2011	121.29	0.7
2012	111.11	0.4
2013	134.80	0.5
2014	126.60	0.9
2015	131.20	0.7
2016	360.22	0.9
2017	541.93	2.0

Table 3.52: *Emission factors for POPs of 1A2gviii*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	mg I-TEQ/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Hard coal	0.0002	0.0035	0.0073	0.0073	0.0070	0.0252	0.0742	0.7913
Wood	0.0007	0.0950	19	19	0.1700	38	0.0431	0.0493
Brown coal	0.0005	0.0035	0.0073	0.0073	0.0070	0.0252	0.0481	0.0519
Fuel Oil	0.0001	4.68	20	3.98	7.57	37	0.1276	0.6116
Natural gas	0.00002	-	-	-	-	-	-	-
Black liquor	0.0001	-	-	-	-	-	-	-
IIW, 1990-1999	0.275	1	19	19	0.17	38.87	3	10
IW, good APC	0.075	1	19	19	017	38.87	3	10

3.7.8.3 Completeness

Emissions are well covered.

3.8 TRANSPORT (NFR 1A3)

3.8.1 CATEGORY DESCRIPTION AND TRENDS

The emissions from the category 1A3 Transport include subcategories Domestic aviation (1A3a), Road transportation (1A3b), Railways (1A3c), Domestic navigation (1A3d) and Pipeline transport (1A3ei). During the recent years, the shift from a public transportation to individual passenger cars has been observed. The level of transit transport (HDV) has increased at the same time. The consumption of fuels in railways is slightly increasing in the recent year and the consumption of fuels in the road transportation is sharply increasing. Total aggregated pollutants in transport decreased against the base year in range of 31.53% ($PM_{2.5}$) and 98.69% (BC – black carbon), although emission of ammonia have increased by 1 276%, in comparison with the base year. More information can be found below in the ***Table 3.53***. Ammonia mostly comes from road transportation, exactly 99.93% of it and the rest is railways and navigation (0.07%). The emissions from road and non-road transport were calculated by using models, default methodologies and the consistent data series from 1990–2017.

Table 3.53: *Overview of the main pollutants in sector Transport in years 1990–2017*

YEAR	EMISSIONS kt					
	NOx		NMVOC		SOx	
1990	61.66	0%	27.43	0%	2.88	0
1995	49.26	-20%	27.60	1%	2.30	-20%
2000	37.41	-39%	20.50	-25%	0.73	-75%
2005	49.09	-20%	20.23	-26%	0.21	-93%
2010	41.53	-33%	12.17	-56%	0.25	-91%
2011	34.24	-44%	8.53	-69%	0.23	-92%
2012	33.19	-46%	8.29	-70%	0.10	-97%
2013	31.94	-48%	7.50	-73%	0.14	-95%
2014	31.91	-48%	6.82	-75%	0.15	-95%
2015	31.83	-48%	6.31	-77%	0.22	-92%
2016	28.75	-53%	6.12	-78%	0.19	-93%
2017	27.37	-56%	5.59	-80%	0.19	-93%
2005-2017	**-**	**-44%**	**-**	**-72%**	**-**	**-8%**

YEAR	EMISSIONS kt					
	NH_3		$PM_{2.5}$		CO	
1990	0.03	0%	3.08	0	195.34	0%
1995	0.09	240%	2.12	-31%	210.73	8%
2000	0.35	1249%	1.51	-51%	169.32	-13%
2005	0.53	1932%	2.29	-26%	170.92	-13%
2010	0.47	1709%	2.28	-26%	88.71	-55%
2011	0.41	1468%	1.70	-45%	57.93	-70%
2012	0.41	1494%	1.72	-44%	55.56	-72%
2013	0.39	1399%	1.62	-48%	49.47	-75%
2014	0.37	1334%	1.58	-49%	42.63	-78%
2015	0.37	1314%	1.58	-49%	38.92	-80%
2016	0.38	1375%	1.49	-52%	35.08	-82%
2017	0.36	1276%	1.48	-52%	32.53	-83%
2005-2017	**-**	**-32%**	**-**	**-35%**	**-**	**-81 %**

YEAR	EMISSIONS					
	kt		t			
	BC		HMs		POPs	
1990	1.45	0.00%	20.08	0%	0.10	0.00%
1995	0.96	-98%	15.54	-23%	0.08	21%
2000	0.72	-99%	5.71	-72%	0.07	26%
2005	1.16	-98%	8.68	-57%	0.12	17%
2010	1.19	-98	9.79	-51%	0.15	49%
2011	0.85	-98%	9.20	-54%	0.14	44%
2012	0.87	-98%	9.52	-53%	0.15	55%
2013	0.81	-98%	9.34	-53%	0.15	52%
2014	0.78	-99%	9.66	-52%	0.16	57%

YEAR	EMISSIONS					
	kt		t			
	BC		HMs		POPs	
2015	0.74	-99%	10.70	-47%	0.18	82%
2016	0.68	-99%	11.11	-45%	0.18	86%
2017	0.68	-99%	11.23	-44%	0.19	91%
2005-2017	-	**-42%**	-	**29%**	**-**	**63%**

3.8.2 CATEGORY-SPECIFIC QA/QC AND VERIFICATION PROCESS

Category specific QA/QC plan is based on the general QA/QC plan described in the **Chapter 1.6.1** of this report. The emissions inventory in the transport categories were prepared by the sectoral experts. 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 begun in the 2017. Although, some results are already available and present here, the discussion between interested organisations is still ongoing. In the next sections are summarized information, gathered until now.

3.8.2.1 Source specific comparison of fuel statistics

QA/QC procedures for the transport sector follow basic rules and activities of the QA/QC. Due to frequent questions for data consistency between IEA statistics and the national inventory, the sources and the data were investigated. Comparison of the activity data and their sources (***Table 3.54***) is also crucial for evaluation of consistency in reporting. Gasoline, diesel oil and biofuels consumption are key activity data in transport sector, thus the comparison was focused on these statistical data across several sources. Datasets for this analysis are the years 2014–2017.

Part of QA/QC activities is comparison of data sources from the available official statistics:

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

Each source has specific forms or questionnaires, CN codes and different reporting rules, methodologies and dates. These data are further processed by other institutions. Source data for Statistical office are import/export and production and fuel information; for the FR SR are data from taxes on sales of products of crude oil and from taxes on sales of biofuels (***Figure 3.39***).[4,5]

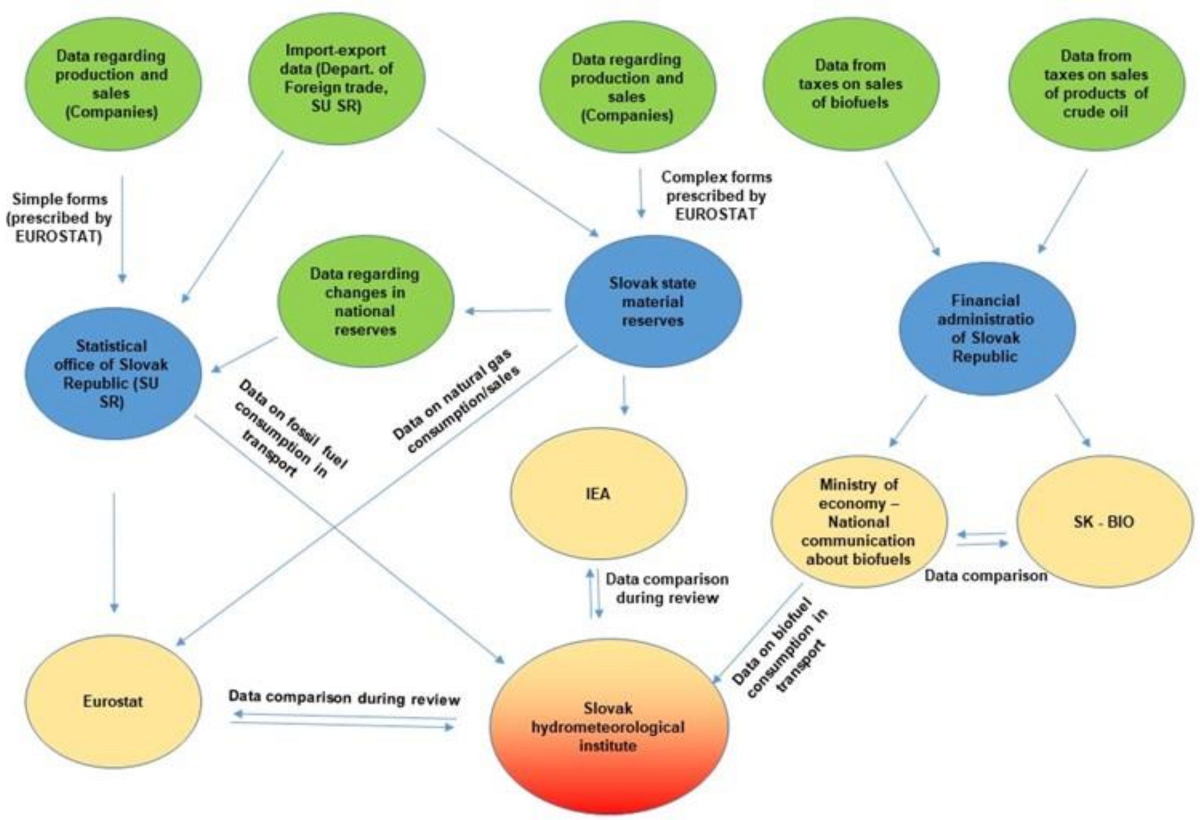
[4] Council Directive (EU) No. 2015/652 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels;

[5] Act No 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/;

Table 3.54: *Crude oil and crude oil products data flow and usage*

ORIGIN OF DATA	PRIMARY USER	SECONDARY USER	TERTIARY USER
Import-export data (Depart. Of foreign trade ŠÚ SR)	Statistical office of Slovak Republic	Eurostat	
Data regarding production and sales (Companies)		Slovak hydrometeorological institute	
Data from taxes on sales of biofuels	Financial administration of Slovak Republic	Ministry of economy	Slovak hydrometeorological institute (NIS)
Data from taxes on sales of products of crude oil		SK - BIO	
Confirmation (Certificate?) of the sustainability of biofuels	Slovak hydrometeorological institute (according to art. 7a of Directive 98/70/EC)	European Environmental Agency	
Data regarding production and sales (Companies)	Slovak state material reserves	International Energy Agency (data on crude oil and crude oil products)	
		Eurostat (natural gas)	
Data regarding fuel sales on gas stations (NIES)	Ministry of Environment (according to art.8 of Directive 98/70/EC)	European Environmental Agency	

Figure 3.39: *Flowchart of data reporting and utilisation (green – original data, blue – primary users, yellow – secondary users, red – tertiary users)*



As it is shown in ***Table 3.55*** and on ***Figure 3.40*** discrepancies occurred between all major sources. During discussions with the main authorities, several information were collected which were further analysed:

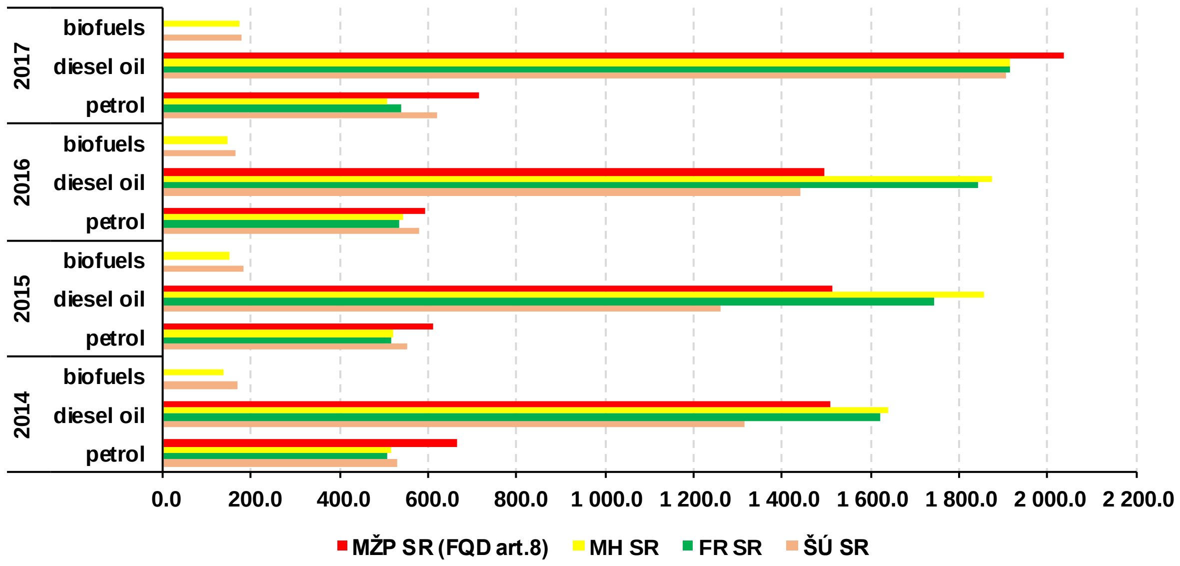
- Each authority report different data in different forms for different institutions or requirements (***Table 3.54*** and ***Figure 3.39***);
- The conversion factors (e.g. density) differs throughout all data suppliers not only between authorities and companies, but also each delivered supply has own characteristics;

- Different data sources;
- Dates of collection for tax reports and reports to the ŠÚ SR differ.

Table 3.55: *The first results of comparison of fuel consumption according to different sources (in kt)*

SOURCE	2014			2015		
	PETROL	DIESEL OIL	BIOFUELS	PETROL	DIESEL OIL	BIOFUELS
ŠÚ SR	529.0	1 315.0	167.0	550.0	1 259.0	182.0
FR SR	508.6	1 619.7	-	516.6	1 743.0	-
MH SR	517.2	1 639.0	138.9	521.5	1 854.8	149.9
MŽP SR (FQD art.8)	664.9	1 507.4	-	613.1	1 514.8	-
SOURCE	**2016**			**2017**		
	PETROL	DIESEL OIL	BIOFUELS	PETROL	DIESEL OIL	BIOFUELS
ŠÚ SR	581.0	1 442.0	163.0	620.0	1 905.0	176.0
FR SR	533.3	1 841.7	-	540.0	1 914.0	-
MH SR	543.8	1 872.3	147.9	506.0	1 914.0	173.0
MŽP SR (FQD art.8)	591.0	1 494.6	-	715.7	2 037.0	-

Figure 3.40: *Comparison of fuel consumption according to different sources (in kt)*



Outcomes of the discussion and analysis are harmonisation of to the most possible level and difference between each source in 2017 is not more than 0.5% for fossil fuels and 2% for biofuels. Full consistency of data on national level is not possible. This is due to different legislation that each authority is required to fulfil regarding to their responsibility (e.g. statistical reporting to EU institutions, tax collection, etc.).[6] Data from the MŽP SR according to article 8 of Directive 98/70/EC (FQD) is differing from other sources, as data collection is governed by directive that has a different source of origin (MŽP SR) as the rest of the directives (MH SR and FR SR). Outcomes showed that most consistent and reliable data source is from the MH SR.

[6] Regulation (EC) No. 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

3.8.3 DOMESTIC AVIATION LTO (NFR 1A3AI) AND INTERNATIONAL AVIATION LTO (NFR 1A3aii)

These categories are not the 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 of 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 predomination of sport flights. Emissions estimation was calculated based on the data directly provided by the individual airports based on LTO cycles and fuel consumption (without fuel type differentiation). Described approach is maintained for a time series 1990–2004. For the time series 2005 2017, EUROCONTROL data on the number of flights, fuel consumption and share of domestic and international flights was used. The emissions of NO_X, SO_X, PMs and CO were taken from EUROCONTROL file for LTO and Cruise separately (in line with NECD review 2017 recommendation SK-1A3aii(ii)-0002) and reported in Domestic and International Aviation LTO cycles (***Table 3.56***). The fuel consumption in category 1A3ai(i) decreased compared to the base year 1990 by 9.35%. The total consumption of jet kerosene was 13.19 TJ and the consumption of aviation gasoline was 0.22 TJ in domestic aviation LTO cycle in 2017. Since 2005, domestic aviation emissions are decreasing until 2016. This decrease and the whole category is influenced by the fact, that the Slovak Republic has no official national airlines as the 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 1A3aii(i) increased compared to the base year 1990 by 147.24%. The total consumption of jet kerosene was 309.76 TJ and the consumption of aviation gasoline was 0.20 TJ allocated in domestic aviation LTO cycle in 2016. Since 2005, international aviation emissions are slightly increasing. Increase in fuel consumption and emissions is influenced by the arrival of low-cost airlines (Ryanair – based in Bratislava, WizzAir – based in Košice) and charter flights.

Table 3.56: *Overview of emissions from domestic and international aviation (1990 – 2017)*

YEAR	EMISSIONS – DOMESTIC AVTIATION LTO (kt)				
	NOx	NMVOC	SOx	$PM_{2.5}$	CO
1990	0.081	0.0007	0.0226	0.0004	0.020
1995	0.054	0.0004	0.0150	0.0003	0.013
2000	0.061	0.0005	0.0172	0.0003	0.015
2005	0.008	0.0001	0.0006	0.0002	0.011
2010	0.004	0.0002	0.0004	0.0002	0.012
2011	0.003	0.0002	0.0003	0.0002	0.011
2012	0.003	0.0002	0.0003	0.0002	0.013
2013	0.003	0.0001	0.0002	0.0002	0.011
2014	0.003	0.0001	0.0003	0.0002	0.009
2015	0.003	0.0002	0.0003	0.0002	0.012
2016	0.003	0.0002	0.0003	0.0002	0.009
2017	0.003	0.0001	0.0003	0.0001	0.010
2005-2017	**-59.48%**	**59.57%**	**-59.20%**	**3.89%**	**-11.92%**
1990-2017	**-96.04%**	**-76.61%**	**-98.88%**	**-58.40%**	**-52.24%**

YEAR	EMISSIONS – INTERNATIONAL AVIATION LTO (kt)				
	NOx	NMVOC	SOx	$PM_{2.5}$	CO
1990	0.102	0.0012	0.027	0.0007	0.068
1995	0.068	0.0008	0.018	0.0005	0.046
2000	0.078	0.0009	0.020	0.0005	0.051
2005	0.070	0.0008	0.005	0.0011	0.063
2010	0.077	0.0011	0.005	0.0008	0.054
2011	0.078	0.0010	0.005	0.0008	0.056
2012	0.072	0.0010	0.005	0.0007	0.056
2013	0.069	0.0011	0.004	0.0008	0.056
2014	0.070	0.0012	0.004	0.0008	0.053

YEAR	EMISSIONS – INTERNATIONAL AVIATION LTO (kt)				
	NOx	NMVOC	SOx	$PM_{2.5}$	CO
2015	0.083	0.0012	0.005	0.0009	0.061
2016	0.092	0.0016	0.006	0.0010	0.069
2017	0.100	0.0015	0.0060	0.0009	0.068
2005-2017	**42.85%**	**94.61%**	**17.42%**	**-17.61%**	**6.96%**
1990-2017	**-2.30%**	**27.22%**	**-77.78%**	**30.24%**	**-0.68%**

3.8.3.1 Methodological issues

Aviation is not a key category. 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 on the airports. For this period, only total number of LTO cycles is known, therefore 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 2005–2015. The share is a constant value. Real share of national and international activities for the period 2005–2017 was taken from the EUROCONTROL database directly. More data and revision is provided in the ***Table 3.57***. Also data regarding disaggregation to LTO and cruise phase is taken from EUROCONTROL and for the period 1990–2004 was used the share based on the real data used for time series 2005–2015 (in line with observation and recommendation ***SK-1A3aii(ii)-2017-0002***).

Table 3.57: *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 this submissions for the years 1990–2004 were calculated as average EFs from available EUROCONTROL data for 2005–2015. These average emission factors (***Table 3.58***) 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_{2016}.

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). Following data were taken from the EUROCONTROL data published in 2016 into 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.

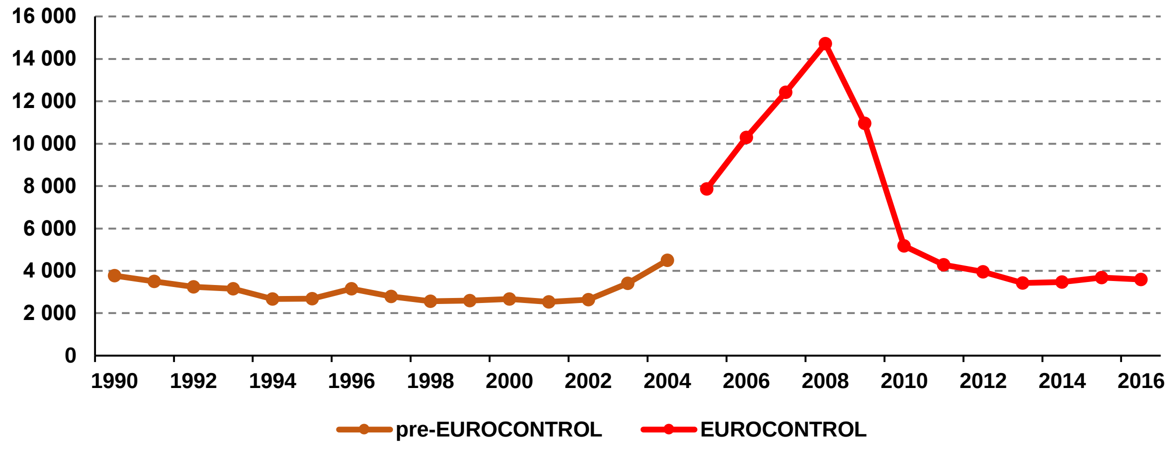
Table 3.58: Average emission factors for the pollutants in civil aviation according to EUROCONTROL

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

3.8.3.2 Category specific QA/QC

Since 2011, the agreement of the European Commission (the EC) and the EUROCONTROL is in place. Based on this agreement, annual comparison of the 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 on a regular basis, for quality check, however this information is not possible to make public available. Consistency of the time-series (***Figure 3.41***) is maintained by using calculated average EFs from EUROCONTROL. The methodology is explained in the **Chapter 3.8.2.1.**

Figure 3.41: *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 SHMU archive the background documents.

3.8.4 ROAD TRANSPORTATION (NFR 1A3b)

Short distance passenger transport is an important part of road transport. It is the most exploited type of transport in the Slovak Republic due to the high density of roads, the quality of road network and interconnection of all municipalities. In the recent 10 years, road transport has expanded significantly in the transport of goods and persons. In 2017, the transport network included 482 km of highways, 282 km of motorways and 3 311 km of the category 1st class roads. Total roads network represented 18 057 km of the roads in the Slovak Republic[7] in 2017. Road transportation is the most important and key category

[7] Slovak Road Database 2017; http://www.cdb.sk/en/maps-and-statistical-outputs-of-road-databank/Statistical-outputs/Lenght-of-the-road.alej

within transport with the highest share of emissions and continually increasing trend in fuel consumption. There is a huge increase in emission of ammonia compared to base year – 1328.2% (***Table 3.59***). This is caused by expand of light commercial vehicles in category EURO 5 and onwards, which have higher EFs as vehicles in category EURO 2, 3 and 4.

Table 3.59: *Overview of emissions in road transport in years 1990–2017*

YEAR	EMISSIONS - ROAD TRANSPORT							
	kt						t	
	NOx	NMVOC	SOx	NH_3	TSP	CO	HMs	POPs
1990	43.813	26.066	2.418	0.025	3.344	193.013	18.998	0.701
1995	37.226	26.618	1.904	0.087	2.404	209.232	14.699	0.621
2000	31.586	20.183	0.693	0.349	1.941	168.310	5.576	0.639
2005	43.273	19.830	0.193	0.526	3.008	170.121	8.579	0.996
2010	36.815	11.817	0.029	0.468	3.025	88.076	9.333	1.257
2011	29.528	8.174	0.027	0.406	2.405	57.334	8.789	1.028
2012	30.989	8.046	0.029	0.412	2.517	55.148	9.340	1.094
2013	29.349	7.204	0.028	0.388	2.375	49.000	9.072	1.045
2014	29.797	6.416	0.028	0.371	2.360	42.175	9.365	1.065
2015	29.282	5.920	0.031	0.366	2.429	38.422	10.288	1.075
2016	26.212	5.694	0.032	0.382	2.401	34.564	10.753	1.060
2017	24.902	5.222	0.034	0.356	2.409	31.999	10.881	1.030
2005-2017	**-42.5%**	**-73.7%**	**-82.3%**	**-32.3%**	**-19.9%**	**-81.2%**	**26.8%**	**3.5%**
1990-2017	**-43.2%**	**-80.0%**	**-98.6%**	**1328.2%**	**-28.0%**	**-83.4%**	**-42.7%**	**47.0%**

The major share of emissions belongs to passenger cars (***Table 3.60***). Most of the HMs comes from tyre and brake wear abrasion. Majority of NOx, NMVOC and CO emission are emitted in the cities (***Table 3.61***).

Table 3.60: *Overview of total emissions according to the type of vehicles in 2017*

VEHICLE CATEGORY	NOx	NMVOC	SOx	NH_3	TSP	CO	HMs	POPs
	kt						t	
Passenger cars	10.14	2.57	0.02	0.30	0.44	25.74	0.08	0.10
Light duty vehicles	3.71	0.28	0.00	0.02	0.21	2.30	0.04	0.02
Heavy duty vehicles and buses	11.02	0.44	0.01	0.03	0.22	3.23	0.05	0.06
Mopeds & motorcycles	0.03	0.11	0.00	0.00	0.00	0.73	0.03	0.0003
Gasoline evaporation	NA	1.83	NA	NA	NA	NA	NA	NA
Automobile tyre and brake wear abrasion	NA	NA	NA	NA	0.83	NA	10.49	NA
Automobile road abrasion	NA	NA	NA	NA	0.71	NE	NE	NE

Table 3.61: *Results from COPERT in distribution for agglomeration mode in 2017*

kt	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	CO
Urban	12.03	4.22	0.01	0.08	0.50	25.07
Rural	9.13	0.68	0.01	0.19	0.24	4.73
Highway	3.75	0.14	0.01	0.09	0.13	2.19

3.8.4.1 Methodological issues

COPERT 5 model (version 1.1) was used for estimation of emissions in the road transportation. The version 5 of the model distinguishes vehicle categories and emission factors reflecting the recent development and research. Calculation in model COPERT 5 is based on EMEP/EEA GB_{2016} 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 level. Statistically recorded fuel consumption and fuel consumption calculated through COPERT 5 methodology are equal. The COPERT 5 defined new vehicle categories for the calculation of pollutants, with the disaggregation into 5 base categories and 372 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 car fleet, the age of the cars, the parameters of operation and fuels or climate conditions.

The estimation is provided for the main 6 groups of input data:

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

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

Exhaust emissions from road transport are divided on two types:

- so-called "cold emissions", which are additional emissions with start of cold motor
- so-called "hot emissions", which are produced by the engine of vehicle warmed on 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 level 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 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 3.62***). Particularly kilometres (km) travelled are not available in Slovakia. Therefore, new input data on mileages was requested from TID (odometers) and NCR (from the Police). As the unique key for binding data from these two registries, VIN number (vehicle identification number) was used. Using MS Access, the average number of mileages was produced. Further data needed were: first registration of vehicle, VIN, vehicle type, engine volume, weight of vehicle, emission category and data from 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. Main source of activity data such as intensity on urban, rural and highways is the Traffic Census of Slovakia,

[8] http://www.minv.sk/?statisticke-prehlady-agendy-vozidiel

conducted every five years (2000, 2005, 2010 and 2015[9]).

Table 3.62: *Overview of input data used in COPERT 5 model in 2017*

CATEGORY OF ROAD VEHICLE	ACTIVITY DATA		CATEGORY OF ROAD VEHICLE	ACTIVITY DATA	
	NUMBER OF VEHICLES	AVERAGE MILEAGE (km/VEH)		NUMBER OF VEHICLES	AVERAGE MILEAGE (km/VEH)
Passenger Cars	**2 144 676**	**9 491.85**	Diesel N1-III	119 518	15 685.49
Petrol Mini	10 296	4 594.65	**Heavy Duty Trucks**	**73 543**	**23 184.11**
Petrol Small	772 035	4 303.10	Petrol >3.5 t	57	6 602.52
Petrol Medium	333 406	5 798.89	Rigid <=7,5 t	19 430	29 817.35
Petrol Large	36 231	6 125.17	Rigid 7,5 - 12 t	15 584	39 271.62
2-Stroke	151	131.12	Rigid 12 - 14 t	3 544	32 092.94
Hybrid Mini	18	4 823.95	Rigid 14 - 20 t	4 416	25 132.91
Hybrid Small	156	9 442.70	Rigid 20 - 26 t	1 332	10 969.69
Hybrid Medium	1 786	7 876.62	Rigid 26 - 28 t	46	15 283.67
Hybrid Large-SUV-Executive	786	8 172.46	Rigid 28 - 32 t	215	14 124.86
Diesel Mini	337	5 522.41	Rigid >32 t	136	3 158.83
Diesel Small	25 549	9 072.61	Articulated 14 - 20 t	28 782	71 471.61
Diesel Medium	749 896	12 965.39	Articulated 40 - 50 t	1	7 099.24
Diesel Large-SUV-Executive	165 165	12 953.75	**Buses**	**8 662**	**40271.36**
LPG Bifuel Mini	28	9 522.48	Urban Buses Midi <=15 t	763	38641.94
LPG Bifuel Small	23 107	16 302.75	Urban Buses Standard 15 - 18 t	261	46233.68
LPG Bifuel Medium	19 378	16 645.65	Urban Buses Articulated >18 t	46	28262.132
LPG Large-SUV-Executive	4 792	13 579.62	Coaches Standard <=18 t	7 302	39 993.80
CNG Bifuel Small	889	14 830.53	Coaches Articulated >18 t	49	55 664.52
CNG Bifuel Medium	621	11 116.21	CNG Buses	241	32 832.07
CNG Large-SUV-Executive	49	16 056.89	**L-Category**	**131 959**	**1 279.65**
Light Commercial Vehicles	**137 294**	**10 524.43**	Mopeds 2-stroke <50 cm³	555	682.77
Petrol N1- I	29 807	8 262.85	Mopeds 4-stroke <50 cm³	25 534	568.04
Petrol N1-II	10 391	8 868.39	Motorcycles 2-stroke >50 cm³	1 348	1 123.02
Petrol N1-III	2 913	8 660.56	Motorcycles 4-stroke <250 cm³	41 563	1 176.75
Diesel N1- I	20 946	13 785.07	Motorcycles 4-stroke 250-750cm³	37 248	1 810.69
Diesel N1-II	73 237	13 045.26	Motorcycles 4-stroke >750 cm³	25 711	2 316.62

Input parameters for the CNG buses are known only since 2000. Before the year 2000, CNG consumption in the 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.

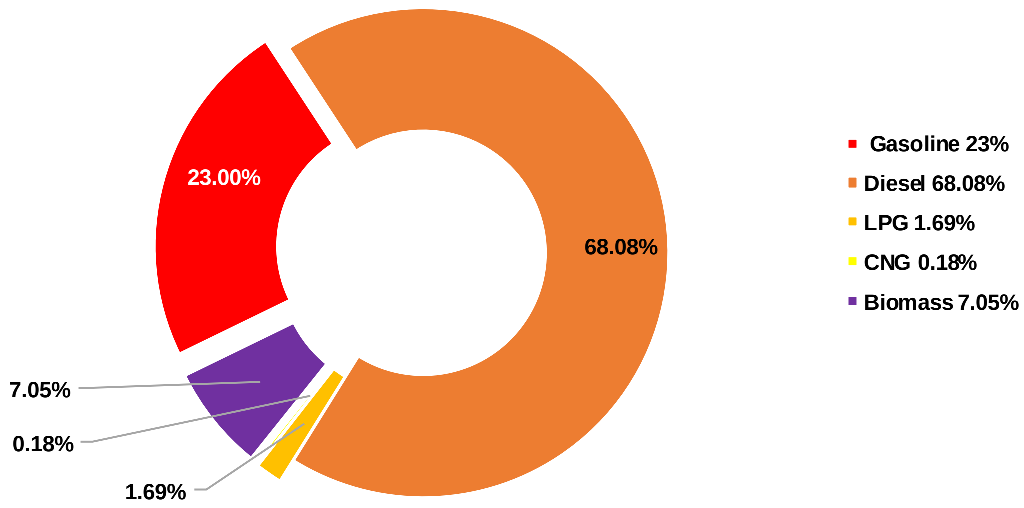
Data regarding of the statistical consumption of petrol, diesel oil and biofuels were received from Ministry of Economy. These data are, according to the latest QA/QC, the most accurate (for more see **Chapter**

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

3.8.3). Data about the LPG distribution and sale were obtained from the Slovak Association of Petrochemical Industry (SAPPO). Data regarding CNG consumption were obtained directly from transport companies that operate CNG fuelled vehicles. All official documents are in the Slovak language and available for the national inventory experts. According to the statistical information, the diesel oil represents 68.08% share on the fuel balance, followed by gasoline with 23.00% share, then LPG (1.69%), CNG (0.18%) and biomass (7.05%) (***Figure 3.42***).

The blending of biomass in liquid fuels was considered and the bio-emissions are calculated since 2007 (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 the 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 bio-component percentage (***Table 3.63***). Because ETBE bio-component is only in 47% (bio) by volume and the activity data are available only in mass units, bio-ETBE was considered also 37% by weight in calculation of total bio-components in fuel. From the biomass (biodiesel) is also subtracted the 4% fossil methanol part.

Figure 3.42: *Fuels balance in road transportation in 2017*



Requirements for the quality of the 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. The report is prepared by the Ministry of Economy of the Slovak Republic with the cooperation of the Finance Administration of the SR and the Ministry of Environment of the Slovak Republic.

Table 3.63: *Estimated activity data and share of biomass for the time series 2007–2017*

GASOLINE	**2007**	**2008**	**2009**	**2010**
Biomass share % (energy)	2.30%	1.23%	2.58%	2.95%
Biomass (TJ)	652.261	358.172	706.723	779.130
DIESEL OIL	**2007**	**2008**	**2009**	**2010**
Biomass share % (energy)	4.09%	4.77%	5.14%	5.28%
Biomass (TJ)	2 677.29	2 795.75	3 090.30	3 577.88
GASOLINE	**2011**	**2012**	**2013**	**2014**
Biomass share % (energy)	2.97%	2.94%	3.21%	4.03%
Biomass (TJ)	715.872	710.557	726.595	859.329
DIESEL OIL	**2011**	**2012**	**2013**	**2014**
Biomass share % (energy)	6.05%	5.79%	6.43%	5.98%
Biomass (TJ)	3 741.68	3 846.12	4 107.36	3 766.08
GASOLINE	**2015**	**2016**	**2017**	

GASOLINE	2007	2008	2009	2010
Biomass share % (energy)	3.45%	3.20%	4.24%	
Biomass (TJ)	747.873	725.623	943.486	
DIESEL OIL	**2015**	**2016**	**2017**	
Biomass share % (energy)	6.09%	7.16%	7.43%	
Biomass (TJ)	4 342.97	5 158.95	5 464.18	

According to the recommendation ***SK-1A3b-2018-0001***, Slovakia managed to distinguish lube oil consumption in 2-stroke vehicles and 4-stroke vehicles (***Table 3.64)***. The emissions from lube oil are allocated according to EMEP/EEA GB 2016 and recommendations:

- lube oil emissions from 2-stroke vehicles accordingly in the 1A3b categories;
- lube oil emissions from 4-stroke vehicles in the 2D3i category

Table 3.64: *Overview of lube oil consumption in the time-series (1990–2017)*

Engine type	1990	1991	1992	1993	1994	1995	1996
2-stroke lube oil (t)	128.68	102.18	88.52	82.21	75.35	65.71	54.26
4-stroke (t)	1 999.93	1 737.05	1 645.6	1 684.13	1 790.83	1 887.86	1 924.45
Engine type	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2-stroke lube oil (t)	46.17	41.02	34.27	25.55	29.35	24.08	25.02
4-stroke (t)	2 022.4	2 226.84	2 216.98	1 999.67	2 298.66	2 329.04	2 414.02
Engine type	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2-stroke lube oil (t)	23.15	26.46	27.43	27.72	26.40	17.77	14.58
4-stroke (t)	2 502.24	2 979.76	2 633.41	3 036.65	3 048.52	2 851.96	3 598.79
Engine type	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
2-stroke lube oil (t)	14.40	13.97	12.97	12.12	14.35	23.36	1.95
4-stroke (t)	3 430.06	3 690.51	3 613.91	3 740.94	4 145.87	4 216.23	4 325.97

Lube oil composition, including HMs was analysed and used for emission estimation for the years 2000–2017 (more info in **Chapter 3.8.4.3**). For the years 1990–1999 were used reconstructed data for fuel composition (***Table 3.67***), vehicle fleet and estimations in line with the recommendations ***SK-1A3b-2018-0003***, ***SK-1A3b-2018-0004*** and ***SK-1A3b-2018-0005***.

Emissions of all HMs are dependent on content level (***Table 3.65***) and fuel consumption, thus all irregularities are caused by 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 the article 8 (***SK-1A3b-2018-0002***). Lead emissions are allocated according to the previous paragraph.

Table 3.65: *Overview of HMs and sulphur content in the time-series 1990–1999*

S (ppm)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Petrol	324.00	324.00	324.00	324.00	324.00	324.00	324.00	324.00	324.00	120.00
Diesel	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00	400.00
Pb (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	20.00	18.40	16.96	15.66	14.50	13.45	12.50	11.65	10.89	10.20
Diesel	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Cd (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	0.010	0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001
Diesel	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	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)

S (ppm)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cu (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	1.70	1.53	1.36	1.19	1.02	0.85	0.68	0.51	0.34	0.17
Diesel	1.70	1.53	1.36	1.19	1.02	0.85	0.68	0.51	0.34	0.18
Cr (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01
Diesel	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01
Ni (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.02	0.02	0.01
Diesel	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.02	0.01	0.01
Se (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Diesel	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Zn (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	1.00	0.90	0.81	0.71	0.61	0.52	0.42	0.32	0.23	0.13
Diesel	1.00	0.90	0.80	0.71	0.61	0.51	0.41	0.31	0.21	0.12
Hg (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Diesel	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
As (ppm)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Petrol	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Diesel	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

3.8.4.2 Category specific QA/QC

QC activities ensuring the quality standards for the preparation of the emissions inventory in the road transportation are based on the cooperation of the 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 experts are responsible for the verification of these input parameters and for the emissions calculation by the COPERT model.

The preliminary results of emissions inventory are sent to other subjects (Ministry of the Environment of the Slovak Republic, Transport Research Institute in Žilina, Ministry of Transport, Construction and Regional Development of the Slovak Republic) for valuation and QA activities. The QA verification process includes the exercise of statistical and calculated data on fuel consumption. The Statistical Office of the Slovak Republic provides the statistical data on fuel consumption. The calculated data on fuel consumption is direct outcome from the COPERT model.

The process of verification is based on cross-checking of 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 central archiving system of SNE at SHMÚ.

Analysis of fuels and lube oils composition

Slovakia is analysing composition of fuels on regular basis. Delivering actual and the most recent data of composition of fuels is crucial for correct calculation and estimation of country-specific emission factors.

Last data update of fuel composition was made in 2018. In this update the subject of analysis were not only the most used fuels but also the most used lube oils. This analysis is also a part of implementation of recommendations ***SK-1A3b-2018-0001***, ***SK-1A3b-2018-0002*** and ***SK-1A3b-2018-0003***.

In the ***Table 3.66*** are presented the fuels from the three greatest sellers in Slovakia. These sellers also represent different refineries that affect the Slovak market.

Table 3.66: *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	5.6	30.7	14.7	1.875	0.020
OMV	1.9	33.1	13.4	1.852	0.021
Unipetrol	3.8	33.9	11.3	1.843	0.024
Average	3.8	32.6	13.1	1.857	0.021

As it was mentioned above, the lube oil is more important for 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 the ***Table 3.67***. These data were used to estimate heavy metal emissions.

Table 3.67: *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	1773	0.097	0.126	2300	2.08
Shell rimula	0.171	0.039	0.101	0.083	0.087	0.037	1923	0.026	0.156	3300	2.02
Castrol edge	0.017	0.298	0.01	0.044	0.03	0.037	1384	0.021	0.159	2200	2.05
Castrol vecton	0.048	0.033	0.02	0.094	0.03	0.037	2440	0.067	0.018	7200	1.97
Average	0.08	0.10	0.05	0.07	0.05	0.04	1880	0.05	0.11	3750	2.03

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 (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 of 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 3.68***), that most of deregistered cars were in EURO 1 emission category or older categories.

Through deeper analysis (***Table 3.69***) it was discovered, that not in all emission categories (EURO), was present reduction of registered cars. Despite of SSP granted new vehicles, there were also purchased 10 years old cars and older (outside of this program). The problem concerns two categories:

- Conventional diesel passenger cars
- EURO 2 passenger cars (petrol and diesel oil)

In the category of conventional diesel PC not inter-annual decrease was recorded (as should be supported by the SSP), but an increase of 14 365 passenger cars. The same 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 positive impact on air quality and climate change up to 80%.

The SSP started up and accelerated the annual rise of new registration of passenger cars in Slovakia with a small positive impact on air quality and climate change.

On the other hand, the SSP is possibly one of the factors causing decrease of fuel consumption (FC) in year 2009. The main drivers of fuel consumption are:

- Fuel type (petrol, diesel oil, LPG, CNG)
- Vehicle type (e.g. engine volume, weight)
- Age of the vehicle

- Average annual mileage
- Temperature (air, vehicle)
- Driving style (defensive/aggressive)

The first four parameters were directly affected by the SSP and was supposed to cause a linear regression. This regression was devalued by the rise of passenger cars in the Conventional PC and EURO 2 PC category. Exact effect cannot be calculated as there are missing data from the SSP needed to evaluate this. However positive effect on GHG emissions and air pollutants is visible.

Table 3.68: *Number of scrapped passenger cars by age (according to Automotive Industry Association statistics)*

AGE OF SCRAPPED CARS	EMISSION CATEGORY	TOTAL NUMBER OF SCRAPPED/DEREGISTERED VEHICLES IN 2009	SHARE OF SCRAPPED VEHICLES DUE TO PROGRAM ON THE TOTAL FLEET
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	

Table 3.69*: Yearly change in number of passenger cars by emission category (according to Police statistics)*

	TOTAL NUMBER OF PC IN 2008	TOTAL NUMBER OF PC IN 2009	DIFFERENCE	AVERAGE MILEAGE IN 2008 (KM)	AVERAGE MILEAGE IN 2009 (KM)	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

Conclusion:

- Cons:

The SSP failed in an intention to decrease a number of pre-EURO 4 vehicles;

The SSP accelerate registration of vehicles (not only new or modern one);

The SSP has no significant effect on GHG emissions;

- Pros:

The SSP caused fuel consumption decrease;

The SSP has moderate effect on air quality.

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 as negligible due to presence of heavier hydrocarbons with lower vapour pressure of diesel fuel.

According to the EMEP/EEA GB2016, updated April 2018 for petrol evaporation are the most important sources of evaporative emissions from a vehicle are the following:

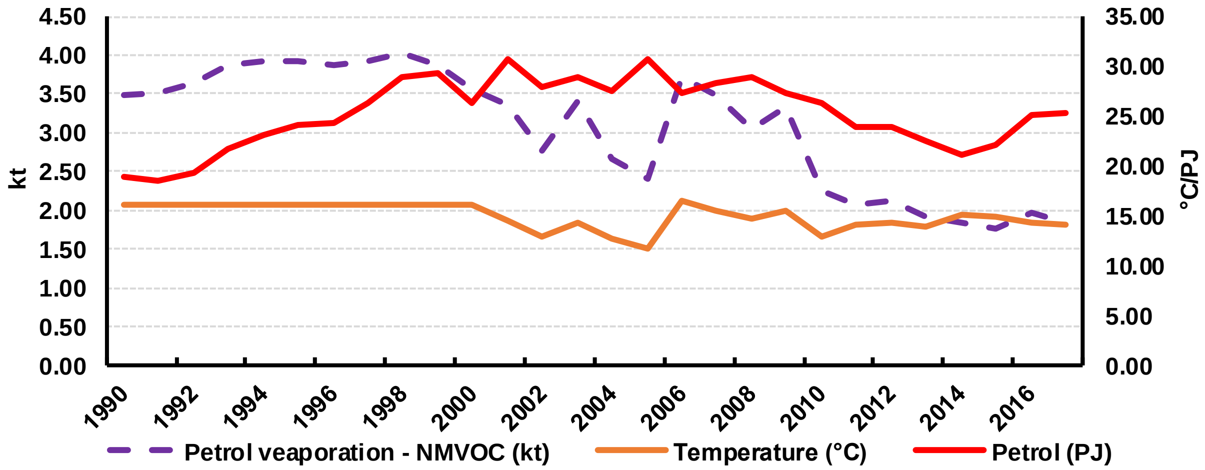
- Breathing losses through the tank vent. Breathing losses are due to evaporation of fuel in the tank during driving and parking, as a result of normal diurnal temperature variation;
- Fuel permeation/leakage. Various studies (e.g. CRC, 2004; Reuter et al., 1994) indicate that liquid fuel seepage and 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 dependant to 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 the category 1A3bv can be explained by ambient temperature (***Figure 3.43***) (according to recommendation ***SK-1A3bv-2018-0001***).

Figure 3.43*: Ambient air temperature and evaporation emissions correlation*



3.8.5 RAILWAYS (NFR 1A3c)

Railways is the second most important source of emissions in transport (except of pipeline transport), despite the decreasing character of this transport mode. Railways and rail transport are modernised with the support of the EU funds. Improved quality and ecology of rail transport and increase in passengers' number are the results of this modernisation. Modernisation of rail infrastructure results in an increase of operational speed to 160 km/h and increase of safety. According to the Annual Report of Slovak Railways[11] in 2017, the length of managed railways was 3 626 km. The length of electric railways was 1 588 km. Total emissions from railways transport decreased by 13.20% compared to year 2005 and by 75.44% compared to base year (***Table 3.70***). The decrease of fuels consumption was caused by the improvements of technical parameters (new locomotives and wagons and electrification of railways).

[11] Annual Report of Slovak Railway 2017, p.10, https://www.zsr.sk/o-nas/vyrocne-spravy/

Table 3.70: Overview of emissions in railways in years 1990–2017

YEAR	EMISSIONS							
	kt						t	
	NOx	NMVOC	SOx	NH_3	TSP	CO	HMs	POPs
1990	6.19	0.55	0.002	0.0008	0.18	1.26	0.34	1.204
1995	3.35	0.30	0.001	0.0004	0.10	0.68	0.18	0.652
2000	2.56	0.23	0.001	0.0003	0.07	0.52	0.14	0.498
2005	1.75	0.16	0.001	0.0002	0.05	0.36	0.09	0.341
2010	1.44	0.13	0.001	0.0002	0.04	0.29	0.08	0.281
2011	1.39	0.12	0.001	0.0002	0.04	0.28	0.08	0.271
2012	1.18	0.10	0.000	0.0002	0.03	0.24	0.06	0.229
2013	1.45	0.13	0.001	0.0002	0.04	0.30	0.08	0.282
2014	1.38	0.12	0.001	0.0002	0.04	0.28	0.07	0.268
2015	1.52	0.13	0.001	0.0002	0.04	0.31	0.08	0.295
2016	1.56	0.14	0.000	0.0002	0.05	0.32	0.08	0.302
2017	1.52	0.13	0.000	0.0002	0.04	0.31	0.08	0.296
2005-2017	**-13.20%**	**-13.20%**	**-39.42%**	**-13.20%**	**-13.20%**	**-13.20%**	**-13.20%**	**-13.20%**
1990-2017	**-75.44%**	**-75.44%**	**-82.86%**	**-75.44%**	**-75.44%**	**-75.44%**	**-75.44%**	**-75.44%**

3.8.5.1 Methodological issues

Railways transport represents the operation of diesel traction using the simple methodology tier 1 according to the EMEP/EEA GB_{2016}. The emissions of the pollutants are calculated from the consumed fuels by diesel rail traction multiplied by the appropriate emission factor. The consumption of diesel oil for the motor traction in the Slovak Republic was obtained from the Railways Company, Ltd. (ZSSK) for the all years in time-series. It is assumed that the consumption of diesel oil in motor traction of railways transportation is equal to the diesel oil sold for the railways. The mobile sources of pollution in the railways transport include vehicles of motor traction of ZSSK. This motor traction is divided into 2 basic groups of vehicles: motor locomotives (Traction 70) and motor wagons (Traction 80). Four depots in the organizational structure of ZSSK have operated the motor traction since 2002 (Bratislava, Zvolen, Žilina and Košice). ***Table 3.71*** shows activity data and statistical information used for inventory preparation. Fuel consumption of the new company operated on the Slovak rails (REGIOJET) is also included in the inventory.

Table 3.71: Overview of activity data used in the inventory for railways transport in 2017

DEPOTS	KOŠICE	ŽILINA	ZVOLEN	BRATI-SLAVA	TOTAL PUBLIC	TOTAL CARGO	REGIO JET
Number of loco	84	65	66	48	263	226	14
1 000 km per year	5 340.2	2 548.7	3 682.3	2 208.6	13 779.8	2 719.9	1 446.9
Operations (hrkm)x1 000	771.8	215.5	308.0	225.5	1 520.8	1 063.7	143.8
Consumption (m^3) (blended)	9 748.7	2 965.4	4 911.7	3 621.0	21 246.8	11 580.6	1 424.4
Consumption (t) (blended)	8 146	2 478	4 104	3 026	13 780	9 677	1 190

3.8.5.2 Category specific QA/QC

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 emissions inventory are sent to other subjects (Ministry of the Environment of the Slovak Republic, Transport Research Institute in Žilina, Ministry of Transport, Construction and Regional Development of the Slovak Republic) for valuation and QA activities. The QC verification process includes the comparison of statistical and calculated data on fuel consumption.

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

The major share of emissions from inland shipping in Slovakia are realized as transit on Danube River. Due to lack of data were these two categories 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, negligible number of movements was 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 3.72***), despite of increase of touristic activities in Slovakia. The emissions for the years 2000 and 2005 were estimated to be negligible, because of increasing prices of diesel oil in the Slovak Republic and decreasing prices of fuels in the neighbouring countries (market discrepancies).

Table 3.72: *Overview of emissions in navigation (national and international) in years 1990–2017*

YEAR	EMISSIONS							
	kt						t	
	NOx	NMVOC	SOx	NH_3	TSP	CO	HMs	POPs
1990	1.626	0.055	0.410	0.0001	0.127	0.152	0.744	0.002
1995	1.433	0.049	0.361	0.0001	0.112	0.134	0.656	0.001
2000	0.001	0.000	0.000	0.0000	0.000	0.000	0.000	0.000
2005	0.018	0.001	0.004	0.0000	0.001	0.002	0.008	0.000
2006	0.760	0.026	0.192	0.0001	0.065	0.071	0.348	0.001
2010	0.837	0.028	0.211	0.0001	0.058	0.078	0.383	0.001
2011	0.743	0.025	0.187	0.0001	0.020	0.069	0.340	0.001
2012	0.259	0.009	0.065	0.0000	0.032	0.024	0.118	0.000
2013	0.408	0.014	0.103	0.0000	0.037	0.038	0.187	0.000
2014	0.474	0.016	0.120	0.0000	0.056	0.044	0.217	0.000
2015	0.714	0.024	0.180	0.0001	0.047	0.067	0.326	0.001
2016	0.597	0.020	0.151	0.0001	0.046	0.057	0.273	0.001
2017	0.588	0.020	0.148	0.0001	0.127	0.055	0.269	0.001
2005-2017	**-23%**	**-23%**	**-23%**	**-23%**	**-14%**	**-23%**	**-16%**	**62%**
1990-2017	**-64%**	**-64%**	**-64%**	**-64%**	**-60%**	**-64%**	**-61%**	**-24%**

3.8.6.1 Methodological issues

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

Shipping between the Slovak ports on 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 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 availability of information about the shipping activity in the Slovak Republic except the Danube River movements. The expert was informed that they register 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 Danube River, occur in Slovakia, however in limited extent. The three shipping routes are:

- River – basin of the Vah (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 the recent years (due increase of tourisms), 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 summer months (May-October).

- The duration of trips (in hours):

The duration can differ according to the type of trips (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 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 average density of diesel oil (**0.84 kg/dm^3**).

The emissions are calculated from the consumed fuel by diesel motor boats multiplied by emission factor. The emission factors are taken from the EMEP/EEA GB$_{2016}$. Activity data for domestic navigation are shown in ***Tables 3.73*** and ***Table 3.74***.

Table 3.73: *The amount of diesel oil sold by shipping companies and allocation to the categories 1A3dii and 1A3di(ii) in selected years 2005–2017*

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL (T)		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1.D.1.b	1A3d + 1.D.1.b
2005	Slovak Shipping and Ports (Danube)	1.3	128.7	130
	International shipping companies	0	84	84
	Total	**1.3**	**212.7**	**214**
2010	Slovak Shipping and Ports (Danube)	91.79	9 087.21	9 179.00
	International shipping companies	0	1 363.00	1 363.00
	Total	**91.79**	**10 450.21**	**10 542.00**
2011	Slovak Shipping and Ports (Danube)	79.75	7 895.25	7 975.00
	Slovak Water Management Enterprise	175	0	175
	Other Companies	1.03	101.97	103
	International shipping companies	0	1 104.00	1 104.00
	Total	**255.78**	**9 101.22**	**9 357.00**
2012	Slovak Shipping and Ports (Danube)	21.01	2 079.99	2 101.00
	Slovak Water Management Enterprise	321	0	321
	Other companies	0.7	69.3	70
	International shipping companies	0	764	764
	Total	**342.71**	**2 913.29**	**3 256.00**
2013	Slovak Shipping and Ports (Danube)	1 083.10	3 249.30	4 332.40
	Slovak Water Management Enterprise	0	0	0
	Other companies	0	0	0
	International shipping companies	0	801	801
	Total	**1 083.10**	**4 050.30**	**5 133.40**
2014	Slovak Shipping and Ports (Danube)	1 244.00	3 732.00	4 976.00
	Slovak Water Management Enterprise	149	0	149

YEAR	SHIPPING COMPANIES	SALE OF DIESEL OIL (T)		
		NATIONAL	INTERNATIONAL	TOTAL
		1A3d	1.D.1.b	1A3d + 1.D.1.b
	Other companies	0	0	0
	International shipping companies	0	844	844
	Total	**1 393.00**	**4 576.00**	**5 969.00**
2015	Slovak Shipping and Ports (Danube)	1 981.79	5 945.38	7 927.17
	Slovak Water Management Enterprise	0	0	0
	Other companies	0.48	47.52	48
	International shipping companies	0	1 016.00	1 016.00
	Total	**1 982.27**	**7 008.90**	**8 991.17**
2016	Slovak Shipping and Ports (Danube)	1 515.13	4 545.38	6 060.50
	Slovak Water Management Enterprise	0	0	0
	Other companies	1.91	189.09	191
	International shipping companies	0	1 272.00	1 272.00
	Total	**1 517.04**	**6 006.47**	**7 523.50**
2017	Slovak Shipping and Ports (Danube)	1 492.90	4 478.71	5 971.62
	Slovak Water Management Enterprise	0	0	0
	Other companies	2.39	236.61	239
	Morsevo (Komárno)	0	1034	1034
	International shipping companies	0	168.52	168.52
	Total	**1 495.29**	**5 917.84**	**7 413.14**

Table 3.74: *The emission estimation in national shipping for touristic purposes (NFR 1A3d) in 2017*

2017	LOCATION						TOTAL
ACTIVITY DATA	Piestany long trip	Piestany short trip	Trencin	Lipt. Mara	Oravska Priehrada	Zempl. Sirava	
Number of Trips (per year)	237	0	36	160	466	150	1 049
Duration of Trip (hours)	1	0	0.35	1	1	0.75	
Total Duration (hours/year)	237	0	12.6	160	466	112.5	988.1
Fuel Consumption (l/hour)	12	0	12	12	5.99	12	
Total Consumption (l/year)	2 844	0	151.2	1 920	2 790	1 350	7 135.2
Total Consumption (kg/year)	2 376	0	126	1 382	2 331	1 128	5 962.2
Total Consumption (TJ/year)	0.100	0	0.005	0.061	0.098	0.048	0.861

3.8.6.2 Category specific QA/QC

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.

3.8.7 PIPELINE TRANSPORT (NFR 1A3ei)

There is a significant decrease of fuel consumption in recent years and this trend is related to decrease of natural gas transit through the Slovak Republic. The fuel emissions are shown in the ***Table 3.75***.

Table 3.75: *Overview of emissions from pipeline transport in years 1990–2017*

YEAR	EMISSIONS (kt)				
	NOx	NMVOC	SOx	TSP	CO
1990	9.844	0.755	0.00179	0.00022	0.821
1995	7.125	0.635	0.00150	0.00018	0.623
2000	3.125	0.087	0.00098	0.00012	0.418
2005	3.974	0.238	0.00096	0.00004	0.365
2010	2.350	0.200	0.00390	0.00004	0.194
2011	2.494	0.211	0.01434	0.00003	0.171
2012	0.689	0.132	0.00001	0.00002	0.082
2013	0.658	0.149	0.00004	0.00002	0.066
2014	0.186	0.260	0.00001	0.00005	0.063

YEAR	EMISSIONS (kt)				
	NOx	NMVOC	SOx	TSP	CO
2015	0.227	0.233	0.00002	0.00008	0.049
2016	0.289	0.263	0.00001	0.00005	0.060
2017	0.252	0.215	0.00001	0.00008	0.089
2005-2017	**-94%**	**-10%**	**-99%**	**98%**	**-76%**
1990-2017	**-97%**	**-72%**	**-100%**	**-62%**	**-89%**

3.8.7.1 Methodological issues

The activity data on consumption of natural gas used for energy to drive turbines were obtained from the NEIS database. Tier 2 methodology and the country specific emission factor was used for emissions estimation in pipeline transport category.

3.8.7.2 Source specific QA/QC

The accuracy of the reported data was guaranteed by verifying the data reported in last year's submission.

3.8.8 CATEGORY-SPECIFIC RECALCULATIONS

Recalculations made in Transport sector were provided and implemented in the line with the Improvement plan reflecting recommendations made during previous reviews.

Table 3.76: *Summary of the recalculations and changes in 1A3*

NUMBER	CATEGORY	DESCRIPTION	REFERENCE
1.	1A3b	Recalculation of the time-series was made according to recommendations ***SK-1A3bv-2018-0001***, ***SK-1A3b-2018-0002, SK-1A3b-2018-0003, SK-1A3b-2018-0004***, ***SK-1A3b-2018-0005***	See **Chapter 3.8.2**
2.	1A3a	Recalculation of PMs as an outcome of miscalculation in years 1990–2004 in previous submission	

Ad 1: Road transport (1A3b) – Recalculation was made according to observations and recommendations ***SK-1A3bv-2018-0001***, ***SK-1A3b-2018-0002***, ***SK-1A3b-2018-0003***, ***SK-1A3b-2018-0004***. ***SK-1A3b-2018-0005***.

Table 3.77: *Recalculation of air pollutants in road transportation for years 1990–2016*

EMISSIONS - ROAD TRANSPORT																		
YEAR	2018	2019		2018	2019		2018	2019		2018	2019		2018	2019		2018	2019	
	NOx (kt)		diff.	NMVOC (kt)		diff.	SOx (kt)		diff.	NH_3 (kt)		diff.	$PM_{2.5}$ (kt)		diff.	CO (kt)		diff.
1990	50.76	43.81	-13.7%	35.54	26.07	-26.6%	2.42	2.42	-0.2%	0.03	0.02	-14.5%	2.68	3.34	24.6%	160.59	193.01	20.2%
1991	42.31	36.74	-13.2%	33.04	24.40	-26.1%	1.97	1.97	-0.1%	0.03	0.02	-11.8%	2.27	2.68	18.2%	149.05	183.93	23.4%
1992	38.39	33.92	-11.6%	31.80	24.23	-23.8%	1.76	1.76	-0.1%	0.03	0.02	-14.8%	1.97	2.34	18.7%	148.81	187.16	25.8%
1993	37.76	33.47	-11.3%	33.83	26.02	-23.1%	1.68	1.68	-0.2%	0.04	0.03	-18.4%	1.82	2.19	20.4%	159.15	203.19	27.7%
1994	39.74	35.65	-10.3%	35.04	26.63	-24.0%	1.80	1.79	-0.4%	0.07	0.05	-20.5%	1.88	2.30	22.4%	164.29	210.45	28.1%
1995	41.07	37.23	-9.4%	34.13	26.62	-22.0%	1.92	1.90	-1.1%	0.11	0.09	-20.3%	2.10	2.40	14.3%	162.34	209.23	28.9%
1996	39.98	37.31	-6.7%	31.69	25.63	-19.1%	1.95	1.95	-0.3%	0.16	0.13	-22.8%	2.02	2.42	19.6%	152.01	199.94	31.5%
1997	39.50	37.55	-4.9%	30.05	25.29	-15.8%	2.01	2.00	-0.5%	0.24	0.19	-22.6%	1.96	2.40	22.5%	152.02	199.51	31.2%
1998	39.82	38.00	-4.6%	29.53	25.75	-12.8%	2.12	2.11	-0.7%	0.33	0.26	-21.2%	2.01	2.51	24.7%	153.10	204.55	33.6%
1999	37.33	35.92	-3.8%	25.98	24.08	-7.3%	0.75	0.75	0.1%	0.52	0.41	-22.7%	1.84	2.39	29.6%	142.42	193.21	35.7%
2000	33.93	31.59	-6.9%	20.48	20.18	-1.5%	0.69	0.69	0.0%	0.34	0.35	1.3%	1.34	1.94	44.8%	170.39	168.31	-1.2%
2001	37.11	34.56	-6.9%	22.94	22.59	-1.5%	0.70	0.70	0.0%	0.43	0.43	1.5%	1.46	2.14	46.6%	199.44	196.56	-1.4%
2002	38.20	35.26	-7.7%	20.96	20.63	-1.6%	0.75	0.75	0.0%	0.41	0.42	1.7%	1.59	2.34	47.0%	183.71	180.74	-1.6%
2003	38.39	35.46	-7.6%	21.08	20.73	-1.6%	0.15	0.15	0.1%	0.45	0.46	1.7%	1.55	2.32	50.0%	178.82	175.52	-1.8%
2004	40.83	37.63	-7.8%	19.33	19.00	-1.7%	0.16	0.16	0.1%	0.45	0.46	1.7%	1.72	2.53	47.1%	166.11	162.84	-2.0%
2005	47.36	43.27	-8.6%	20.20	19.83	-1.8%	0.19	0.19	0.1%	0.52	0.53	1.6%	2.04	3.01	47.6%	173.80	170.12	-2.1%
2006	42.21	39.22	-7.1%	16.57	16.31	-1.6%	0.18	0.18	0.1%	0.46	0.46	0.8%	1.72	2.58	49.9%	122.20	119.61	-2.1%
2007	46.76	42.98	-8.1%	15.61	15.64	0.2%	0.20	0.20	0.1%	0.49	0.49	0.6%	1.95	2.92	49.9%	115.81	113.16	-2.3%
2008	48.62	45.32	-6.8%	14.67	14.69	0.2%	0.20	0.20	0.1%	0.50	0.50	0.4%	1.94	2.93	50.7%	109.92	107.20	-2.5%
2009	42.99	39.91	-7.2%	13.62	13.69	0.5%	0.19	0.19	0.1%	0.47	0.47	0.1%	1.76	2.66	50.8%	99.63	97.00	-2.6%
2010	41.57	36.82	-11.4%	11.69	11.82	1.1%	0.03	0.03	0.4%	0.47	0.47	0.4%	1.94	3.03	55.7%	89.83	88.08	-1.9%
2011	32.81	29.53	-10.0%	8.02	8.17	1.9%	0.03	0.03	0.4%	0.40	0.41	0.4%	1.51	2.40	59.5%	58.75	57.33	-2.4%
2012	34.36	30.99	-9.8%	7.88	8.05	2.1%	0.03	0.03	0.4%	0.41	0.41	0.4%	1.65	2.52	52.2%	56.57	55.15	-2.5%
2013	32.45	29.35	-9.5%	7.05	7.20	2.2%	0.03	0.03	0.3%	0.39	0.39	0.5%	1.57	2.38	51.7%	50.37	49.00	-2.7%
2014	32.95	29.80	-9.6%	6.29	6.42	2.0%	0.03	0.03	0.5%	0.37	0.37	0.5%	1.57	2.36	50.4%	43.55	42.17	-3.2%
2015	26.98	29.28	8.5%	5.66	5.92	4.6%	0.03	0.03	8.2%	0.37	0.37	-1.2%	1.39	2.43	74.9%	39.16	38.42	-1.9%
2016	22.70	26.21	15.5%	5.29	5.69	7.7%	0.03	0.03	14.3%	0.40	0.38	-4.3%	1.13	2.40	113.3 %	35.24	34.56	-1.9%

YEAR	2018	2019		2018	2019		2018	2019		2018	2019		2018	2019	
	Pb (t)		diff.	Cd (t)		diff.	Hg (t)		diff.	HM additional (t)		diff.	POPs (t)		diff.
1990	7.85	9.14	16.4%	0.02	0.01	-70.2%	-	0.01	-	18.68	10.33	-44.7%	0.11	0.09	-19.4%
1991	7.46	8.21	10.1%	0.02	0.01	-69.3%	-	0.01	-	15.56	8.40	-46.0%	0.09	0.07	-19.1%
1992	7.59	7.85	3.4%	0.02	0.01	-69.2%	-	0.01	-	14.34	7.43	-48.2%	0.08	0.06	-20.0%
1993	8.29	8.13	-2.0%	0.02	0.01	-69.4%	-	0.01	-	14.20	7.09	-50.1%	0.08	0.06	-20.3%
1994	8.64	8.06	-6.7%	0.02	0.01	-72.2%	-	0.01	-	15.38	7.22	-53.1%	0.09	0.07	-21.3%
1995	8.63	7.85	-9.1%	0.02	0.005	-73.2%	-	0.01	-	16.49	7.26	-56.0%	0.09	0.07	-22.6%
1996	8.22	7.41	-9.9%	0.02	0.004	-76.3%	-	0.01	-	16.91	7.02	-58.5%	0.09	0.07	-23.1%
1997	8.25	7.46	-9.6%	0.02	0.004	-79.0%	-	0.01	-	17.75	6.90	-61.1%	0.10	0.07	-24.4%
1998	8.38	7.72	-7.9%	0.02	0.004	-81.7%	-	0.01	-	18.56	6.98	-62.4%	0.10	0.08	-23.6%
1999	7.88	7.32	-7.2%	0.02	0.003	-84.6%	-	0.01	-	18.08	6.47	-64.2%	0.10	0.07	-22.9%
2000	0.43	0.43	1.6%	0.01	0.002	-80.0%	0.01	0.01	0.0%	7.43	5.57	-25.1%	0.08	0.07	-13.9%
2001	0.48	0.49	1.7%	0.01	0.002	-80.2%	0.01	0.01	0.0%	8.48	6.32	-25.4%	0.09	0.08	-14.2%
2002	0.50	0.51	1.9%	0.01	0.003	-79.7%	0.01	0.01	0.0%	8.68	6.55	-24.5%	0.10	0.08	-16.0%
2003	0.52	0.53	2.1%	0.01	0.003	-79.8%	0.01	0.01	0.0%	8.99	6.78	-24.6%	0.10	0.08	-15.9%
2004	0.55	0.56	2.2%	0.01	0.003	-79.3%	0.01	0.01	0.0%	9.46	7.21	-23.8%	0.11	0.09	-16.1%
2005	0.66	0.67	2.1%	0.02	0.003	-79.2%	0.01	0.01	0.0%	11.22	8.56	-23.7%	0.14	0.11	-17.6%
2006	0.61	0.62	2.1%	0.01	0.003	-78.7%	0.01	0.01	0.0%	10.30	7.95	-22.8%	0.12	0.10	-13.8%
2007	0.70	0.71	2.3%	0.02	0.003	-78.5%	0.01	0.01	0.0%	11.75	9.11	-22.5%	0.15	0.12	-15.9%
2008	0.71	0.73	2.2%	0.02	0.004	-78.3%	0.01	0.01	0.0%	12.05	9.35	-22.4%	0.14	0.13	-13.0%
2009	0.66	0.67	2.3%	0.02	0.003	-78.5%	0.01	0.01	0.0%	11.15	8.62	-22.7%	0.13	0.12	-14.0%
2010	0.71	0.73	2.7%	0.02	0.004	-80.1%	0.01	0.01	0.0%	12.39	9.32	-24.8%	0.19	0.14	-24.9%
2011	0.66	0.68	3.3%	0.02	0.003	-80.3%	0.01	0.01	0.0%	11.67	8.77	-24.8%	0.19	0.14	-27.0%
2012	0.70	0.73	3.5%	0.02	0.004	-80.4%	0.01	0.01	0.0%	12.42	9.32	-24.9%	0.21	0.15	-27.1%
2013	0.68	0.71	3.8%	0.02	0.003	-80.5%	0.01	0.01	0.0%	12.08	9.06	-25.0%	0.20	0.15	-27.6%
2014	0.70	0.73	3.9%	0.02	0.004	-80.5%	0.01	0.01	-0.4%	12.46	9.35	-25.0%	0.21	0.15	-28.2%
2015	0.72	0.80	10.7%	0.02	0.004	-81.4%	0.01	0.01	5.5%	13.50	10.27	-23.9%	0.18	0.18	-2.8%
2016	0.74	0.84	12.5%	0.02	0.004	-80.5%	0.01	0.01	9.4%	13.65	10.74	-21.4%	0.15	0.18	22.3%

Table title: **EMISSIONS - ROAD TRANSPORT**

Ad 2: International aviation LTO and Domestic aviation LTO (1A3ai(i) and 1A3aii(i) had to be recalculated as an outcome of miscalculation in years 1990–2004. Results are in the ***Table 3.78***.

Table 3.78: *Recalculation of air pollutants in road transport for years 1990–2004*

EMISSIONS - International aviation LTO				EMISSIONS - Domestic aviation LTO			EMISSIONS - International aviation LTO		
YEAR	**2018**	**2019**		**2018**	**2019**		**2018**	**2019**	
	$PM_{2.5}$ (kt)		**diff.**	**$PM_{2.5}$ (kt)**		**diff.**	**PM_{10} (kt)**		**diff.**
1990	0.0007	0.0007	0.0%	0.0004	0.0005	0.4%	0.0007	0.0007	3.0%
1991	0.0006	0.0006	0.0%	0.0004	0.0004	0.4%	0.0006	0.0006	3.0%
1992	0.0007	0.0007	0.0%	0.0004	0.0004	-11.1%	0.0006	0.0007	18.8%
1993	0.0006	0.0006	0.0%	0.0004	0.0004	0.6%	0.0005	0.0006	3.0%
1994	0.0005	0.0005	-3.0%	0.0003	0.0003	0.3%	0.0005	0.0005	0.0%
1995	0.0005	0.0005	0.0%	0.0003	0.0003	0.7%	0.0005	0.0005	3.0%
1996	0.0005	0.0005	0.0%	0.0003	0.0003	1.0%	0.0005	0.0005	3.0%
1997	0.0005	0.0005	0.0%	0.0003	0.0003	1.0%	0.0005	0.0005	3.0%
1998	0.0004	0.0004	0.0%	0.0003	0.0003	1.2%	0.0004	0.0004	3.0%
1999	0.0004	0.0004	0.0%	0.0003	0.0003	0.9%	0.0004	0.0004	3.0%
2000	0.0005	0.0005	0.0%	0.0003	0.0003	0.1%	0.0005	0.0005	3.1%
2001	0.0005	0.0005	0.0%	0.0004	0.0004	-0.2%	0.0005	0.0005	3.1%
2002	0.0005	0.0005	0.0%	0.0004	0.0004	-0.4%	0.0005	0.0005	3.1%
2003	0.0006	0.0006	0.0%	0.0004	0.0004	0.7%	0.0006	0.0006	3.0%
2004	0.0006	0.0006	0.0%	0.0003	0.0003	4.0%	0.0006	0.0006	2.8%

EMISSIONS - Domestic aviation LTO				EMISSIONS - International aviation LTO			EMISSIONS - Domestic aviation LTO		
YEAR	**2018**	**2019**		**2018**	**2019**		**2018**	**2019**	
	PM_{10} (kt)		**diff.**	**TSP (kt)**		**diff.**	**TSP (kt)**		**diff.**
1990	0.0005	0.0007	52.2%	0.0007	0.0007	3.0%	0.0005	0.0007	52.2%
1991	0.0004	0.0006	52.2%	0.0006	0.0006	3.0%	0.0004	0.0006	52.2%
1992	0.0004	0.0007	75.5%	0.0006	0.0007	18.8%	0.0004	0.0007	75.5%
1993	0.0004	0.0006	55.4%	0.0005	0.0006	3.0%	0.0004	0.0006	55.4%
1994	0.0003	0.0005	47.2%	0.0005	0.0005	0.0%	0.0003	0.0005	47.2%
1995	0.0003	0.0005	55.8%	0.0005	0.0005	3.0%	0.0003	0.0005	55.8%
1996	0.0003	0.0005	60.0%	0.0005	0.0005	3.0%	0.0003	0.0005	60.0%
1997	0.0003	0.0005	59.8%	0.0005	0.0005	3.0%	0.0003	0.0005	59.8%
1998	0.0003	0.0004	62.0%	0.0004	0.0004	3.0%	0.0003	0.0004	62.0%
1999	0.0003	0.0004	58.9%	0.0004	0.0004	3.0%	0.0003	0.0004	58.9%
2000	0.0003	0.0005	48.7%	0.0005	0.0005	3.1%	0.0003	0.0005	48.7%
2001	0.0004	0.0005	44.4%	0.0005	0.0005	3.1%	0.0004	0.0005	44.4%
2002	0.0004	0.0005	42.8%	0.0005	0.0005	3.1%	0.0004	0.0005	42.8%
2003	0.0004	0.0006	56.5%	0.0006	0.0006	3.0%	0.0004	0.0006	56.5%
2004	0.0003	0.0006	96.6%	0.0006	0.0006	2.8%	0.0003	0.0006	96.6%

3.8.9 CATEGORY-SPECIFIC IMPROVEMENTS AND IMPLEMENTATION

Implementation of recommendation No ***SK-1A4cii-2018-001*** is planned for the next submission.

3.9 SMALL COMBUSTION (NFR 1A4, 1A5)

3.9.1 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 the 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 the fuel, 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 production of thermal energy in larger combustion activities, with the exception of the simple design of smaller appliances like fireplaces and stoves.

Relevant pollutants are SO_2, 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 to categories:

1A4a — Commercial/institutional;

1A4b — Residential;

1A4c — Agriculture/forestry; and

1A5a — Other (stationary combustion).

All non-road mobile machinery is reported in category 1A4cii.

Figure 3.44: *Trend of air emissions pollutants in small combustion 1A4 in kt*

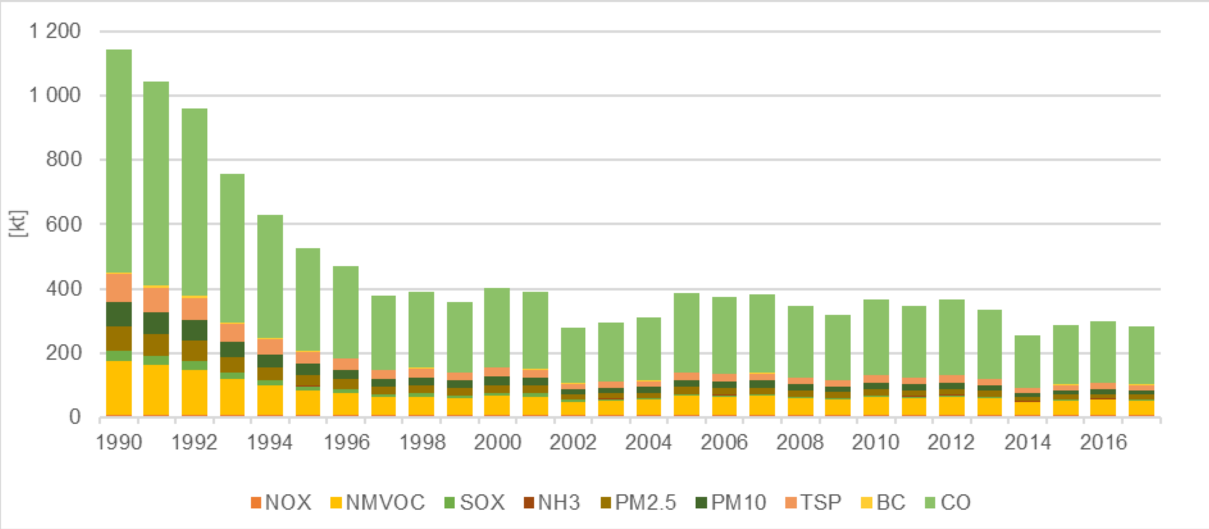
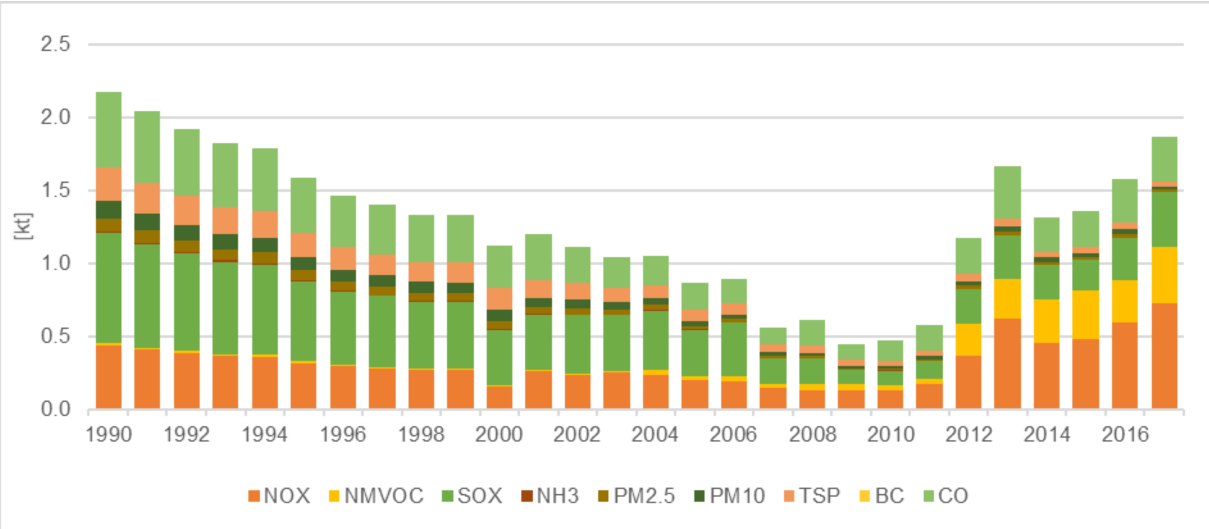


Figure 3.45: *Trend of air emissions pollutants in small combustion 1A5 in kt*



3.9.1 COMMERCIAL/INSTITUTIONAL: STATIONARY (NFR 1A4ai)

3.9.1.1 Overview

The fuel consumption in long term has decreasing trend, but since 2010 the consumption of biomass have increase. As a direct consequence of change in fuel base, the heavy metals calculated by T1 method using the EMEP/EEA GB_{2016} default factors reflecting the increase in Zn.

Figure 3.461: *Trends in emissions of air pollutants in 1A4ai*

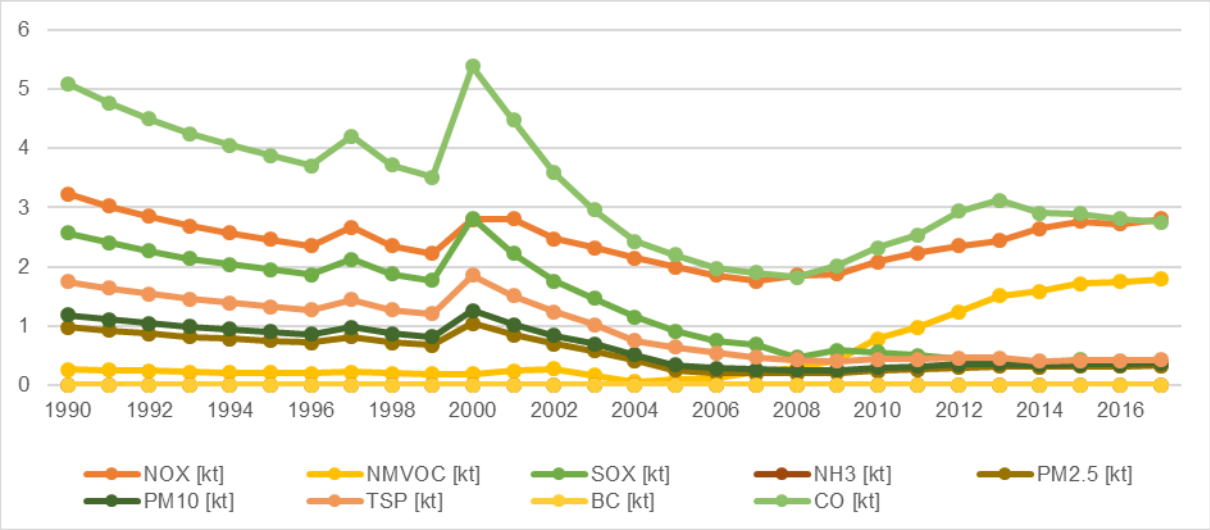


Figure 3.47: *Trends in emissions of heavy metals in 1A4ai*

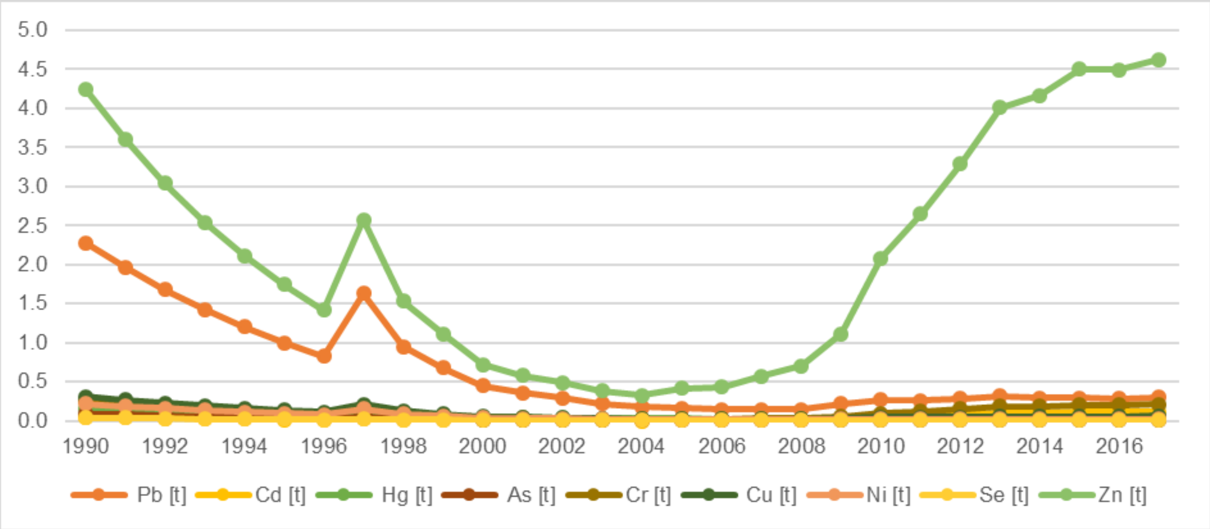
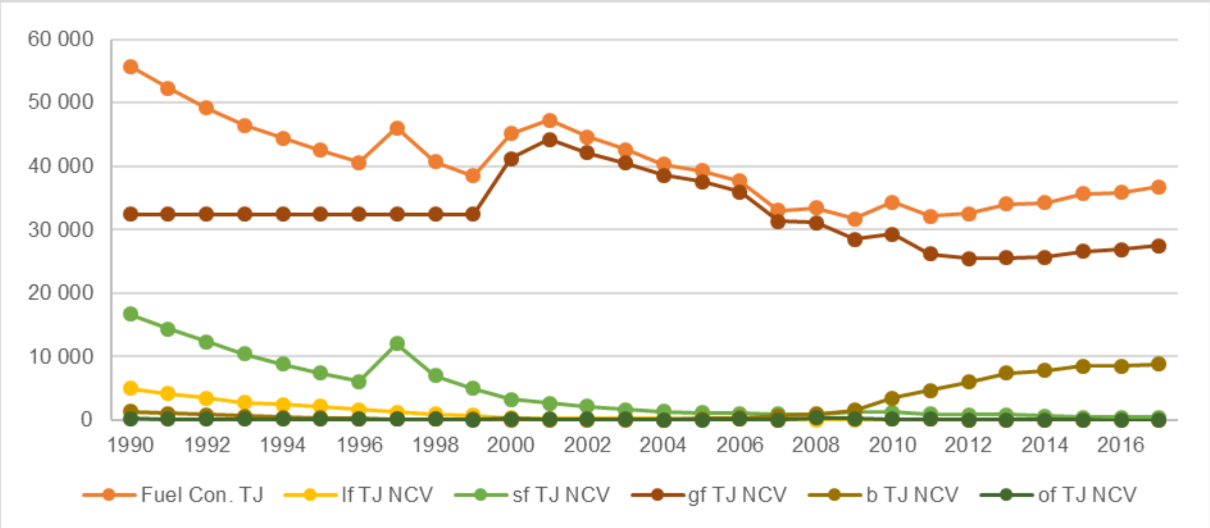


Figure 3.48: *The fuel consumption of NFR 1A4ai in TJ*



3.9.1.2 Methodological Issues

Table 3.79: *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

Table 3.80: *The overview of share of used calculation type for category 1A4ai in NEIS*

1A4ai	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	36%
4	Calculation using emission factor and amount of fuel	60%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.2%
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	4%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

Heavy metals are calculated as Tier 1 level. Emission factors used for calculation of heavy metals are default EF from EMEP/EEA GB_{2016} (***Table 3.81***). According to the recommendation No ***SK-1A4ai-2018-0001***, correct emission factors for liquid fuels are shown in ***the Table 3.81***. Emission factors for POPs are country specific and originate from Magulová (2003) (***Table 3.82***).

Table 3.81: *Emission factor for heavy metals in 1A4ai*

T1	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
Unit	mg/GJ	mg/GJ	mg/GJ	mg/GJ
Pb	2	134	0.011	27
Cd	0.6	1.8	0.0009	13
Hg	0.4	7.9	0.54	0.56
As	4.2	4	0.1	0.19
Cr	0.6	13.5	0.013	23
Cu	2	17.5	0.0026	6
Ni	0.4	13	0.013	2
Se	2.1	1.8	0.058	0.5
Zn	36	200	0.73	512

Table 3.82: *Emission factor for POPs in 1A4ai*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	mg I-TEQ/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Hard coal	0.000236	0.00352	0.00732	0.00732	0.00703	0.02519	0.074183	0.7913
Wood	0.000685	0.095	19	19	0.17	38.265	0.043124	0.0493
Brown coal	0.000534	0.00352	0.00732	0.00732	0.00703	0.02519	0.048101	0.0519
Fuel oil	0.000101	4.68	20.3	3.98	7.57	36.53	0.127575	0.6116
Natural gas	0.00017	-	-	-	-	-	-	-

3.9.2 COMMERCIAL/INSTITUTIONAL: MOBILE (NFR 1A4aii)

3.9.2.1 Overview

This activity is included in the category 1A4cii, therefore notation key IE was used.

3.9.3 RESIDENTIAL: STATIONARY (NFR 1A4bi)

3.9.3.1 Overview

The emission inventory for households' heating has undergone the improvement of methodology and increase of methodological level from T1 to T2, because households' heating is a significant contributor of particulate matters (approximately 75% as well as other emissions in Slovakia. Trend in emission as well as the fuel consumption are relatively stable with slight downward trend.

Figure 3.49: *Trends in emissions of air pollutants in 1A4bi*

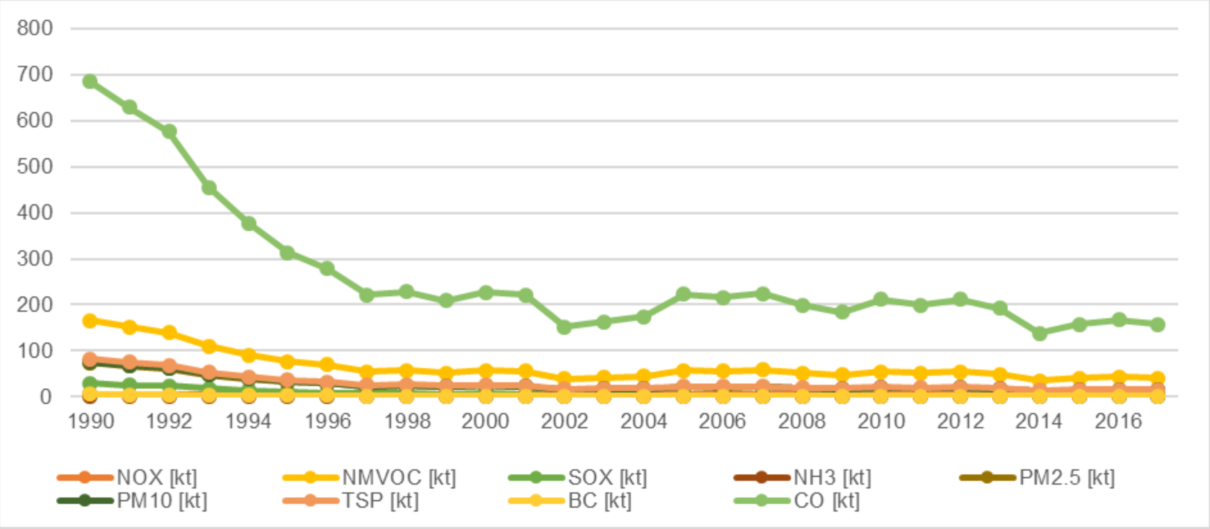


Figure 3.50: *Trends in emissions of heavy metals in 1A4bi*

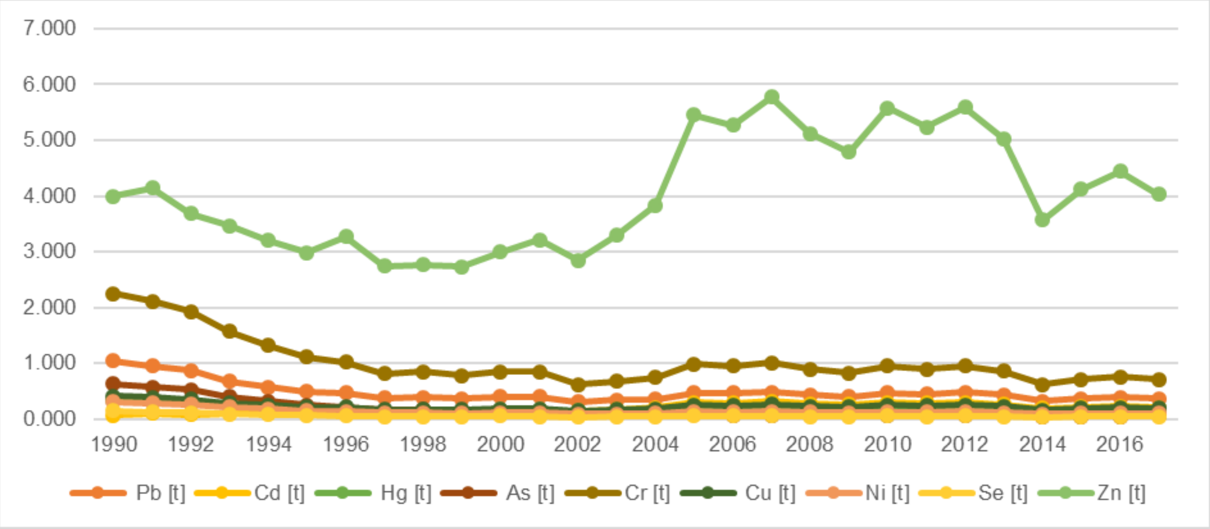
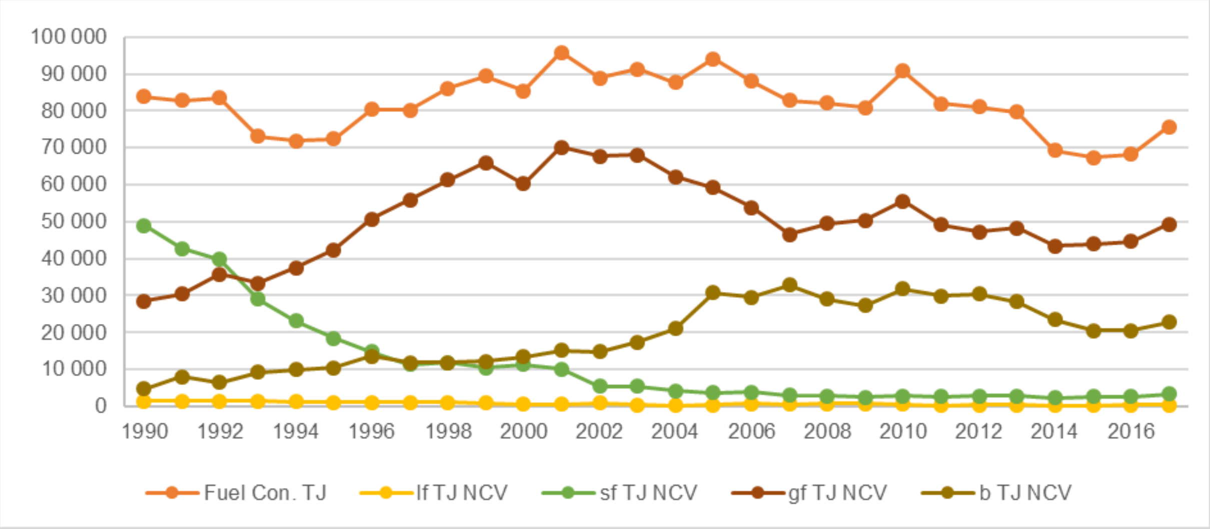


Figure 3.51: The fuel consumption of NFR 1A4bi in TJ



3.9.3.2 Methodological issues

According to the recommendations No ***SK-1A4bi-2018-0001*** and ***SK-1A4bi-2018-0002*** the improvement of methodology for households' heating was done as a part of the project QUALITY IMPROVEMENTS OF THE AIR EMISSION ACCOUNTS AND EXTENSION OF PROVIDED TIME-SERIES funded by Eurostat (detailed implementation report is available at link of SHMU webpage).

The essential sub-tasks of this project were the obtaining of new missing information from households to enable the progress in methodology of emission calculations. Therefore, the focus and majority of time of the project was devoted to the heating in the family houses with solid fuels as primary heating fuel. During the project, the statistical survey was designed for a specific purpose of obtaining information on energy use, solid fuels consumption and heating appliances in households. Statistical survey was prepared and conduced in collaboration with The Statistical Office of The Slovak. It was a standalone one-off statistical survey conducted within the pilot study.

Development and update of methodology and implementation of new gained data

The update of the methodology was performed and new total household's energy demand was determined and verified with the new input data. Several options for manner of methodology improvement for emissions from households' heating have been considered. The endeavours for harmonisation with Air Quality Modelling methodologies input data was not fully possible. This approach was only partially implemented. The international EMEP/EEA Guidebook for compilation of air pollutants requires the historical time-series data of specific type of fuel used, but improved data from the survey relates only to one year. Because of the inaccurate historical data on households fuel use registered by the Statistical Office of the SR and the absence of any other relevant source, it was concluded that the most reliable and accurate estimate of fuel consumption of wood is based on the principle of total energy demand (TED) per m^2 of occupied area in the household sector.

The attention was focused on the reassessment and update of the all input and auxiliary data, development of new time-series and most importantly the implementation of new gathered information and elements as climate factors, new standards for constructed houses, new age structure of houses, new structure of heating appliances, new emission factors, etc.

The basic principle of the methodology

The methodology for households' heating is based on the principle of total energy demand (TED) per m^2 of occupied area with the implementation of aging structure of housing units linked to the energy construction standards and the implementation of climate factor. Activity data on solid fuels sold to households from retailers are collected in the separate module of the NEIS database. (Obligation of reporting the fuel sold according to annual forms presented in table 45 in **ANNEX IV**). The consumption of natural gas for individual households and dwellings is periodically announced by the Slovak Gas Industry, LtD. (SPP, a.s.). The overall data on wood and wooden briquettes consumption are compiled from the energy demand by applying available values of fuels consumption from national statistics. The final emission compilation includes the division of appliances used in the households into the structure of 6 types and related emission factors for particular type of combustion appliance.

During the preparation of inventory, the climate factor was further enhanced after closer cooperation with external expert for GHG inventory in data harmonization. The ratio of the number of households, which *are not connected to central heating system* in the individual regions has been used in the calculation of the overall climate parameter for the entire territory of the Slovak Republic as presented in the ***Table 3.83***. The Total energy demand has modified (in average by the +- 0.02%).

Table 3.83: *The weights for calculations of climate factors*

DISTRICT_ID	DISTRICT	WEIGHT
1	BA	9.80%
2	TT	11.64%
3	TN	11.58%
4	NR	15.06%
5	ZA	13.22%
6	BB	13.67%
7	PO	13.54%
8	KE	11.51%

Emission factors

The Country specific emission factors for combustion of solid fuels (hard and brown coal, briquettes, coal and wood), natural gas and fuel oil were obtained from results of VEC VŠB[12] measurement at low and nominal heat rating. These data were provided in the 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 3-14 and 3-17) modern masonry/built-in tile stoves and pellets stoves (table 3-25) were obtained from the EMEP/EEA GB_{2016} (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.

The following ***Table 3.84*** provides the TED used for compilations of reported emission in reporting 2019. TED is very slightly different from data in final project report (in average by the +- 0.02%). The climate factor decreased in average of -6.41%.

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

Table 3.84: *Enhanced TED and TED with climate factor used for compilation od households' emissions*

YEAR	TOTAL ENERGY DEMAND (PJ)	NUMBER OF HEATING DEGREE DAYS	RATIO ON NORMALIZED HEATING DEGREE DAYS (3422)	TED +CLIMA_FACTOR (PJ)
1990	66.45	3 608	1.05	70.06
1991	67.01	4 000	1.17	78.33
1992	67.59	3 786	1.11	74.78
1993	68.20	3 770	1.10	75.13
1994	68.93	3 468	1.01	69.86
1995	69.67	3 819	1.12	77.75
1996	70.41	4 102	1.20	84.40
1997	71.13	3 953	1.16	82.17
1998	71.81	3 737	1.09	78.42
1999	72.41	3 637	1.06	76.96
2000	72.97	3 281	0.96	69.96
2001	73.08	3 675	1.07	78.48
2002	72.49	3 636	1.06	77.02
2003	72.00	3 848	1.12	80.96
2004	71.49	3 737	1.09	78.07
2005	71.00	3 889	1.14	80.70
2006	70.56	3 668	1.07	75.64
2007	70.13	3 415	1.00	69.99
2008	69.69	3 445	1.01	70.16
2009	69.24	3 436	1.00	69.53
2010	68.81	3 830	1.12	77.02
2011	67.43	3 523	1.03	69.43
2012	66.12	3 581	1.05	69.19
2013	64.92	3 551	1.04	67.37
2014	63.84	3 009	0.88	56.13
2015	62.84	3 335	0.97	61.25
2016	62.08	3 504	1.02	63.56
2017	61.61	3 675	1.07	66.18

Description of entire methodology and all EF are available in final implementation report.

3.9.4 RESIDENTIAL: MOBILE (NFR 1A4bii)

3.9.4.1 Overview

This activity is included in the category 1A4cii, therefore notation key IE was used.

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

3.9.5.1 Overview

The development of emission trends is provided in following figures. The significant peak of Zn emissions is visible in year 2014 and 2015. T1 and EF are from EMEP/EEA GB_{2016} are used in calculations of Zn. The reason of increase is the fuel basement that has recorded the increase of biomass usage in the category. Heavy metals are calculated as Tier 1 level. Emission factors used for calculation of heavy metals are default EF from EMEP/EEA GB_{2016}.

Figure3.52: *Trends in emissions of air pollutants in 1A4ci*

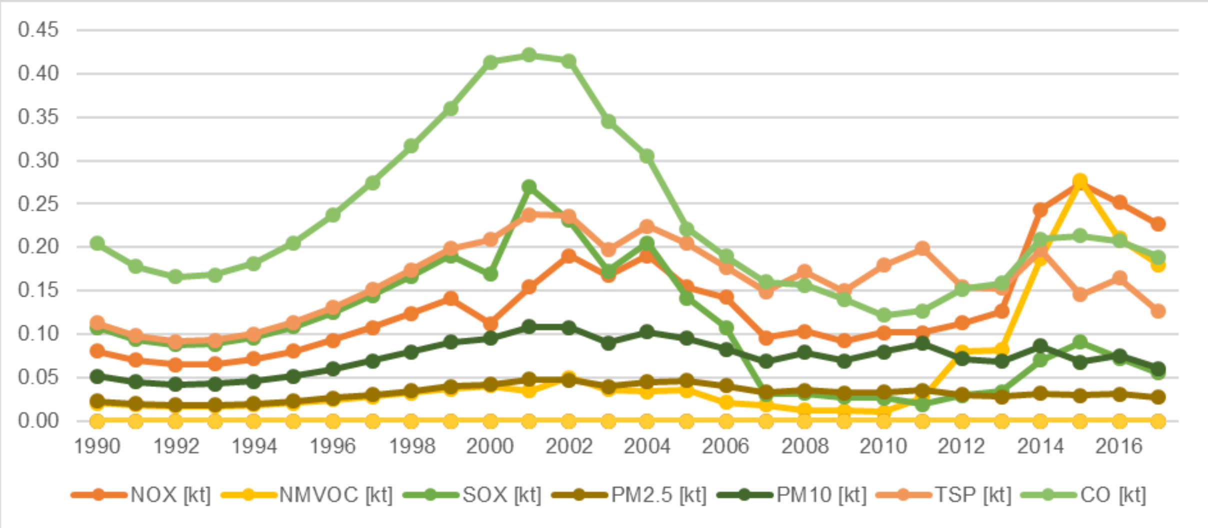


Figure 3.53: *Trends in emissions of heavy metals in 1A4ci*

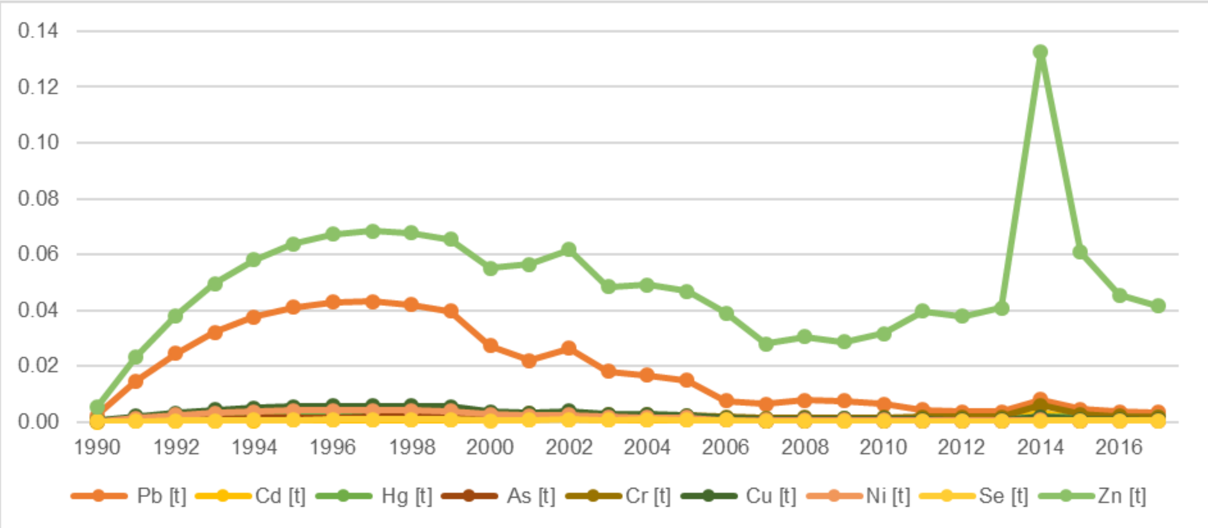
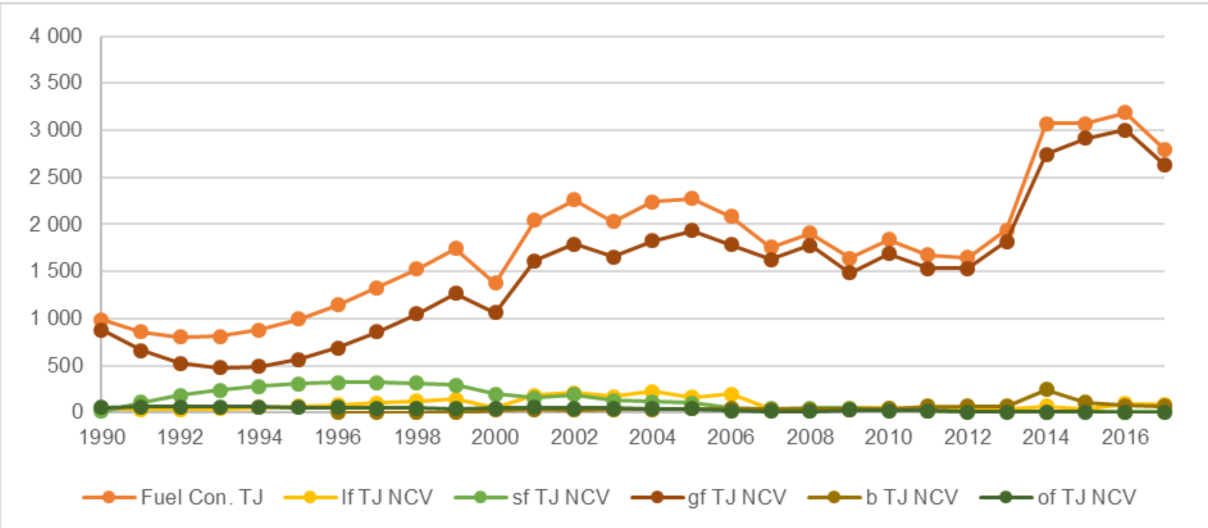


Figure 3.54: *The fuel consumption of NFR 1A4ci in TJ*



3.9.5.2 Methodological issues

***Table 3.85:** 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

***Table 3.86:** The overview of share of used calculation type for category 1A4ci in NEIS*

1A1a	Type of emission compilation/calculation	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	1%
3	Calculation using representative individual mass flow and number of operating hours	60%
4	Calculation using emission factor and amount of fuel	34%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	1%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	3%

Most of the calculation of annual emissions are performed in NEIS. The emissions were balanced in comply with general EF of the Bulletin of Ministry of Environment. These emissions factors are presented in **ANNEX IV, Chapter A4.6**. Heavy metals are calculated as tier 1 level. Emission factors used for calculation of heavy metals are default EF from EMEP/EEA GB_{2016} (***Table 3.87***). Emission factors for POPs are country specific and originate from Magulová (2003) (***Table 3.88***).

***Table 3.87:** Emission factor for heavy metals in 1A4ci*

T1	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS
Unit	mg/GJ	mg/GJ	mg/GJ	mg/GJ
Pb	2	134	0.011	27
Cd	0.6	1.8	0.0009	13
Hg	0.4	7.9	0.54	0.56
As	4.2	4	0.1	0.19
Cr	0.6	13.5	0.013	23
Cu	2	17.5	0.0026	6
Ni	0.4	13	0.013	2
Se	2.1	1.8	0.058	0.5
Zn	36	200	0.73	512

***Table 3.88:** Emission factor for POPs in 1A4ci*

	DIOX	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCBs
Unit	mg I-TEQ/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Hard coal	0.000236	0.00352	0.00732	0.00732	0.00703	0.02519	0.0741825	0.79128
Wood	0.000685	0.095	19	19	0.17	38.265	0.0431235	0.049284
Brown coal	0.000534	0.00352	0.00732	0.00732	0.00703	0.02519	0.0481005	0.051918
Fuel oil	0.000101	4.68	20.3	3.98	7.57	36.53	0.127575	0.61155
Natural gas	0.000017	-	-	-	-	-	-	-

3.9.6 AGRICULTURE/FORESTRY/FISHING: OFF-ROAD VEHICLES AND OTHER MACHINERY (NFR 1A4cii)

3.9.6.1 Overview

All non-road mobile machinery is reported in this category including 1A4aii; 1A4bii; 1A2gvii (e.g. agricultural machinery (tractors, harvesters, etc.), forestry machinery, industry machinery (forklifts, excavators, etc.) and residential machinery (hedge cutters, garden shredders, etc.) are included in the category).

The data collected by questionnaires in households in the frame of the project “Improve of the quality of air emission accounts and expansion of the time-series provided” were used for estimation of emissions from residential machinery (1A4bii).

Slovakia is still working on separation of all four categories and will be able to report them separately in the 2020 submission.

3.9.6.2 Source specific recalculations

Recalculation was made due to new statistical fuel consumption according to outcomes of analysis in **Chapter 3.8.4.1**.

Table 3.89: *Recalculation of non-road mobile machinery (1A4cii)*

EMISSIONS – NON-ROAD MOBILE MACHINERY						
YEAR	2018	2019		2018	2019	
	NOx (kt)		diff.	NMVOC (kt)		diff.
2014	2.62	3.11	18.7%	0.71	0.84	18.7%
2015	2.44	2.86	17.1%	0.66	0.77	17.1%
2016	2.25	2.84	26.1%	0.61	0.77	26.1%
EMISSIONS - ROAD TRANSPORT						
YEAR	2018	2019		2018	2019	
	SOx		diff.	NH3		diff.
2014	0.002	0.002	18.7%	0.001	0.001	18.7%
2015	0.002	0.002	17.1%	0.001	0.001	17.1%
2016	0.002	0.002	26.1%	0.001	0.001	26.1%
EMISSIONS - ROAD TRANSPORT						
YEAR	2018	2019		2018	2019	
	$PM_{2.5}$		diff.	CO		diff.
2014	0.13	0.15	18.7%	20.40	24.22	18.7%
2015	0.12	0.14	17.1%	19.00	22.26	17.1%
2016	0.11	0.14	26.1%	17.53	22.11	26.1%

3.9.7 AGRICULTURE/FORESTRY/FISHING: NATIONAL FISHING (NFR 1A4ciii)

3.9.7.1 Overview

The category is reported as NO - no activity in SR.

3.9.8 OTHER STATIONARY (INCLUDING MILITARY) (NFR 1A5a)

3.9.8.1 Overview

The overview of trends in emission and fuel provide the following figures. The rising emissions are linked with the increasing consumption of biomass in recent years especially HM, but peaks in years since 2012 and especially 2013 there is also recorded the higher consumption of gaseous fuels.

Figure 3.55: Trends in emissions of air pollutants in 1A5a

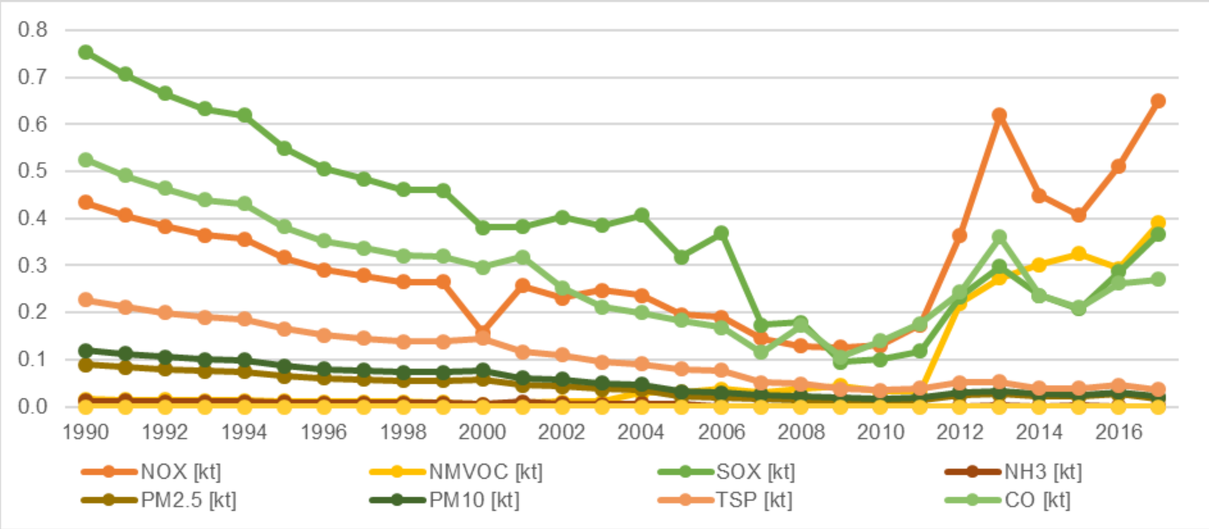


Figure 3.56: Trends in emissions of heavy metals in 1A5a

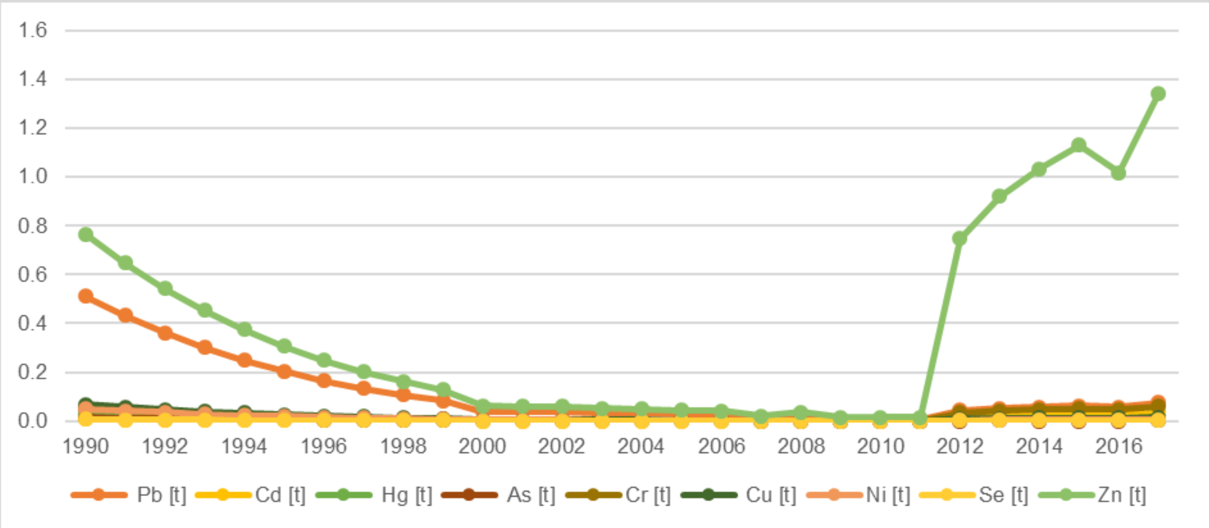
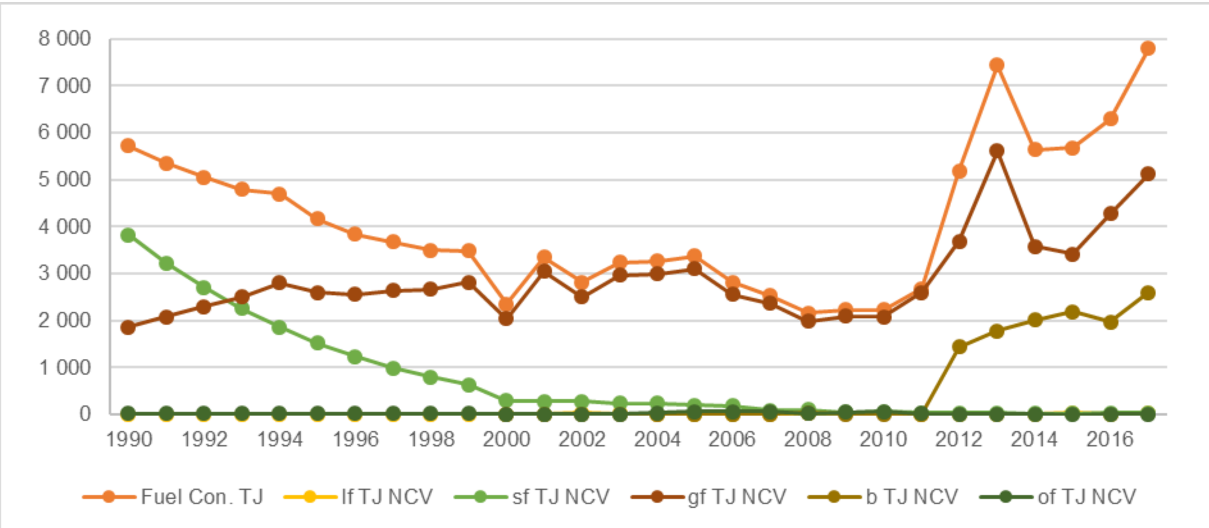


Figure 3.57: The fuel consumption of NFR 1A5a in TJ



3.9.8.2 Methodological issues

The stationary sources and emissions from their activities included in 1A5a are presented in following table. All data are from operator – facility data.

Table 3.90: *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	

Table 3.91: *The overview of share of used calculation type for category 1A5a in NEIS*

1A5a	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	77%
4	Calculation using emission factor and amount of fuel	22%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	1%
8	Calculation using emission factor related to calorific value	1%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

Due to the high share (77%) of using plant specific data, in ***Table 3.92*** it is provided only the implied emission factors related to overall volume of fuel consumed for 2016 in category and weighted IEF related to overall volume of fuel consumed for years 2000–2017.

The 22% of emission were balanced in comply with general EF of the Bulletin of Ministry of Environment. These emissions factors are presented in **ANNEX IV, Chapter A4.6**.

Table 3.92: *Implied emission factors for air pollutants of 1A5a*

IEF g/GJ	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %PM2.5	CO
2017	83.52	50.14	47.17	0.07	47.93%	59.42%	4.59	NE	34.81
W-IEF g/GJ	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
2000-2003	75.93	2.78	131.88	2.17	39.59%	52.78%	39.68	NE	91.77
2000-2016	72.24	27.24	72.28	0.68	39.59%	52.78%	18.21	NE	57.74

3.9.9 OTHER, MOBILE (INCLUDING MILITARY, LAND BASED AND RECREATIONAL BOATS) (NFR 1A5b)

3.9.9.1 Overview

This category was first time reported in year 2018. Total fuel consumption was 217.31 TJ. This consumption includes petrol, diesel oil and jet fuel. Emissions of mobile combustion in military are shown in ***Table 3.93***.

Table 3.93 *Overview of emissions from military based fuel consumption*

YEAR	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2015	0.0773	0.0004	0.0045	0.0000002	0.0004	0.0004	0.0004	0.0002	0.0337
2016	0.0779	0.0004	0.0045	0.0000002	0.0005	0.0005	0.0005	0.0002	0.0339
2017	0.0723	0.0004	0.0042	0.0000002	0.0004	0.0004	0.0004	0.0002	0.0315

3.10 FUGITIVE EMISSIONS (NFR 1B)

3.10.1 FUGITIVE EMISSION FROM SOLID FUELS: COAL MINING AND HANDLING (NFR 1B1a)

3.10.1.1 Overview

The category reports the emissions of NMVOC and particulates from the mining activity. Default emission factor (T2 - Underground mining) for NMVOC is used. For TSP and PMi tier 1 emission factor from EMEP/EEA GB_{2016} were used due to the available activity data of coal produced.

Figure 3.58: *Trends in emissions of air pollutants in 1B1a*

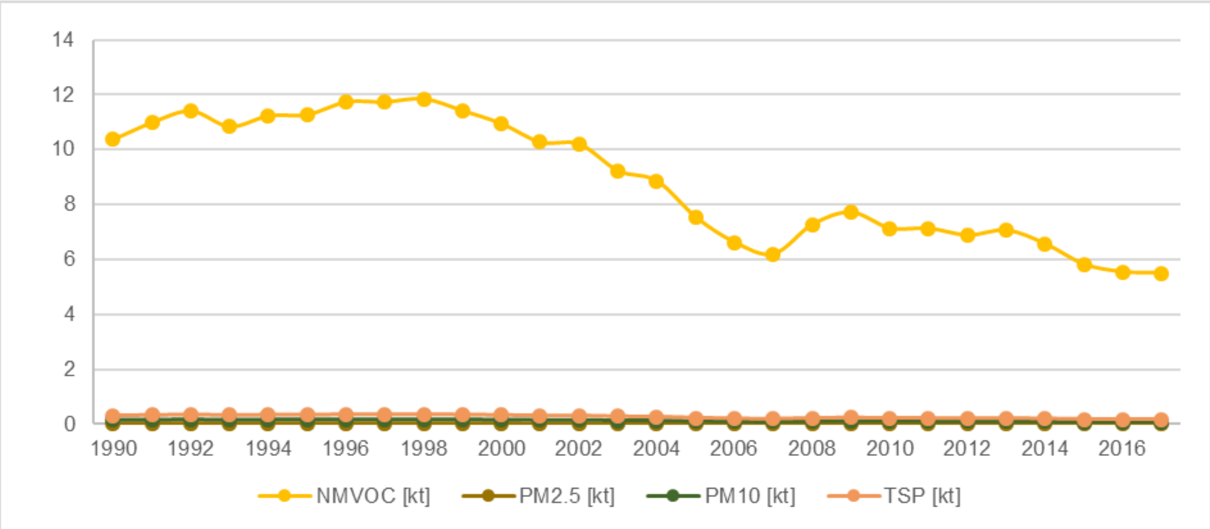
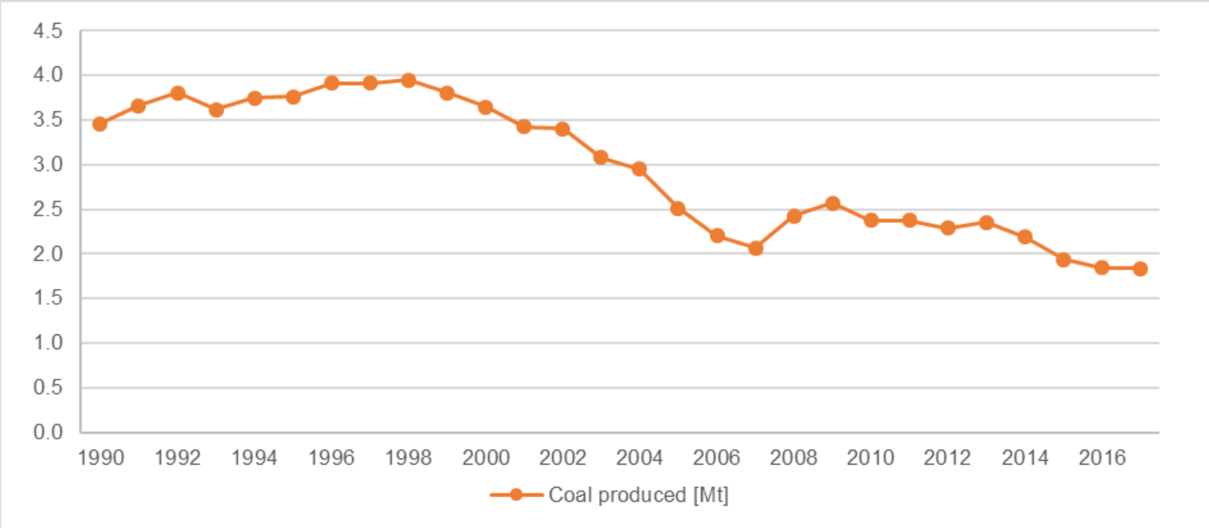


Figure 3.59: *Trends in activity data in 1B1a*



3.10.1.2 Methodological issues

During the review NECD 2017 the issue of default emission factor (error of an order of magnitude) was raised for the category. On recommendation of TERT during the NECD, the revised estimates were included in emission inventory.

Table 3.94: *Implemented recommendations in Fugitive emission in 2018 submission*

NUMBER	NFR, POLLUTANT(S), YEAR(S)	BRIEF DESCRIPTION
SK-1B-2017-0004	1B Fugitive emissions from Fuels, NMVOC, PM, 2000-2015	For category 1B1a, pollutants NMVOC and PM2.5, and for all years the TERT noted that the emissions were underestimated by a factor of 1000. In response to a question raised during the review, Slovakia provided revised estimates for all years for both pollutants. The TERT agreed with the revised estimate provided by Slovakia and attached it to the annex of the review report. The TERT recommends that Slovakia includes the revised estimate in its next submission

3.10.2 FUGITIVE EMISSION FROM SOLID FUELS: SOLID FUEL TRANSFORMATION (NFR 1B1b)

3.10.2.1 Overview

Production of coke has slightly decreasing trend that is reflect also the emissions of category as presented in following Figures.

Figure 3.60: *Trends in emissions of air pollutants in 1B1b*

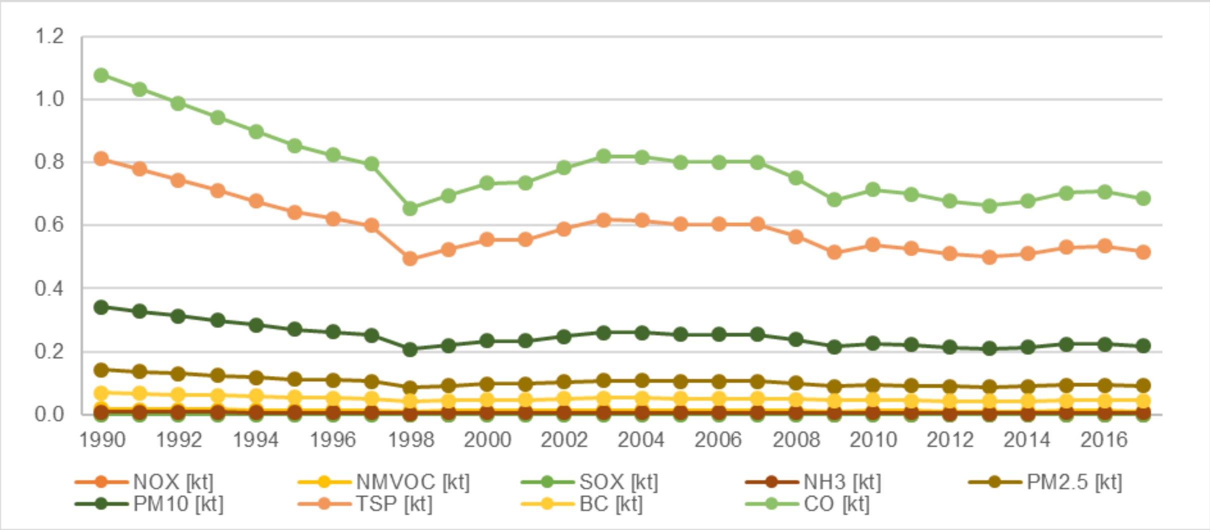


Figure 3.61: *Trends in emissions of heavy metals in 1B1b*

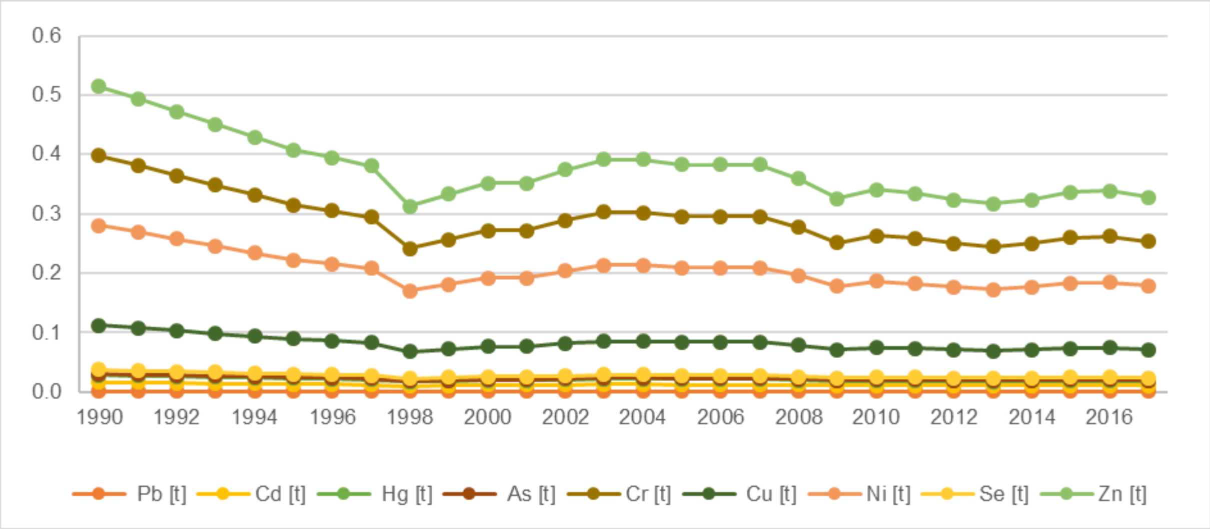


Figure 3.62: *Trends in emissions of POPs in 1B1b*

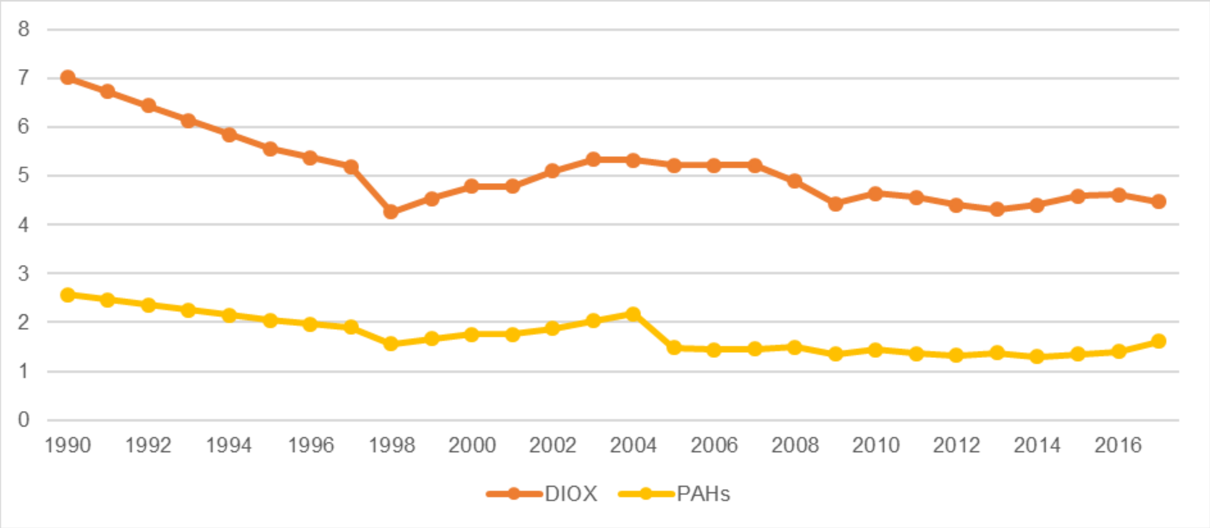
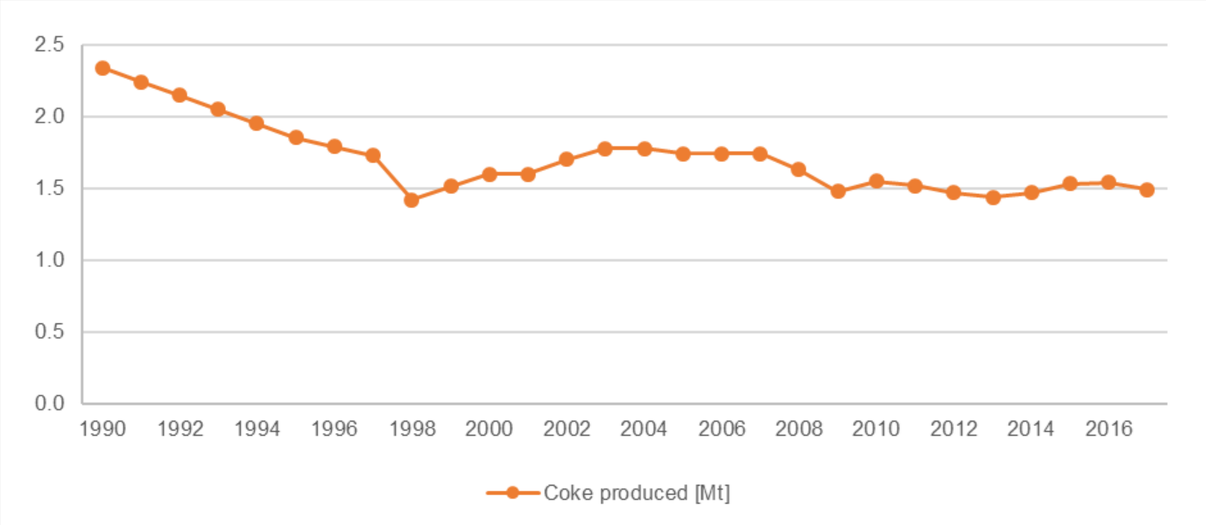


Figure 3.63: Trends in activity data of category 1B1b



3.10.2.2 Methodological issues

The category report all emissions according to the method of EMEP/EEA GB_{2016}. Default emission factors are used for the calculation of emissions (***Table 3.95***).

Table 3.95: Default EF used in fugitive emission from solid fuels transformation

AP	$EFGB_{2016}$ - T1	Unit
NOx	0.9	g/Mg coke
NMVOC	7.7	g/Mg coke
SOX	0.8	g/Mg coke
NH3	3.7	g/Mg coke
PM2.5	61	g/Mg coke
PM10	146	g/Mg coke
TSP	347	g/Mg coke
BC	0.49	$\%PM_{2.5}$
CO	460	g/Mg coke
Pb	0.38	g/Mg coke
Cd	0.007	g/Mg coke
Hg	0.012	g/Mg coke
As	0.013	g/Mg coke
Cr	0.17	g/Mg coke
Cu	0.048	g/Mg coke
Ni	0.12	g/Mg coke
Se	0.016	g/Mg coke
Zn	0.22	g/Mg coke
DIOX	3	µg I-TEQ /Mg coke
B(a)P	0.16	g/Mg coke
B(b)F	0.2	g/Mg coke
B(k)F	0.1	g/Mg coke
I()P	0.07	g/Mg coke
PAHs	0.53	g/Mg coke

3.10.3 FUGITIVE EMISSIONS FROM SOLID FUELS (NFR 1B1c)

3.10.3.1 Overview

There is no activity in Slovak Republic, notation key NO is used.

3.10.4 FUGITIVE EMISSIONS OIL: EXPLORATION, PRODUCTION, TRANSPORT (NFR 1B2ai)

3.10.4.1 Overview

The category reports only the NMVOC emissions. Notation key of NA is used for the other emissions except of SO_X where NE is used in comply with the EMEP/EEA GB_{2016}. Production of crude oil has decreasing trend. Transported oil has fluctuating character of trend in recent years. The emissions of category is presented in following ***Figures 3.64*** and ***3.65***.

Figure 3.64: *Trends in emissions of NMVOC of 1B2ai*

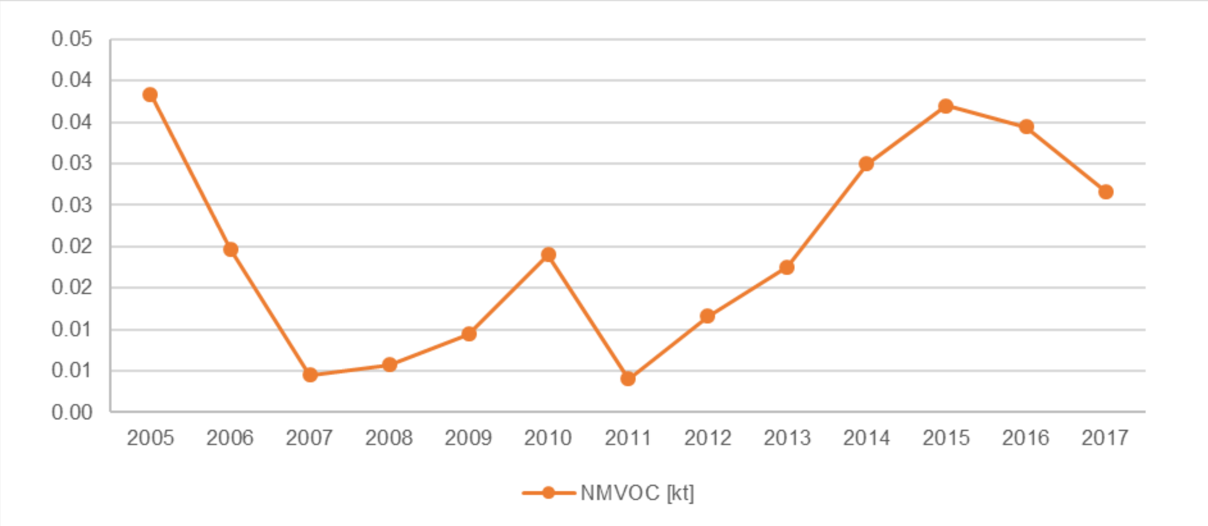
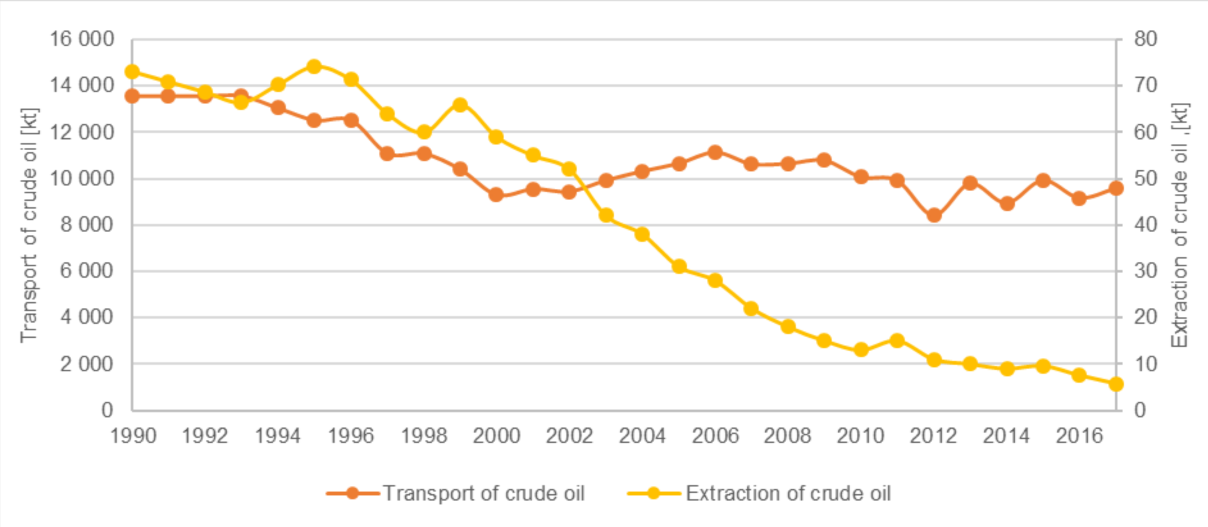


Figure 3.65: *Trends in activity data of category 1B2ai*



3.10.4.2 Methodological issues

For the calculation of NMVOC emissions are used the data from The NEIS reported by operators (definition of included activities is shown in ***Table 3.96***) and they are completed by the calculations of emissions from extracted oil. For the calculation the default EF=0.1 kg/t is used (Land-based activities).

Table 3.96: *Activities according to national categorization included in 1B2ai*

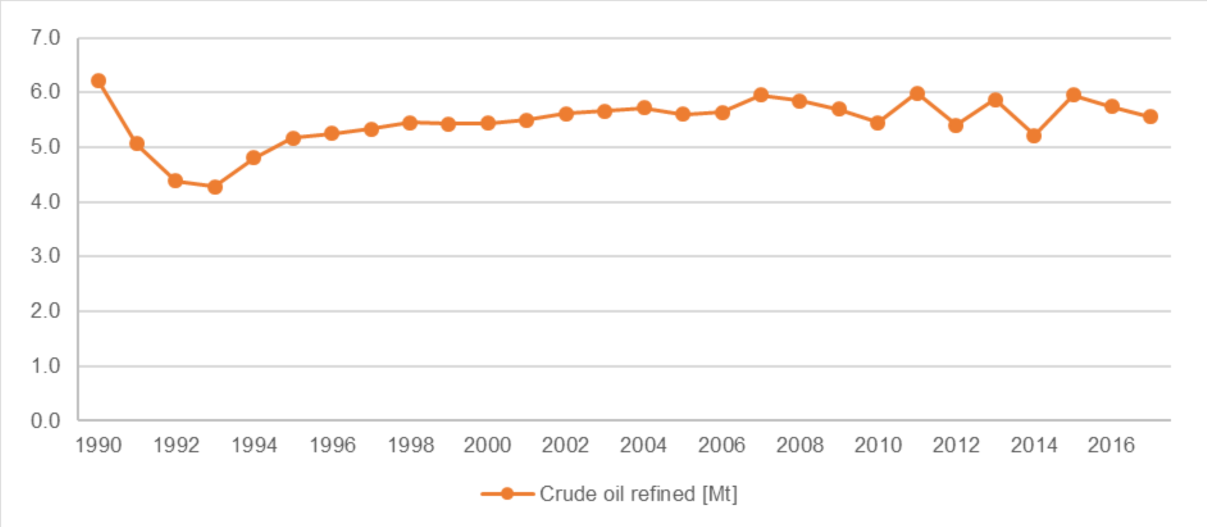
CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.2. Oil extraction and related transport and storage

3.10.5 FUGITIVE EMISSIONS OIL: REFINING / STORAGE (NFR 1B2aiv)

3.10.5.1 Overview

Overall trend of activity data is shown in the ***Figure 3.66***.

Figure 3.66: *Trends in activity data of category 1B2aiv*



3.10.5.2 Methodological issues

The data from The NEIS covering fugitives are reported in the chapter of Petroleum refining (NFR 1A1b), and notation key IE was used as the recommendation No ***SK-1B2aiv-2018-0001*** raised during last review recommends.

Calculation for heavy metals and POPs remain for reporting. The calculation use the default EF from EMEP/EEA GB_{2016}.

Table 3.97: *Emission factors in the category 1B2aiv*

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	DIOX
Unit	g/mg	g/mg	g/mg	g/mg	g/mg	g/mg	g/mg	g/mg	g/mg	µg/mg
Emission factor	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0057

3.10.6 DISTRIBUTION OF OIL PRODUCTS (NFR 1B2av)

3.10.6.1 Overview

The overview of reported emissions is presented in ***Figure 3.67***.

Figure 3.67: *Trends in emissions in 1B2av*

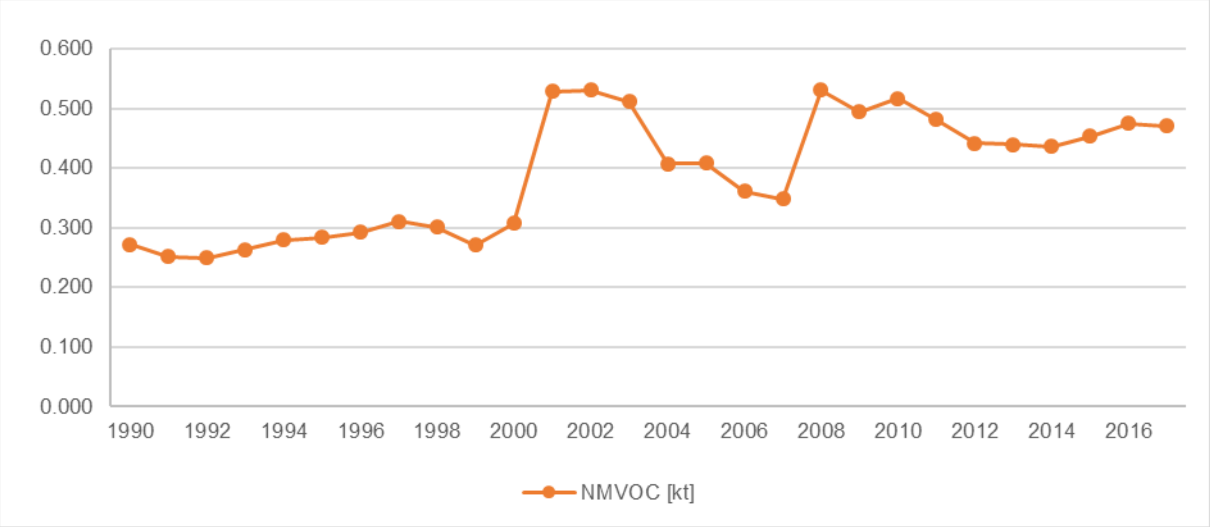
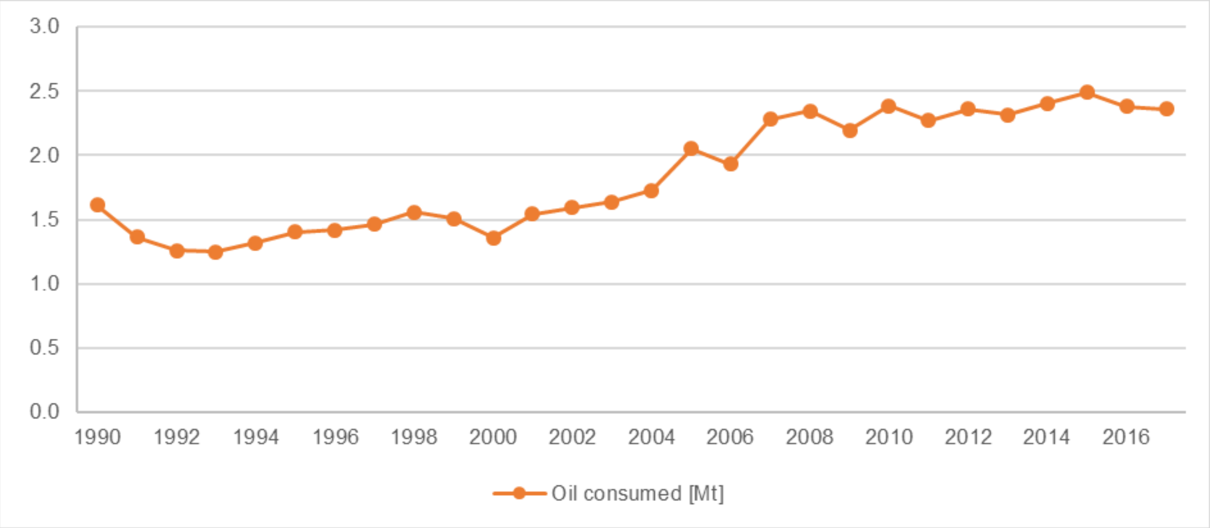


Figure 3.68: *Trends in activity data of 1B2av*



3.10.6.2 Methodological issues

The reported emissions of NMVOC are compiled in the NEIS. The definition of stationary sources and emissions from their activities included in 1B2av are presented in following ***Table 3.98***. All data are from operator – facility data. Historical data were calculated with the emission factor 199.4 g/Mg that was calculated as average of IEFs for individual years (2003-2015). Notation key of NA is used for the other emissions except of SO_X and PCDD/F where NE is used in comply with the EMEP/EEA GB_{2016}.

Table 3.98: *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

3.10.7 FUGITIVE EMISSIONS FROM NATURAL GAS (EXPLORATION, PRODUCTION, PROCESSING, TRANSMISSION, STORAGE, DISTRIBUTION AND OTHER) (NFR 1B2b)

3.10.7.1 Overview

The overview of reported emissions is presented in ***Figure 3.69***.

Figure 3.69: *Trends in emissions in 1B2b*

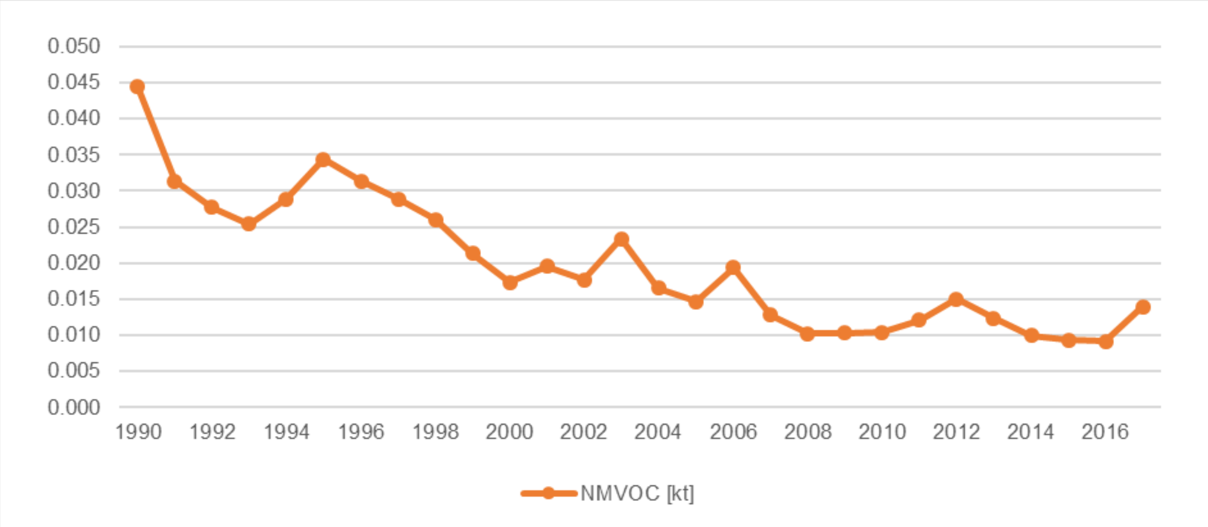
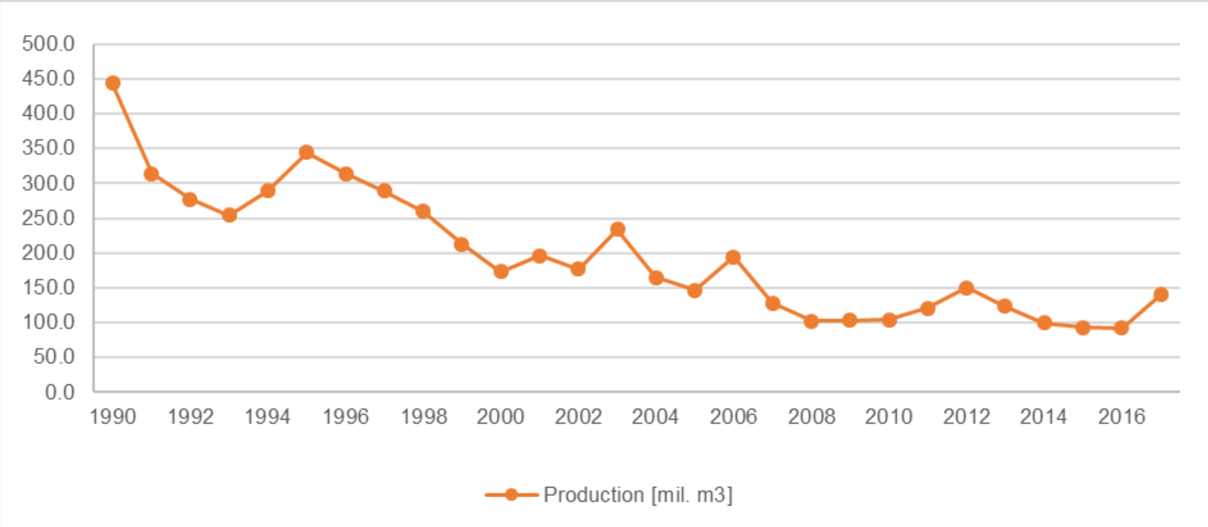


Figure 3.70: *Trends in activity data of 1B2b*



3.10.7.2 Methodological issues

The calculation of reported emissions of NVMOC are performed by default EF of EMEP/EEA **GB_{2016} EF = 0.1 g/m^3 NG**.

3.10.8 VENTING AND FLARING (OIL, GAS, COMBINED OIL AND GAS) (NFR 1B2c)

3.10.8.1 Overview

The reason for allocation of emission is that fugitive emissions from flaring in refinery, technological losses and storage are included in different categories, because they are part of already categorised sources in NEIS (1A1c; 1A1b).

3.10.9 OTHER FUGITIVE EMISSIONS FROM ENERGY PRODUCTION (NFR 1B2d)

3.9.9.1 Overview

The category is reported as NE. Geothermal energy is not developed in the Slovak Republic. Most of the sources are used for recreational purposes and they are considered as negligible.

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

This Chapter was prepared by the sectoral experts involved in the National Inventory System of the Slovak Republic:

INSTITUTE	CHAPTER	SECTORAL EXPERT
Slovak Hydrometeorological Institute	All chapters	Ivana Ďuricová
Slovak Hydrometeorological Institute	All chapters - POPs	Zuzana Jonáček

4.1 OVERVIEW OF THE SECTOR

The emissions covered by industry sector originate from industrial processes but also from combined combustion and technology processes, which are united reported for basic unit (source). The emissions and facility data reported directly from operator that are recorded in the national database NEIS 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 mineral products industry (NFR 2A: 2A1, 2A2, 2A3, 2A5a, 2A5b, 2A6), in chemical industry (NFR 2B: 2B2, 2B5, 2B10a, 2B10b), in metal production (NFR 2C: 2C1, 2C2, 2C3, 2C4, 2C5, 2C7a, 2C7c), in solvent use (NFR 2D: 2D3a, 2D3b, 2D3c, 2D3d, 2D3e, 2D3f, 2D3g, 2D3h, 2D3i), in other product manufacture (NFR 2G) and in other industrial activities (NFR 2H: 2H1, 2H2, 2H3, NFR 2I, NFR 2K). The list of used categories according NFR structure and tier level of inventory is presented in the ***Table 4.1***.

National emission inventory of air pollutants is prepared from several sources to cover all potential sources of pollution.

The data sources

a/ NEIS database of stationary large and medium sources of air pollution providing facility data for nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) sulphur oxides (SOx), ammonia (NH_3), total suspended particles (TSP, PM_{10} and $PM_{2.5}$ are consequently compiled) and carbon monoxide (CO). All data that comes from database is considered as T3 methodology. In year 2017 the system contained 863 (742 of it in operation) large sources and 12 709 (10 504 of it in operation) medium sources.

b/ 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 as T2 or T1.

The inventory is partly 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 compilation of final emissions.

Table 4.1: *Overview of reported categories, tier or notation key used in industrial sector*

NFR	LONGNAME OF CATEGORY	METHODOLOGY / TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TZL	BC	HM	POPs
		MINERAL INDUSTRY					
2A1	Cement production	T3	T3,NO	T3	T1	T1, NK	NK
2A2	Lime production	T3	NK	T3	T1	NK	T1, NK
2A3	Glass production	T3	T3	T3	T1	T2	T1, 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	NO	NO	NO	NO	NO	NO
2B2	Nitric acid production	T3, NK	T3	NK	NK	NK	NK
2B3	Adipic acid production	NO	NO	NO	NO	NO	NO
2B5	Carbide production	T3	NK	T3	NK	NK	NK
2B6	Titanium dioxide production	NO	NO	NO	NO	NO	NO
2B7	Soda ash production	NO	NO	NO	NO	NO	NO
2B10a	Chemical industry: Other	T3	T3	T3	T1	T3, NK	T2, NK
2B10b	Storage, handling and transport of chemical products	T3	T3,NO	T3	NK	NK	NK
		METAL INDUSTRY					
2C1	Iron and steel production	T3	T3	T3	T1	T1	T1, NK
2C2	Ferroalloys production	T3	T3	T3	T1	T1	T1, NK
2C3	Aluminium production	NK	NK	NK	NK	T1, NK	T1, NK
2C4	Magnesium production	T3	T3	T3	NK	T1	NK
2C5	Lead production	T3	NK	T3	NK	T2, NK	T1, NK
2C6	Zinc production	NO	NO	NO	NO	NO	NO
2C7a	Copper production	NK	NK	NK	NK	T2, NK	NK
2C7b	Nickel production	NO	NO	NO	NO	NO	NO
2C7c	Other metal production	T3	T3	T3	T1	T2, NK	NK
2C7d	Storage, handling and transport of metal products	NK	NK	NK	NK	NK	NK
		SOLVENTS					
2D3a	Domestic solvent use including fungicides	T1, NK	NK	NK	NK	T1, NK	NK
2D3b	Road paving with asphalt	T3, NK	NK	T3	NK	NK	NK
2D3c	Asphalt roofing	T3, NK	NK	T4	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	NK	NK
2D3h	Printing	T2+T3, NK	NK	NK	NK	NK	NK
2D3i	Other solvent use	T2+T3, NK	NK	NK	NK	NK	NK
		OTHER INDUSTRIAL ACTIVITIES					
2H1	Pulp and paper industry	T3	NO	T3	T1	NK	NK
2H2	Food and beverages industry	T1, NK	NK	NK	NK	NK	NK
2H3	Other industrial processes	T3	T3	T3	NK	NK	NK

NFR	LONGNAME OF CATEGORY	METHODOLOGY / TIER					
		NOx, NMVOC, SOx, CO	NH_3	$PM_{2.5}$, PM_{10}, TZL	BC	HM	POPs
2I	Wood processing	T3	T3	T3	NK	NK	NK
2J	Production of POPs	NO	NO	NO	NO	NO	NO
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	NO	NO	NO	NO	NO	NO

4.2 TRENDS IN THE SECTOR INDUSTRY

From provided figures ***Figure 4.1*** and ***Figure 4.2*** is visible a clear decreasing trend since 1990 due the strict air protection legislation. This, together with the advancements and progress of abatement systems led to reduction of air pollutants as a result of transposition of European legislation, continual improvement in the national legislation and endeavour of industry to implement BAT technologies (if the investments are available).

Figure 4.1: *The overall trend in emissions of industry sector NFR 2*

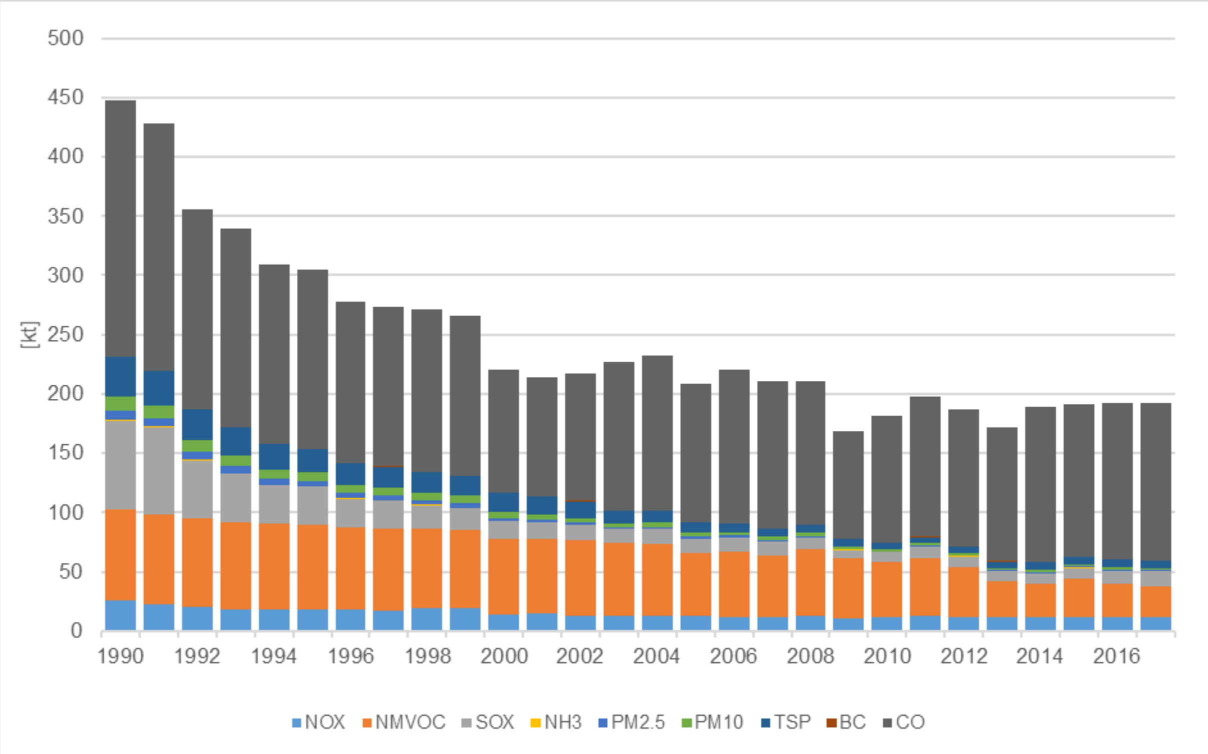


Figure 4.2: *The trends of emission in kt in individual divisions of industry NFR 2A*

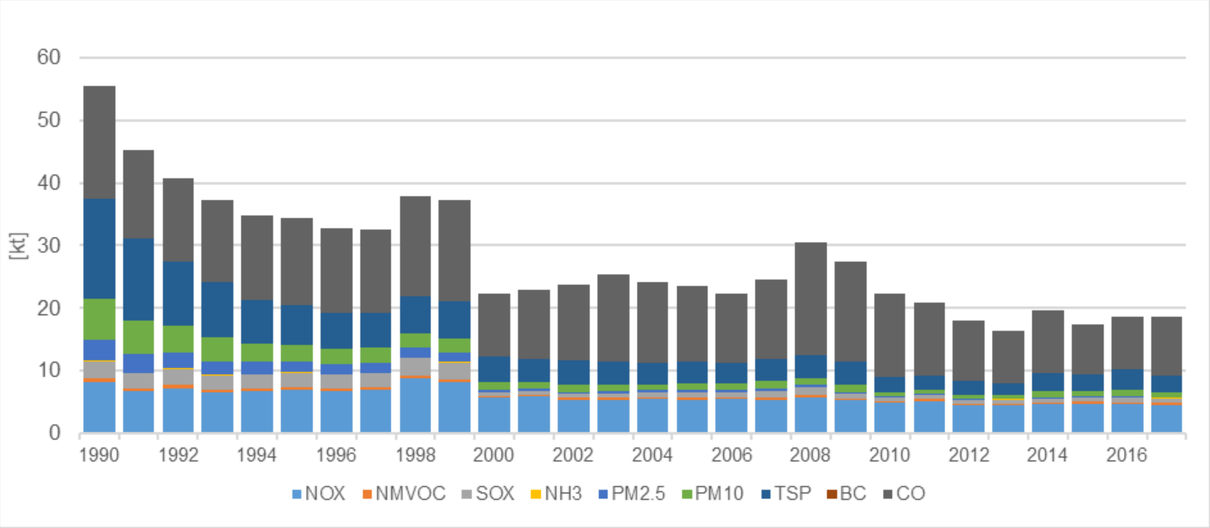


Figure 4.3: *The trends of emission in kt in individual divisions of industry NFR 2B*

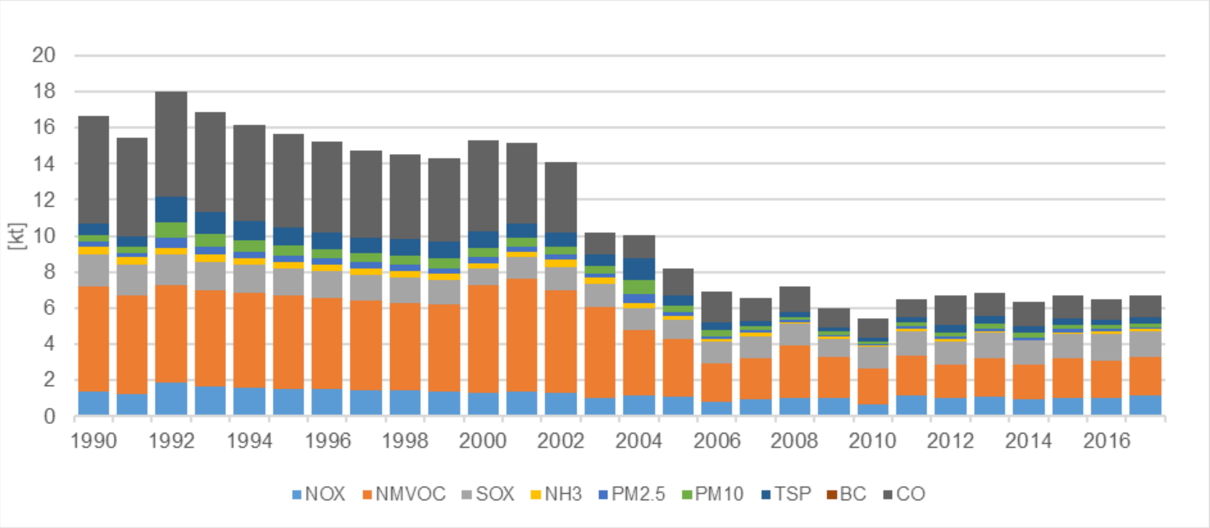


Figure 4.4: *The trends of emission in kt in individual divisions of industry NFR 2C*

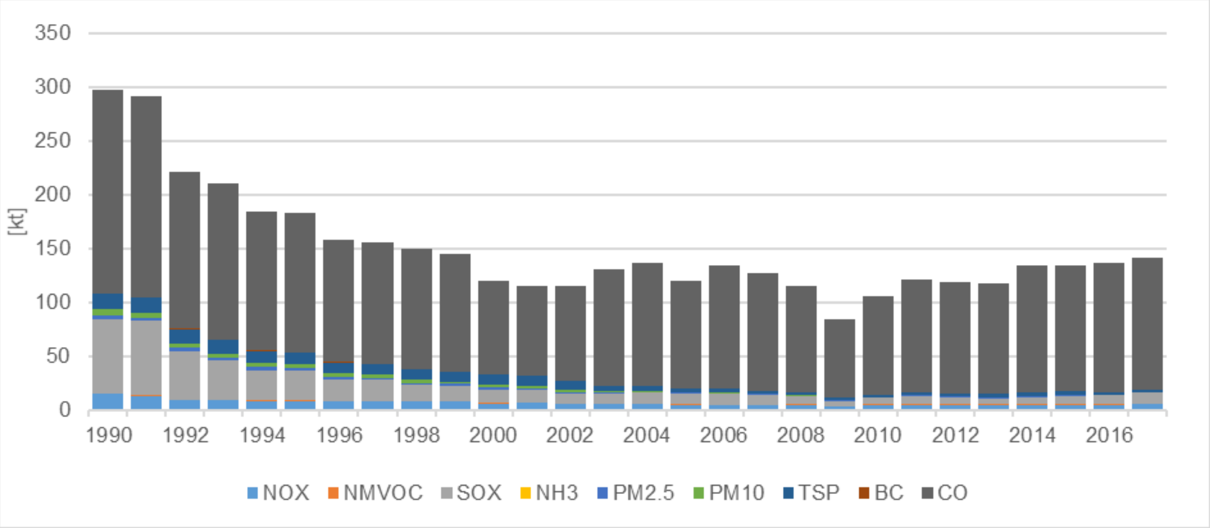
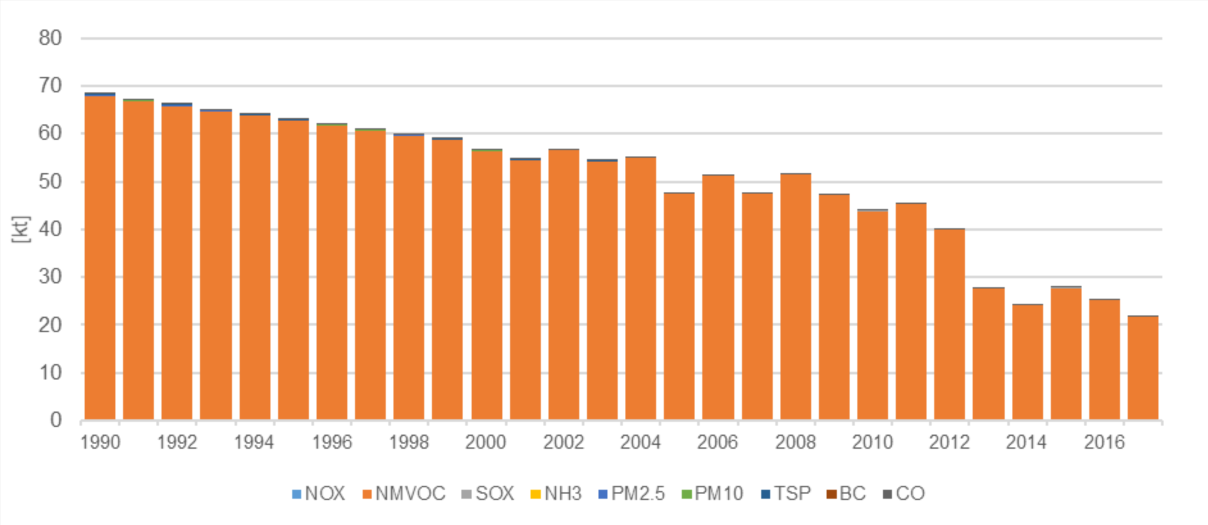


Figure 4.5: The trends of emission in kt in individual divisions of industry NFR 2D



4.3 UNCERTAINTY ANALYSIS

The chapter on uncertainty analyses were not done yet. Legislation in Slovakia requires monitoring of emissions by the operator as transposed from the IED and MCPD (and previous directives), covering the all significant installations and plants, except the minor ones. In this meaning continuous or periodic measurements shall be applied. Sampling and analysis of polluting substances and measurements of process parameters as well as any alternatives shall be based on methods enabling reliable, representative and comparable results. Methods complying with harmonised EN standards shall be presumed to satisfy this requirement.

4.4 METHODS AND DATA SOURCES

4.4.1 NEIS DATABASE

The major data source is the national database NEIS. Detail information on methodology of NEIS is provided and emission factors in **ANNEX IV** and partly in the **Chapter 3.5.**

4.5 MINERAL INDUSTRY (NFR 2A)

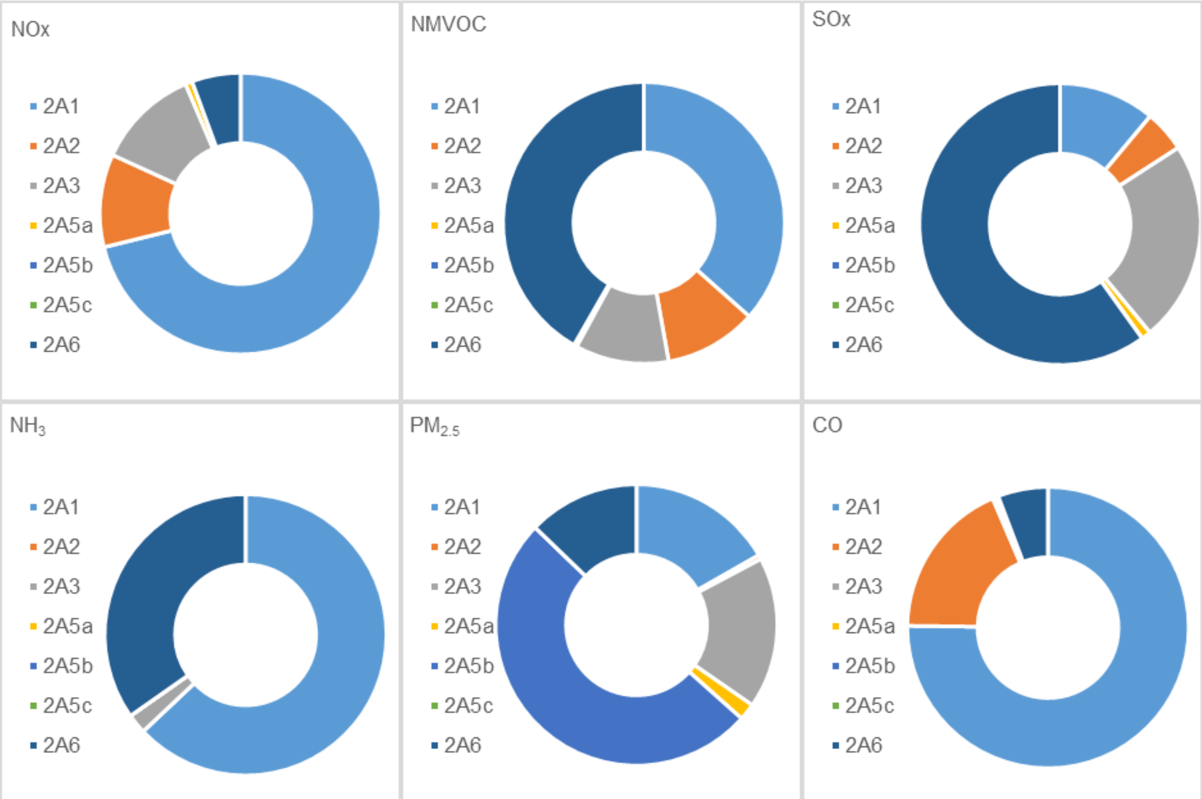
4.5.1 OVERVIEW

The category covers these NFR activities: Cement production (NFR 2A1), Lime production (NFR 2A2), Glass production (NFR 2A3), Quarrying and mining of minerals other than coal (NFR 2A5a), Construction and demolition (NFR 2A5b), Other mineral products (2A6). The category 2A5c is reported as IE.

Most of the producers, which are important concerning a release of emissions in sector, belong to international concerns and operates in several states. Slovakia produce a moderate range of mineral products and does not belong to significant world producer of mineral commodities. Mining and quarrying sector is not a significant contributor to the country's economy.

Shares of NO_X, NMVOC, SO_X, NH_3, $PM_{2.5}$, CO emission in 2017 NFR categories included in mineral industry are shown in ***Figure 4.6***.

__Figure 4.6:__ Shares of emission in 2A in 2017



4.5.1 CEMENT PRODUCTION (NFR 2A1)

4.5.1.1 Overview

The cement manufacturing is 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 temperature (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. Burning process takes place typically in rotary kiln.

The manufacture of cement is strongly regulated process by legislative limits for pollution. Primary fuel used is usually finely ground coal dust, products based on coal dust (coal, stern pellets) petroleum coke, pyrolysis. All four cement producers (large point sources) in the Slovak Republic have 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 in the purpose of energy and resource recovery. The plant provides the yearly report on types and amounts alternative fuel used.

Emission trends are showed in the ***Figure 4.7*** – ***Figure 4.8***.

Figure 4.7: *Trends in emissions of air pollutants in 2A1*

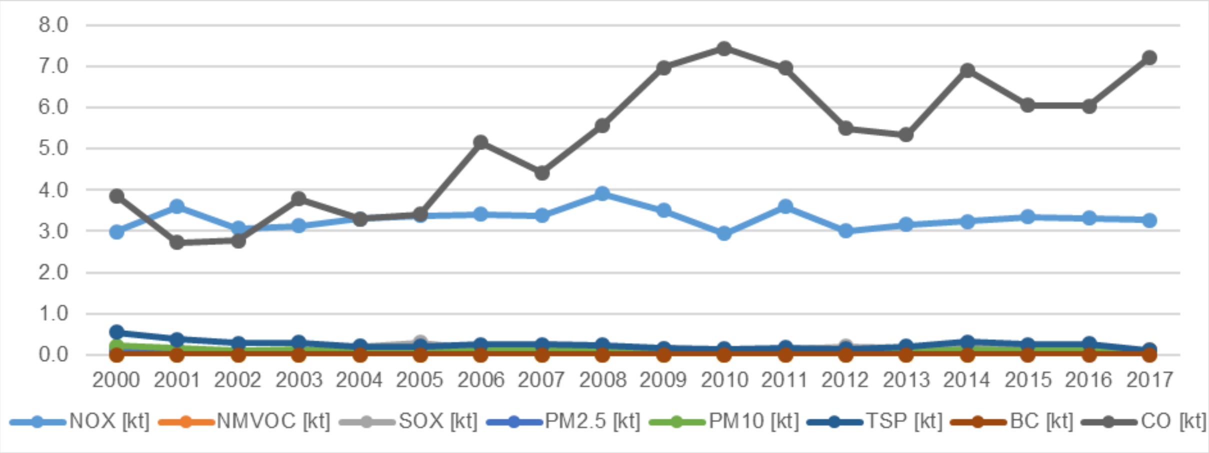


Figure 4.8: *Trends in emissions of heavy metals in 2A1*

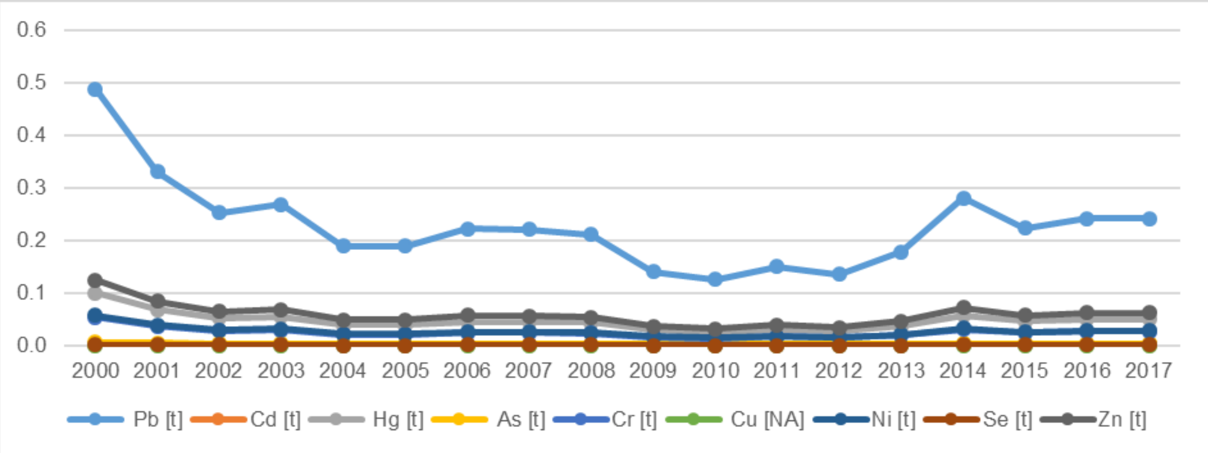


Figure 4.9: *The fuel consumption of NFR 2A1 in TJ*

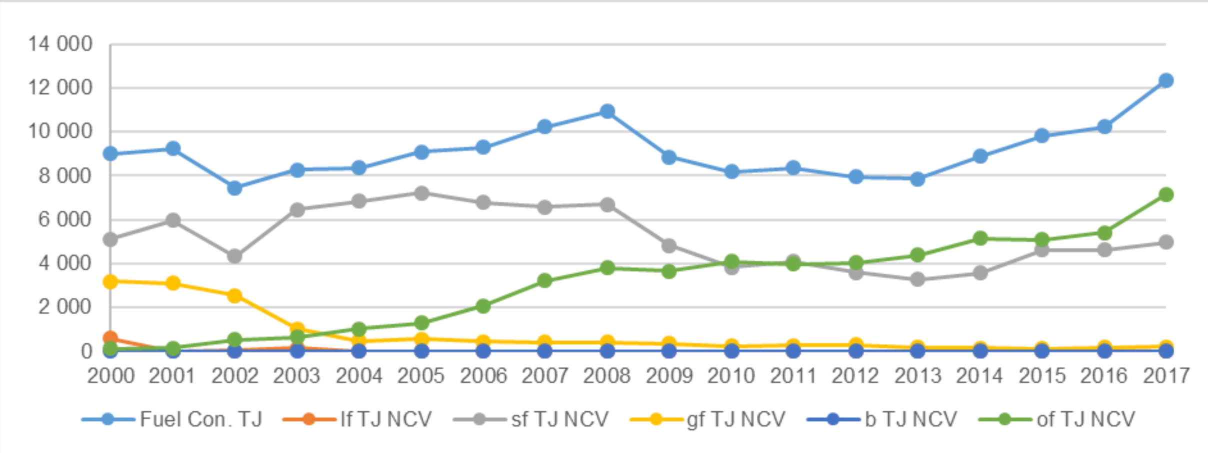


Table 4.2: *Activity data of 2A1 in selected years*

ACTIVITY DATA	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	CLINKER PRODUCED
YEAR	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**[kt]**
1990	NE	NE	NE	NO	NE	2 836
1995	NE	NE	NE	NO	NE	2 236
2000	578	5 107	3 191	NO	115	2 314
2005	2	7 233	562	NO	1 298	2 353
2010	9	3 843	240	NO	4 094	1 654

ACTIVITY DATA	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	CLINKER PRODUCED
YEAR	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
2011	4	4 105	262	NO	3 983	2 434
2012	6	3 598	306	NO	4 041	2 126
2013	4	3 289	169	NO	4 400	2 161
2014	4	3 559	164	NO	5 161	2 415
2015	2	4 612	131	NO	5 087	2 506
2016	23	4 609	194	NO	5 406	2 599
2017	2	4 969	221	NO	7 178	2 699

4.5.1.2 Methodological issues

Table 4.3: *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 database. Otherwise general EFs of the Bulletin of Ministry of Environment and detailed methodology are presented in **ANNEX IV.** The following ***Table 4.4*** presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS. As it is seen from table, the majority (79%) of emissions are determined or monitored by continuous measurement and (20%) by discontinuous measurement of representative mass flow and monitored operational hours.

Table 4.4: *The overview of share of used calculation type for category 2A1 in NEIS*

2A1	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	79%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	20%
4	Calculation using emission factor and amount of fuel	0%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	2%

In the process is used various types of fuels including the alternative waste. Derived implied emission factors are provided for the last reporting year 2017, but also weighted IEF for period 2000-2016 and EF used for reconstruction of historical years 1990–1999.

Table 4.5: *Implied emission factors for air pollutants for in 2A1.*

IEF [g/t CLINKER PRODUCED]	NOx	NMVOC	SOx	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	BC $_{\%PM2.5}$	CO
2017	1213.66	40.74	29.27	15.70	18.00%	42.00%	42.67	3.00%	2677.11
W-IEF [g/t CLINKER PRODUCED]	NOx	NMVOC	SOx	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	BC $_{\%PM2.5}$	CO
2000-2016	1 406.81	30.89	64.51	1.60	17.65%	41.38%	109.14	3.00%	2 153.82
EF [g/t CLINKER PRODUCED]	NOx	NMVOC	SOx	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	BC $_{\%PM2.5}$	CO
1990-1999	1 406.81	30.89	374.00	NO	17.65%	41.38%	260.00	3.00%	2 153.82

HM

Heavy metal are reported by T1 method.

*EM = EF*AD*

As activity data the emissions of TSP are used and emission factor provided in ***Table 4.6*** was determined from the measurements. However, the methodology is older and the revision of emission factor is planned.

Table 4.6: *Emission factors of heavy metals in 2A1*

2A1	Pb	As	Cd	Cr	Hg	Ni	Se	Zn	Cu
Ef [g/t_{TZL}]	880.00	10.90	2.60	96.40	180.69	102.00	1.40	224.60	-

POPs

POPs are not estimated for this category.

4.5.2 LIME PRODUCTION (NFR 2A2)

4.5.2.1 Overview

The production of lime during the year 2017 in Slovakia was operated by 5 companies in 7 stationary sources. All sources are covered by the NEIS.

Production of lime, which is chemically calcium oxide (CaO), is performed by a 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 (***Figure 4.10, Figure 4.11***) and activity data (***Figure 4.12*** and ***Table 4.7***) are presented in following figures.

Figure 4.10: *Trends in emissions of air pollutants in 2A2*

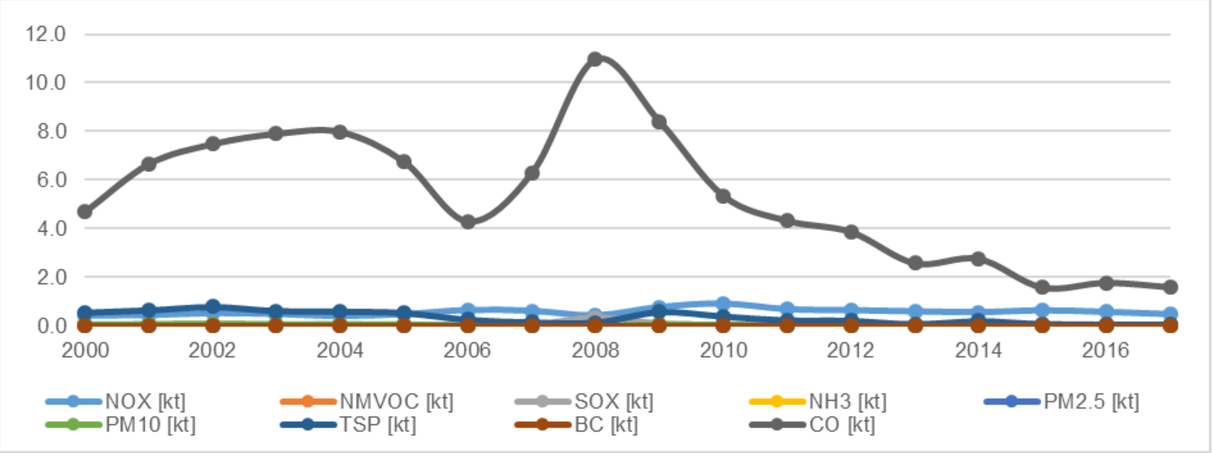


Figure 4.11: *Trends in emissions of POPs in 2A2*

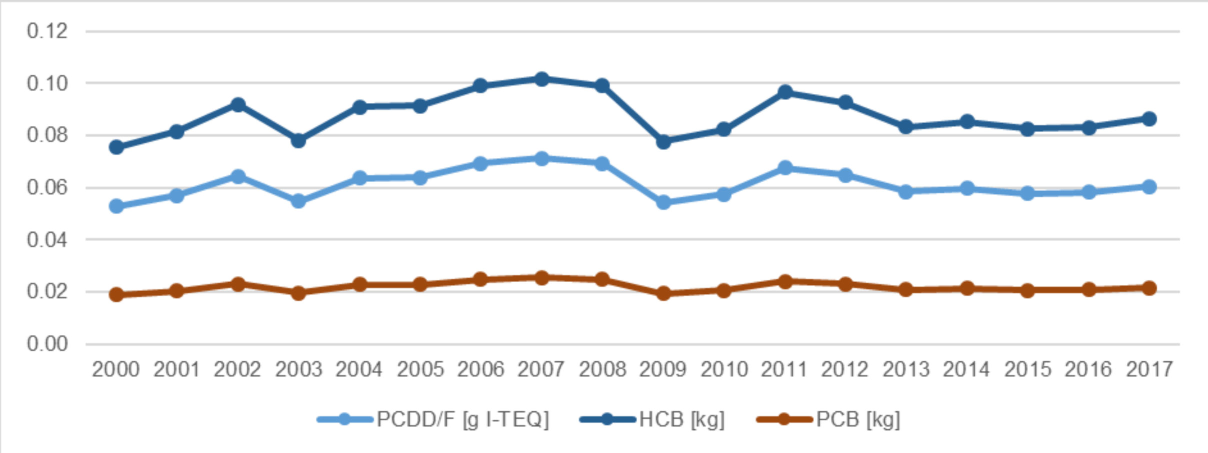


Figure 4.12: *The fuel consumption of NFR 2A2 in TJ*

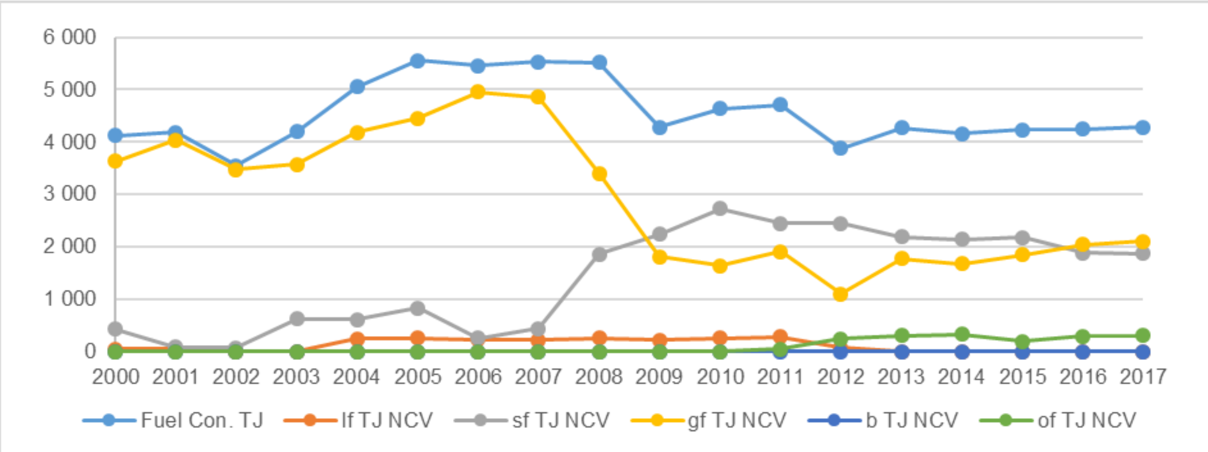


Table 4.7: *Activity data of 2A2 in selected years*

ACTIVITY DATA	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	LIME PRODUCED
YEAR	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	[kt]
1990	NE	NE	NE	NO	NO	1 076
1995	NE	NE	NE	NO	NO	803
2000	53	436	3 639	NO	NO	754
2005	256	841	4 452	NO	NO	913
2010	266	2 735	1 638	NO	NO	822
2011	292	2 452	1 914	NO	53	967
2012	81	2 451	1 102	NO	249	927
2013	NO	2 190	1 774	NO	310	834
2014	NO	2 143	1 682	NO	336	852
2015	NO	2 186	1 849	NO	202	825
2016	NO	1 890	2 052	NO	299	831
2017	NO	1 881	2 103	NO	305	864

4.5.2.2 Methodological issues

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 could be used for sources recorded in database. Otherwise general EFs of the Bulletin of Ministry of Environment and detailed methodology are presented in **ANNEX IV.** The following ***Table 4.9*** presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Table 4.9: *The overview of share of used calculation type for category 2A2 in NEIS*

2A2	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	22%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	76%
4	Calculation using emission factor and amount of fuel	2%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

In the process is used several types of fuels (gaseous, solid, waste). Derived implied emission factors are provided for the last reporting year 2017, but also weighted IEF for period 2000-2016 and EF used for reconstruction of historical years 1990–1999.

Table 4.10: *Implied emission factors for air pollutants in 2A2*

IEF [g/t LIME PRODUCED]	NOx	NMVOC	SOx	NH_3	$PM_{2.5\ \%TSP}$	$PM_{10\ \%TSP}$	TSP	$BC_{\ \%PM2.5}$	CO
2017	568.35	36.96	39.50	NA	1.00%	12.00%	70.78	0.46%	1847.47
W-IEF [g/t LIME PRODUCED]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5\ \%TSP}$**	**$PM_{10\ \%TSP}$**	**TSP**	**$BC_{\ \%PM2.5}$**	**CO**
2000-2016	667.22	40.13	64.16	NA	1.00%	12.00%	415.11	0.46%	6 280.21
EF [g/t LIME PRODUCED]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5\ \%TSP}$**	**$PM_{10\ \%TSP}$**	**TSP**	**$BC_{\ \%PM2.5}$**	**CO**
1990-1999	1 369	40.13	316	NA	1.00%	12.00%	799.56	0.46%	8 312.22

TSP, PMs

Reported values are taken from the NEIS (Tier 3) from technological units or from part of technological units that do not use fuel, thus are consider as the processing emissions.

HM

Heavy metals in 2A2 are reported with notation key NA according to EMEP/EEA GB_{2016}.

POPs

Country specific emission factors on Tier 1 level were used. Emission factors originate from the study of Magulová (2003).

EM = EF*AD

Table 4.11: *Emission factors of POPs in 2A2*

POLLUTANT	DIOX	HCB	PCBs
Unit	[mg/t]	[mg/t]	[mg/t]
Value	0.00007	0.1	0.025

4.5.3 GLASS PRODUCTION (NFR 2A3)

4.5.3.1 Overview

The emission from glass production are coved in registry of NEIS (5 companies: Johns Mansville Slovakia, Rona, Vetropack, R-Glass, Poltár Crystal & Steel). 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.

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 glass production process. The main emissions originated during the manufacturing are sulphur oxides (SOx), nitrogen oxides (NOx) and carbon dioxide (CO_2). However, other pollutants are also occurring: emissions of particulate matter (PMi) from handling raw materials, emissions of heavy metals are produced by the melting process or are presented in PM; carbon monoxide (CO), or nitrous oxide (N_2O). DIOX emissions were balanced for the first time in this submission. Reported emissions, their trends (***Figure 4.13, Figure 4.14,*** and ***Figure 4.15***) and activity data (***Figure 4.16*** and ***Table 4.12***) from glass production are presented below.

Figure 4.13: *Trends in emissions of air pollutants in 2A3*

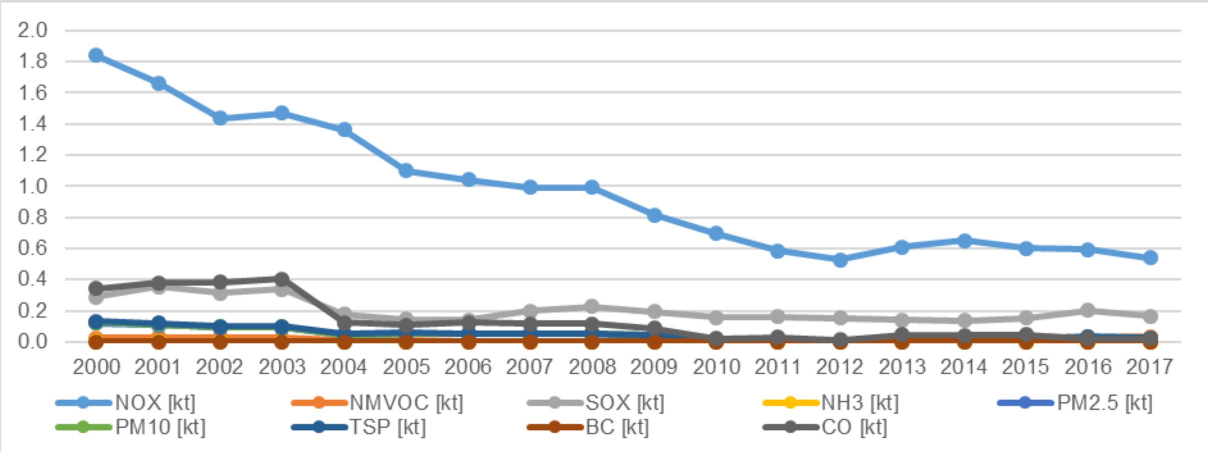


Figure 4.14: *Trends in emissions of heavy metals in 2A3*

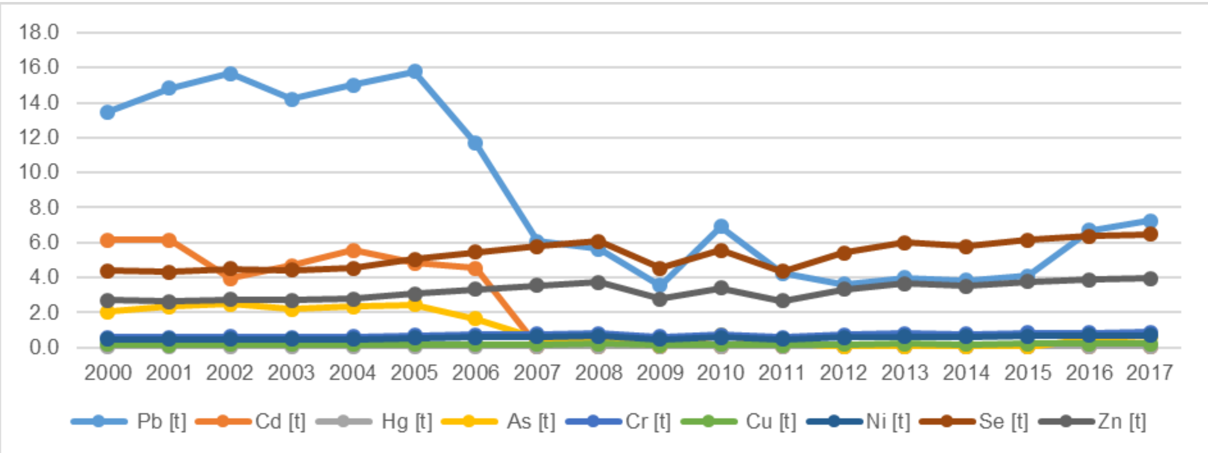


***Figure 4.15**: Trend in emissions of DIOX in g I-TEQ*

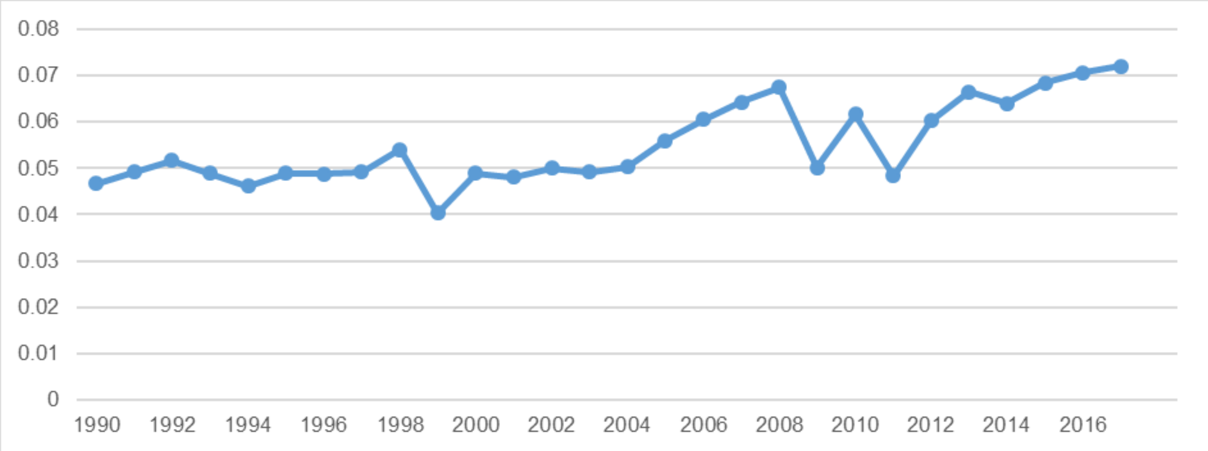


***Figure 4.16:** The fuel consumption of NFR 2A3 in TJ*

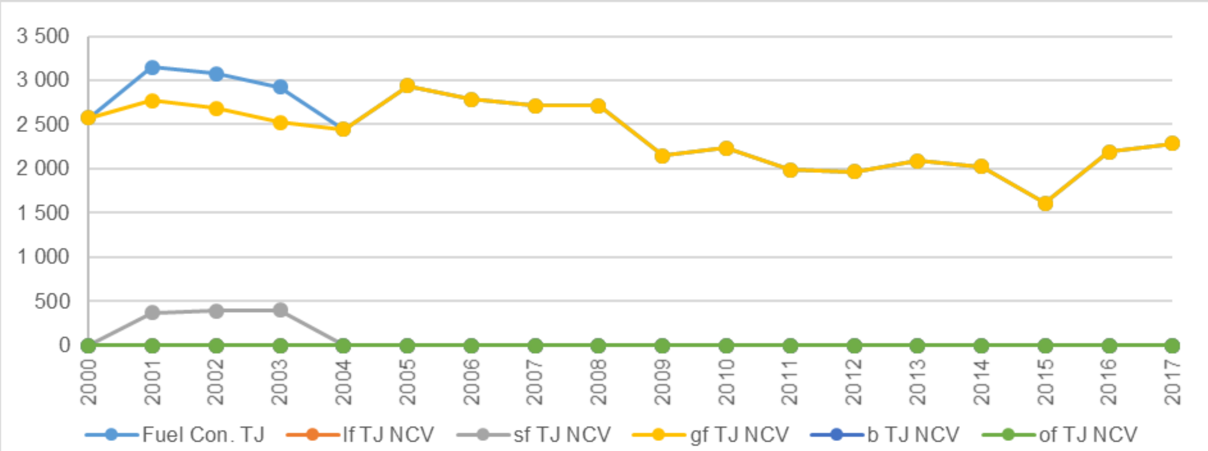


***Table 4.12:** Activity data of 2A3 in selected years*

ACTIVITY DATA	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	GLASS PRODUCED
YEAR	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**[kt]**
1990	NA	NE	NE	NA	NA	233
1995	NA	NE	NE	NA	NA	244
2000	NA	0	2 576	NA	NA	245
2005	NA	NO	2 940	NA	NA	280
2010	NA	NO	2 236	NA	NA	308
2011	NA	NO	1 985	NA	NA	242
2012	NA	NO	1 966	NA	NA	301
2013	NA	NO	2 087	NA	NA	332
2014	NA	NO	2 026	NA	NA	320
2015	NA	NO	1 611	NA	NA	342
2016	NA	NO	2 193	NA	NA	353
2017	NA	NO	2 285	NA	NA	360

4.5.3.2 Methodological issues

***Table 4.13:** 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 wit projected melting capacity in t/d

Emission data is compiled in the NEIS therefore the individual specific EF could be used for sources recorded in database. Otherwise general EFs of the Bulletin of Ministry of Environment and detailed methodology are presented in **ANNEX IV*.*** The following ***Table 4.14*** presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Table 4.14: *The overview of share of used calculation type for category 2A3 in NEIS*

2A3	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0.45%
3	Calculation using representative individual mass flow and number of operating hours	97%
4	Calculation using emission factor and amount of fuel	3%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

Table 4.15: *Implied emission factors for air pollutants in 2A3*

IEF [g/t GLASS PRODUCED]	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %PM2.5	CO
2017	1502.03	89.73	457.15	4.22	91.00%	95.00%	65.87	0.062	61.55
W-IEF [g/t GLASS PRODUCED]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
2000-2016	3 450.49	48.46	706.15	5.76	91.00%	95.00%	177.75	0.062	488.74
EF [g/t GLASS PRODUCED]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %PM2.5**	**CO**
1990-1999	8 000	110.00	1 960	15.00	91.00%	95.00%	600	0.062%	1 500

HM

Heavy metal are reported by T2 method.

The emissions of heavy metals are processed by the national emission factors presented in ***Table 4.16***. The methodology distinguish several types of products.

$EM = \sum AD_{pi} * EF_i$

AD_{pi} = amount of product (i)

EF_i = emission factor (i) related to specific product (i)

Table 4.16*: Emission factors of heavy metals in 2A3*

EF [g/t [PRODUCT] / TYPE OF PRODUCT	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Flat glass	12	0.15	0.05	0.12	2.4	0.6	1.9	18	11
Lead glass (till 2006)	810.26	0.15	0.05	140	2.4	2.4	1.9	18	11
Lead crystal glass	480	0.15	0.05	96	2.4	0.6	1.9	18	11
Green glass (till 2006)	12	100	0.05	0.12	2.4	0.6	1.9	18	11
Green glass (after 2006)	12	0.2	0.05	0.12	2.4	0.6	1.9	18	11

POPs

In the country specific methodology (Magulová, 2003), DIOX emission factor for production of glass was identified and applied to the inventory. Tier one methodology was used.

Table 4.17: Emission factor of DIOX in 2A3

UNIT	[µg I-TEQ/t GLASS]
Value	0.2

4.5.4 QUARRYING AND MINING OF MINERALS OTHER THAN COAL (NFR 2A5a)

4.5.4.1 Overview

At the territory of the Slovak Republic was occurring the surface and underground quarrying and mining locations for various materials during the year 2017 (lignite, oil and natural gas are not included in 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 form the extractions of these minerals are mainly particulate matters. The other air pollutants relate to technological units and equipment necessary for quarrying, handling and processing of material. Reported emissions from this category, their trends (***Figure 4.17***) and activity data (***Figure 4.18*** and ***Table 4.18***) are presented on following figures.

Figure 4.17: Trends in emissions of air pollutants in 2A5a

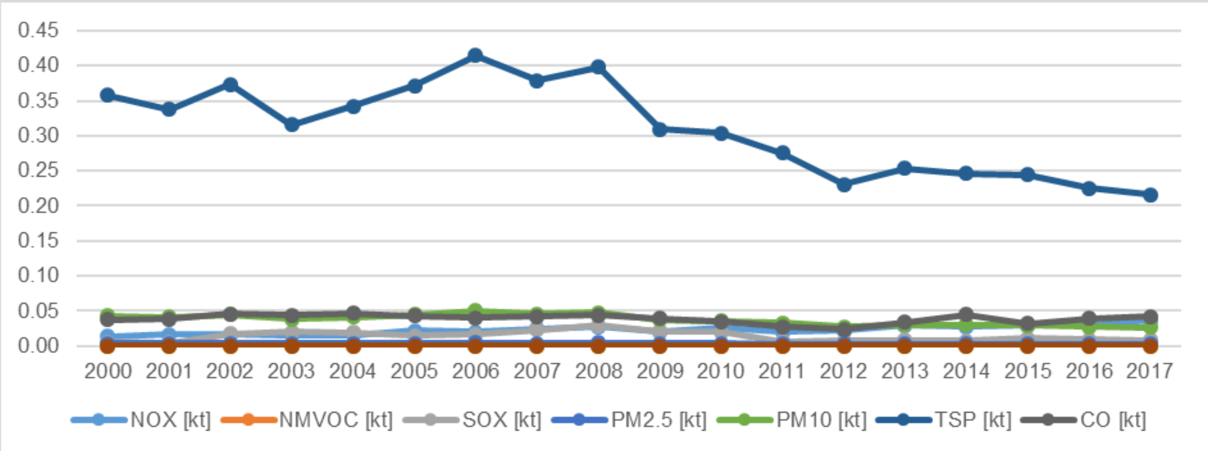


Figure 4.18: The fuel consumption of NFR 2A5a in TJ

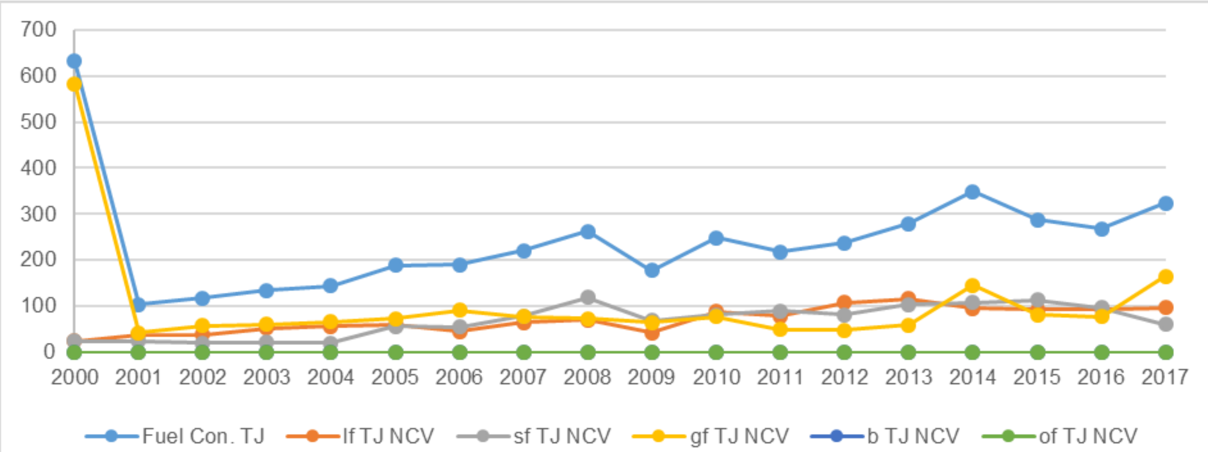


Table 4.18: Activity data of 2A5a in selected years

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	MATERIAL QUARRIED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[Mt]
1990	24	25	253	NO	NA	NA
1995	24	25	211	NO	NA	NA

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	MATERIAL QUARRIED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[Mt]
2000	24	25	583	NO	NA	NA
2005	60	56	73	NO	NA	NA
2010	89	82	78	NO	NA	NA
2011	79	90	49	0.01	NA	NA
2012	108	82	48	0.03	NA	NA
2013	116	104	59	0.03	NA	NA
2014	96	109	145	0.02	NA	NA
2015	92	113	82	0.02	NA	NA
2016	94	97	77	0.02	NA	NA
2017	97	61	165	0.05	NA	NA

4.5.4.2 Methodological issues

***Table 4.19**: 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 construct materials. Or mining and processing of other materials used in industry except of sand and gravel in the wet state.

***Table 4.20:** The overview of share of used calculation type for category 2A5a in NEIS*

2A5a	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	34%
4	Calculation using emission factor and amount of fuel	1%
5	Calculation using emission factor and amount of related quantity other than fuel	64%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.04%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	1%

For Quarries and related stone processing for emission calculation it can be use the official bulletin of Ministry of Environment.

***Table 4.21:** 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

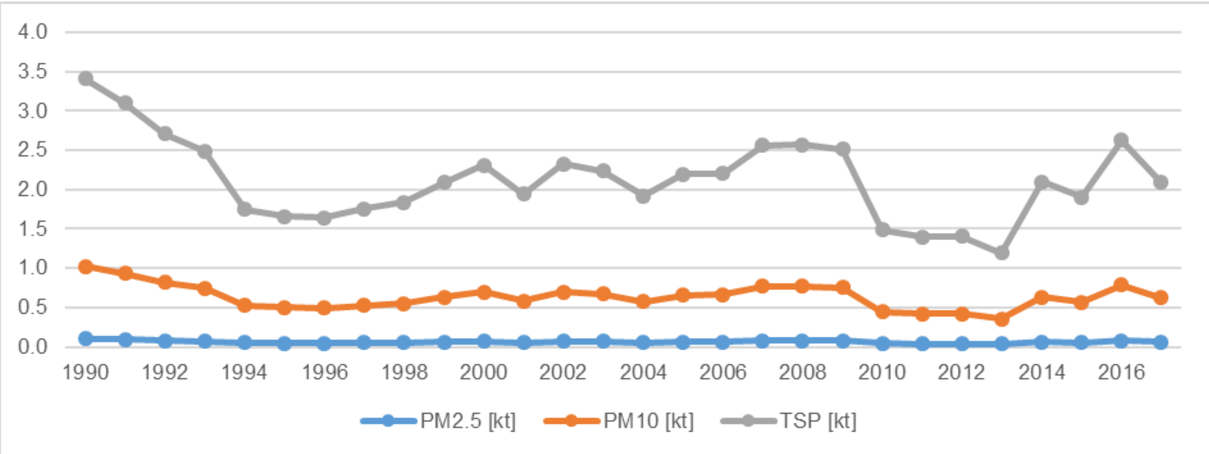
PROCESS - EQUIPMENT	EF FOR TSP IN G/T PROCESSED STONE							
	HUMIDITY IN %							
	0-0.5	0.5-1	1-1.5	1.5-2	2-3	3-4	4-5	5-7
Tertiary crushing	53	36	24	16	8.8	4	1.8	0.5
Tertiary sorting	51	35	23	15	8.5	3.8	1.7	0.5
Transporting on conveyor belts	8	5.5	3.7	2.5	1.4	0.6	0.3	0.1
Tertiary fine crushing (under 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

4.5.5 CONSTRUCTION AND DEMOLITION (NFR 2A5b)

4.5.5.1 Overview

The chapter covers the emissions of particulate matters originated form the activities of building and housing construction and demolition. Overall trend of emissions are shown in the ***Figure 4.19***.

Figure 4.19: *Trends in emissions of air pollutants in 2A5b*



4.5.5.2 Methodological issues

The emissions are reported in the category according to methodology of EMEP/EEA GB$_{2016}$ in division of Non-residential construction, Construction of apartments, Construction of houses (detached single family, detached two family and single family terraced). Road construction was not included yet due to missing activity data.

Table 4.22: *EF used for the calculations in category 2A5b*

$EF_{GB2016\ -\ division}$	[kg/m^2]	[kg/m^2]	[kg/m^2]
Road construction	0.23	2.3	7.7
Non-residential construction	0.1	1	3.3
Construction of apartments	0.03	0.3	1
Construction of houses (detached single family, detached two family and single family terraced)	0.0086	0.086	0.29

4.5.6 STORAGE, HANDLING AND TRANSPORT OF MINERAL PRODUCTS (NFR 2A5c)

The category is reported by notation key NA and IE for TSP and PMi because the emissions from handling are already included in outputs from individual technologies and it would be the double counting if reported in this category separately by T1.

4.5.7 OTHER MINERAL PRODUCTS (2A6)

4.5.7.1 Overview

The category covers other industrial activities of mineral industry not covered in described NFR categories. Reported emissions under the category, their trends and activity data are presented below (***Figure 4.20*** and ***Table 4.23***).

The list of included activities is provided in the ***Table 4.24***.

Figure 4.20: *Trends in emissions of air pollutants in 2A6*

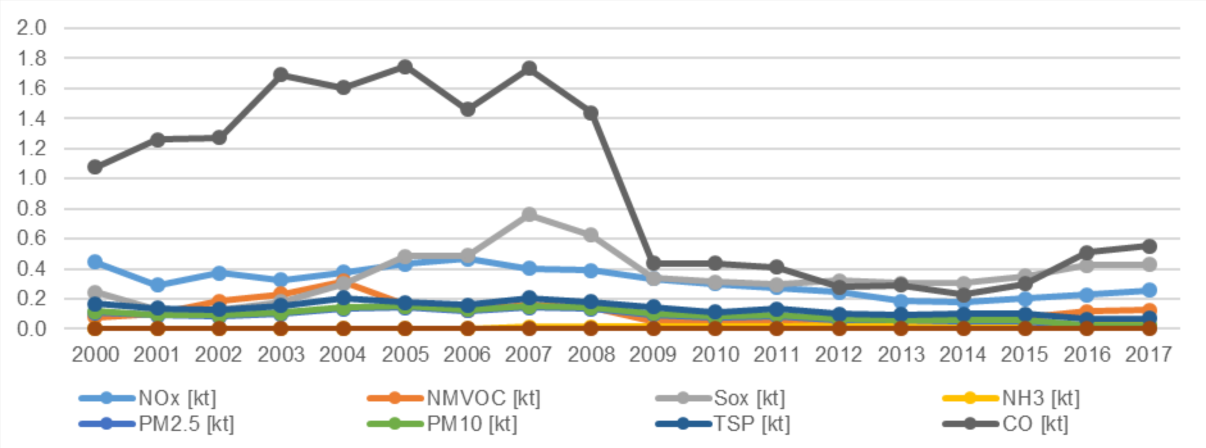


Table 4.23: *Activity data of 2A6 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	OTHER ACTIVITY
Unit	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	
1990	86.3	353.7	3 681.8	NA	NA	NA
1995	68.4	354.6	3 059.1	NA	NA	NA
2000	52.6	40.4	2 069.5	NA	NA	NA
2005	22.8	477.7	2 124.3	NA	NA	NA
2010	13.3	455.9	716.0	NA	NA	NA
2011	6.3	479.5	648.0	NA	NA	NA
2012	4.9	426.8	705.7	NA	NA	NA
2013	4.5	384.8	716.6	NA	NA	NA
2014	3.1	385.5	667.8	NA	NA	NA
2015	4.7	407.6	585.5	NA	NA	NA
2016	9.3	470.8	736.1	NA	NA	NA
2017	7.1	501.6	772.8	NA	NA	NA

4.5.7.2 Methodological issues

Table 4.24: *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 m3 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 m3 /d
3.12. Production of unfired masonry materials and precast units with a projected production capacity m3 /h
3.13. Industrial production of concrete, mortar or other building materials with a projected production capacity in m3/h

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

Table 4.25: *The overview of share of used calculation type for category 2A6 in NEIS*

2A6	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	2%
3	Calculation using representative individual mass flow and number of operating hours	92%
4	Calculation using emission factor and amount of fuel	1%
5	Calculation using emission factor and amount of related quantity other than fuel	4%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.002%
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	0.007%
8	Calculation using emission factor related to calorific value	0.054%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0.48%

Industrial production of concrete for emission calculation it can be use the official bulletin of Ministry of Environment:

LFS - large fraction of stones

FFS - fine fraction of stones

Table 4.26: *Emission factors provided by Bulletin of MoE*

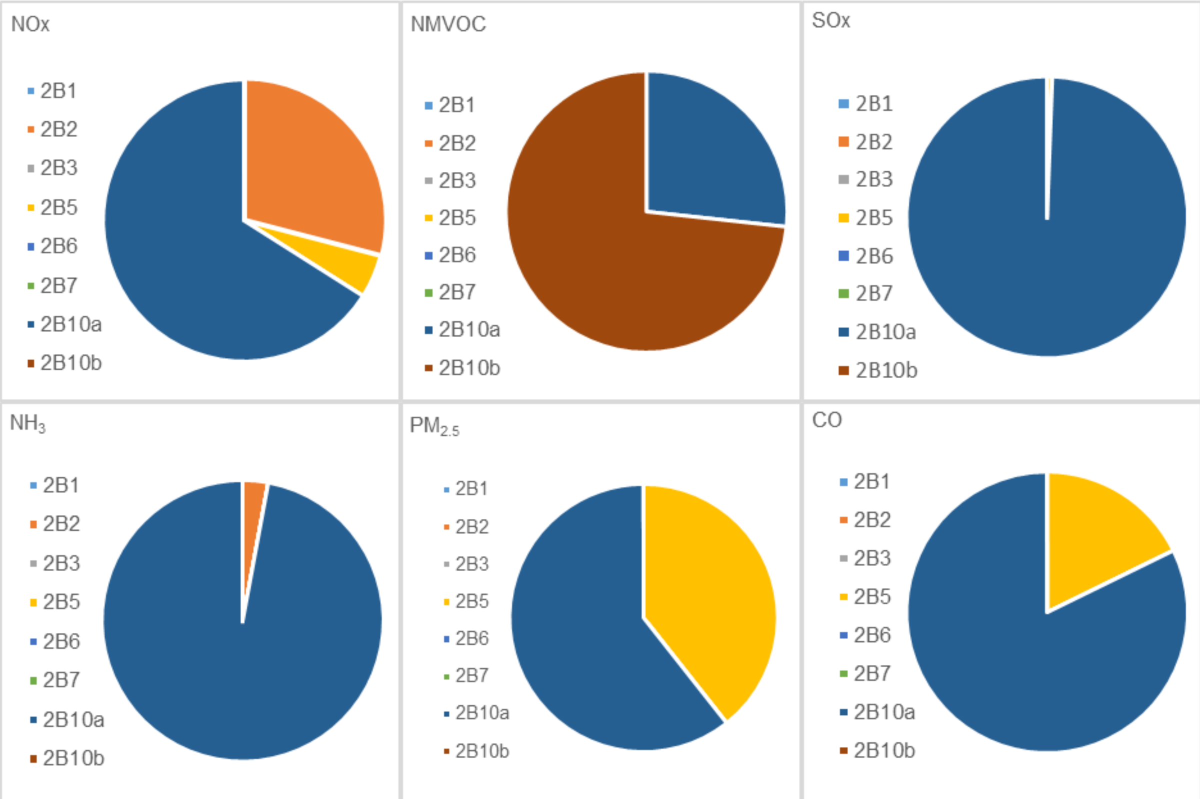
PROCESS	EF	
	TSP	PM_{10}
	g/m^3	
Transport and loading of LFS into boxes - fugitive emissions	3.8	1.8
Transport and loading of FFS into boxes - fugitive emissions	1	0.5
loading of LFS into underground storage or transport equipment - fugitive emissions	3.8	1.8
loading of FFS into underground storage 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 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

4.6 CHEMICAL PRODUCTS (2B)

4.6.1 OVERVIEW

The category covers the NFR activities: Ammonia production (NFR 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). Not all are occurring at territory of Slovakia. Shares of released emission of air pollutants in 2017 NFR categories included are provided on Figure below (***Figure 4.21***).

Figure 4.21: *Shares of emissions in 2B in 2017*



4.6.2 AMMONIA PRODUCTION (2B1)

4.6.2.1 Overview

Category is reported with notation key NO.

4.6.2.2 Methodological issues

The ammonia production in Slovakia is related to the production of urea (carbamide) production. In recorded sets of the database NEIS 2000-2003, producer of urea (operator: Duslo) was categorized as production of ammonia, because the national legislation did not specified the urea production in that period. The issue of reporting was technically solved after the review 2017. For the purpose of reporting, emissions of 2000–2003 were included in 2B10a as the other year of urea production. In production source is currently used the process with the complete recycling of ammonia and carbon dioxide, so called stripping process. The notation keys NO is used due to the mentioned reasons.

4.6.2.3 Recalculations, improvements and implementation of recommendations

According to the recommendation No ***SK-2B1-2018-0001*** notation key for activity data was changed from NA to NO.

4.6.3 NITRIC ACID PRODUCTION (2B2)

4.6.3.1 Overview

NO_X emissions increased by 8.9% in 2017 compared to 2016 (***Figure 4.22***). The malfunction in production during the years 2006–2007 led to strong decrease of NOx and NH_3 emissions, which is visible on provided figure.

Similarly, total nitric acid production increased inter-annually (2016/2017) by 14% and reached the value as in 2015. Nitric acid production in the Slovak Republic is presented at the ***Figure 4.23.***

Figure 4.22*: Trends in emissions of air pollutants in 2B2*

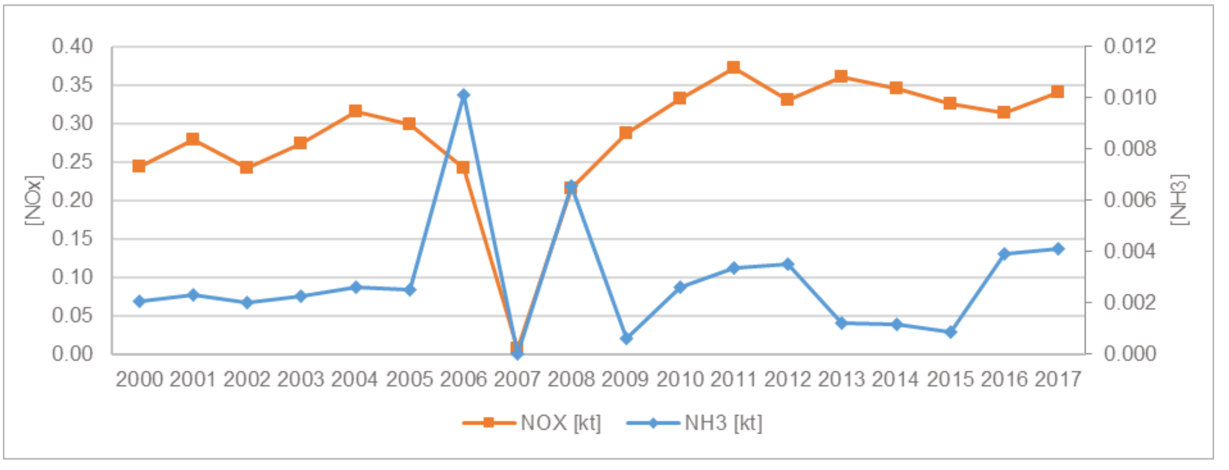
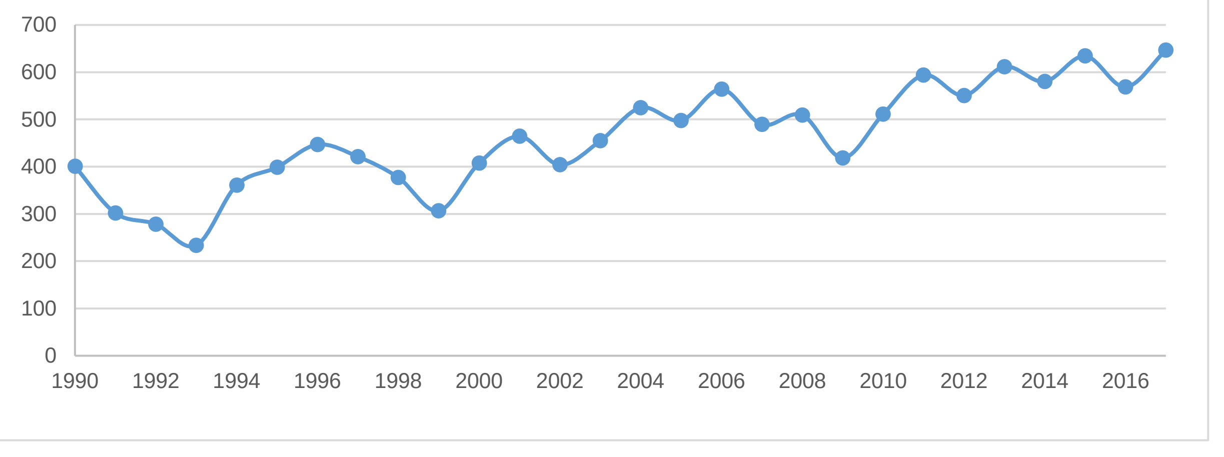


Figure 4.23: *Time series of activity data in category 2B2 - Nitric acid production in kilotons*



4.6.3.2 Methodological issues

The definition of activities covered by the category 2B2 is provided in the ***Table 4.27***. 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 single operator).

Table 4.27: *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 the 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 in medium- and high-pressure technologies by 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 (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 could be used for sources recorded in database. Almost all emissions are calculated by using measured representative individual mass flow and number of operating hours per year as it can be seen in ***Table 4.28***.

Table 4.28: *The overview of share of used calculation type for category 2B2 in NEIS*

2B2	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	99.80%
4	Calculation using emission factor and amount of fuel	0%
5	Calculation using emission factor and amount of related quantity other than fuel	0.095%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0.108%

Calculated values of implied emission factor related to production in 2017 are for nitrogen oxides **IEF_{NOx}=527.21 g/t**, for ammonia **IEF_{NH3} = 6.38 g/t**. For reconstruction of historical years before 2005 (data in the NEIS are recorded since 2005), rounded weighted IEF of available data was used (excluding the year of malfunction), therefore implied emission factor for this period for nitrogen oxides was **IEF_{NOx}=600 g/t** and for ammonia **IEF_{NH3} = 5 g/t**.

Notation key for fuel was changed from NA to NO likewise in 2B1, where use of NO key also for fuels was advised by TERT.

4.6.4 ADIPIC ACID PRODUCTION (2B3)

4.6.4.1 Overview

Adipic acid is not produced in the Slovak Republic, therefore notation key “NO” was used.

4.6.5 CARBIDE PRODUCTION (2B5)

4.6.5.1 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 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, the 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 category covers all sub-processes of the manufacturing as they are together in data set under the category. Relevant rising emissions from this manufacturing, their trends (***Figure 4.24***) and activity data (***Figure 4.25, Table 4.29*)** are presented.

Figure 4.24: *Trends in emissions of air pollutants in 2B5*

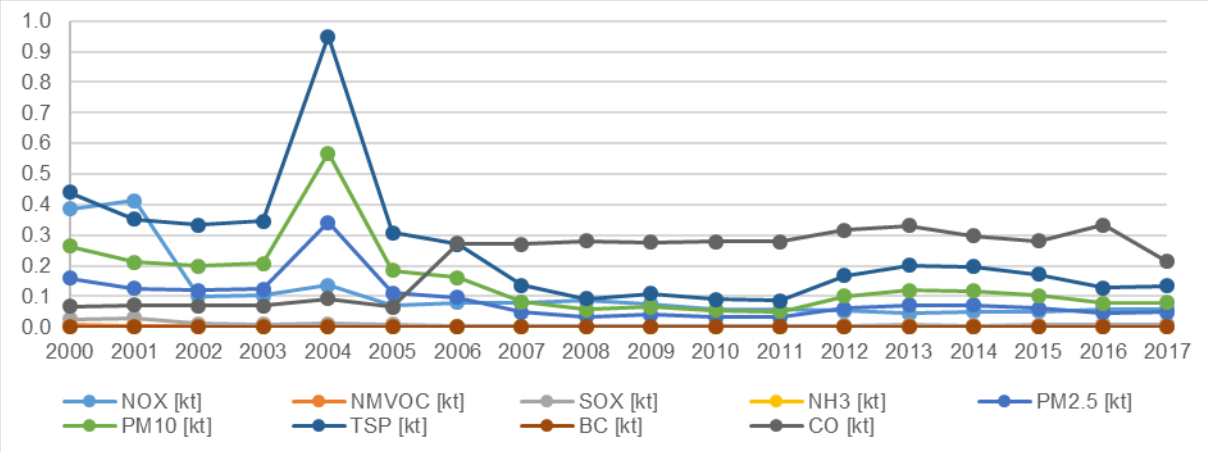


Figure 4.25: *The fuel consumption of NFR 2B5 in TJ*

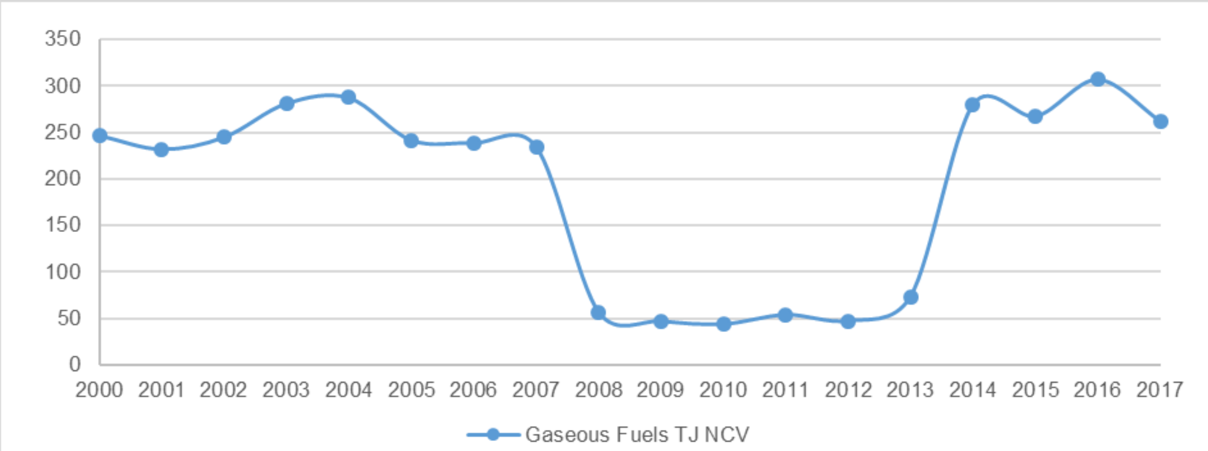


Table 4.29: *Activity data of 2B5 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	CARBIDE PRODUCED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
1990	NA	NA	NO	NA	NA	NO
1995	NA	NA	213	NA	NA	84.30
2000	NA	NA	247	NA	NA	88.82
2005	NA	NA	242	NA	NA	97.03
2010	NA	NA	44	NA	NA	98.26
2011	NA	NA	54	NA	NA	107.40
2012	NA	NA	47	NA	NA	100.48
2013	NA	NA	74	NA	NA	81.79
2014	NA	NA	280	NA	NA	74.30
2015	NA	NA	267	NA	NA	56.18
2016	NA	NA	307	NA	NA	67.95
2017	NA	NA	262	NA	NA	68.95

4.6.5.2 Methodological issues

The definition of activities covered by category 2B5 is provided in the ***Table 4.30***. The characteristic of involved industrial activity is wider, but only activity of calcium carbide production belonging to the occurring production activities.

Table 4.30: *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 could be used for sources recorded in the database. Majority of the emissions are calculated by using measured representative individual mass flow and number of operating hours per year as it can be seen in ***Table 4.31*.**

Table 4.31*: The overview of share of used calculation type for category 2B5 in NEIS*

2B5	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	71%
4	Calculation using emission factor and amount of fuel	0.25%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	29.18%

4.6.5.3 Recalculations, improvements and implementation of recommendations

Review 2017 has risen the issue of carbide production (***SK-2B10a-2017-0002***). During the following reporting cycle 2018 recommendation was partly implemented. For better transparency, the emissions of carbide production were separated in the inventory system. All source data are reported in 2B5 since reporting 2018. Recommendation No ***SK-2B10a-2018-0001*** asked for the further investigation the activity of flaring (***Table 4.32***).

Table 4.32: *Recommendation of review 2017 and 2018.*

NUMBER	NFR, POLLUTANT(S), YEAR(S)	BRIEF DESCRIPTION
SK-2B10a-2017-0002	2B10a Chemical industry: Other, $PM_{2.5}$, 1990-2015	The TERT notes that some Member State countries report particle emissions from flaring in carbide production industry (2B5) and that these emissions can be quite substantial. The TERT also notes that particle emissions from flaring do not correlate directly to production data and IEFs are therefore only useful as a pointer for order of magnitude. Measurements from other MSs show IEFs for flaring in carbide production of 3-8 kg/Mg. The TERT also notes that carbide production occurs in Slovakia and that particle emissions from flaring in chemical industries should be reported under 2B10a if they occur. The TERT kindly asks Slovakia if flaring occurs in carbide production industry in Slovakia.
SK-2B10a-2018-0001	2B10a Chemical industry: Other, $PM_{2.5}$, 1990-2015	The TERT reiterates recommendation SK-2B10a-2017-0002 from the 2017 NECD Review on flaring in Carbide production being a potentially large source of $PM_{2.5}$ emissions but that it is not documented in the IIR. During the 2018 NECD Review, the TERT also noted that all chapters for category 2B are 'in development and will be available at the next submission' (p. 140). In response to a question raised during the 2018 NECD Review, Slovakia provided some information on the methods and approaches and confirmed that the recommendation was partly implemented with work to separate the emissions from carbide production and analysis of the possibility of reallocation of identified combustion emissions. Slovakia also explained that in the next reporting cycle there will be focused on the industrial part. The TERT accepted the progress made and recommends Slovakia continues to implement the improvements and to fully document its developments in the IIR.

Emissions originate from several various activities in manufacturing process: coke crushing, drying and sorting of coke, transport of materials by conveyor belts, carbonization process in furnace, discharge of fugitive from the space above the carbide furnaces containing, discharge of unfiltered gases (the majority of emissions of TSP and $PM_{2.5}$ are mainly from this sub-process), combustion of CO-dust, storage, handling the product cooling, crushing, drying and transport of product.

During the review 2018, we provided also information that source also combust the CO, this process is probably investigated as flaring by review team. CO emission originate from carbonization process. During the suction, released gases take also dust particles. Collected CO-dust in filtering batteries is further treated (cooled, cyclone separator) and combusted by using gaseous fuel (natural gas) in rotary kilns. Part of released gas is used with energy recovery in technology of coke drying and for production of steam. The emissions from this processes are measured by calculation using representative individual mass flow and number of operating hours using the EF from the Bulletin MoE (**ANNEX IV, Chapter A4.6**). These emissions are negligible compared to the other processes.

Implied emission factors for source are provided in the ***Table 4.33***. IEF for TSP is calculated by two manners, one regarding to natural gas consumed as the other pollutants and also regarding to carbide production. Values of IEF concerning TSP to the production is in wider range since year 2000 (4 961g/Mg) with decreasing tendency to recent values around 1 900 g/Mg with peak in 2004 and two declines in 2007 and 2011. Weighted IEF for period 2000-2017 is 2 745 g/Mg of carbide produced.

***Figure 4.26**: IEFs of carbide production*

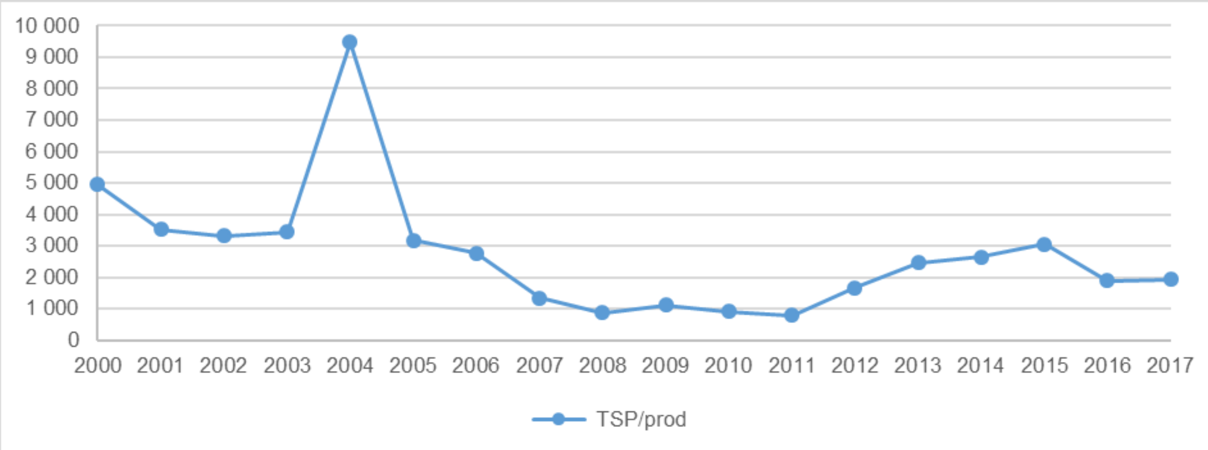


***Table 4.33:** Implied emission factors for air pollutants in 2A5*

IEF [g/TJ OF NG]	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	TSP [g/T PRODUCT]	CO
2017	221.12	0.12	31.47	NA	36.00%	60.00%	509.91	1 940.91	814.97
W-IEF [g/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**TSP [g/T PRODUCT]**	**CO**
2000-2017	567.91	9.13	42.89	NA	36.00%	60.00%	1 309.44	3 305.79	1 123.31
EF [g/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %$PM_{2.5}$**	**CO**
1990-1999	1 500	25	100	NA	36.00%	60.00%	2 000	NE	1 123.31

In years 1990 and 1991, notation key NO was used, because the production started in 1992. Ammonia and PCB were reported using the notation key NA because no emissions were recorded from the activity. Heavy metals and POPs are reported as NE due to absence of measured data or recommended methodology in EMEP/EEA GB_{2016}.

4.6.6 TITANIUM DIOXIDE PRODUCTION (2B6)

4.6.6.1 Overview

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

4.6.6.2 Methodological issues

Notation key for fuel was changed from NA to NO likewise in 2B1, where use of NO key also for fuels was advised by TERT.

4.6.7 SODA ASH PRODUCTION (2B7)

4.6.7.1 Overview

Soda ash is not produced in the Slovak Republic and "NO" notation key was used.

4.6.8 CHEMICAL INDUSTRY: OTHER (2B10a)

4.6.8.1 Overview

The category included various activities of chemical industry. The overview of activities is provided in the ***Table 4.37.*** Overall trend of emissions are presented in following ***Figure 4.27*** and ***Figure 4.28***. Activity data from the NEIS is presented in the ***Table 4.34***. Emissions of air pollutants have decreasing tendency in long-term.

Figure 4.27: *Trends in emissions of air pollutants in 2B10a*

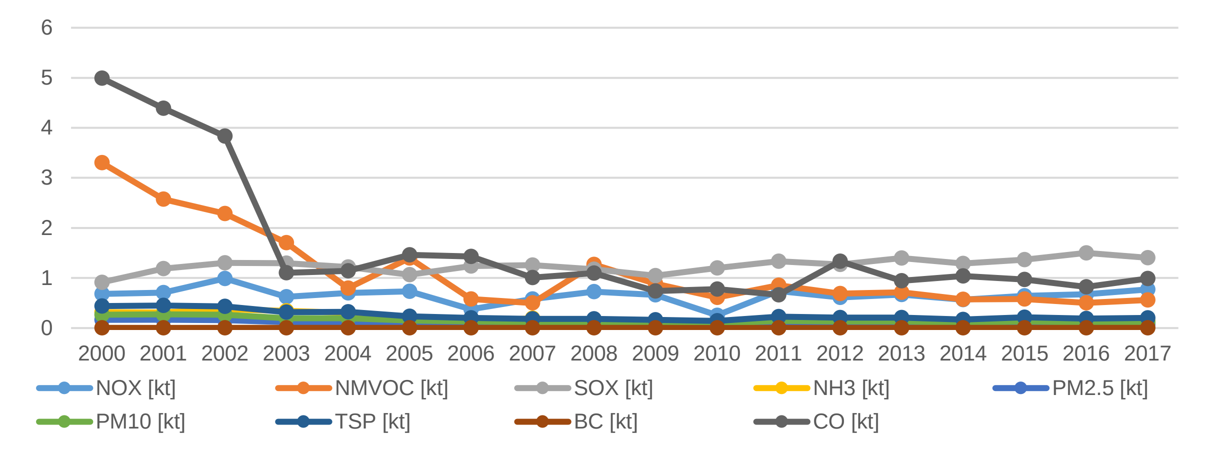


Figure 4.28: *Trends in emissions of Hg and POPs in 2B10a*

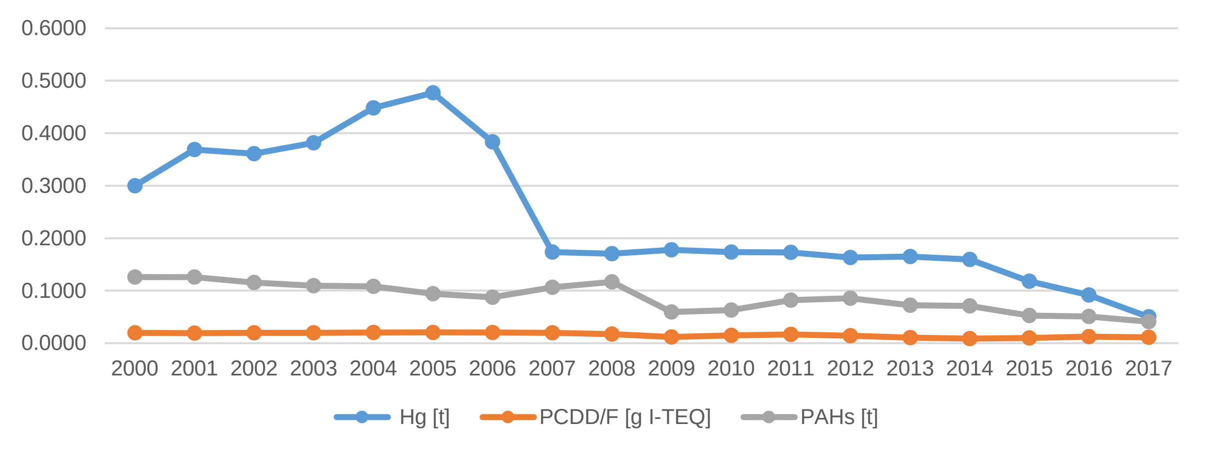


Table 4.34: *Activity data of 2B10a in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	CARBONACEOUS MATERIALS
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
1990	44	NA	8 390	NO	NO	81
1995	49	NA	7 376	NO	NO	19

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	CARBONACEOUS MATERIALS
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
2000	90	NA	7 215	NO	NO	67
2005	135	NA	5 970	3	NO	69
2010	68	NA	3 986	NO	26	50
2011	56	NA	13 755	NO	25	56
2012	47	NA	11 925	NO	19	47
2013	14	NA	13 426	NO	20	35
2014	NO	NA	11 231	NO	19	29
2015	NO	NA	13 511	NO	20	33
2016	0	NA	13 397	NO	NO	41
2017	0	NA	14 214	NO	NO	37

4.6.8.2 Methodological Issues

Air pollutants are taken from the NEIS, Heavy metals are reported as NA, except of emissions of Hg, which originate from production of Cl_2.

Table 4.35: *Activities according to national categorization included in 2B2*

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 of biocides
4.16 Production of auxiliary agents for 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 a bleaching preparations
4.31 Production of industrial explosives
4.32 Production and processing of carbon materials: a) production of charcoal with a projected production in kg/d b) production of soot c) burning carbonaceous materials, including impregnation d) mechanical processing of carbonaceous materials
4.34 Production of soaps, detergents and cosmetics with a production capacity in kg/h: a) detergents b) cosmetics
4.99 Other unspecified chemical production including the raw materials and intermediate products processing a) the part of technology is the fuel combustion with a rated thermal input in MW b) share of emission mass flow of air pollutant before abatement and emission mass flow of air pollutant, that is noted in annex 3 for existing installations: AP with carcinogenic effects, organic vapour, other air pollutants

Implied emission factor for main air pollutants are provided only for a whole category yet. The overview of using calculation techniques is provided in ***Table 4.36***. Emission of Hg were reported by the operator to the NEIS as the measured emission value. Emission factors for POPs are provided in the ***Table 4.37***.

Table 4.36: *Implied emission factors for air pollutants in 2B10a*

IEF [g/TJ]	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %$PM_{2.5}$	CO
2017	54.44	39.42	98.73	9.64	37.22%	61.40%	14.01	1.80%	69.73
W-IEF [g/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %$PM_{2.5}$**	**CO**
2000-03	130.39	427.62	203.55	58.25	39.90%	63.97%	71.12	1.80%	620.23
EF [g/TJ]	**NOx**	**NMVOC**	**SOX**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %$PM_{2.5}$**	**CO**
1990-1999	130	428	204	58.25	37.00%	61.00%	71	1.80%	620.23

Table 4.37: *Emission factors of POPs in the category 2B10a*

EFs	Unit	DIOX	B(a)P	B(b)F	Bk)F	I()P	Total 1-4
Carbonaceous materials production (1990-1995)	mg/t	-	115000	80000	80000	10000	285000
Carbonaceous materials production (1995-)	mg/t	-	2300	2400	2300	300	7300
PVC production	mg/t	0.0003	-	-	-	-	-
Wood impregnation (1990-1995)	mg/t	-	750	375	375	375	1875
Wood impregnation (1995-)	mg/t	-	500	250	250	250	1250

Prevailing manner - 62% of amount of all emissions is determined as continuous measuring (***Table 4.38***).

Table 4.38*: The overview of share of used calculation type for category 2B10a in NEIS*

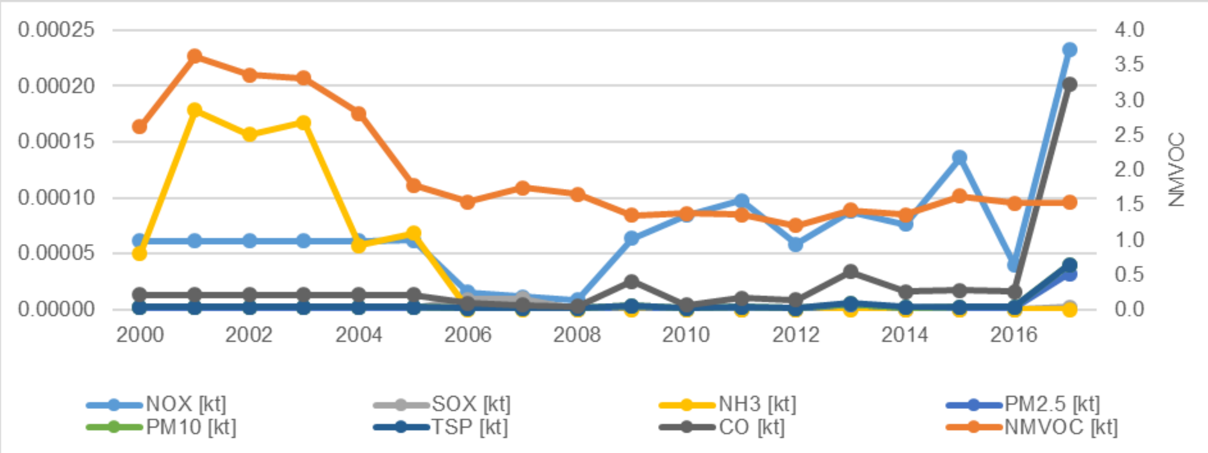
2B10a	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	62%
2	Calculation using representative concentration and volume of flue gas	0.002%
3	Calculation using representative individual mass flow and number of operating hours	26%
4	Calculation using emission factor and amount of fuel	11%
5	Calculation using emission factor and amount of related quantity other than fuel	0.17%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.000%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0.27%

4.6.9 STORAGE, HANDLING AND TRANSPORT OF CHEMICAL PRODUCTS (2B10B)

4.6.9.1 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 are presented in the ***Figure 4.29***. Heavy metals and POPs are reported with notation key NA.

Figure 4.29: *Trends in emissions of air pollutants in 2B10b*



4.6.9.2 Methodological issues

Table 4.39: *Activities according to national categorization included in 2B2*

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: installed aggregated storage capacity in m^3 or a projected or real annual turnover in m3 according to which is higher.

Majority of emissions are calculated by the use of specific individual mass flow and number of operating hours (87%). However, we do not have available the activity data to calculate IEF.

Table 4.40*: The overview of share of used calculation type for category 2B10a in NEIS*

2B10B	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	87%
4	Calculation using emission factor and amount of fuel	13%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

4.7 METAL PRODUCTION (2C)

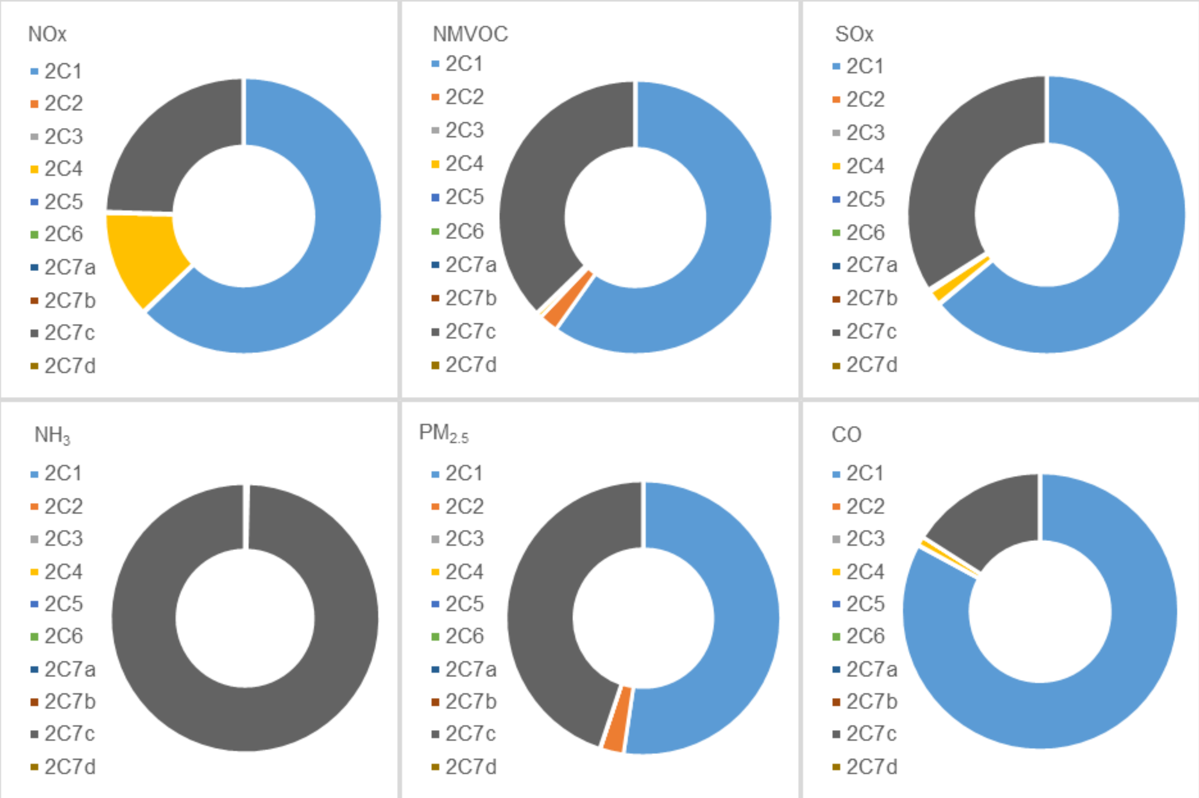
4.7.1 OVERVIEW

Metal production is important sector in 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).

Iron and steel production is major contributor of almost all emissions from metal production (NO_X 63%; NMVOC 60%; SO_X 64%; $PM_{2.5}$ 52%; CO 82.9%). Shares of released emissions of air pollutants in 2017 included in NFR categories 2C are presented on ***Figure 4.30***.

Figure 4.30: *Shares of emissions in 2A in 2017*



4.7.2 IRON AND STEEL PRODUCTION

4.7.2.1 Overview

Iron and steel industry is significant activity in the Slovak Republic, which produced 27% of national CO emissions and 23% of national SOx emissions in 2017. Activities defined in national legislation involved in category are presented in ***Table 4.42***. The trends of emission from iron and steel production are presented at ***Figures 4.31***, ***Figures 4.32, Figure 4.33*** and trends in fuel at ***Figures 4.34***. Emission in 2017 are higher compared to year 2016. The production of steel also rose, but not significantly.

Figure 4.31: *Trends in emissions of air pollutants in 2C1*

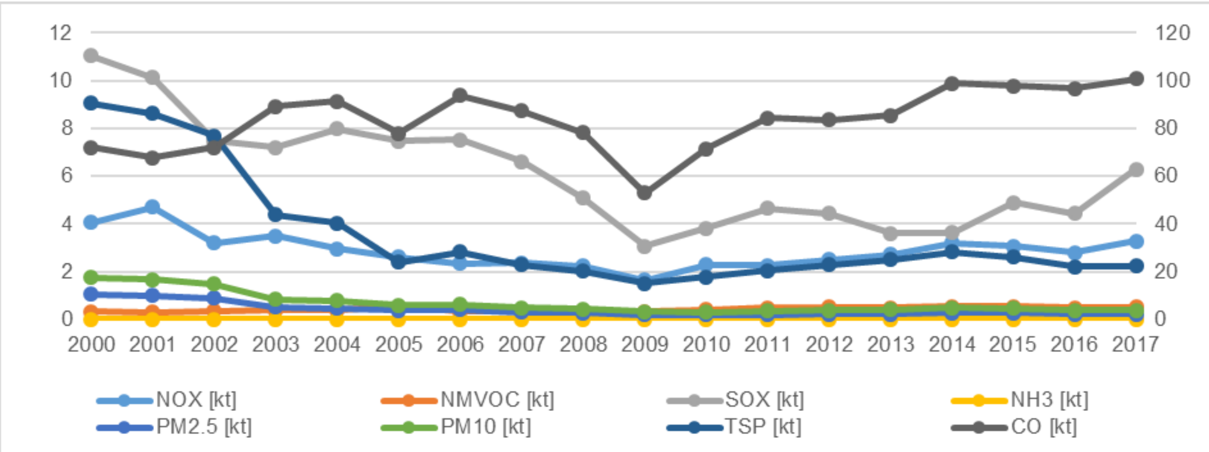


Figure 4.32: *Trends in emissions of heavy metals in 2C1*

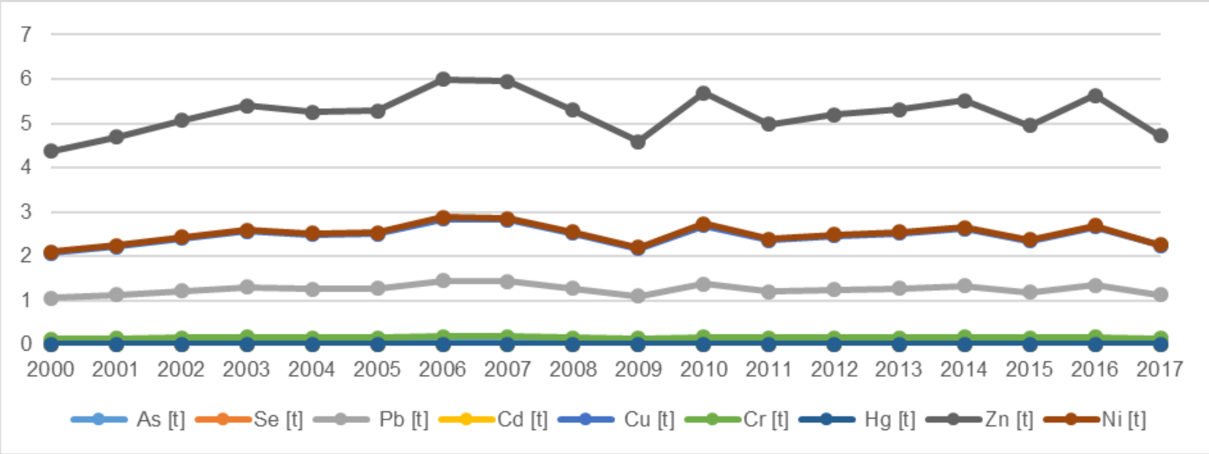


Figure 4.33*: Trends in emissions of POPs in 2C1*

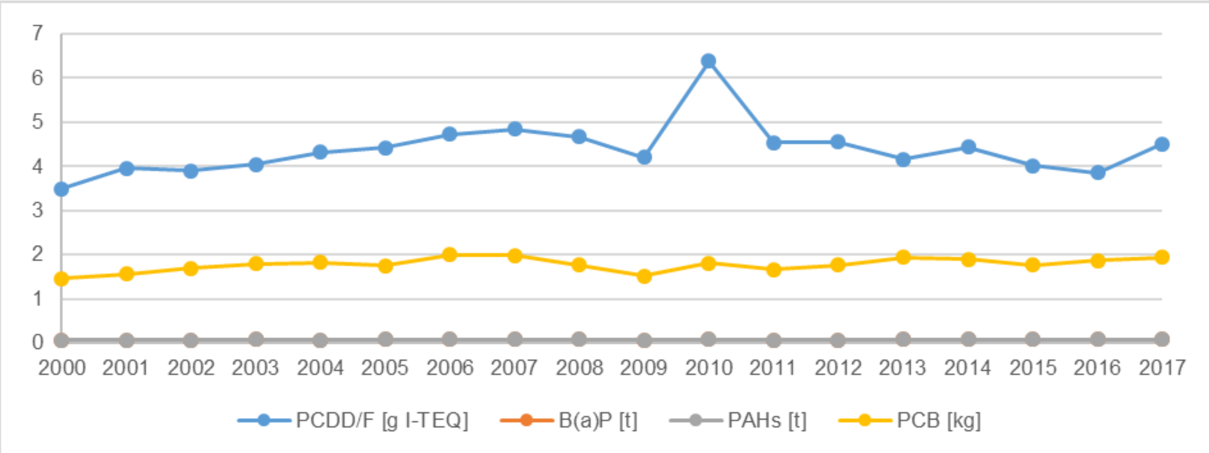
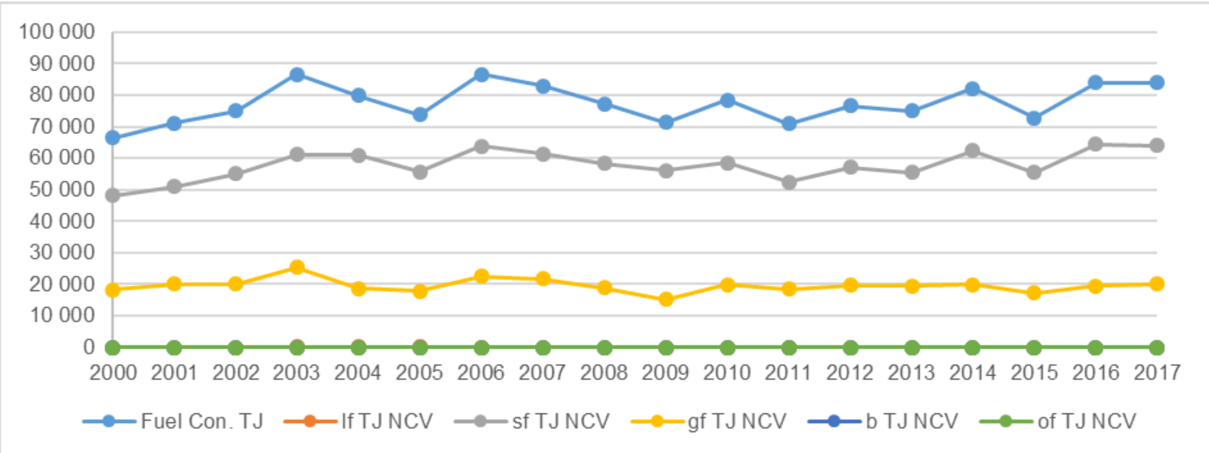


Figure 4.34: *2C1 Fuel Consumption in TJ*



Activity data values including the produced steel for particular years are presented in ***Table 4.41.***

Table 4.41: *Activity data of 2C1 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	STEEL PRODUCED	EAF STEEL
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]	[kt]
1990	14	57 018	21 727	NO	NO	3 561.50	311
1995	9	57 161	21 134	NO	NO	3 207.40	315
2000	5	48 132	18 301	NO	NO	3 519.99	316

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	STEEL PRODUCED	EAF STEEL
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]	[kt]
2005	145	55 761	17 832	NO	NO	4 238.12	357
2010	NO	58 543	19 937	NO	NO	4 401.78	331
2011	NO	52 446	18 529	NO	NO	3 961.02	374
2012	NO	57 122	19 615	NO	NO	4 236.19	372
2013	NO	55 603	19 444	NO	NO	4 344.25	711
2014	NO	62 346	19 833	NO	NO	4 439.48	528
2015	NO	55 528	17 181	NO	NO	4 310.94	315
2016	NO	64 456	19 528	NO	NO	4 599.44	294
2017	NO	64 073	19 998	NO	NO	4 712.96	357

4.7.2.2 Methodological issues

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 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, 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 kilojoule per hammer - ≤ 20 MW and projected power in kilojoule per hammer

Category covers sources of several companies operating in the Slovak Republic (for year 2017).

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; ZTS Metalurg, a.s.; Ironworks Železiarne Podbrezová a.s., Slovakia steel mills, a.s

In category is also included 14 operators of secondary metallurgical production and processing of ferrous metals. Only operators of large sources are presented.

Cat. 2.5: U.S. Steel Košice, a.s; ZTS Metalurg, a.s; Ironworks Železiarne Podbrezová a.s; Slovakia steel mills a.s; Kovohuty, 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.).

The manufacturers of iron and steel in blast furnaces (integrated production of iron and steel) produced totally 2.04 kt of pig iron (which was sold and not processed to steel) and 4 712.96 kt of steel in 2017. Total production of steel produced by the EAF technology was 356.80 kt in 2017. The plant UNEX Prakovce did not produce steel since 2013. New plant, Slovakia Steel Mills, started their production by the EAF technology in 2013. However, due to the sanctions to Russian Federation, its production decreased and in the end of 2014, the production was stopped.

70% of amount of all emissions of air pollutants (HM and POP are separately calculated) are continuously measured (***Table 4.43***). But the rest is determined by other manner. IEF provided in ***Table 4.44*** are not specifically detailed, but relates to amount of total fuel consumption. For the next submission, we would like to provide more detailed EF related to individual steps of production and to specific category of secondary metallurgical production and processing of ferrous metals (cat 2.5).

Table 4.43: *The overview of share of used calculation type for category 2C1 in NEIS*

2C1	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	70.9%
2	Calculation using representative concentration and volume of flue gas	0.010%
3	Calculation using representative individual mass flow and number of operating hours	3.5%
4	Calculation using emission factor and amount of fuel	8.9%
5	Calculation using emission factor and amount of related quantity other than fuel	0.73%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	16.0%

Table 4.44: *Implied emission factors for air pollutants in 2C1*

IEF [G/TJ]	NOx	NMVOC	SOX	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC %$PM_{2.5}$	CO
2017	39.08	6.12	74.74	0.00003	9.59%	17.16%	26.73	0.36%	1199.45

Heavy metals

Inventory of heavy metals is calculated by using older national EF for specific activities in below ***Table 4.45*** and activity data in ***Table 4.47***.

Table 4.45: *Emission factor for heavy metals using in calculations for iron and steel production*

EF [G/T PRODUKT]	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Ore agglomeration Košice (sinter prod.)	6.785	0.010	0.004	0.022	2.230	0.016	0.171	0.315	3.550
Ore agglomeration Košice since 2007	3.5	0.018	0.004	0.016	0.033	0.049	0.09	0.02	0.06
Ore agglomeration Rudňany	-	0.743	-	-	-	1.992	-	-	-
Iron production	0.034	0.003	0.054	0.257	0.020	0.086	0.856	0.011	2.141
Steel production	0.276	0.015	0.003	0.035	0.545	0.003	0.551	0.003	1.150

POPs

POPs are calculated using country specific emission factors (Magulová, 2003). These are listed in the ***Table 4.46***.

Table 4.46: *Emission factors of POPs in 2C1*

EFs	UNIT	DIOX	b(a)p	b(b)f	b(k)f	I()p	PAHs	HCB	PCBs
Steel Production (U.S. Steel)	*mg/t*	0.0002	17.0	-	-	-	17.0	-	0.3830
Steel production	*mg/t*	0.0100	17.0	-	-	-	17.0	-	0.3830

Table 4.47: *Activity data for calculation of heavy metals in 2C1*

YEAR	ORE AGGLOMERATION KOŠICE	ORE AGGLOMERATION KOŠICE SINCE 2007	ORE AGGLOMERATION RUDŇANY	IRON PRODUCTION	STEEL PRODUCTION
1990	3982	NO	1728	3561	4779
1995	3251	NO	1046	3207	3958
2000	3598	NO	1503	3166	3799
2005	3495	NO	622	3681	4595
2010	NO	2480	NO	3649	4950
2011	NO	2920	NO	3346	4335
2012	NO	3142	NO	3520	4520
2013	NO	3060	NO	3617	4616

YEAR	ORE AGGLOMERATION KOŠICE	ORE AGGLOMERATION KOŠICE SINCE 2007	ORE AGGLOMERATION RUDŇANY	IRON PRODUCTION	STEEL PRODUCTION
2014	NO	3791	NO	3863	4799
2015	NO	3740	NO	3738	4311
2016	NO	3713	NO	3987	4894
2017	NO	3748	NO	5070	4108

4.7.3 FERROALLOYS PRODUCTION (2C2)

4.7.3.1 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. Emission trends are shown in the following figures.

Figure 4.35: *Trends in emissions of air pollutants in 2C2*

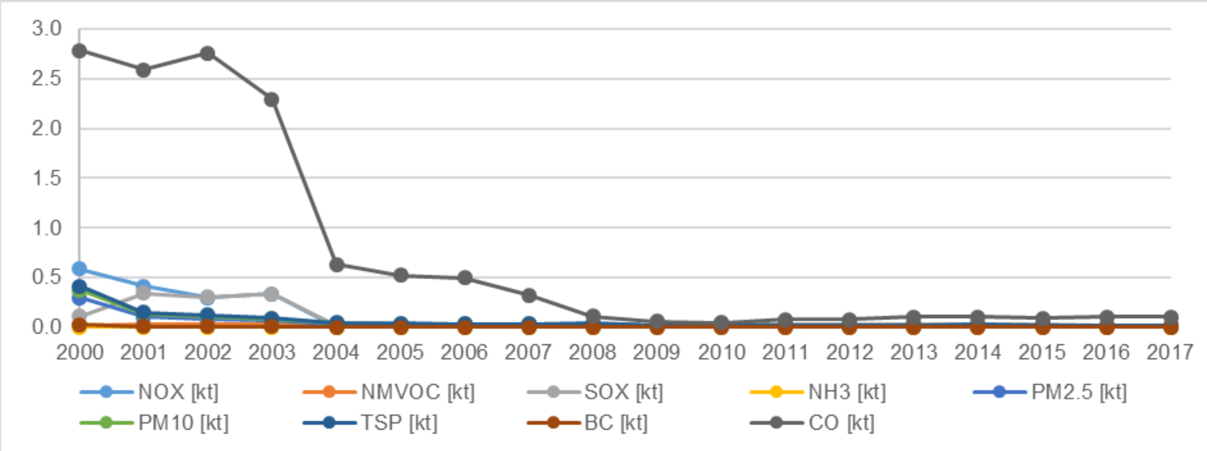


Figure 4.36: *Trends in emissions of heavy metals in 2C2*

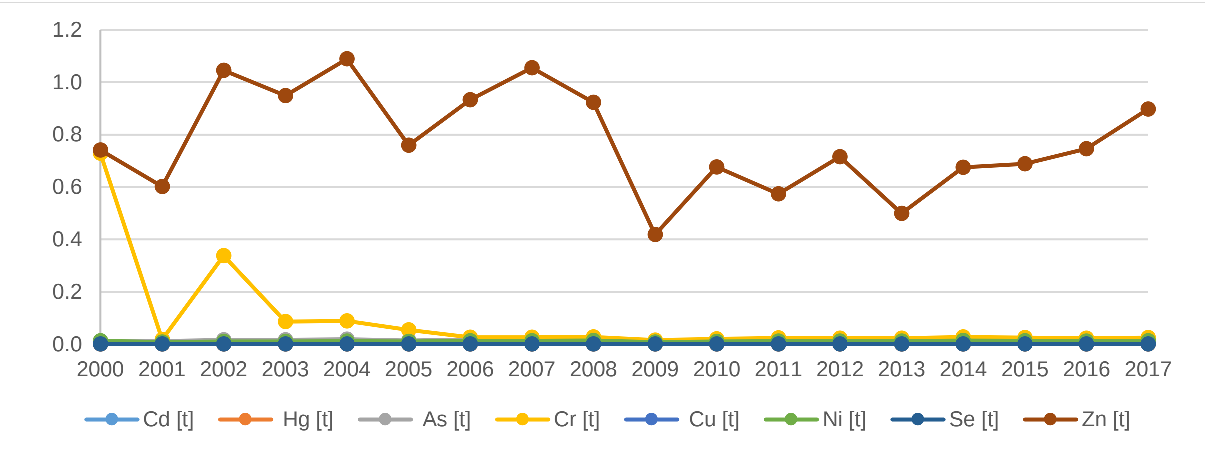


Figure 4.37: *Trends in emissions of POPs in 2C2*

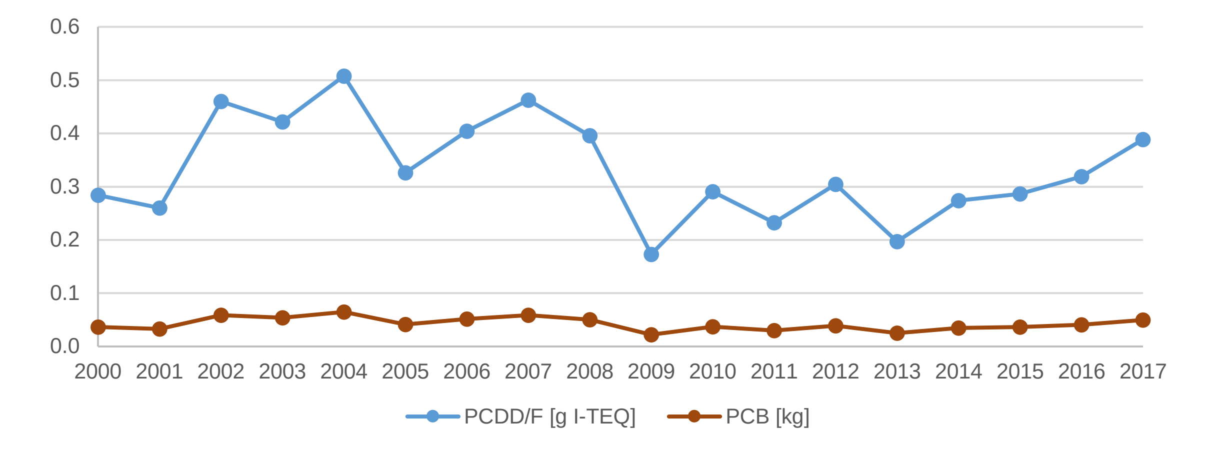


Table 4.48: *Activity data of 2C2 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	FERROALLOYS PRODUCED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
1990	NO	157	816	NO	NO	169
1995	NO	158	631	NO	NO	135
2000	NO	272	705	NO	NO	95
2005	NO	144	13	NO	NO	109
2010	NO	122	27	NO	NO	97
2011	NO	96	11	NO	NO	78
2012	NO	77	12	NO	NO	102
2013	NO	428	13	NO	NO	66
2014	NO	106	8	NO	NO	91
2015	NO	134	19	NO	NO	96
2016	NO	142	18	NO	NO	106
2017	NO	176	17	NO	NO	129

4.7.3.2 Methodological issues

Activities of cast iron and cast iron product according to national legislation were separated to the individual category 2C2.

Table 4.49: *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

More than 98% of air pollutant emissions are measured by the way of representative individual mass flow and number of operating hours (***Table 4.50***). IEF related to ferroalloy production are provided in the ***Table 4.51.***

Table 4.50: *The overview of share of used calculation type for category 2C2 in NEIS*

2C2	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	98.42%
4	Calculation using emission factor and amount of fuel	0.72%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%

2C2	TYPE OF EMISSION COMPILATION/CALCULATION	%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0.72%

Table 4.51: *Implied emission factors for air pollutants in 2C2*

IEF [g/PRODUCTION]	NOx	NMVOC	SOX	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC $\%PM_{2.5}$	CO
2017	62.9	150.9	95.7	0.04	71.00%	90.00%	123.3	10.00%	791.5

Heavy metals

Inventory of heavy metals is calculated by using older national EF for specific activities in below ***Table 4.52*** and activity data in ***Table 4.54***.

Table 4.52: *Emission factor for heavy metals using in calculations for ferroalloys production*

EF [g/T PRODUCTION]	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Cast iron production	2.400	0.100	0.050	0.400	-	-	0.200	0.000	1.700
Production of ferroalloy ferrochrome	0.633	0.033	0.019	40.287	0.076	-	0.243	0.000	11.167
Production of ferroalloys ferromanganese	1.284	0.091	0.039	0.025	0.049	-	0.012	0.000	6.210

POPs

POPs were balanced using country specific emission factors (Magulová, 2003). ***Table 4.53*** shows emission factor used in the calculations.

T***able 4.53:*** *Emission factors of POPs in 2C2*

EFs	UNIT	DIOX	PCBs
Ferroalloys produced	mg/t	0.003	0.383

Table 4.54: *Activity data for calculation of heavy metals in 2C2*

YEAR	CAST IRON PRODUCTION	PRODUCTION OF FERROALLOY FERROCHROME	PRODUCTION OF FERROALLOYS FERROMANGANESE
1990	150.59	53.00	116.00
1995	88.10	45.00	89.80
2000	38.76	17.66	77.07
2005	46.84	0.83	107.89
2010	44.43	NO	96.83
2011	54.44	NO	77.56
2012	49.48	NO	101.59
2013	53.81	NO	65.68
2014	63.62	NO	91.23
2015	56.41	NO	95.52
2016	50.36	NO	106.27
2017	54.81	NO	129.48

4.7.3.3 Recalculations, improvements and implementation of recommendations

Following table shows recommendation from the review 2018.

Table 4.55: *Recommendation of review 2018*

NUMBER	NFR, POLLUTANT(S), YEAR(S)	BRIEF DESCRIPTION
SK-2C2-2018-0001	2C2 Ferroalloys production, SO_2, NOx, NH_3, NMVOC, 2000-2015	A) allocating all ferroalloys productions under NFR 2C2 if possible; On B) correcting the notation keys for NH_3 emissions for 2004-2009 to 'NO' as well as including the reason for the use of the notation key: The TERT notes that in the current submission estimates for NH_3 are included for 2004-2009 and C) to verify historical data for 2005 with the operators to find the reason for the decrease in the NMVOC emission for this year. During the 2018 NECD Review, Slovakia confirmed that these issues were not thoroughly investigated with operators yet and thus are not implemented and that in the next reporting cycle there will be focused on the industrial part. The TERT recommends Slovakia to implement these improvements for the next submission..

Review 2018 has risen the issue for 2C2 (***SK-2C2-2018-0001***). In inventory system, we separated the emissions of ferroalloys according to classification of the source in comply with type of activity. Ammonia emissions were corrected with notation key NO. NMVOC party relates with the decrease of production of ferroalloys.

4.7.4 ALUMINIUM PRODUCTION (2C3)

4.7.4.1 Overview

Aluminium is produced by the electrolysis of alumina dissolved in 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 is 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 production are made in separate plants. Due to this technology, emissions are much lower than in the Søderberg process.

Table 4.56: *Activity data of 2C3 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	ALUMINIUM PRODUCED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
1990	NA	NA	NA	NA	NA	67
1995	NA	NA	NA	NA	NA	33
2000	NA	NA	NA	NA	NA	110
2005	NA	NA	NA	NA	NA	159
2010	NA	NA	NA	NA	NA	163
2011	NA	NA	NA	NA	NA	163
2012	NA	NA	NA	NA	NA	161
2013	NA	NA	NA	NA	NA	163
2014	NA	NA	NA	NA	NA	168
2015	NA	NA	NA	NA	NA	171
2016	NA	NA	NA	NA	NA	174
2017	NA	NA	NA	NA	NA	173

4.7.4.2 Methodological issues

Emissions of air pollutants are included in category 2C7c - Other metal production because definition of activity according to categorization of the Annex No 6 of decree no 410/2012 coll. as amended do not divide for specific type of metal production only general: Treatment of non-ferrous metals ores and manipulation with these materials in powder form. Notation key IE is used for reporting.

Heavy metals

Inventory of heavy metals is calculated using older national EF for specific activities in below ***Table 4.57*** and activity data in ***Table 4.59***.

Table 4.57: *Emission factor for heavy metals using in calculations for aluminum production*

EF [g/T PRODUCTION]	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Cast iron production	2.400	0.100	0.050	0.400	-	-	0.200	0.000	1.700
Production of ferroalloy ferrochrome	0.633	0.033	0.019	40.287	0.076	-	0.243	0.000	11.167
Production of ferroalloys ferromanganese	1.284	0.091	0.039	0.025	0.049	-	0.012	0.000	6.210

POPs

POPs were calculated using country specific emission factors described in Magulová (2003) (***Table 4.58***)

Table 4.58: *Emission factors of POPs in 2C3*

EFs	UNIT	B(a)P	B(b)F	B(k)F	I()P	PAHs
Production of anodes for aluminium production	mg/t	2300	2400	2300	300	7300
Aluminium production	mg/t	1200	1160	1160	151	3671

Table 4.59: *Activity data for calculation of heavy metals in 2C3*

	TREATMENT OF AL ORE	PRODUCTION OF AL BY ELECTROLYSIS
1990	200.7	67.4
1995	57.4	32.6
2000	NO	109.8
2005	NO	159.2
2010	NO	163.0
2011	NO	162.8
2012	NO	160.7
2013	NO	163.3
2014	NO	167.7
2015	NO	171.3
2016	NO	173.6
2017	NO	173.5

4.7.5 MAGNESIUM PRODUCTION (2C4)

4.7.5.1 Overview

The production of magnesium oxide from magnesite and production of basic refractory materials with projected production capacity in t / d are occurring in the Slovak Republic. Therefore this activity was included in to category 2C4.

The trends of emission from production are presented at ***Figures 4.38***, ***Figures 4.39*** and trends in activity data at ***Table 4.60***.

Figure 4.38: Trends in emissions of air pollutants in 2C4

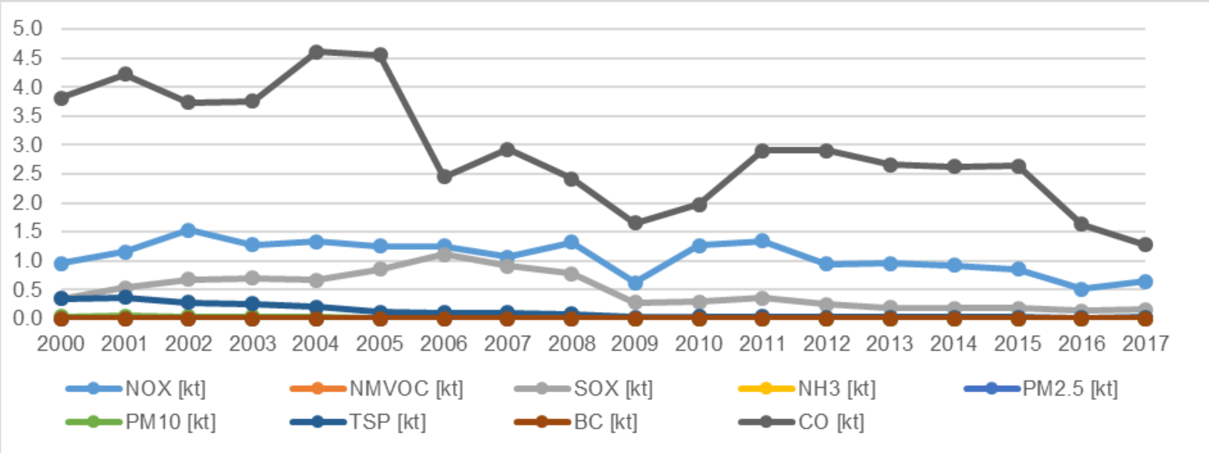


Figure 4.39: Trends in emissions of heavy metals in 2C4

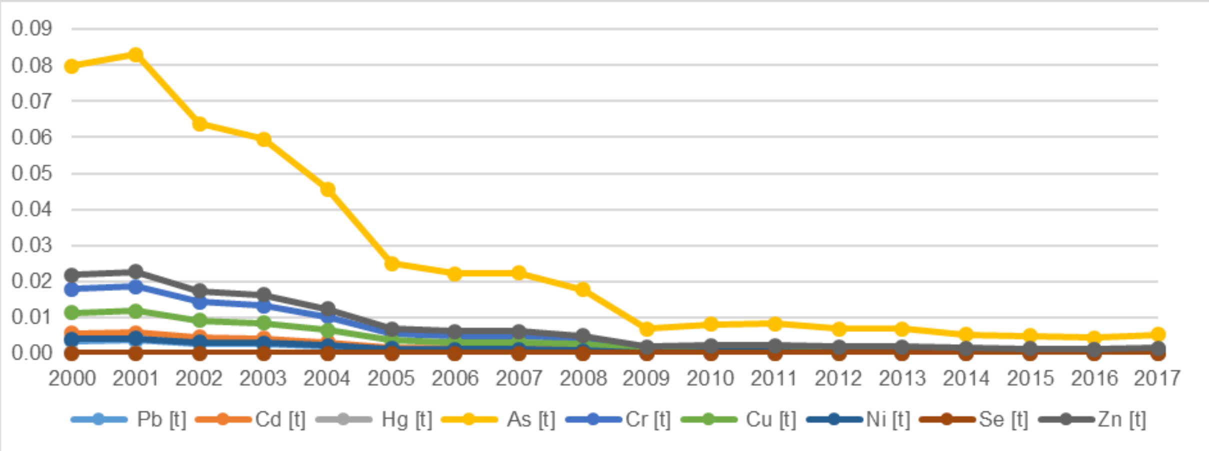


Table 4.60: Activity data of 2C4 in selected years

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	MAGNESITE RAW MATERIALS
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
1990	2 046	NA	4 160	NA	NA	888
1995	1 699	NA	3 696	NA	NA	604
2000	1 031	NA	2 947	NA	NA	851
2005	1 075	NA	2 629	NA	NA	989
2010	466	NA	3 068	NA	NA	820
2011	117	NA	2 982	NA	NA	724
2012	86	NA	2 308	NA	NA	635
2013	12	NA	2 236	NA	NA	603
2014	8	NA	2 243	NA	NA	590
2015	54	NA	1 997	NA	NA	550
2016	58	NA	1 613	NA	NA	463
2017	105	NA	2 219	NA	NA	464

4.7.5.4 Methodological issues

Table 4.61: Activities according to national categorization included in 2C4

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 basic refractory materials with projected production capacity in t / d

Table 4.62: The overview of share of used calculation type for category 2C4 in NEIS

2C4	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	28.7%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	71.2%
4	Calculation using emission factor and amount of fuel	0.034%
5	Calculation using emission factor and amount of related quantity other than fuel	0.00000%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

More than 71% of air pollutant emissions are measured by the way of representative individual mass flow and number of operating hours and 29% are measured by continuous measurement (***Table 4.62***). IEF related to production are provided in ***Table 4.63***.

***Table 4.63:** Implied emission factors for air pollutants in 2C4*

IEF [g/PRODUCTION]	NOx	NMVOC	SOX	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC $\%PM_{2.5}$	CO
2017	1 405	10.62	348	0.01	1.01%	12.01%	49.86	NE	2 750.86

Heavy metals

Inventory of heavy metals is calculated using older national EF for specific activities in below ***Table 4.64***. Activity data is values of total suspended particles.

Table 4.64: Emission factor for heavy metals using in calculations for magnesium production

POLLUTANT	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
EF [g/t TSP]	9.93	226.84	15.81	50.74	0.79	11.31	0.00	61.80	32.29

4.7.6 LEAD PRODUCTION (2C5)

4.7.6.1 Overview

The production, regeneration and disposal of electric accumulators and cells is occurring in the Slovak Republic. Therefore this activity was included in to the category 2C5. The trends of emissions from production are presented in ***Figures 4.40***, ***Figures 4.41*** and trends in activity data in ***Table 4.65***.

Figure 4.40: *Trends in emissions of air pollutants in 2C5*

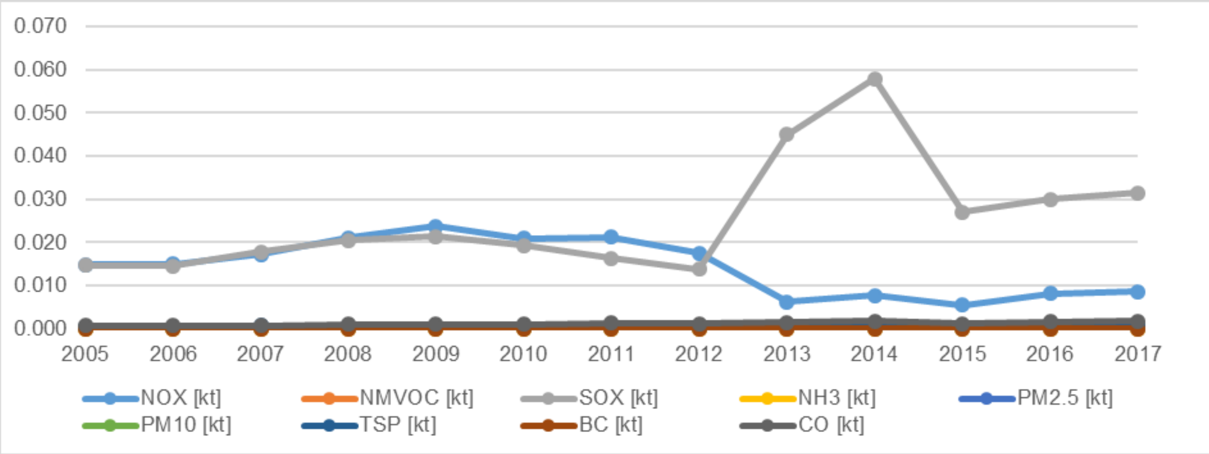


Figure 4.41: *Trends in emissions of heavy metals in 2C5*

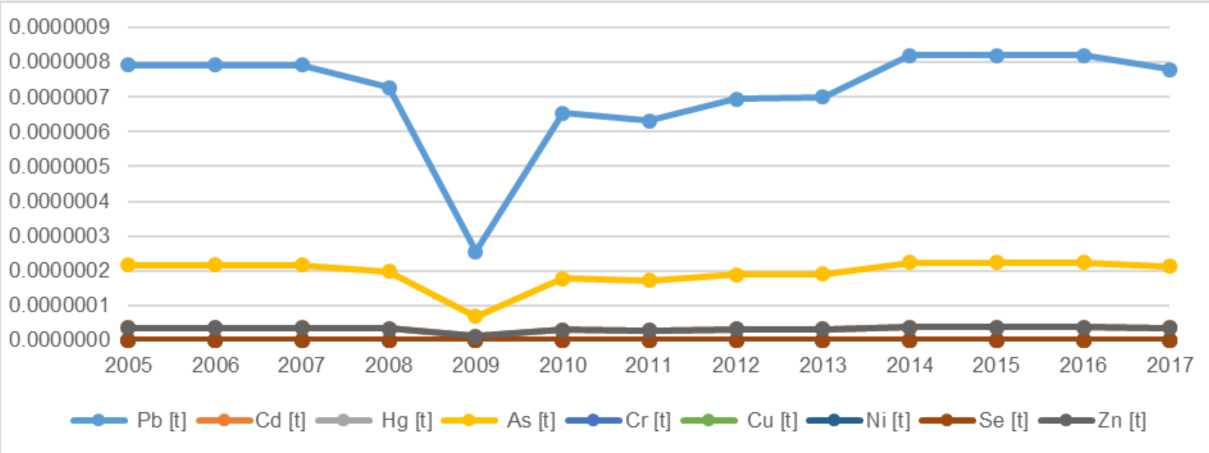


Figure 4.42: *Trends in emissions of POPs in 2C5*

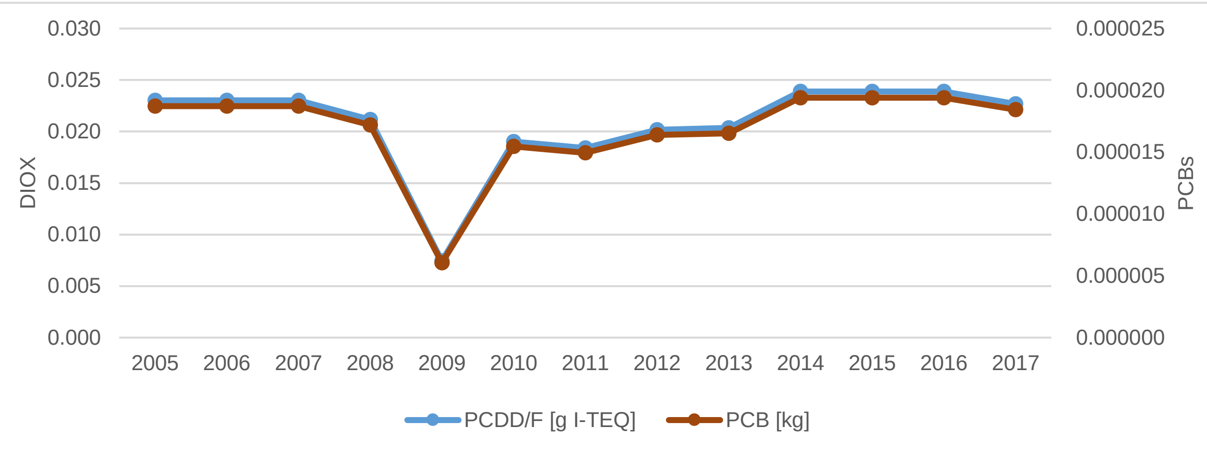


Table 4.65: *Activity data of 2C5 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	LEAD PRODUCED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[t]
1990	NA	NA	NA	NA	NA	NO
1995	NA	NA	NA	NA	NA	NO
2000	NA	NA	NA	NA	NA	NO
2005	NA	NA	NA	NA	NA	NO

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	LEAD PRODUCED
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[t]
2010	NA	NA	34	NA	NA	5.948
2011	NA	NA	31	NA	NA	5.748
2012	NA	NA	36	NA	NA	6.307
2013	NA	NA	24	NA	NA	6.359
2014	NA	NA	0.3	NA	NA	7.464
2015	NA	NA	26	NA	NA	7.464
2016	NA	NA	27	NA	NA	7.464
2017	NA	NA	28	NA	NA	7.091

4.7.6.2 Methodological issues

Table 4.66: *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

Table 4.67: *The overview of share of used calculation type for category 2C5 in NEIS*

2C5	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	98%
4	Calculation using emission factor and amount of fuel	2%
5	Calculation using emission factor and amount of related quantity other than fuel	0%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0%

POPs

POPs were balanced using country specific emission factors described in Magulová (2003) (***Table 4.68***).

Table 4.68: *Emission factors of POPs in 2C5*

POLLUTANT	DIOX	PCBs
Unit	µg I-TEQ/Mg lead produced	µg/Mg lead produced
EF	3.2	2.6

4.7.7 ZINC PRODUCTION (2C6)

4.7.7.1 Overview

Category is reported with notation key NO. This production is not occurring in the Slovak Republic. Notation key for fuel was changed from NA to NO likewise in 2B1, where use of NO key also for fuels was advised by TERT.

4.7.8 COPPER PRODUCTION (2C7a)

4.7.8.1 Overview

Emissions of air pollutants were included in category 2C7c - Other metal production because definition of activity according to categorization of the Annex No 6 of decree no 410/2012 coll. as amended do not divide for specific type of metal production only general: Treatment of non-ferrous metals ores and manipulation with these materials in powder form. Notation key IE is used for reporting.

Heavy metals

Inventory of heavy metals is calculated by using older national EF for specific activities in below ***Table 4.69*** and activity data in **Table 4.70**.

Table 4.69*: Emission factor for heavy metals using in calculations for copper production*

EF [g / Mg PRODUCT]]	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Production of Cu - concentrate	2.876	1929			1404	319.83			
Convertor Cu - RH	209	2103			1480				388
Cu - kamienok	2.876	1929			1404	319.83			
Cu anodes	212				332			103	
Cu-black	250	100	15		300	0.06			200
Convertor Cu - HSO	209	2103			1480				388

Table 4.70*: Activity data for calculation of heavy metals in 2C7a*

	PRODUCTION OF CU - CONCENTRATE	CONVERTOR CU - RH	CU - KAMIENOK	CU ANODES	CU-BLACK	CU CONVERTOR- - HSO
1990	13.48	NO	24.61	NO	NO	NO
1995	0.35	4.72	NO	19.75	4.55	4.13
2000	0.22	NO	NO	NO	NO	0.00
2005	NO	NO	NO	15.50	10.26	7.68
2010	NO	NO	NO	46.87	12.84	8.80
2011	NO	9.43	NO	49.19	13.86	NO
2012	NO	8.22	NO	41.73	9.56	NO
2013	NO	5.59	NO	18.46	6.97	NO
2014	NO	10.38	NO	23.33	10.54	NO
2015	NO	12.20	NO	41.00	12.41	NO
2016	NO	13.19	NO	47.49	17.61	NO
2017	NO	12.38	NO	44.15	17.98	NO

4.7.9 NIKEL PRODUCTION (2C7b)

4.7.9.1 Overview

Category is reported with notation key NO. This production is not occurring in the Slovak Republic. Notation key for fuel was changed from NA to NO likewise in 2B1 where use of NO key for fuels was advised by TERT.

4.7.10 OTHER METAL PRODUCTION (2C7c)

4.7.10.1 Overview

The trends of emission from other metal production are presented in ***Figures 4.43***, ***Figures 4.44,*** and trends in fuel in ***Table 4.71***.

***Figure 4.43**: Trends in emissions of air pollutants in 2C7c*

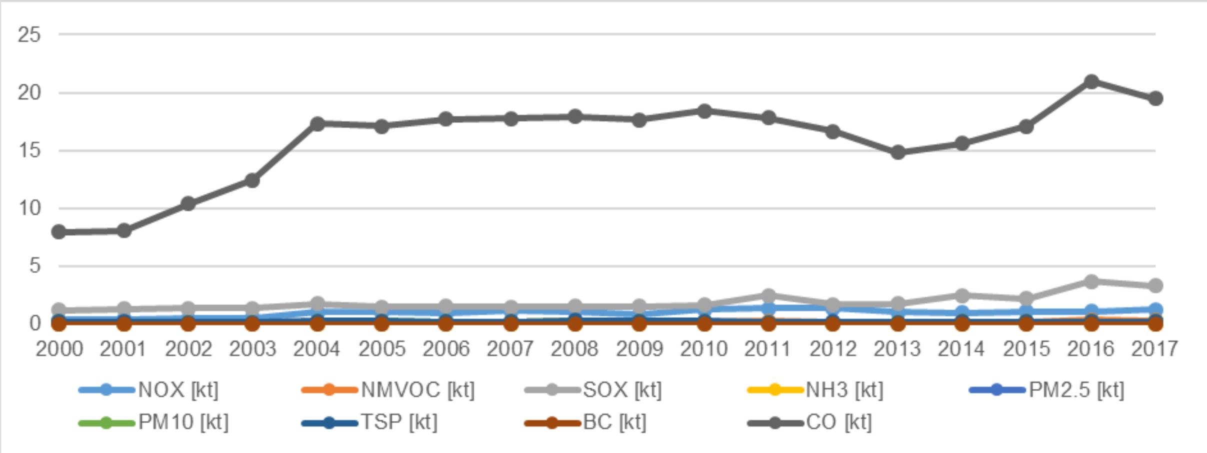


***Figure 4.44**: Trends in emissions of heavy metals in 2C7c*

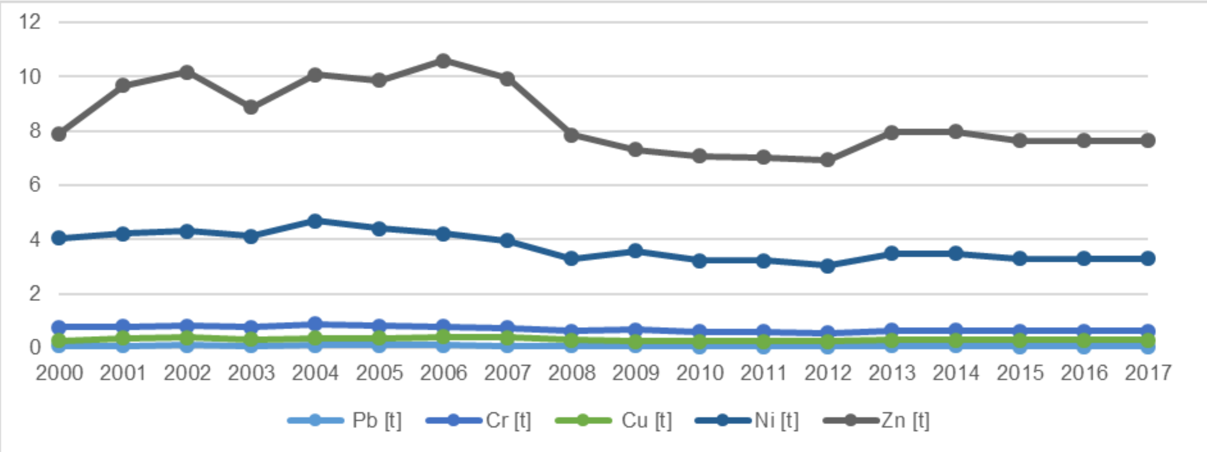


***Table 4.71:** Activity data of 2C7c in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	OTHER ACTIVITY UNITS
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[cpt]
1990	NE	NE	NE	NA	NA	NA
1995	NE	NE	NE	NA	NA	NA
2000	1	0	869	NA	NA	NA
2005	17	130	2 083	NA	NA	NA
2010	6	138	2 527	NA	NA	NA
2011	16	136	2 657	NA	NA	NA
2012	0	2	1 797	NA	NA	NA
2013	0	2	2 508	NA	NA	NA
2014	1	2	2 593	NA	NA	NA
2015	1	8	2 882	NA	NA	NA
2016	1	0	2 916	NA	NA	NA
2017	1	4	3 100	NA	NA	NA

4.7.10.2 Methodological issues

In the submission 2018 reallocation of emissions between Energy and IPPU was done, which caused changes in the national inventory.

***Table 4.72:** 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 an electrolytic processes with projected volume of baths in m3 b) Surface treatment - by using an chemical processes with projected volume of baths in m3 c) Surface treatment - application of metal or alloy layers and metal coatings and their alloys except for crude steel in melt with a projected capacity in kg / h d) Surface treatment - application of metal or alloy layers, using flame, electric arc, plasma or other method with projected capacity in kg/h e) Surface treatment - application of protective coating from molten metals with 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 treatment, with a projected capacity of application in m2 / h h) Related activities - abrasive cleaning (blasting), excluding cassette equipment, with a projected capacity of processed material in m2 / h i) Related activities - thermal cleaning: - with the volume of the combustion chamber in m3 or - with operation hours per year j) Related activities - electrolytic-plasma cleaning, degreasing and polishing with a projected capacity in dm2 / h

***Table 4.73**: The overview of share of used calculation type for category 2C7c in NEIS*

2C7C	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0.003%
3	Calculation using representative individual mass flow and number of operating hours	24.473%
4	Calculation using emission factor and amount of fuel	0.251%
5	Calculation using emission factor and amount of related quantity other than fuel	0.684%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0.018%
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	0.000%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	74.6%

4.7.11 STORAGE, HANDLING AND TRANSPORT OF METAL PRODUCTS (2C7D)

4.7.11.1 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. Heavy metals and POPs are reported by NA or NE.

4.8 SOLVENTS AND OTHER PRODUCT USE (NFR 2D, 2G)

The chapter provides information on emission inventory of NMVOC for the sector solvents, which covers NFR categories 2D3a, 2D3b, 2D3c, 2D3d, 2D3a, 2D3h, 2D3e, 2D3f, 2D3g, 2D3i and 2G. In categories 2D3b and 2D3c are relevant emissions of PMi, TSP, BC and PCDD/F and in sources of 2D3c is emitted in addition CO emissions. In the category 2D3i, emissions of lubricant consumption in transport were added. The categories included in emission balance are namely listed in ***Table 4.74***

Table 4.74: *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

4.8.1 OVERVIEW

Concerning the air protection, the most important emissions rising up from the categories so-called solvents are non-methane volatile organic compounds (NMVOC). They are part of many different substances, which are used in the 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, variety of household products or car care products, fuels, hydraulic fluids and others. However, the fuels are not primary objective of this chapter. Their versatility leads to more difficult tracking the fluxes and some categories are estimated, especially for domestic use.

4.8.2 TRENDS IN SOLVENTS

The development of NMVOC emissions has overall decreasing trend. Emissions of NMVOC in kt for particular years are presented in ***Table 4.75***. Percentage decrease for particular years is presented in ***Table 4.76***. The drivers for the emissions decline are the implementation of effective techniques in the industrial sources. The share of categories for year 2017 is presented in ***Figure 4.45***.

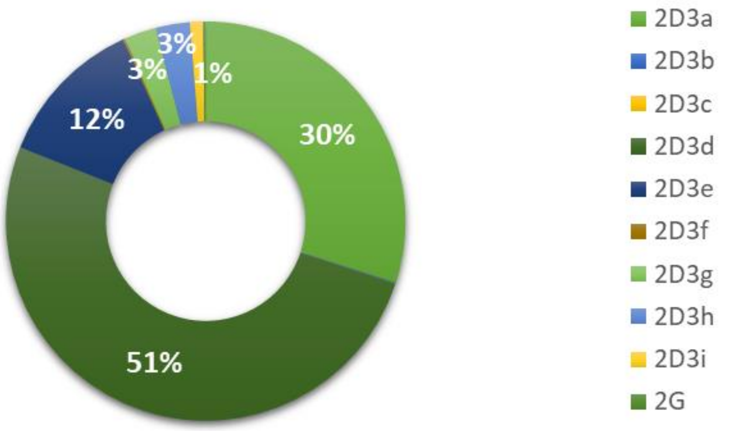
Table 4.75: *NMVOC emissions in the category 2D by categories (Gg) in particular years*

Y/NFR	2D3a	2D3b	2D3c	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G	∑
1990	6.36	0.06	0.047	22.20	10.85	0.10	14.95	12.29	1.02	0.003	67.89
1995	6.44	0.03	0.024	21.94	9.49	0.09	13.64	10.21	0.86	0.023	62.74
2000	6.48	0.01	0.016	20.47	8.14	0.07	12.33	8.12	0.70	0.026	56.37
2005	6.46	0.02	0.006	19.02	6.96	0.06	10.13	4.45	0.39	0.120	47.63
2010	6.52	0.01	0.002	18.35	3.84	0.05	10.08	4.53	0.42	0.043	43.86
2015	6.51	0.02	0.001	15.18	4.63	0.04	0.59	0.56	0.17	0.041	27.75
2017	6.53	0.02	0.001	11.08	2.65	0.04	0.56	0.60	0.23	0.044	21.75

Table 4.76: Trends of NMVOC for particular years

TREND/NFR	2D3a	2D3b	2D3c	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G	∑
1990/2017	2.6%	-70.0%	-97.2%	-50.1%	-75.6%	-62.5%	-96.2%	-95.1%	-77.3%	1255%	-68%
2005/2017	0.9%	-2.1%	-77.7%	-41.7%	-62.0%	-43.5%	-94.4%	-86.5%	-40.3%	-63.3%	-54%
2016/2017	0.1%	-1.1%	-34.2%	-15.5%	-34.0%	-11.0%	-2.4%	7.8%	6.1%	7.3%	-13%

Figure 4.45 *The share in NMVOC emissions of individual categories in 2D in 2017*



4.8.3 METHODOLOGICAL ISSUES

Sectoral approach applied in general for emission inventory of pollutants provides a detailed elaboration of individual NFR categories and quantification of explicit activities. Since reporting 2016, methodology combine more approaches. First, direct usage of activity data of VOC and released emissions reported to NEIS database. National database NEIS covers industrial sources which operate the technologies using volatile organic compounds and provides yearly validated data set of emissions and activity data. Second, direct usage of activity data of VOC and released emissions reported to NEIS database combine with statistical data to cover the rest from the overall consumption in Slovakia, which is not reported in the NEIS. More detailed description of methods are in chapters of categories. Third, solely statistical data of inhabitants for estimation of emission by using of guideline methodology.

A general model for calculation of NMVOC is presented in ***Table 4.77***. Table provides information about used Tier, activity data, division of national database NEIS source categories included in NFR and method for calculation.

Table 4.77: The overview of activity data, method and Tier used for SOLVENTS categories

NMVOC NFR	TIER	ACTIVITY DATA	NEIS CATEGORIES (DECREE NO 410/2012)	METHOD FOR REPORTING
2D3a	T1	ŠÚSR	-	Em_{TOTAL} = inhabitants * $Ef_{(GB2016)}$
2D3b	T3	NEIS	NEIS: 3.5	Em_{TOTAL} = 100% NEIS
2D3c	T3	NEIS	NEIS: 4.37	Em_{TOTAL} = 100% NEIS
2D3d	T2+T3	ŠÚSR + NEIS	NEIS: 6.1 6.2 6.3 6.9	Em_{TOTAL} = Small sources * Ef + Em_{NEIS}
2D3e	T2+T3	ŠÚSR + NEIS	NEIS: 6.4	Em_{TOTAL} = Small sources * Ef + Em_{NEIS}
2D3f	T3	NEIS	NEIS: 6.5	Em_{TOTAL} = 100% NEIS
2D3g	T3	NEIS	NEIS: 4.19 4.20 4.33 4.38 6.10 6.11	Em_{TOTAL} = 100% NEIS
2D3h	T2+T3	ŠÚSR + NEIS	NEIS: 6.7	Em_{TOTAL} = Small sources * Ef + Em_{NEIS}
2D3i	T2+T3	ŠÚSR + NEIS	NEIS: 4.35 6.6	Em_{TOTAL} = Small sources * Ef + Em_{NEIS}

4.8.4 RECALCULATIONS AND IMPORVEMENTS

Category 2D3d - Coating application:

The explanation of emission reduction for years 2010 – up to the last reported year was added to the methodology (**Chapter 4.8.8.4**)

Category 2D3e - Degreasing:

Few minor improvements in steps of calculations occures. Explanation is provided in the **Chapter 4.8.9.4**.

Category 2D3h - Printing:

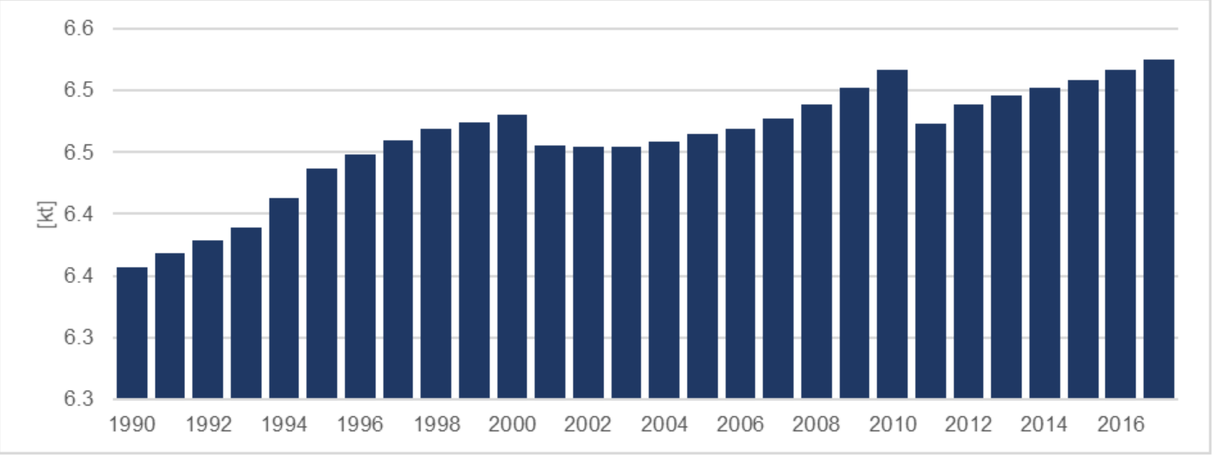
The description of recalculation in reporting 2018 was added to the methodology (**Chapter 4.8.12.4**)

4.8.5 DOMESTIC SOLVENT USE INCLUDING FUNGICIDES (NFR 2D3a)

4.8.5.1 Overview

Emissions of NMVOCs have increasing character in this category due to the trend in activity data (***Figure 4.46***).

Figure 4.46: *NMVOC emission trend in the category 2D3a*



4.8.5.2 Methodological issues

This category is performed by Tier 1 method due to the lack of detailed activity data from households. The equation is used:

$$Em_{TOTAL} = AD * EF_{(GB2016)}$$

Where

AD = inhabitants

EF = 1200 [g/capita]

Activity data (Mid-year population) is from Statistical Office. Emission factor (EF) used for calculation is based on the EMEP/EEA GB_{2016}. for Other countries **1 200 g/capita**.

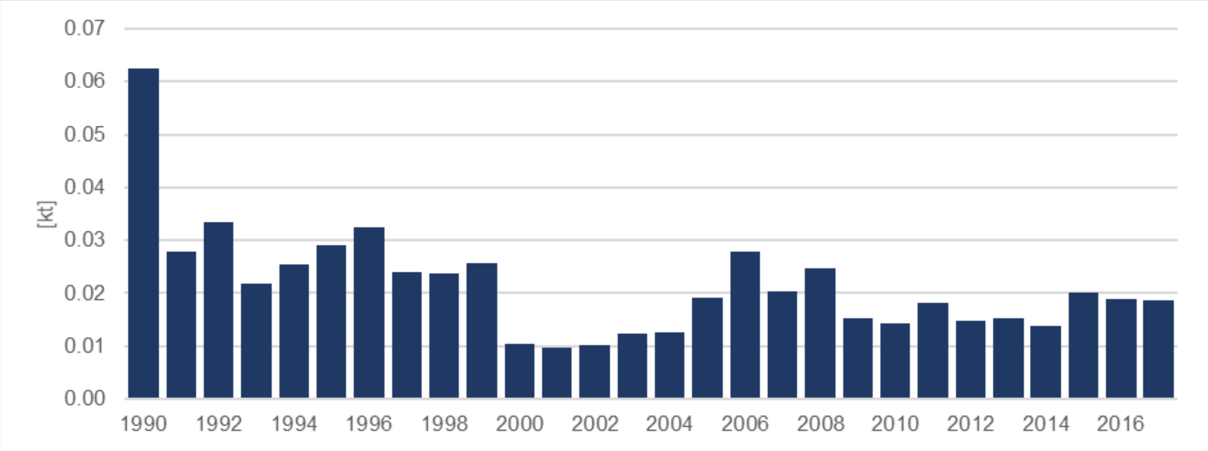
4.8.6 ROAD PAVING WITH ASPHALT (NFR 2D3b)

The category reports NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC and PCDD/PCDF emissions. The emissions have decreasing overall trend (***Table 4.75***).

4.8.6.1 Overview

Yearly numbers of operators vary around 50 installations. 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.

Figure 4.47: *NMVOC emission trend in the category 2D3b*



4.8.6.2 Methodological issues

The source of emissions is NEIS database – recorded facility data from operators. No small sources are on the territory of the SR, thus data from NEIS covers all activity. The category uses T3 method.

The category source is NEIS database.

Table 4.78: *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 / hours.

The sources are considered as mixed and have inseparable combustion and technological emissions at release, because NFR code assignment is associated to the entire source coding (3.5). However, most of sources use the 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 PMi do not create 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 database).

Calculations: Most of the operators in category (approx. 70 %) report their emissions by way of mass flow multiplied by number of operational hours per related year. Mass balance is determined by authorized measurement according to ISO standard procedures.

$$Em\ [t] = q\ [kg/hod] * t\ [hod] * 10^{-3}$$

Where

q = Mass flow

t = Number of operational hours for related year

The rest of operators (approx. 30 %) report the emissions by the calculation:

$$Em\ [t] = (1-\eta/100) * EF\ [kg/M\ of\ AD] * AD\ [M\ of\ AD] * 10^{-3}$$

Where

EF = Emission Factor

AD = Activity Data (M of AD = Quantity of related Activity Data)

In case of activity data is fuel, because of mix sources (combined combustion and technological process), the emissions are performed by the calculation:

$$Em\ [t] = (1-\eta/100) * EF\ [kg/t] * AD\ [t] * 10^{-3}$$

$$Em_{TOTAL} = (1-\eta/100) * EF\ [kg/mil.m^3] * AD\ [tis.m^3]$$

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 registry of the NEIS and final emission are calculated with respect of separator at individual technologies. The overview of different types of separators is presented in **ANNEX IV: Chapter A4.7**.

Calculation of PMi: The compilation of PMi is performed in the environment of NEIS database. 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 SHMU with the base of GAINS methodology published by IIASA[2].

Activity data: Some information can be find in the NEIS. The production is independently obtained from the Research Institute of Engineering Constructions who is authorized by the Slovak Association for Asphalt roads (SAAV) for collecting and verification of data. The activity data is in form of annual reports of produced and used asphalt and asphalt mixtures in the road construction sector.

Historical data: The emissions are taken from the NEIS for years 2005 to 2017.

The national emission factors are used for the calculation of historical data. The EF were calculated as weighted average from the values of implied emission factors, which were calculated for every available years 2005-2015 and related yearly consumption of asphalt. PMi were calculated as average of share from TSP in previous years 2005–2015.

EF_{NMVOC} = 170 [g/Mg Asphalt]

EF_{TSP} = 510.80 [g/Mg Asphalt]

$EF_{PM2.5}$ = 1% EF_{TSP}

$EF_{PM2.5}$ = 12% EF_{TSP}

4.8.7 ASPHALT ROOFING (NFR 2D3c)

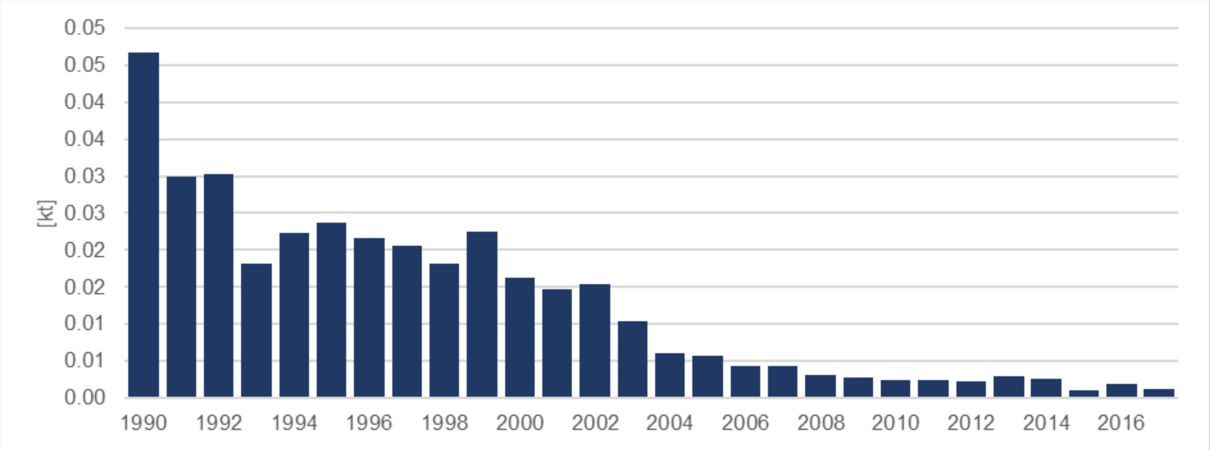
4.8.7.1 Overview

The category reports NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC and PCDD/F emissions. The emissions have overall decreasing trend (***Figure 4.48***), but increase is recorded in year 2016. However, in absolute values, the amount of released emissions in 2017 is 0.001 kt, which is insignificant amount.

[1] 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.

[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

Figure 4.48: *NMVOC emission trend in the category 2D3c*



4.8.7.2 Methodological issues

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

Table 4.79: Industrial activities included in 2D3c according to national categorization

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
4.37 Production of waterproofing materials and floor coverings with a projected amount of raw materials processed in kg/h.

No small sources are on the territory of SR thus T3 is used.

$$Em_{TOTAL} = Em_{NEIS}$$

The category code is associated to 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 NEIS database is a technological facility (installation) or a particular part of facility (installation). Source uses a fuel directly into technological process. Therefore source's output/discharge emissions compiled by NEIS or based on measurements contains 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 years 2005 to 2017.

The national emission factors are used for the calculation of historical data. The EF were calculated as weighted average from the values of implied emission factors, which were calculated for every available years 2005-2015 and related consumption of asphalt used for roofing from statistics. PMi were calculated as average of share from TSP in previous years 2005–2015. BC is calculated according to EF from EMEP/EEA GB_{2016}.

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

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

EF_{CO} = 5.53 [g/Mg Asphalt Use for Roofing]

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

$EF_{PM2.5}$ = 99% EF_{TSP}

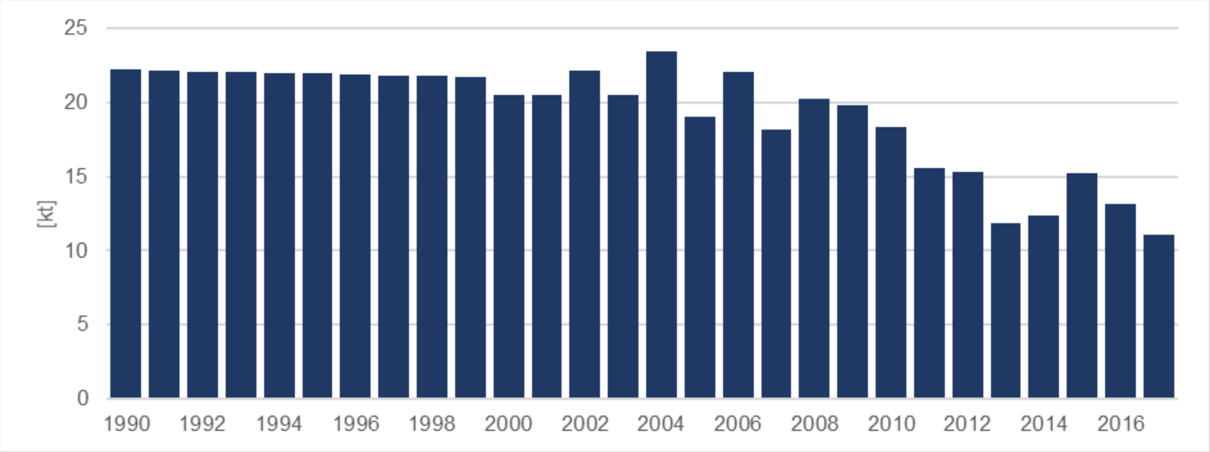
$EF_{PM2.5}$ = 0.013% EF_{TSP}

4.8.8 COATING APPLICATIONS (NFR 2D3d)

4.8.8.1 Overview

The category reports NMVOC emissions. The emissions have overall decreasing trend (***Figure 4.49***).

Figure 4.49: *NMVOC emission trend in the category 2D3d*



4.8.8.2 Methodological issues

The source of emissions is NEIS database – recorded facility data from operators. Small sources on the territory of SR not covered by NEIS are calculated from statistical data. Combination of T2+T3 is used.

Table 4.80*: 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 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 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, chips with a projected processing capacity in v m^3 / day c) production of agglomerated materials with projected consumption of polycondensated 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 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 to the wood processing as defined in the NFR. Therefore, the mechanical processing of wood is included. Yearly numbers of operators vary around 450 and covers 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:

$$Em_{TOTAL} = Em_{SMALL\ SOURCES} + Em_{NEIS}$$

Calculations in the NEIS: Reporting of solvents in the NEIS evidence is performed in Balance sheets of organic solvents for individual releases. Quantity of VOC are calculated by equations:

a) $E\ [t] = c\ [mg/m^3] * V\ [tis.m^{-3}] * 10^{-6}$

Where

c = concentration of air pollutant

V = quantity/volume of released waste gas

b) $E\ [t] = q\ [kg/hod] * t\ [hod] * 10^{-3}$

Where

q = mass flow

t = number of operational hours for related year

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 top down approach. The statistical data is processed and total solvents consumption is calculated according to scheme of the interim studies on specific solvents 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 as 100%.

Small sources calculation:

Production + Import – Export = Total Product Consumption

Total Product Consumption → Calculation of Total Solvents Consumption

Total Solvents Consumption - Industrial Solvents Consumption = Small Sources

Adjustment for VOC content: To implement recommendation No ***SK-2D3d-2018-0001***, following section was added. The data is reduced by the coefficient 0.7 from 2010 to the last reported year. The coefficient represents average reduction referred to the reduced content of VOCs in products since 2010 to previous values. The calculation of VOC emission reduction is based on the implementation of the VOC reduction regarding the Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC. Our specific VOC content used in 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 years 2005 to 2017. Due to the absence of statistical data before 2001 as well as data in NEIS before 2005, the historical data are extrapolated with linear trend.

Table 4.81: *Statistical activity data of total product consumption in t*

YEAR	SB	WB
2001	32 009	21 231
2002	36 099	23 569
2003	33 595	26 342
2004	40 746	26 516
2005	35 395	30 356
2006	47 038	31 443
2007	37 268	37 450
2008	37 402	76 942
2009	38 083	62 771
2010	51 429	77 875
2011	45 838	47 400
2012	45 410	43 655
2013	46 748	52 248
2014	52 626	58 059
2015	54 251	97 764
2016	51 658	65 932
2017	43 334	74 089

Table 4.82: *2D3d - Emission of NMVOC (t) in division of Small sources and Industrial sources*

YEAR	EM SS	EM NEIS
2005	12 542	6 479
2006	15 663	6 430
2007	10 436	7 735
2008	13 140	7 063
2009	13 422	6 371
2010	11 196	7 154
2011	8 355	7 234
2012	7 995	7 335
2013	8 816	3 052
2014	9 094	3 259
2015	11 843	3 342
2016	9 624	3 490
2017	7 422	3 658

4.8.8.3 Source specific recalculations

Few minor changes in steps of calculations were done during data checking and improved:

- Usage of weighted averages for better representing of product distribution.
- Check for the balance of statistical activity data, final values are slightly different.
- The incorrect activity data in 2012 was identified and removed. The emissions calculated from new activity data has risen.
- The double counting in calculation VOC in two products was identified and removed. All timelines were recalculated. The final values have slightly decreased.
- The average decline of recalculated total emission values of 2D3d is -1.6%.

Table 4.83: Recalculations in the category 2D3d

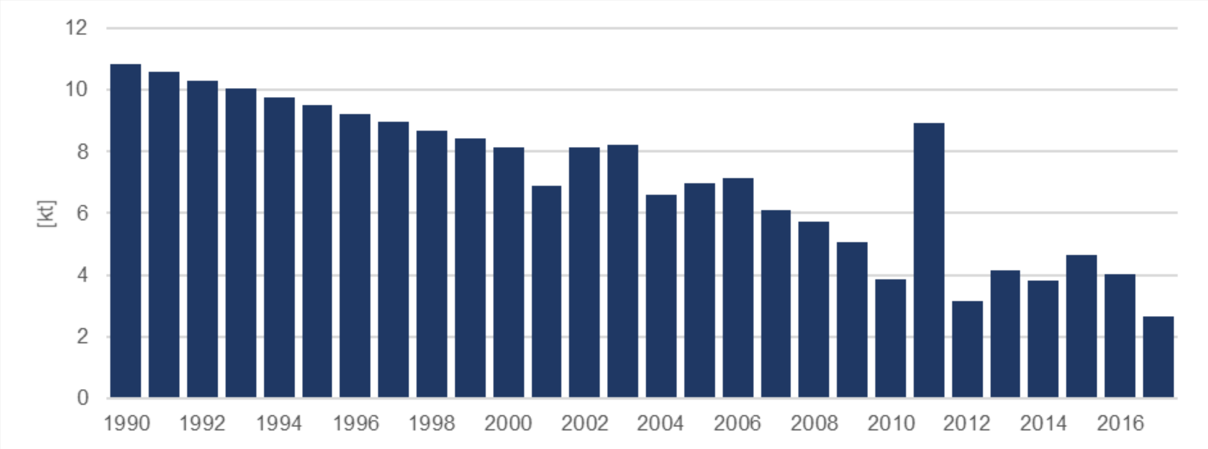
	PREVIOUS	REFINED	CHANGE
1990	22.55	22.20	-2%
1991	22.50	22.15	-2%
1992	22.45	22.10	-2%
1993	22.39	22.04	-2%
1994	22.34	21.99	-2%
1955	22.29	21.94	-2%
1996	22.23	21.88	-2%
1997	22.18	21.83	-2%
1998	22.13	21.78	-2%
1999	22.08	21.72	-2%
2000	21.26	20.47	-4%
2001	21.13	20.50	-3%
2002	22.82	22.11	-3%
2003	21.12	20.46	-3%
2004	24.28	23.48	-3%
2005	19.72	19.02	-4%
2006	22.63	22.09	-2%
2007	18.60	18.17	-2%
2008	20.63	20.20	-2%
2009	20.23	19.79	-2%
2010	18.56	18.35	-1%
2011	15.61	15.59	0%
2012	13.60	15.33	13%
2013	12.24	11.87	-3%
2014	12.77	12.35	-3%
2015	15.61	15.18	-3%
2016	13.30	13.11	-1%

4.8.9 DEGREASING (NFR 2D3e)

4.8.9.1 Overview

The category reports NMVOC emissions. The emissions have decreasing overall trend (***Figure 4.50***). The peak of recorded emission in 2011 relates to the activity data from statistics, namely decrease of exported solvents and increased amount of imported.

Figure 4.50: *NMVOC emission trend in the category 2D3e*



4.8.9.2 Methodological issues

The source of emissions is NEIS database – recorded facility data from operators. Small sources on the territory of SR not covered by the NEIS are calculated from statistical data. Combination of T2 + T3 is used.

Table 4.84: *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, electrocomponents, 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 obligation of solvents 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.

$$Em_{\text{TOTAL}} = Em_{\text{SMALL SOURCES}} + Em_{\text{NEIS}}$$

Calculations in NEIS: Please, see methods of Calculations in 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 top down approach. The statistical data is processed and total solvents consumption is calculated but without the step of calculating the VOC specific content because of the specific pure solvents that are used for this purposes in SR (for VOC using for degreasing activities are richlorethylene, Tetrachlorethylene (perchlorethylene), 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 → Calculation of Total Solvents Consumption

Total Solvents Consumption - Industrial Solvents Consumption = Small Sources

Table 4.85: *2D3c- Emission of NMVOC (t) in division of small sources and industrial sources*

YEAR	EM SS	EM NEIS
2005	6 680	280
2006	6 866	277
2007	5 742	359

YEAR	EM SS	EM NEIS
2008	5 418	292
2009	4 864	210
2010	3 627	217
2011	8 700	214
2012	2 934	202
2013	4 060	96
2014	3 719	89
2015	4 542	90
2016	3 918	94
2017	2 536	112

4.8.9.3 Source specific recalculations

Few minor changes in steps of calculations were done during data checking and improved:

- Check for the balance of statistical activity data, the activity data in 2012 and 2016 were corrected. The emissions calculated from new activity data in 2012 slightly rose, in 2016 decreased.

- Estimation of historical data before 1999 was adjusted in relation to change of trend derived from new values.

- The average decline of recalculated total emission values of 2D3d 0.27%.

Table 4.86: *Recalculations in the category 2D3e Degreasing*

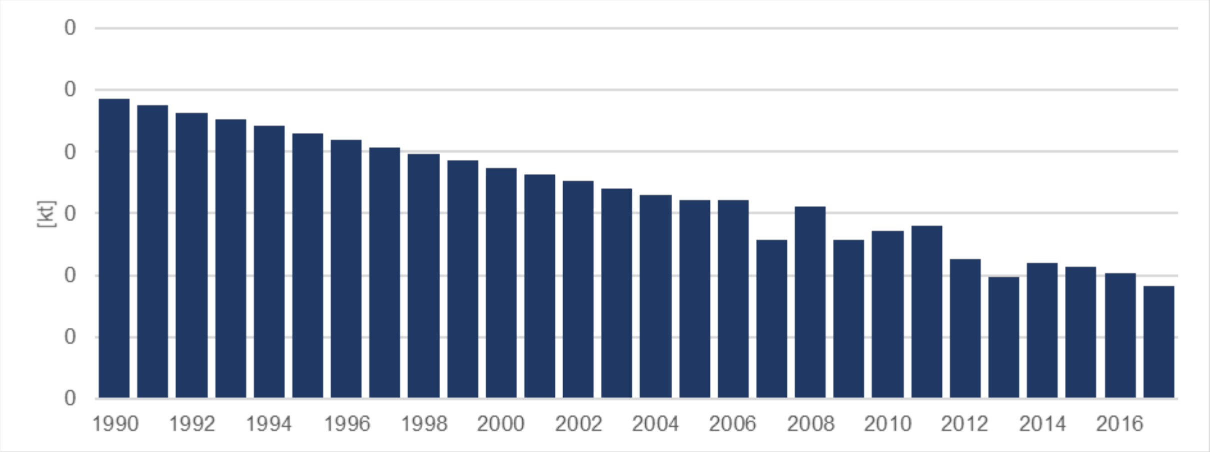
YEAR	PREVIOUS	REFINED	CHANGE
1990	10.78	10.85	1%
1991	10.51	10.58	1%
1992	10.24	10.31	1%
1993	9.98	10.04	1%
1994	9.71	9.76	1%
1995	9.44	9.49	1%
1996	9.18	9.22	0%
1997	8.91	8.95	0%
1998	8.64	8.68	0%
1999	8.38	8.41	0%
2000	8.11	8.14	0%
2001	6.89	6.89	0%
2002	8.12	8.12	0%
2003	8.23	8.23	0%
2004	6.59	6.59	0%
2005	6.96	6.96	0%
2006	7.14	7.14	0%
2007	6.10	6.10	0%
2008	5.71	5.71	0%
2009	5.07	5.07	0%
2010	3.84	3.84	0%
2011	8.91	8.91	0%
2012	3.10	3.14	1%
2013	4.16	4.16	0%
2014	3.81	3.81	0%
2015	4.63	4.63	0%
2016	4.24	4.01	-5%

4.8.10 DRY CLEANING (NFR 2D3f)

4.8.10.1 Overview

The category reports NMVOC emissions. The emissions have decreasing overall trend (***Figure 4.51***).

Figure 4.51: *NMVOC emission trend in the category 2D3f*



4.8.10.2 Methodological issues

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

Table 4.87: *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, 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

Yearly numbers of operators has declined from 127 to approximately 100 in recent 10 years that is the driver of decline. No small sources are on the territory of SR, because Decree defined limit = 0 for obligation of solvents evidence and registering into the NEIS as a medium source of air pollution.

$$Em_{TOTAL} = Em_{NEIS}$$

Calculations in the NEIS: Reporting of solvents in the NEIS evidence is performed in Balance sheets of organic solvents for individual releases. Quantity of VOC are calculated by equations:

$E\ [t] = c\ [mg/m^3] * V\ [tis.m^{-3}] * 10^{-6}$

Where

c = concentration of air pollutant

V = quantity/volume of released waste gas

b) $E\ [t] = q\ [kg/hod] * t\ [hod] * 10^{-3}$

Where

q = mass flow

t = number of operational hours for related year *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 years 2005 to 2017. Due to the absence of statistical data before 2001 as well as data in NEIS before 2005, the historical data are extrapolated with linear trend.

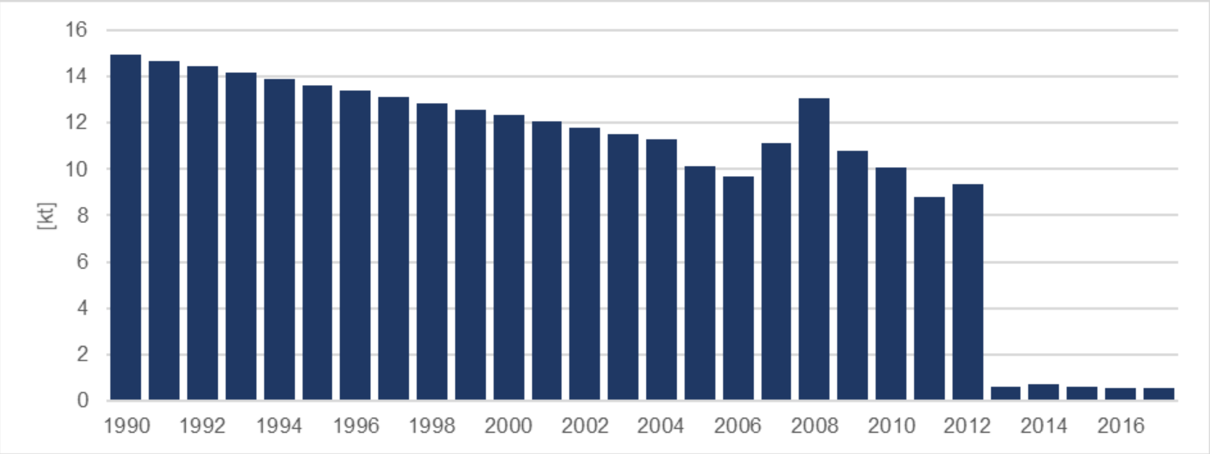
4.8.11 CHEMICAL PRODUCTS (NFR 2D3g)

4.8.11.1 Overview

The category reports NMVOC emissions. The emissions have decreasing overall trend (***Figure 4.52***). The most remarkable decline was in 2013 (from 9.569 kt in 2012 dropped to 0.666 kt in 2013) as well as in 2015 (0.6817 kt; 13% in 2015). The significant change has been caused by reconstruction of the major contributing company, that is classified under 4.19 – Manufacture of paints, varnishes, inks, glues and adhesives during 2013 when the installation was out of the service, while in the 2015 the small emission values was due to the realization of technological improvements.

Also, the data for 2012 and earlier were processed by the same method, but the technical inconsistence in database was found as a result of quality check. The solution for correcting data will be delivered in next submission. Emissions in the period 1990-2012 are overestimated significantly.

Figure 4.52: *NMVOC emission trend in the category 2D3g*



4.8.11.2 Methodological issues

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

Table 4.88: *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:

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
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 addition of styrene or epoxy resins with amines, such as production of boats, trucks, car parts, with a projected consumption of raw materials in kg / day
d) the processing of amino and phenolic resins with a projected consumption of raw materials in kg / day
e) production of polyurethane products with a projected consumption of organic solvents in tonnes / year
f) manufacturing expanded plastic, such as polystyrene foam, with a projected consumption of organic blowing agents in tonnes / year
6.10 Manufacturing and processing of leather:
a) manufacture of leather with a projected quantities for tonne / day
b) treatment of the leather, except of footwear and shoes 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 production and activities. Thus facility data from NEIS (b/ Tier 3: Em TOTAL = 100% NEIS) is used.

$$Em_{TOTAL} = Em_{NEIS}$$

<u>*Calculations in NEIS:*</u> Reporting of solvents in NEIS evidence is performed in Balance sheets of organic solvents for individual releases. Quantity of VOC are calculated by equations:

a) $E\ [t] = c\ [mg/m^3] * V\ [tis.m^{-3}] * 10^{-6}$

Where

c = concentration of air pollutant

V = quantity/volume of released waste gas

b) $E\ [t] = q\ [kg/hod] * t\ [hod] * 10^{-3}$

Where

q = mass flow

t = number of operational hours for related year

c) Direct and indirect balance in case of unambiguous emission dependence

$E = O1 + F$

Where

O1 = Emissions released by outputs

The activities of 6.10 was included here according to guidebook 2D3g Table 3-13 manufacturing of shoes and similarly 6.11 according the EMEP/EEA GB_{2016} Table 3-14 Leather tanning instead of 2D3i, where the activities were before.

The other emissions are recorded from sources in 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_{2016}.

Historical data: The emissions are taken from the NEIS for years 2005 to 2017. Due to the absence of any statistical data before 2001 as well as data in NEIS before 2005, the historical data are extrapolated with linear trend.

4.8.11.3 Source specific recalculations

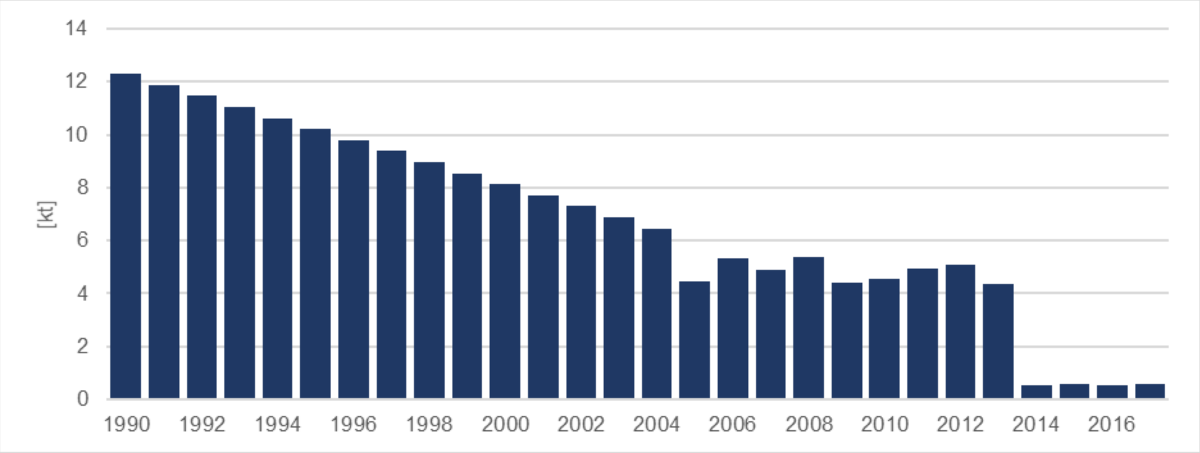
Technical inconsistence in database was found as a result of quality check. The solution for correcting data will be delivered in next submission (2020).

4.8.12 PRINTING (NFR 2D3h)

4.8.12.1 Overview

The category reports NMVOC emissions. The emissions have decreasing overall trend (***Figure 4.53***). Decrease in 2013 is a result of the technological problem within the source database. Emissions in the period 1990-2012 are overestimated significantly.

Figure 4.53: *NMVOC emission trend in the category 2D3h*



4.8.12.2 Methodological issues

The source of emissions is 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. 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:

$$Em_{\text{TOTAL}} = Em_{\text{SMALL SOURCES}} + Em_{\text{NEIS}}$$

Please, see methods of Calculations in NEIS in **ANNEX IV Chapter A4.1-A4.5**

Calculations of Small Sources: Small sources were balanced. The balance is performed by top down approach. The statistical data are processed and total solvents consumption is calculated. From the total balance of 2D3d the printing inks has been separated and allocated into 2D3h as a small sources.

Small sources calculation:

Production + Import – Export = Total Product Consumption

Total Product Consumption → Calculation of Total Solvents Consumption

Total Solvents Consumption - Industrial Solvents Consumption = Small Sources

Historical data: The emissions are taken from the NEIS for years 2005 to 2017. Due to the absence of any statistical data before 2001 as well as data in NEIS before 2005, the historical data are extrapolated with linear trend.

4.8.12.3 Source specific recalculations

Timeline values reported in 2019 are in comply with values reported in 2018. The recalculation of category was done during the preparation of reporting cycle 2018. Double counting in calculations was found. The emission of VOC from total solvent consumption were incorrectly counted as small sources and counted together with industrial emissions. Instead of deduction of the industrial solvents consumption from the total solvents consumption calculated from statistics to determine the missing part of small sources.

According to definition of limit value for medium sources, there is an assumption for existing of small sources for printing activities. However, the values of statistical balance are comparable or lower in some years than solvents for industrial sources with printing activities registered in database and we assume that all consumption is covered.

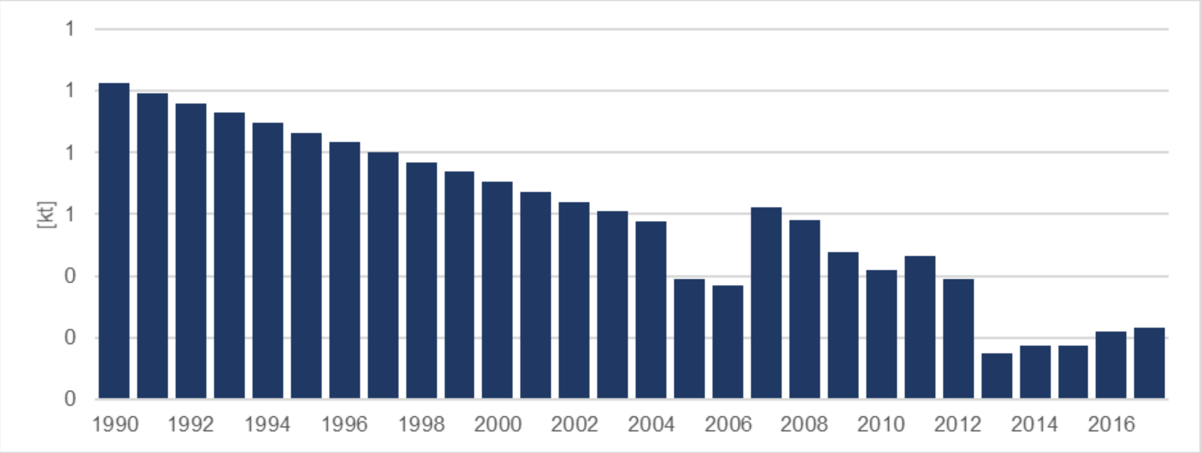
After review recommendation No ***SK-2D3h-2018-0001***, the data of NEIS was checked. The data were processed by the same method, but for 2012 and older years, the technical inconsistence in database was found as a result of quality check. The solution for correcting data will be performed in next submission.

4.8.13 OTHER SOLVENT USE (NFR 2D3i)

4.8.13.1 Overview

The category reports NMVOC emissions. The emissions have decreasing overall trend (***Figure 4.54***).

Figure 4.54: *NMVOC emissions in the category 2D3i*



4.8.13.1 Methodological issues

The source of emissions is 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. Combination of T2 + T3 is used.

According to the recommendation ***SK-1A3b-2018-0001***, lubricant consumption in road transport was calculated for the first time and allocated into this category. Emissions of SOx and heavy metals were added.

Table 4.90: *Emissions from lubricant consumption in transport*

	SOx	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	0.01	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	3.69
1995	0.01	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	3.49
2000	0.01	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	3.76
2005	0.02	0.0002	0.0003	0.0001	0.0003	0.0002	0.0001	0.0001	0.0001	5.60
2010	0.03	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.77
2011	0.03	0.0003	0.0003	0.0002	0.0004	0.0002	0.0002	0.0002	0.0001	6.45
2012	0.03	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.94
2013	0.03	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	6.79
2014	0.03	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002	0.0002	0.0001	7.03
2015	0.03	0.0003	0.0004	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	7.79
2016	0.03	0.0003	0.0004	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	7.93
2017	0.03	0.0003	0.0004	0.0002	0.0005	0.0003	0.0002	0.0002	0.0002	8.13

Table 4.91: *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 industry:

$$Em_{\text{TOTAL}} = Em_{\text{SMALL SOURCES}} + Em_{\text{NEIS}}$$

Please, see methods of Calculations in the NEIS in **ANNEX IV Chapter A4.1-A4.5**.

Historical data: The emissions are taken from the NEIS for years 2005 to 2016. Due to the absence of statistical data before 2001 as well as data in the NEIS before 2005, the historical data are extrapolated with linear trend.

Emission calculations in transport are based on the model COPERT.

4.8.13.3 Source specific recalculation

Emissions from lubricant consumption were added to the inventory.

4.8.14 OTHER PRODUCT USE (2G)

4.8.14.1 Overview

In this category, emissions arising from tobacco combustion and use of fireworks are reported.

Tobacco smoke contains a number of 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

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

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. The ***Table 4.92*** below shows significant increase of emissions in this category from the 1990 due to increase of tobacco and fireworks use. In the ***Figure 4.55*** substantial increase of tobacco combusted, and therefore emissions too, were recorded in the year 2005 and 2009. These peaks were caused by growth of imported tobacco after Slovakia entered EU (2005) and last year of operation of only Slovak tobacco factory in 2009. Use of fireworks and associated emissions, was influenced by economic status in the Slovak Republic. Significant decrease in 2010 related to economic depression of inhabitants after crisis. The next period of economic stability brought an increase in sales of this segment until 2017 although usage of fireworks has been since 2014 limited[4].

Table 4.92: *Overview of main pollutants emissions in the category Other product use*

	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	0.037098
1995	0.0087	0.0232	0.0004	0.0199	0.1293	0.1293	0.1293	0.0582	0.264703
2000	0.0097	0.0257	0.0016	0.0220	0.1433	0.1433	0.1433	0.0645	0.296114
2005	0.0447	0.1196	0.0024	0.1025	0.6670	0.6671	0.6671	0.3001	1.366742
2010	0.0161	0.0431	0.0004	0.0370	0.2404	0.2404	0.2404	0.1082	0.491507
2011	0.0160	0.0425	0.0020	0.0365	0.2372	0.2372	0.2373	0.1067	0.488761
2012	0.0164	0.0436	0.0024	0.0374	0.2433	0.2433	0.2433	0.1095	0.502112
2013	0.0144	0.0380	0.0031	0.0325	0.2118	0.2119	0.2119	0.0953	0.439387
2014	0.0153	0.0404	0.0027	0.0346	0.2254	0.2254	0.2254	0.1014	0.466155
2015	0.0155	0.0410	0.0030	0.0352	0.2289	0.2289	0.2289	0.1030	0.473973
2016	0.0155	0.0409	0.0031	0.0350	0.2281	0.2281	0.2281	0.1026	0.472697
2017	0.0167	0.0439	0.0041	0.0376	0.2448	0.2448	0.2449	0.1101	0.509032
1990/2017	**1 274%**	**1 255%**	**3 842%**	**1 255%**	**1 255%**	**1 256%**	**1 256%**	**1 255%**	**1 272%**
2016/2017	**8%**	**7%**	**31%**	**7%**	**7%**	**7%**	**7%**	**7%**	**8%**

	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Zn [t]
1990	0.0268	0.0001	0.0000	0.0000	0.0005	0.0152	0.0010	0.0089
1995	0.0925	0.0002	0.0000	0.0002	0.0018	0.0524	0.0036	0.0307
2000	0.4180	0.0008	0.0000	0.0007	0.0083	0.2368	0.0160	0.1386
2005	0.6138	0.0013	0.0000	0.0010	0.0122	0.3477	0.0236	0.2036
2010	0.0932	0.0002	0.0000	0.0002	0.0019	0.0528	0.0036	0.0309
2011	0.5192	0.0010	0.0000	0.0009	0.0103	0.2941	0.0199	0.1722
2012	0.6244	0.0012	0.0000	0.0011	0.0124	0.3537	0.0239	0.2071
2013	0.7939	0.0015	0.0001	0.0013	0.0158	0.4496	0.0304	0.2633
2014	0.6932	0.0014	0.0001	0.0012	0.0138	0.3926	0.0265	0.2299
2015	0.7700	0.0015	0.0001	0.0013	0.0153	0.4361	0.0295	0.2554
2016	0.8080	0.0016	0.0001	0.0014	0.0161	0.4577	0.0309	0.2680
2017	1.0569	0.0020	0.0001	0.0018	0.0210	0.5986	0.0405	0.3505
1990/2017	**3 842%**	**3 670%**	**3 842%**	**3 842%**	**3 842%**	**3 842%**	**3 838%**	**3 842%**
2016/2017	**31%**	**30%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**

	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

[4] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2014/58/

	PCDD/F [g I-TEQ]	B(a)P [t]	B(b)F [t]	B(k)F [t]	I()P [t]	PAHs [t]
2000	0.0005	0.0006	0.0002	0.0002	0.0002	0.0013
2005	0.0025	0.0027	0.0011	0.0011	0.0011	0.0061
2010	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2011	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2012	0.0009	0.0010	0.0004	0.0004	0.0004	0.0022
2013	0.0008	0.0009	0.0004	0.0004	0.0004	0.0019
2014	0.0008	0.0009	0.0004	0.0004	0.0004	0.0021
2015	0.0008	0.0009	0.0004	0.0004	0.0004	0.0021
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
1990/2017	**1 255%**	**1 255%**	**1 255%**	**1 255%**	**1 255%**	**1 255%**
2016/2017	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**

Figure 4.55: *Amount of tobacco combusted in the Slovak Republic*

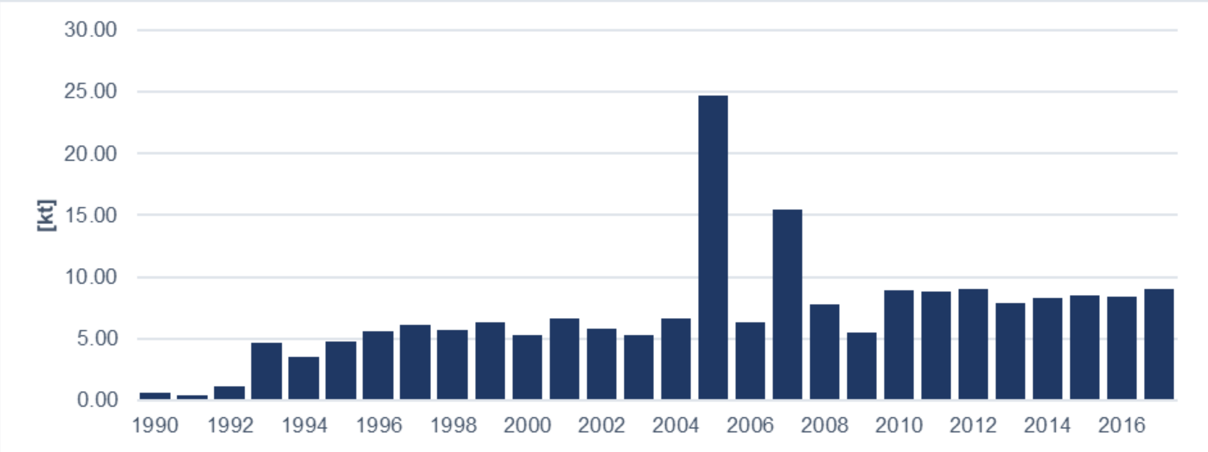
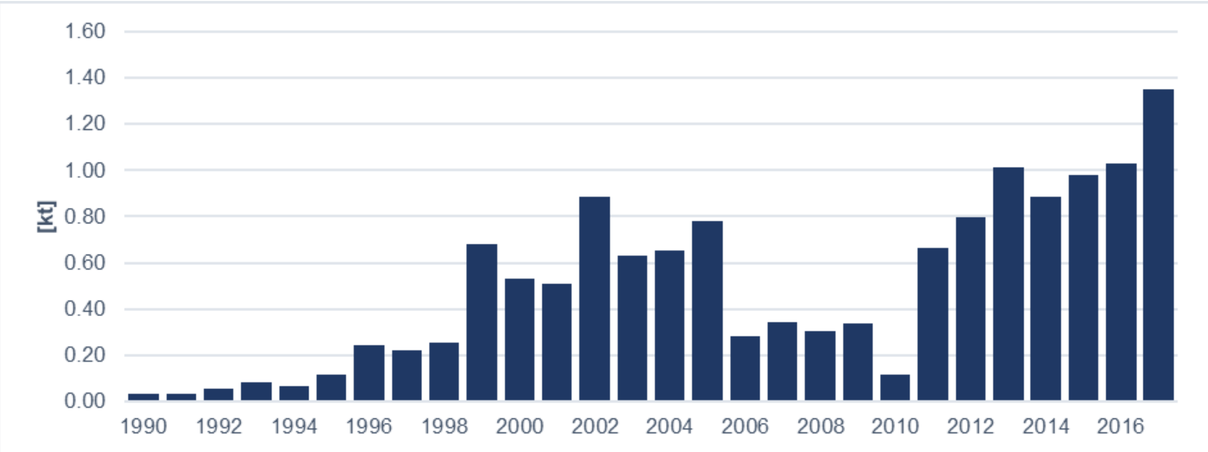


Figure 4.56: *Amount of fireworks used in the Slovak Republic*



4.8.14.2 Methodological issues

Activity data about amounts of fireworks and tobacco, import/export data from the statistical office were used. There were no production of firework in the Slovak Republic in the whole time series. For calculations of fireworks used ***Equation 4.1*** for the period 1991-2017 was used:

Equation 4.1: *Amount of product used in the Slovak Republic in particular year*

$$Product\ total\ = Product\ import\ total - Product\ export\ total$$

There were 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 4.1*** was used for cigarettes for period 2005-2017 and for cigars and cigarillos for period 2009-2017.For the previous periods, it was assumed that production was equal to export and only import data entered into calculations. For the next submission, obtaining of confidential data about production of tobacco product were planned. ***Table 4.93*** shows results of these calculations.

Table 4.93*: Activity data used in the category Other product use*

YEAR	TOBACCO COMBUSTED [kt]	FIREWORKS USED [kt]
1990	0.67	0.03
1995	0.42	0.03
2000	1.10	0.06
2005	4.68	0.08
2010	3.51	0.07
2011	4.79	0.12
2012	5.61	0.24
2013	6.09	0.22
2014	5.68	0.26
2015	6.34	0.68
2016	5.30	0.53
2017	6.68	0.51

Emission factors for the calculations originate from the Tier 2 methodology in EEA/EMEP GB_{2016} (***Table 4.94***). **Condensable component of PMs** is included in emission factors for tobacco combustion, for use of fireworks is this information unknown.

Table 4.94: *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

POLLUTANT	NOx	NMVOC	NH3	PM2.5	PM10	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

4.8.14.3 Source specific recalculations

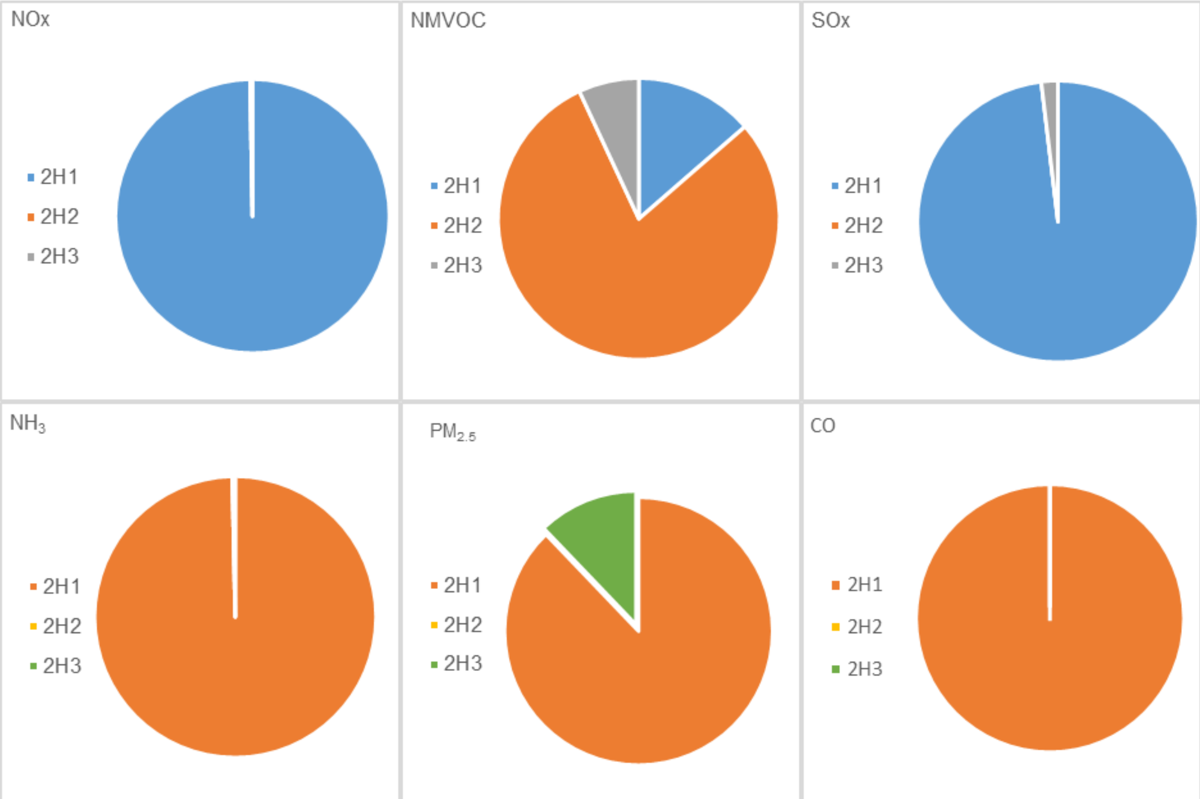
This category was balanced for the first time in this submission.

4.9 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)

Shares of NO_X, NMVOC, SO_X, NH_3, $PM_{2.5}$, CO emission in 2017 included in NFR categories are shown in ***Figure 4.57****.*

Figure 4.57: *Shares of emissions in 2H in 2017*



4.9.1 PULP AND PAPER INDUSTRY (NFR 2H1)

4.9.1.1 Overview

Pulp and paper production consists 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.

Emissions from paper and pulp production include non-methane volatile organic compounds (NMVOC), sulphur oxides (SOx), particulates, nitrogen oxides (NOx) and carbon monoxide (CO).

Several companies (10) were operating during the year 2017 in pulp and paper industry in the Slovak Republic. Among them only one is categorized as a medium source, the rest are large sources. In the ***Figure 4.58*** can be seen that emissions of all pollutants decreased in general since the year 1990.

Figure 4.58: *Emissions trends in the category 2H1*

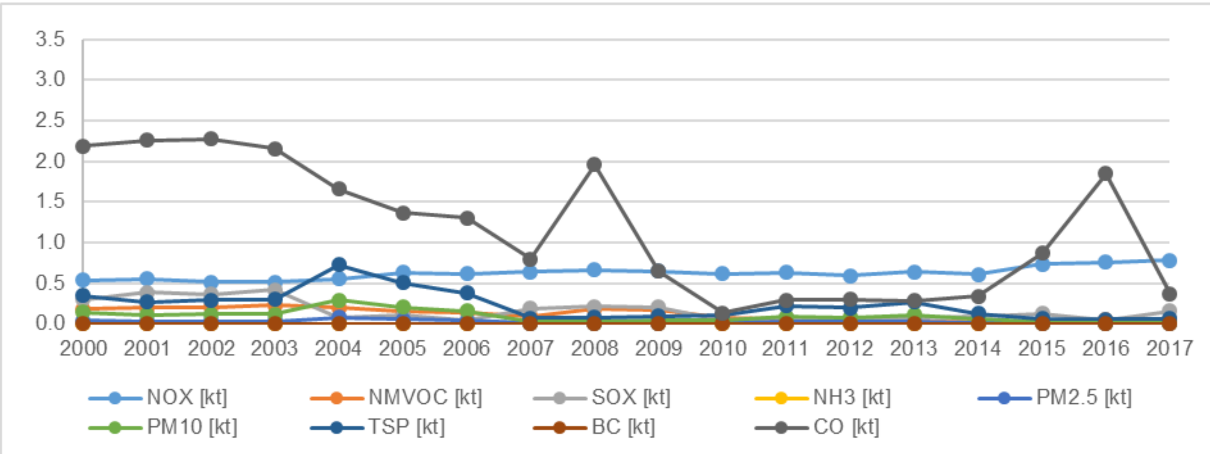


Table 4.95: *Activity data of 2H1 in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	PULP PRODUCTION
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[kt]
1990	496.7	NA	278	NA	15 437	NA
1995	385.1	NA	388	NA	15 835	NA
2000	361.7	NA	568	NA	10 754	NA
2005	36.9	NA	688	NA	16 057	NA
2010	NA	NA	645	NA	19 658	NA
2011	NA	NA	584	NA	18 878	NA
2012	NA	NA	538	NA	18 379	NA
2013	NA	NA	546	NA	18 235	NA
2014	NA	NA	655	NA	17 756	NA
2015	NA	NA	1 720	NA	6 004	NA
2016	NA	NA	548	NA	15 993	NA
2017	NA	NA	617	NA	15 799	NA

4.9.1.2 Methodological issues

Table 4.96: *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, cardboard with projected output in t / d

Emission data is compiled in the NEIS database therefore the individual specific EF could be used for sources recorded in database. Otherwise general EFs of the Bulletin of Ministry of Environment and detailed methodology of NEIS are presented in **ANNEX IV*.*** The following table presents the share in percent of use of different types of calculation of emissions reported from plants and sources in the NEIS.

Table 4.97: *The overview of share of used calculation type for category 2H1 in NEIS*

2H1	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	87.43%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	0.08%
4	Calculation using emission factor and amount of fuel	1.05%
5	Calculation using emission factor and amount of related quantity other than fuel	1.03%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	10.41%

Emissions from production of pulp and paper is in large scale continuously measured (87.4%). Activity data on air dried paper is not available. Implied emission factors are related to total consumption of fuels and they are presented in the following ***Table 4.98***.

Table 4.98: *Implied emission factors for air pollutants in 2H1*

IEF [g/TJ]	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC $\%PM_{2.5}$	CO
2017	47.73	2.91	9.53	0.001	11.39%	41.19%	4.05	2.60%	22.46
W-IEF [G/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC $\%PM_{2.5}$**	**CO**

2000-2003	41.86	16.10	29.13	NO	10.77%	40.66%	23.77	2.60%	174.90
EF [g/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC %$PM_{2.5}$**	**CO**
1990-1999	41.86	16.10	29.13	NO	10.77%	40.66%	23.77	2.60%	174.90

Since 2012 ammonia is occurring in registry of NEIS, previous years are reported with notation key NO. Timelines 1990-1999 of BC emissions were completed by using default EFG_{B2016} = 2.6% of $PM_{2.5}$ Heavy metals, PCDD/F and HCB are reported with notation key NA, other POPs are reported with notation key NE in comply with the EMEP/EEA GB_{2016}.

4.9.1.3 Recalculations, improvements and implementation of recommendations

Table 4.99: *Recommendation of review 2018*

NUMBER	NFR, POLLUTANT(S), YEAR(S)	BRIEF DESCRIPTION
SK-2H1-2018-0001	2H1 Pulp and paper industry: SO_X, NOx 1990-2015	The TERT noted that recommendation SK-2H1-2017-0001 from the 2017 NECD Review was implemented to a large extent but that any explanation on the category and recalculations is missing in the IIR. In response to a question raised during the review Slovakia explained that this part of IIR was not provided due to the other activities related to the inventory and last year's review and that the current reporting cycle will be focused on the industrial part. The TERT recommends that Slovakia includes the detailed description of methods, AD and EF in its next IIR.

Description was completed.

Further recalculations emission of period 1990 - 1999 relates to the harmonization and overall controlling of NCVs in fuels. IEF are related to total fuel consumption and were slightly changed due to the final fuel values. Emissions of air pollutants are lower in compare to submission from the year 2018.

4.9.2 FOOD AND BEVERAGES INDUSTRY (NFR 2H2)

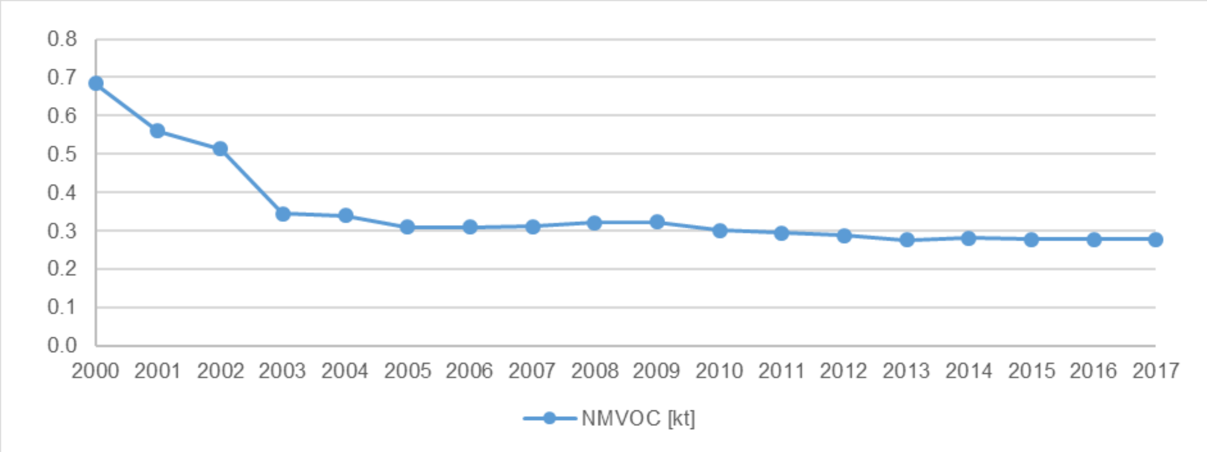
4.9.2.1 Overview

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 fermentation of sugar, which comes from fruit, cereals or other vegetables. Sugar is converted by yeast into the 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 a number of years before consumption.

Emissions of NMVOC are reported under this category. As shown in the ***Figure 4.59***, emissions have decreasing character until 2005, since then they remain stable.

Figure 4.59: *Emission trend of NMVOC in the category 2H2*



4.9.2.2 Methodological issues

Activity data comes from statistics. Methodology has not been updated.

EM= AD(production)*EF(Default)

EF_{wine} = 0.08 [kg/thous. litre of product]

EF_{beer} = 0.02 [kg/thous. litre of product]

EF_{bread} = 3 [kg/t of product]

Emissions of $PM_{2.5}$, PM_{10}, BC and TSP are reported with notation key NE. Other emission are reported NA according to EMEP/EEA GB_{2016}.

Table 4.100: *Emission factors of NMVOC in the category 2H2*

ACTIVITY	EF	UNIT
Animal rendering	0.33	kg/Mg meat
Fish meal processing	1	kg/Mg fish
Grain drying	1.3	kg/Mg grain dried
Hop processing	7.8	g/Mg beer
Maturation	20	kg/Mg alcohol
Handling of agricultural products (grains, soya)	24	g/ton
Bread, typical EU	4.5	kg/Mg bread
Sponge-dough bread	8	kg/Mg bread
White bread	4.5	kg/Mg bread
White bread shortened process	2	kg/Mg bread
Wholemeal bread	3	kg/Mg bread
Light Rye bread	3	kg/Mg bread

Table 4.101: *Activity data in the category 2H2 in th.m³ or tonnes*

	WHITE WINE	RED WINE	SPARKLING WINE	SPIRITS	BEER	WHITE BREAD	WHOLE GRAIN BREAD	BAKERY PRODUCTS	EDIBLE VEGETABLE FATS AND OILS
1990	44660	11871	5000	61000	460700	154780	63220	221300	55533
1995	46928		5000	49000	436900	171000		100000	63560
2000	32966			NA	449137	124344			78618
2005	27 586			NA	387 863	110 043			70 241
2010	20 141			NA	295 710	97 902			32 790
2011	31 389			NA	297 317	95 832			46 362
2012	37 190			NA	299 838	93 418			34 435
2013	41 613			NA	288 251	89 112			IE
2014	38 441			NA	264 803	91 299			IE
2015	49 021			NA	240 434	89 941			IE
2016	16176.02			NA	221095.09	87178.68			IE
2017	19 726			NA	235360.35	87612.02			IE

4.9.3 OTHER INDUSTRIAL PROCESSES (NFR 2H3)

4.9.3.1 Overview

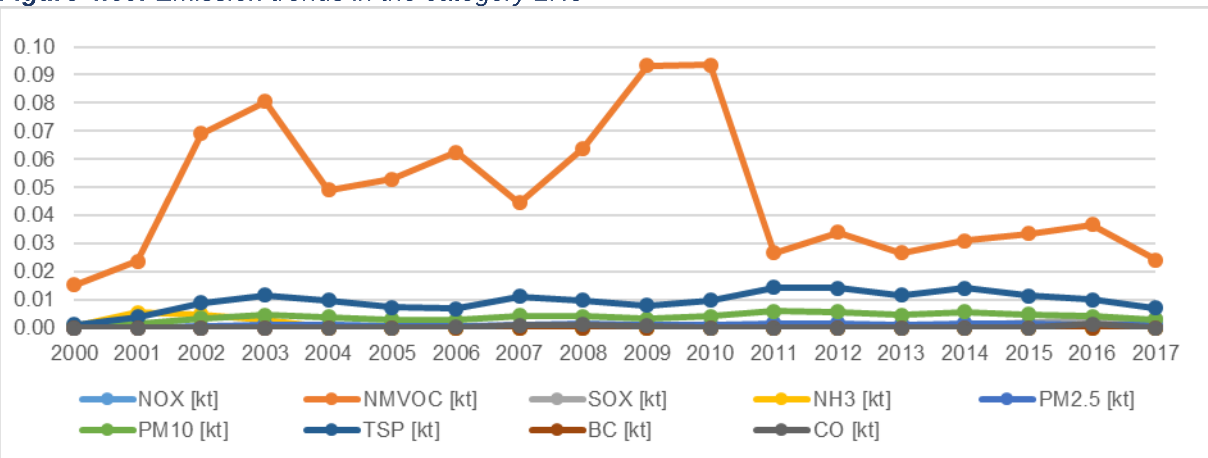
In this category activities listed in the ***Table 4.102*** were reported. This category includes various sources such as body shops, grain silos, galvanic lines etc.

Table 4.102: *Activities according to national categorization included in 2H3*

CATEGORIZATION ACCORDING TO THE ANNEX NO 6 OF DECREE NO 410/2012 COLL. AS AMENDED:
6.99 Other industrial technology, manufacturing, processing equipment not listed in points 1 to 5 - breakdown according to paragraph 2.99

Figure 4.60 shows emission trend in this category.

Figure 4.60: *Emission trends in the category 2H3*



4.9.3.2 Methodological issues

Table 4.103: *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, processing equipment not specified in points 1 to 5

Table 4.104*: The overview of share of used calculation type for category 2H3 in NEIS*

2H3	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	0%
2	Calculation using representative concentration and volume of flue gas	0%
3	Calculation using representative individual mass flow and number of operating hours	96.8%
4	Calculation using emission factor and amount of fuel	0%
5	Calculation using emission factor and amount of related quantity other than fuel	1.8%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	1.4%

Heavy metals and POPs are reported with notation key NA.

Total category emissions represent 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 1990-1999 were extrapolated by linear trend.

4.10 WOOD PROCESSING (NFR 2I)

4.10.1 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.

Figure 4.61 shows emission trends in this category, where emissions decreasing in general until 2013.

Figure 4.61: *Emission trends in the category 2I*

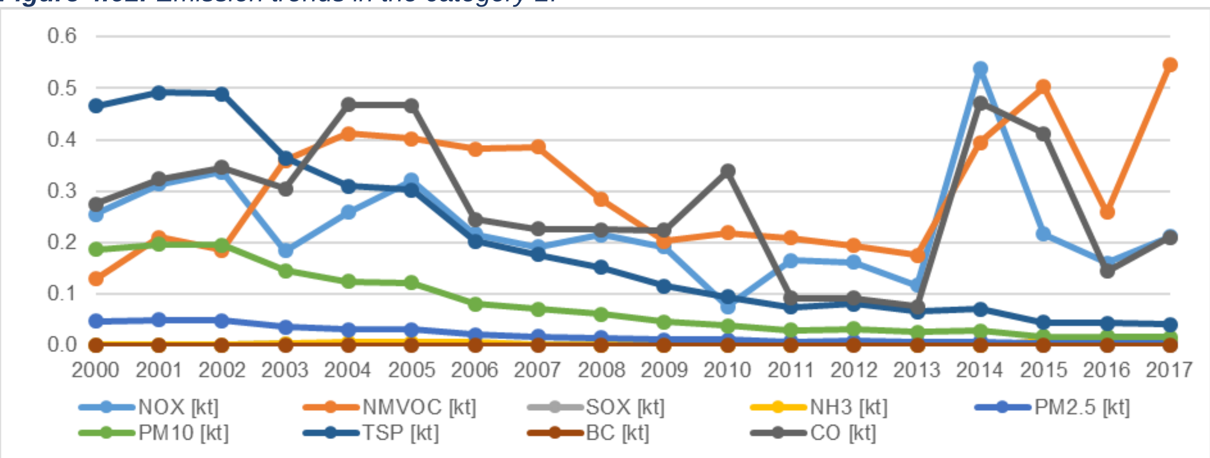


Table 4.105: Activity data of 2I in selected years

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV
1990	73.6	NA	234	103.4	NA
1995	56.9	NA	240	103.7	NA
2000	58.9	NA	110	14.7	NA
2005	NO	NA	390	13.9	NA
2010	NO	NA	219	2.3	NA
2011	NO	NA	139	2.9	NA
2012	NO	NA	165	112.4	NA
2013	NO	NA	326	66.7	NA
2014	7.6	NA	412	76.3	NA
2015	0.1	NA	155	433.0	NA
2016	0.1	NA	153	936.5	NA
2017	0.2	NA	168	1 007.1	NA

4.10.2 METHODOLOGICAL ISSUES

The definition of activities covered by category 2I is provided in the ***Table 4.106***. 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. Heavy metal and POPs are reported with notation key NA.

Table 4.106: 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, chips with a projected processing capacity in v m^3 / day
c) production of agglomerated materials with projected consumption of polycondensated 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

Table 4.107: The overview of share of used calculation type for category 2I in NEIS

2I	TYPE OF EMISSION COMPILATION/CALCULATION	%
1	Continuous measurement	32.99%
2	Calculation using representative concentration and volume of flue gas	0.08%
3	Calculation using representative individual mass flow and number of operating hours	17.61%
4	Calculation using emission factor and amount of fuel	4.81%
5	Calculation using emission factor and amount of related quantity other than fuel	43.97%
6	Calculation using emission factor related to content of AP in fuel and amount of fuel	0%
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	0.01%
8	Calculation using emission factor related to calorific value	0%
9	Calculation using emission factor related to content of AP in fuel and related to calorific value and to amount of fuel	0%
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	0%
99	Other manner of determination	0.53%

Implied emission factors related to total fuels are provided, other activity data are not available. Emission in the period 1990-1999 were calculated by using the weighted IEF from existing data. Overview is in the ***Table 4.108*** below.

Table 4.108: Implied emission factors for air pollutants in 2I

IEF [G/TJ]	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$ %TSP	PM_{10} %TSP	TSP	BC $\%PM_{2.5}$	CO
2017	179.79	463.71	0.04	7.94	10.00%	40.00%	35.03	NE	178.74
W-IEF [G/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC $\%PM_{2.5}$**	**CO**
2000-2004	1 060.2	1 019.3	7.8	8.7	10.00%	40.00%	1 667.1	NE	1 349.4
EF [G/TJ]	**NOx**	**NMVOC**	**SOx**	**NH_3**	**$PM_{2.5}$ %TSP**	**PM_{10} %TSP**	**TSP**	**BC $\%PM_{2.5}$**	**CO**
1990-1999	1 060.2	1 019.3	7.8	8.7	10.00%	40.00%	1 667.1	NE	1 349.4

4.11 PRODUCTION OF POPS (NFR 2J)

4.11.1 OVERVIEW

This activity is not occurring in the Slovak Republic, therefore notation key NO was used. Notation key for fuel was changed from NA to NO likewise in 2B1 where use of NO key for fuels was advised by TERT

4.12 CONSUMTION OF POPS AND HEAVY METALS (NFR 2K)

4.12.1 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. Trend of emissions and activity data are presented in ***Figures 4.62, 4.63*** and ***Table 4.109***.

Figure 4.62: Trend of Hg emissions in 2K

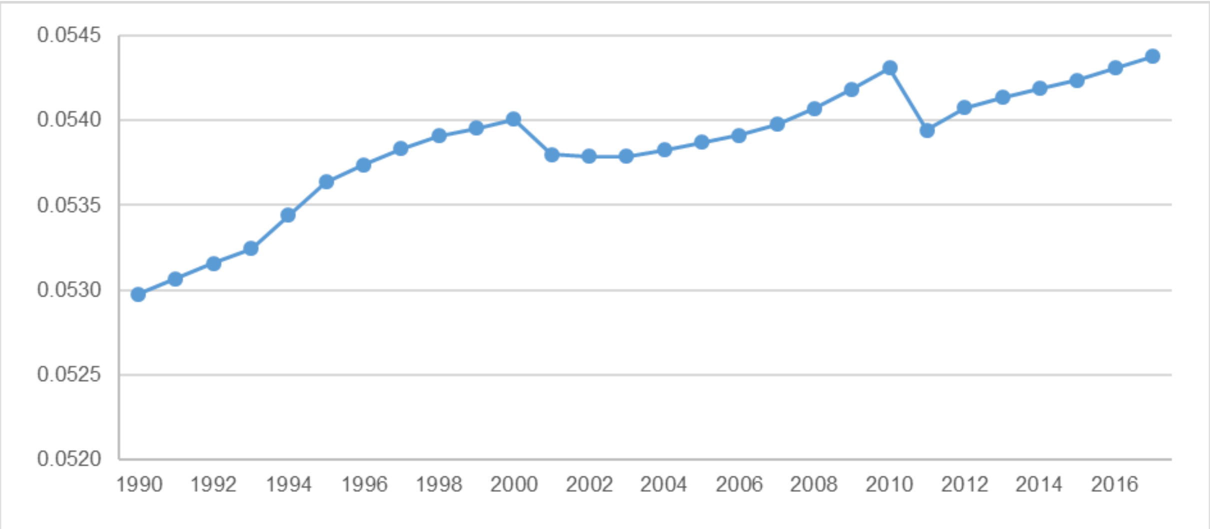


Figure 4.63: *Trend of PCB emissions in 2K*

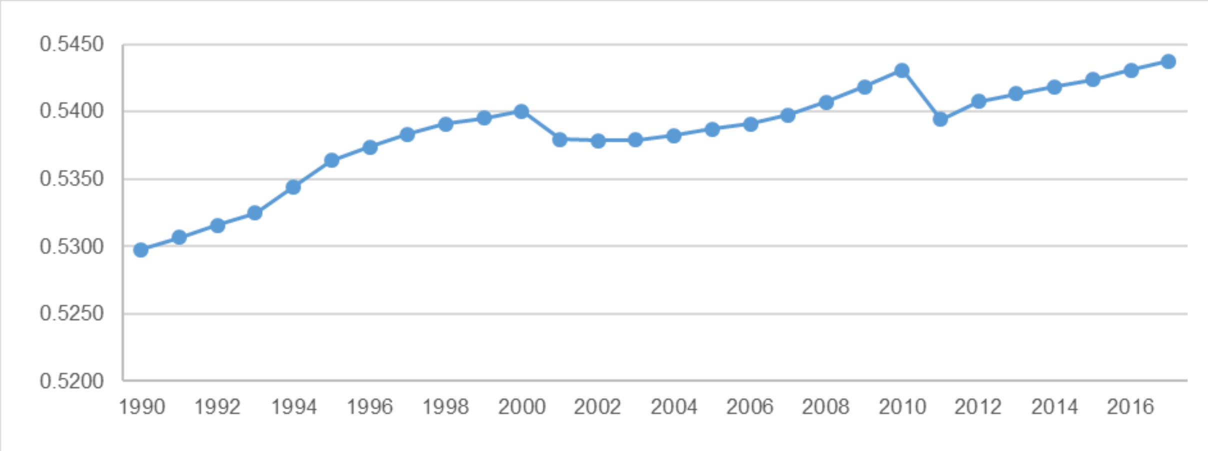


Table 4.109: *Activity data of 2K in selected years*

YEAR	LIQUID FUELS	SOLID FUELS	GASEOUS FUELS	BIOMASS	OTHER FUELS	INHABITANTS
	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV	[cpt]
1990	NA	NA	NA	NA	NA	5 297 774
1995	NA	NA	NA	NA	NA	5 363 676
2000	NA	NA	NA	NA	NA	5 400 679
2005	NA	NA	NA	NA	NA	5 387 285
2010	NA	NA	NA	NA	NA	5 431 024
2011	NA	NA	NA	NA	NA	5 394 251
2012	NA	NA	NA	NA	NA	5 407 579
2013	NA	NA	NA	NA	NA	5 413 393
2014	NA	NA	NA	NA	NA	5 418 649
2015	NA	NA	NA	NA	NA	5 423 800
2016	NA	NA	NA	NA	NA	5 430 798
2017	NA	NA	NA	NA	NA	5 437 754

4.12.2 METHODOLOGICAL ISSUES

Emission of Hg and PCB are calculated by Tier 1 method according to EMEP/EEA GB_{2016}. Activity data were obtained from the ŠÚ SR – number national population - Mid-year population.

EF = Inhabitants*EF(Default)

Other pollutants (NO_X, NMVOC, SO_X, NH_3, PMi, TSP, BC, CO, POPs) are reported in comply with EMEP/EEA Guidebook with notation key NA, as well as fuels, and with notation key NE for heavy metals and HCB.

Simple equation was needed to balance emissions of Hg and PCBs from this source category:

$$E = EF_{GB2016} * AD_{(ŠÚ\ SR)}$$

Emission factors used for the calculation are shown in the ***Table 4.110***.

Table 4.110: *Emission factors in the category 2K*

POLLUTANT	Hg	PCBs
Unit	g/capita	g/capita
Value	0.01	0.1

4.13 OTHER PRODUCTION, CONSUMPTION, STORAGE, TRANSPORTATION OR HANDLING OF BULK PRODUCTS (NFR 2L)

4.13.1 OVERVIEW

Category is reported with notation key NO. This production is not occurring in the Slovak Republic. Notation key for fuel was changed from NA to NO likewise in 2B1 where use of NO key for fuels was advised by TERT.

CHAPTER 5: AGRICULTURE (NFR 3)

This chapter was prepared by the sectoral experts and institutions 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 considered as 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), non-methane volatile organic compound (NMVOC) and nitrogen oxides (NO_X) emissions are analysed according to the EMEP/EEA GB_{2016} when principles of good practice in agriculture are taken into account. The emissions of NH_3, NO_X, PM, TSP, and NMVOC can reduce 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 storage and application of manure resulted in the fact that the emissions were evaluate in the same way as usual. Slovak agricultural inventory takes advantage of parallel inventory preparation and reporting of greenhouse gases (GHGs) 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-budget 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 regionalisation of agricultural areas in the Slovak Republic. The Ministry of Agriculture and Rural Development of the Slovak Republic issues annual statistics in the Green Report, part agriculture, and food. Activity data are also available in the Statistical Yearbooks. Sector agriculture is prepared in the 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.

5.1 OVERVIEW OF THE SECTOR (NFR 3)

The share of agriculture and food industry in the macro-economic indicators of the national economy has increased in the most indicators in 2017 (income, cost, sales from own products). The result of this development is increase of activity in the agriculture and food sector in the Slovak economy in the last years and continuing recovery of the agriculture and food industry. The subsidies from the Slovak Government funds to improve economic results increased about 11.7 % compared to the previous year. The subsidies have a positive influence on sales and cash flow of enterprises. Gross value added in agriculture upsurges a result of the increase in total agricultural output in crops by 60.4% and in animals by 39.6%, with a concurrent in intermediate consumption and a significant upsurge in product subsidies. The prices of raw products were stabilized compared to last year. The increase in costs was visible in raw cow's milk (11.0%), eggs (34%), and cereals (7.5%).

Unfavourable climatic conditions, extreme drought in summer and frosts in winter caused sales outage of 20 mils — €, especially on fruit orchards, vineyards, sugar beet, and winter rape and rape. The decrease is visible in yields of most commodity crop production, in particular, wheat (27.3%), maize (37.7%), sugar beet (18.3%) potatoes (25.5%) and oil plants (0.3%).

Higher-mass production of almost all groups of slaughter animals was recognized, in particular, cattle (8.6%) pigs (5.6%) and goats (22.4%), in addition to the slaughter of poultry (1.9%). Also, higher-mass production of cattle milk (0.5%) and eggs (2.4%) was recognized. Production of milk sheep increased by 0.8% (Based on references published in the Green Report 2018).[1]

Slovak farmers adapted to changes in Agriculture after 1990. They invested in the development of their farms to avoid the bankrupt, 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, decrease of pasture time, new storage capacity for organic waste, which was supported by the Degree No 389/2005 Coll. and Nitrates Directive.[2]

Table 5.1: *Overview of the GHG gases and Tiers reported in the Agriculture sector according to the CRF categories in 2017*

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-T2, NOx-T2,PM-T1, NMVOC-T1, TSP-T1
3Da1 Inorganic N-fertilizers	NH_3-T1,NO_x-T1
3Da2 Animal manure applied to the soil	NH_3-T2, 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	PMi-T1, TSP-T1
3De Cultivated Crops	NMVOC-T1

5.2 EMISSION TRENDS

5.2.1 AMMONIA (NH_3)

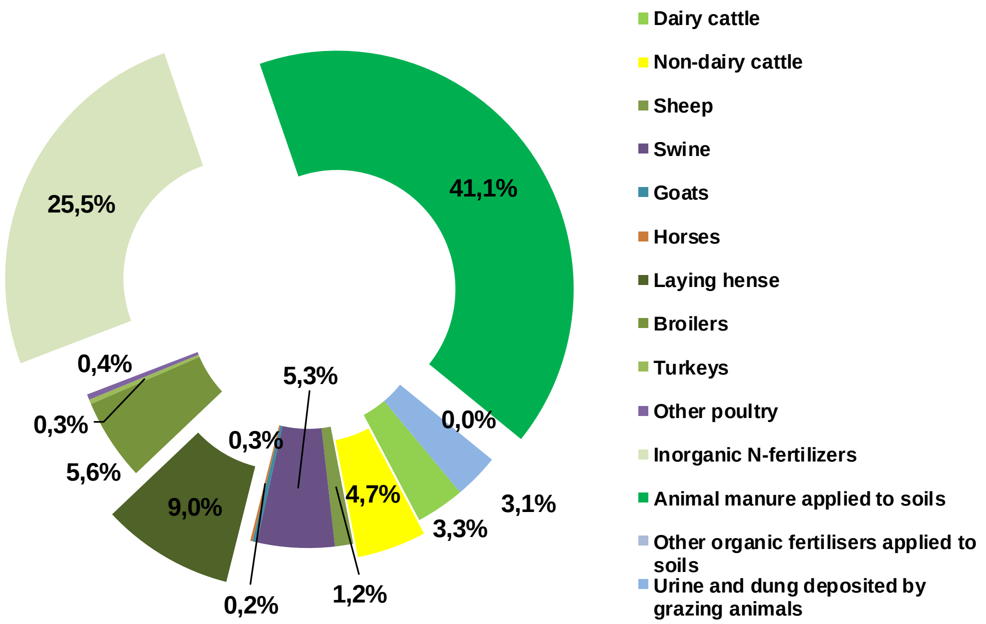
Sector agriculture is a dominant contributor to NH_3 emissions, with 91% share of the national total in 2017. The largest share of ammonia emissions was generated by 3D Agricultural soils, which produced 16.75 Gg (70%) of NH_3 within the sector in 2017. The key NH_3 emissions source is the Animal manure applied to soils with the share of 41%, followed by the category Inorganic N-fertilizers representing 25.5% of the total NH_3 emissions. Emissions from 3B1 Cattle, 3B3 Swine and 3B2 Sheep produced 3.5

[1] http://www.mpsr.sk/index.php?navID=122&id=13741 (In Slovak)

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

Gg of NH_3 (14.6%) in the sector in 2017. ***Figure 5.1*** shows distribution of significant categories of ammonia from agriculture for 2017.

Figure 5.1: *NH_3 emissions per subsectors in %*



Agricultural NH_3 emissions have decreased by 67% since 1990 (***Table 5.2*** and ***Figure 5.2***). The main drivers of this drop was the significant decrease in the emissions from cattle and swine, due to the dramatic reduction in livestock population. Focusing on the period between 2011 and 2015 NH_3 emissions from the agricultural sector have increased due to the increase in animal livestock especially in sheep, goats and laying hens categories. However, in the last two years a decrease in the emissions has been identified due to the implementation of abatements into the calculations (more information in **ANNEX VI**).

Figure 5.2: *NH_3 emission trend by sectors in Gg*

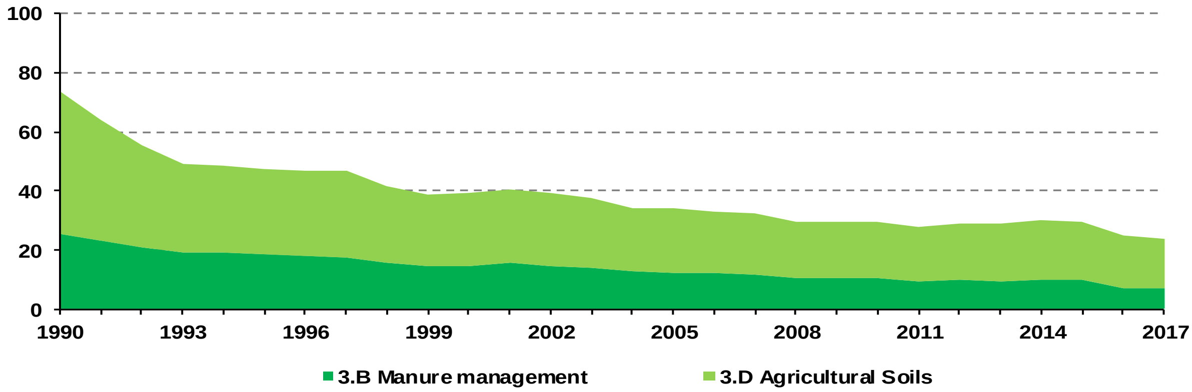


Table 5.2: *NH_3 emission time-series by sub-sectors in Gg*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
		in Gg	
1990	25.68	48.26	73.94
1995	18.35	28.85	47.20
2000	14.73	24.39	39.12
2005	12.45	21.69	34.14
2010	10.29	19.14	29.43
2011	9.55	18.52	28.08
2012	9.86	19.28	29.14
2013	9.53	19.46	28.98
2014	9.80	20.17	29.96
2015	9.83	19.88	29.71
2016	7.04	17.96	25.00
2017	7.29	16.75	24.04
SHARE WITH TOTAL IN 2017	**28%**	**63%**	**91%**
TREND 1990-2017	**-72%**	**-65%**	**-67%**
TREND 2005-2017	**-41%**	**-23%**	**-30%**

5.2.2 PARTICULATE MATTERS

In 2017, agriculture accounted for 1% (0.19 Gg), 11% (2.49 Gg) and 14% (4.2 Gg) of the national total $PM_{2.5}$, PM_{10} and TSP emissions. The Agriculture sector is no key source for particulate matter. The contribution of the 3Dc sector was 38% (0.7 Gg) to the total PM_{10} emissions from the sector.

$PM_{2.5}$, PM_{10} emissions from agriculture have stagnated in the 2005-2017 period (***Table 5.3*** and ***Figure 5.4)*** as a result of the decreasing emissions from 3B Manure management and increasing partial emissions from 3D Agricultural Soils. PM_{10} emissions from Agriculture shown in ***Figure 5.3***.

Figure 5.3: *PM_{10} emission trends by sectors in Gg*

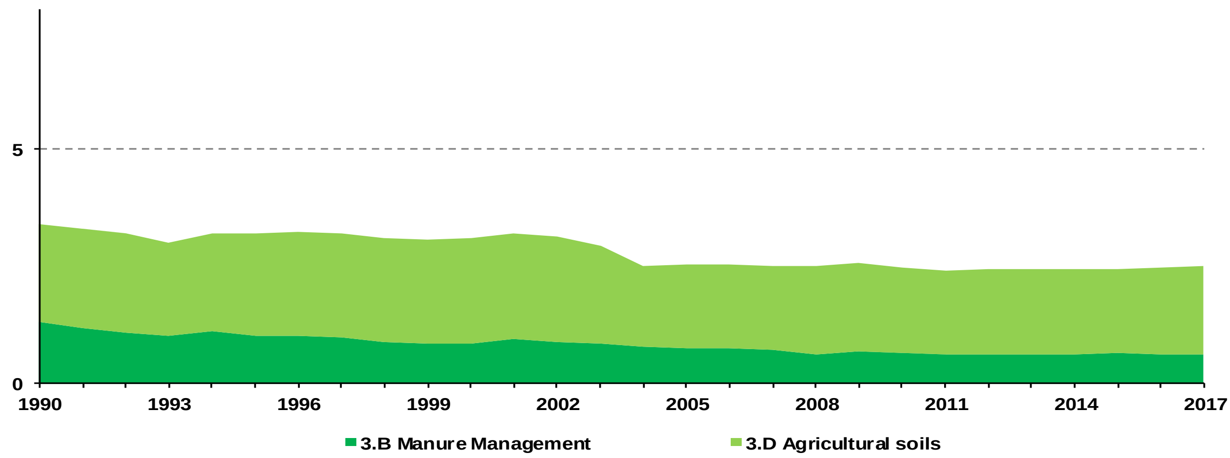


Figure 5.4: *PM$_{2.5}$ emission trends by sectors in Gg*

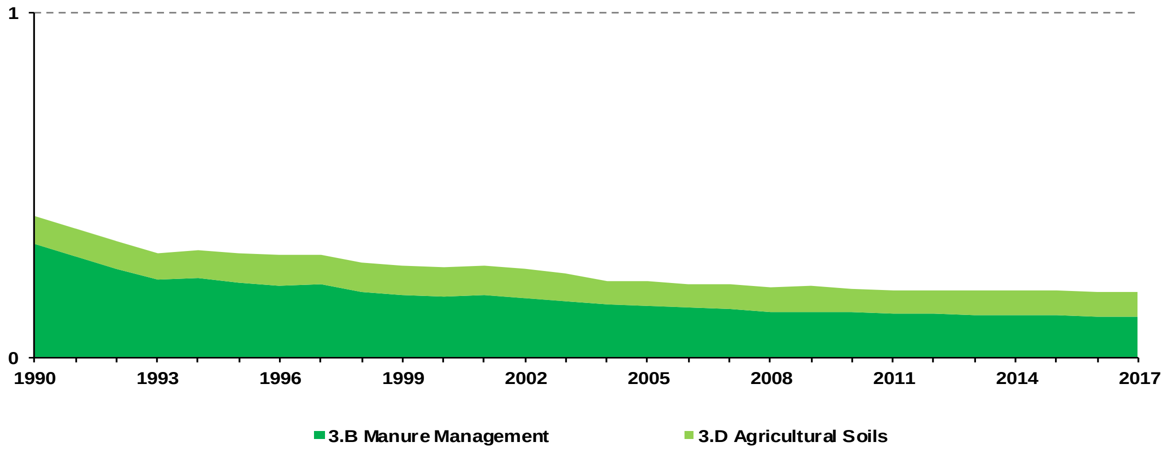


Table 5.3: *TSP emission time-series by sub-sectors in Gg*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
	in Gg		
1990	5.33	2.08	7.41
1995	4.34	2.18	6.52
2000	3.37	2.24	5.61
2005	2.92	1.79	4.71
2010	2.50	1.83	4.33
2011	2.31	1.81	4.11
2012	2.39	1.81	4.20
2013	2.28	1.83	4.11
2014	2.32	1.82	4.14
2015	2.39	1.81	4.20
2016	2.29	1.88	4.18
2017	2.35	1.87	4.21
SHARE WITH TOTAL IN 2017	**8%**	**6%**	**14%**
TREND 1990-2017	**-56%**	**-10%**	**-43%**
TREND 2005-2017	**-20%**	**4%**	**-11%**

5.2.3 NON-METHANE VOLATILE ORGANIC COMPOUNDS (NMVOC)

In 2017, Agricultural NMVOC emissions consisted of 6.47 Gg and 7.2% share of the national total (***Table 5.4***). The primary agricultural source of MNVOC emissions is the 3B Manure management accounting for 72% of total NMVOC emission. 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, while cultivated crops were an insignificant source with a share of 6% of total NMVOC emissions. NMVOC emissions have decreased by 63% over the period 1990-2017, as a result of the dropping of animal livestock.

5.4 Table: *NMVOC emission time-series by sub-sectors in Gg*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
	in Gg		
1990	12.15	5.11	17.26
1995	8.32	3.39	11.71
2000	6.87	2.79	9.67
2005	5.95	2.26	8.21
2010	4.99	1.98	6.97
2011	4.71	1.96	6.67
2012	4.79	1.95	6.74
2013	4.64	1.92	6.57
2014	4.81	1.93	6.74
2015	4.75	1.89	6.65
2016	4.53	1.85	6.38
2017	4.65	1.81	6.47
SHARE WITH TOTAL IN 2017	5%	2%	7%
TREND 1990-2017	-62%	-65%	-63%
TREND 2005-2017	-22%	-20%	-21%

5.2.4 NITROGEN OXIDES (NOX)

Agricultural NOx emissions have decreased by 50% 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 2011 and 2017, NOx emissions from the agricultural sector increased due to a markedly increase in inorganic fertilizer use in the last five years

Table 5.5: *NOx emission time-series by sub-sectors in Gg*

YEARS	3B	3D	3
	MANURE MANAGEMENT	AGRICULTURAL SOILS	AGRICULTURE TOTAL
	in Gg		
1990	0.029	11.72	11.75
1995	0.019	4.59	4.61
2000	0.016	4.31	4.33
2005	0.013	4.42	4.44
2010	0.011	4.49	4.50
2011	0.010	4.71	4.72
2012	0.010	5.05	5.06
2013	0.010	5.53	5.54
2014	0.010	5.76	5.77
2015	0.010	5.58	5.59
2016	0.010	5.99	6.00
2017	0.010	5.87	5.88
SHARE WITH TOTAL IN 2017	0.01%	8.9%	9%
TREND 1990-2017	-66%	-50%	-50%
TREND 2005-2017	-25%	33%	33%

5.3 CATEGORY-SPECIFIC IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

According to the Final Outcomes Report 2018 of the Second phase of the review of national air pollution emission inventories (published in July 2018), several improvements were made as a reflection to identified recommendations from the previous reviews:

- The explanation of Field Burning of Agricultural Residues activity in the IIR:

  Status: Recommendation No ***SK-3.F-2018-0002*** *was implemented in 2019 submission, information is*
  in **Chapter 5.13** *of this Report.*

- The revision of methodology and correction of $PM_{2.5}$ emissions

  Status: Recommendation No ***SK-3B-2018-0002*** *was implemented in 2019 submission, information is*
  in **Chapters 5.8.5.1** and **5.7.5.4** *of this Report.*

- Additional information to improve transparency in the dairy cattle category:

  Status: Recommendation No ***SK-3B-2018-0001*** *was implemented in 2019 submission, description is in* **Chapters 5.8.2, 5.8.2.1** and **5.8.2.2** *of this Report.*

- Correction of the emissions factors in calculations and appropriated explanation in IIR implemented:

  Status: Recommendation No ***SK-3Da3-2018-0001*** *was implemented in 2019 submission, information is in* **Chapter 5.8.4** *of this Report.*

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 sectoral level) and follow basic QA/QC rules and activities as defined in the EMEP/EEA GB_{2016}.

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.

Part of QA/QC activities is a comparison of FAO database and national inventory, described in the **Chapter 5.4.1** below.

An opportunity to cross-check the activity data and emissions with the pollutions inventory to ensure the consistency between the two inventories provides. 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 the 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 of the correct use of the units in the calculation sheets.
- Check of reasons for data gaps and provide explanations.
- Cross-check of data sources of the activity data if possible (e.g., total annual milk yield per cow, amount of wool, harvested area).
- Check of recalculation differences.

- Check for errors between the calculation sheets and the templates

5.4.1 COMPARISON OF THE FAO DATA WITH THE NATIONAL ACTIVITY DATA

The comparison of consistency with the international bodies and statistics were made. The several presentations on international and national conferences, publications and references were published in Meteorological journal 2017.[3] Results of this article were presented in the international conference Air Protection 2017.[4] Detailed information was presented in the SVK IIR 2017 (**Chapter 5.3.1**). The NIS SR decided that data consistency will be provided every year until full consistency. The activity data were also compared during the 2019 submission preparation.

2019 submission

- New corrected data were sent in the FAO.

Outcomes of the comparison:

The Ministry of Environment of the Slovak Republic compiled an official letter, which was sent to all relevant and responsible parties (ÚKSUP, ŠÚ SR). The official letter contained our results of the comparison. Comparison results are available in the next section.

INORGANIC N-FERTILIZERS:

The QA comparison of activity data was provided for the data of fertilizer consumption. Main inconsistency between FAO 2019 and SVK IIR 2019 data caused a shift in the timeline and different rules of fertilizers rounding. The data on consumption was not available for 2017 in the FAOSTAT.

Table 5.6: *Fertilizers consumption and comparison of FAO 2019 and SVK IIR 2019 data (t/year)*

COMPARISON YEARS	SVK IIR 2019	FAO 2019
2002	88 260. 000	81 300. 000
2003	81 300. 000	79 911. 000
2004	79 911. 000	81 317. 000
2005	81 317. 000	78 681. 000
2006	78 681. 120	88 935. 000
2007	88 935. 400	87 737. 000
2008	87 736. 950	77 058. 000
2009	77 058. 450	86 873. 000
2010	86 873. 000	92 969. 000
2011	92 969. 000	101 004. 000
2012	101 004. 000	113 581. 000
2013	113 581. 390	113 581. 000
2014	119 036. 050	113 036. 000
2015	114 773. 000	114 773. 000
2016	126 235. 769	126 236. 000

THE NUMBER OF LIVESTOCK:

The number of animals is the most important input parameter into the emission inventory. We recognized differences in the methodological approach of data collection used by FAOSTAT and by national statistical authority. FAOSTAT grouped livestock numbers in 12-months periods ending on September 30 each year. On the other hand, the ŠÚ SR provides annual national data on numbers of livestock by December 31 of a given year. The statistical survey is based on data collected from selected farms, animal census, by selected animal's categories, up to the regional level and finally up to national

[3] http://www.shmu.sk/File/ExtraFiles/MET_CASOPIS/2017-1_MC.pdf

[4] https://www.kongres-studio.sk/inpage/ochrana-ovzdusia-2017/

level. Therefore, the animal population of the FAO 2019 and the data used in the SVK IIR 2019 are different. In addition, with the detailed analyses of the data provided in the ***Table 5.7*** below, a shift in the timeline is visible for goats (since 1994), for sheep (since 1994), for horses (since 1994) and for swine (since 1994) and wrong allocation of cattle population in FAO 2018. The huge inconsistency occurring in cattle is caused by the different rules for allocation between dairy and non-dairy cattle. Revision of the number of livestock caused data unification between two databases in the cattle category, but wrong allocations and shift in the timelines are still ongoing. The inconsistency is visible in the poultry category. The revision of poultry population provided by the ŠÚ SR into the FAO is still not in a good shape, because FAO methodology in this way is not transparent. The FAO should change their activity data to the official data from the Slovak Republic or data directly obtained from the EUROSTAT. The ŠÚ SR collects processes and disseminates the data in line with current EU legislation and the data is in line with the EUROSTAT methodology. The most appropriate solution for this situation is to adopt the complete database from all Member States of Eurostat database to the FAOSTAT.

Table 5.7: *Comparison of livestock population (heads) for the time series 1993–2017*

YEAR	DAIRY CATTLE		NON-DIARY CATTLE		GOATS		SHEEP		HORSES		SWINE		POULTRY	
	SVK IIR 2019	FAO 2019	SVK IIR 2019	FAO 2019	SVK IIR 2019	FAO 2019	SVK IIR 2019	FAO 2019	SVK IIR 2019	FAO 2019	SVK IIR 2019	FAO 2019	SVK IIR 2019	FAO 2019
1993	282 274	386 000	710 689	795 660	24 974	20 278	411 442	571 837	11 188	11 652	2 179 029	2 269 232	12 234 120	13 084 000
1994	272 450	364 000	643 703	628 963	25 010	24 974	397 043	411 442	10 652	11 188	2 037 371	2 179 029	14 245 954	12 057 000
1995	262 664	350 000	666 042	566 153	25 046	27 747	427 844	397 043	10 109	10 000	2 076 439	2 037 370	13 382 391	7 852 000
1996	245 833	339 000	646 158	589 706	26 147	25 046	418 823	427 844	9 722	10 109	1 985 223	2 076 439	14 147 177	13 214 000
1997	299 614	309 700	503 784	582 291	26 778	26 147	417 337	418 823	9 533	9 722	1 809 868	1 985 223	14 221 713	13 985 000
1998	267 282	299 614	437 510	503 784	50 905	26 778	326 200	417 337	9 550	9 533	1 592 599	1 809 868	13 116 796	14 071 000
1999	250 974	262 000	414 081	442 792	51 075	50 905	340 346	326 199	9 342	9 550	1 562 106	1 592 599	12 247 440	13 027 000
2000	242 496	250 974	403 652	414 081	51 419	51 075	347 983	340 346	9 516	9 342	1 488 441	1 562 105	13 580 042	12 160 000
2001	230 379	242 496	394 811	403 652	40 386	51 419	316 302	347 983	7 883	9 516	1 517 291	1 488 441	15 590 404	13 482 000
2002	230 182	230 379	377 653	394 811	40 194	40 386	316 028	316 302	8 122	7 883	1 553 880	1 517 291	13 959 404	15 352 000
2003	214 467	230 182	378 715	377 653	39 225	40 194	325 521	316 028	8 114	8 122	1 443 013	1 553 880	14 216 798	13 817 000
2004	201 725	214 467	338 421	378 715	39 012	39 225	321 227	325 521	8 209	8 114	1 149 282	1 443 013	13 713 239	14 052 000
2005	198 580	201 725	329 309	338 421	39 566	39 012	320 487	321 227	8 328	8 209	1 108 265	1 149 282	14 084 079	13 565 000
2006	184 950	198 580	322 870	329 309	38 352	39 566	332 571	320 487	8 222	8 328	1 104 829	1 108 265	13 038 303	13 932 000
2007	180 207	184 950	321 610	322 870	37 873	38 352	347 179	332 571	8 017	8 222	951 934	1 104 829	12 880 124	12 882 000
2008	173 854	180 207	314 527	321 610	37 088	37 873	361 634	347 179	8 421	8 017	748 515	951 934	11 228 140	12 718 000
2009	162 504	173 854	309 461	314 527	35 686	37 088	376 978	361 634	7 199	8 421	740 862	748 515	13 583 284	11 081 000
2010	159 260	162 504	307 865	309 461	35 292	35 686	394 175	376 978	7 111	7 199	687 260	740 862	12 991 916	13 438 000
2011	154 105	159 260	309 253	307 865	34 053	35 292	393 927	394 175	6 937	7 111	580 393	687 260	11 375 603	12 846 000
2012	150 272	154 105	320 819	309 253	34 823	34 053	409 569	393 927	7 249	6 937	631 464	580 393	11 849 818	11 252 000
2013	144 875	150 272	322 945	320 819	35.457	34 823	399 908	409 569	7 161	7 249	637 167	631 464	10 968 918	11 693 000
2014	143 083	144 875	322 460	322 945	35 178	35 457	391 151	399 908	6 828	7 161	641 827	637 167	12 494 074	10 786 000
2015	139 229	143 083	318 357	322 460	36 324	35 178	381 724	391 151	6 866	6 828	633 116	641 827	12 836 224	13 084 000
2016	132 610	139 229	313 502	318 357	36 355	36 324	368 896	381 724	6 407	6 866	585 843	633 116	12 130 501	12 057 000
2017	129 863	130 124	309 963	310 486	37 067	36 355	365 344	368 896	6 145	6 407	614 384	585 843	13 353 837	13 133 000

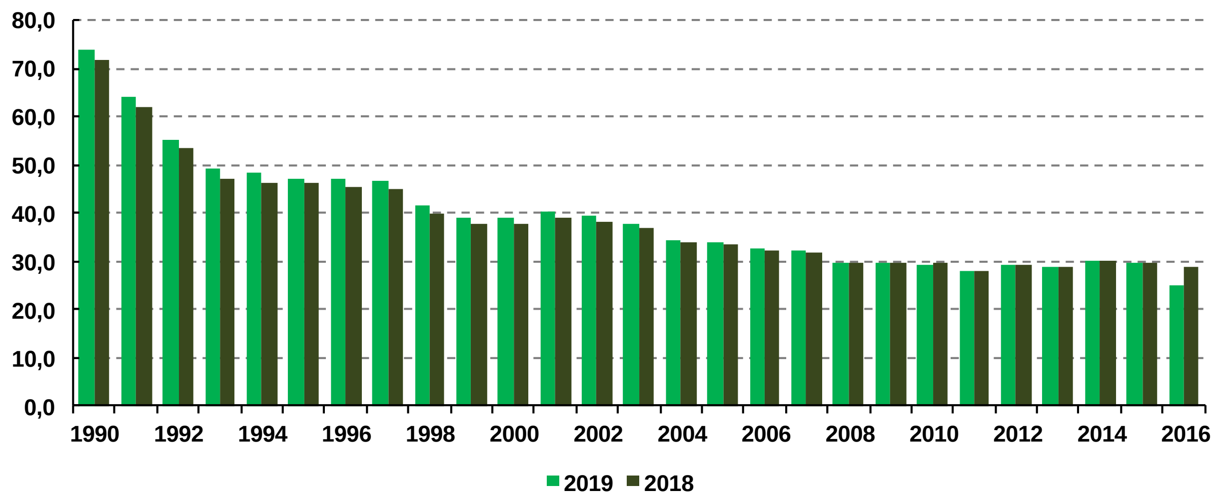
5.5 CATEGORY-SPECIFIC RECALCULATIONS

Recalculations made in the agriculture sector were provided and implemented in line with the Improvement Plan reflecting recommendations made during previous reviews. ***Table 5.8*** shows an overview of these recalculations and corrections, which were corrected and implemented in the 2019 submission.

Table 5.8: *Overview of recalculations in the agricultural sector*

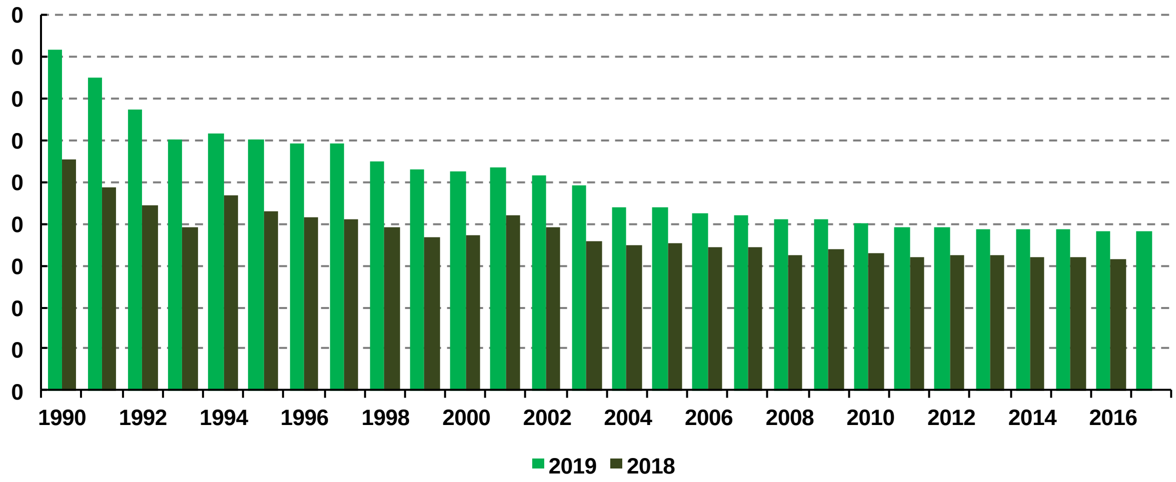
NUMBER	CATEGORY	POLLUTION	DESCRIPTION	REFERENCE
15.FEBRUARY 2019				
1	3B	PM_{10}	AAP replaced the number of heads- Revision of methodology.	5.8.5.4
2	3B	$PM_{2.5}$	AAP replaced the number of heads- Revision of methodology.	5.8.5.4
3	3B	TSP	AAP replaced the number of heads- Revision of methodology.	5.8.5.4
4	3Da3	NOx	Revision of EFs. German value was replaced with Guidance value.	5.8.4
5	3B2	NH_3, NOx	Emissions were calculated on regional level	5.8.4
6	3B3	NH_3, NOx	Tier 2 approach for NEx determination was implemented, emissions were calculated on a regional level.	5.8.2
7	3B1a	NH_3, NOx	Correction of mall function in this category	5.8.4
8	3B4gii	NOx	Correction of mall function in this category	5.8.4
9	3B4giii	NOx	Correction of mall function in this category	5.8.4
10	3B	NH_3	Abatements technics were implemented into the inventory for 2016 and 2017 years	5.8.4, ANNEX VI
11	3D	NH_3	Abatements technics were implemented into the inventory for 2016 and 2017 years	5.9.2, ANNEX VI
12	3Da3	NH_3, NOx	Revision is connected with the revisions in 3.B	5.9.2
13	3.D.a.2.a	NH_3, NOx	Revision is connected with the revisions in 3.B	5.9.2

Figure 5.5: *Comparison of NH_3 emissions from the Agriculture sector due to recalculations (in Gg.)*



Nitrogen excretion rate was changed for years 1990–2017, due to the implementation of a higher Tier 2 approach in the 3B3 category, values of N_{EX}s increase. The recalculation led to increase in swine NOx and NH_3 emissions from manure management by 26.4% in 2016. A significant decrease in emissions is visible in the 3B2 category. The reason for changes is a disaggregation of NOx and NH_3 emissions on a regional level in 3B2 and 3B3 as well. The changes documents in **Chapter 5.8.4**.

Figure 5.6: *Comparison of NOx emissions from the Agriculture sector due to recalculations (in Gg.)*



For the first time, the Slovak Republic prepared an analysis of mitigation measures in the sector Agriculture. The mitigation measures are very difficult to estimate in the condition of the Slovak Republic, due to lack of official statistical information. The NEIS (National Emission Inventory System) was used as an information source for mitigation measures. Mitigations were implemented only for 2016 and 2017, due to limited information's and high uncertainty. The recalculations led to a significant emission decrease in all animal subcategories and categories 3Da2a Animal applied into the soils. The methodology is described in **ANNEX VI*.***

All changes in 3B Manure Management has an influence on emission changes in 3D Agriculture soils, mainly in categories 3Da3 and 3Da2a. Changes are documented in **Chapter 5.9.2**

Figure 5.7: *Comparison of $PM_{2.5}$ emissions from the Agriculture sector due to recalculations (in Gg)*

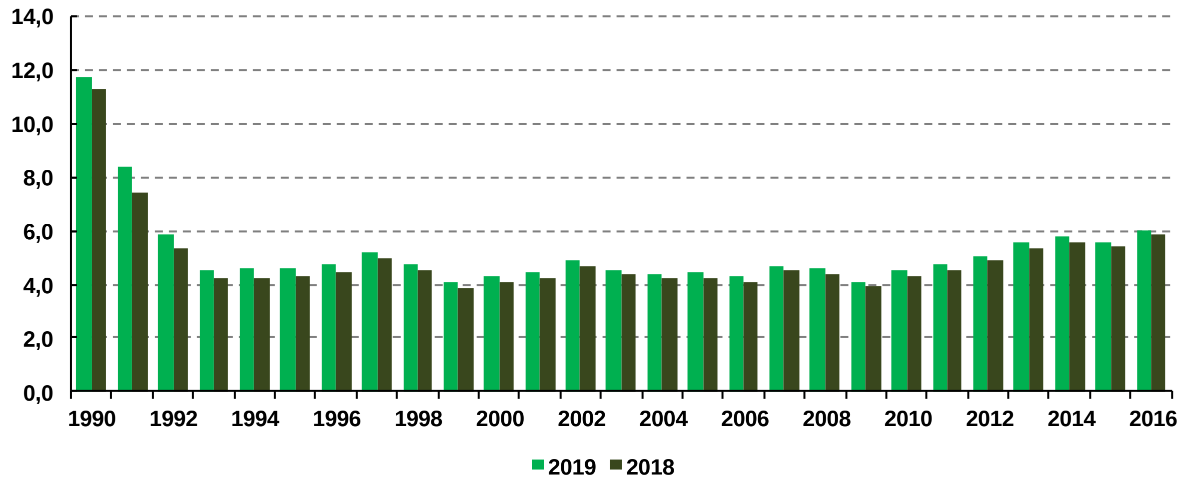


Figure 5.8: *Comparison of PM_{10} emissions from the Agriculture sector due to recalculations (in Gg)*

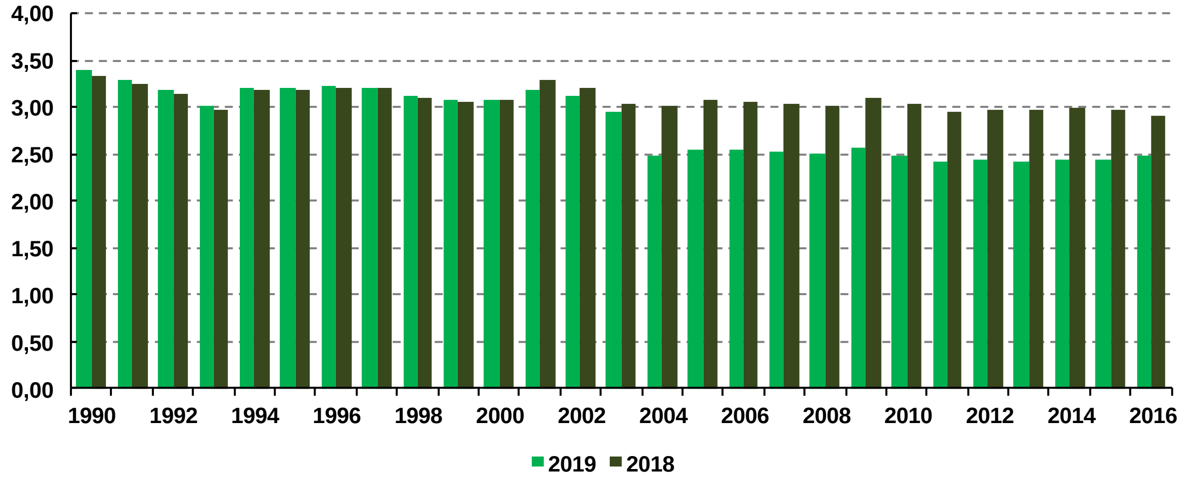
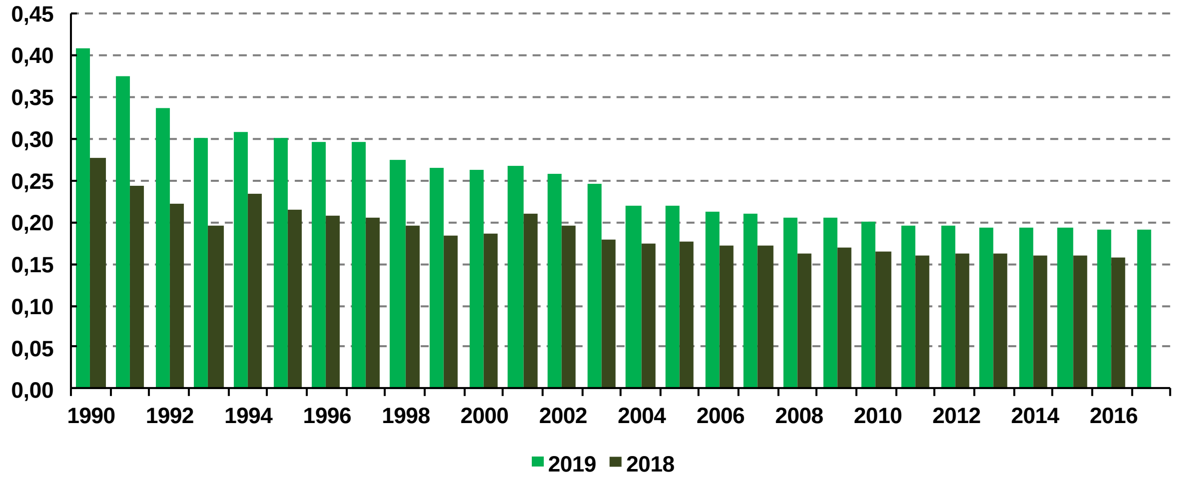


Figure 5.9: *Comparison of TSP emissions from the Agriculture sector due to recalculations (in Gg)*



In 2018 submission, the number of livestock was used to the calculation of TSP and PM emissions. Parameter housing time was not considered in the methodology. The number of livestock were replaced with AAP. More information´s are documented in **Chapter 5.8.3**.

5.6 NATIONAL CIRCUMSTANCES AND TIME-SERIES CONSISTENCY

Farmers had to follow new strict criteria like higher milk yield, changing of housing systems, a decrease of pasture time, new storage capacity for organic waste, which was supported by the Degree No 389/2005 Coll. and Nitrates Directive.[5] These measures are well advanced and copy the practices used in Western European countries. Therefore, also in inventory, default parameters for Western Europe are used.

Cattle

Cattle breeding in the Slovak Republic is comparable with the Western European countries, which is documented by high milk yield of dairy cattle and high daily weight gains of non-daily cattle. To maintain a high milk yield and high daily gain food rich on proteins and cereals are important. Dairy cows in three Slovak regions (Bratislava, Trnava, and Nitra) produce 20-23 liters/day. In other regions, milk

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

productivity is 14-15 liters/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 document ***Figures 5.10*** and ***5.11***. High producing dairy cows (milked 23 liters/day) need to be fed by 8 kg of cereals with excellent digestibility and high nutrition. Annual increases of milking productivity document increase in the productivity of animal production. Balanced and sustainable farming in Slovakia has an impact on the high value of AGEI (287.3 MJ/head/day) (***Table 5.9***).

Table 5.9: *The comparison of the Slovak milk yield with other milk production in 2017*

DAIRY COWS	SLOVAKIA	WESTERN EUROPE (AVERAGE)	EASTERN EUROPE (AVERAGE)	NORTH AMERICA (AVERAGE)
Milk yield kg/year/cow	6 924	6 000	2 550	8 400

Figure 5.10 *Trend of average gross energy intake in different Slovak regions*

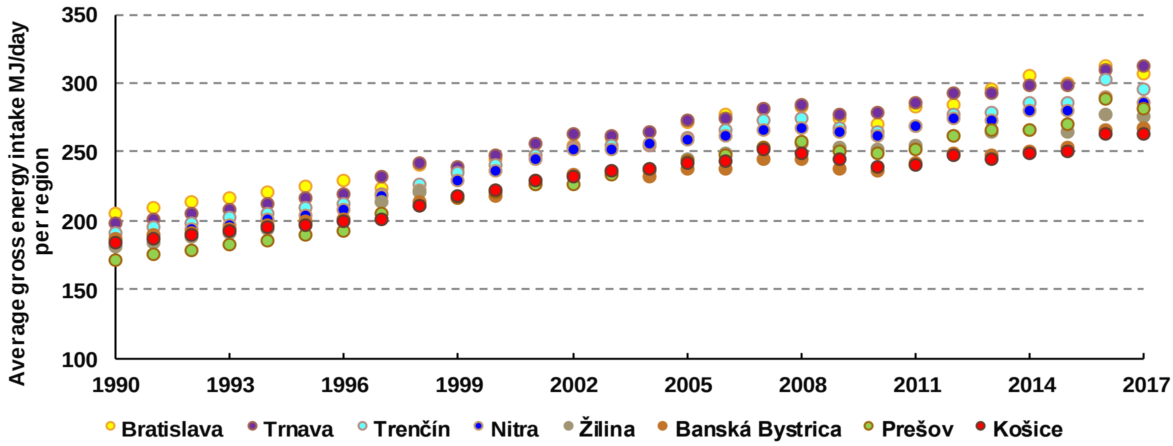
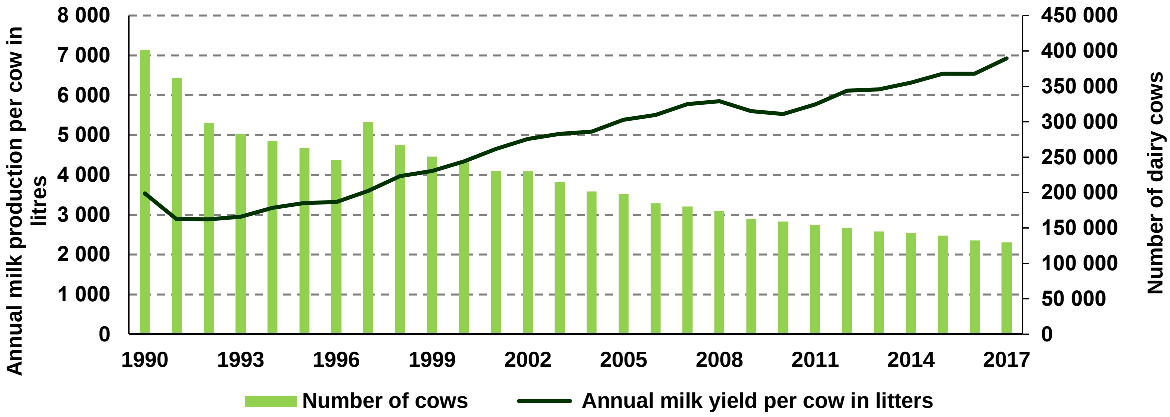


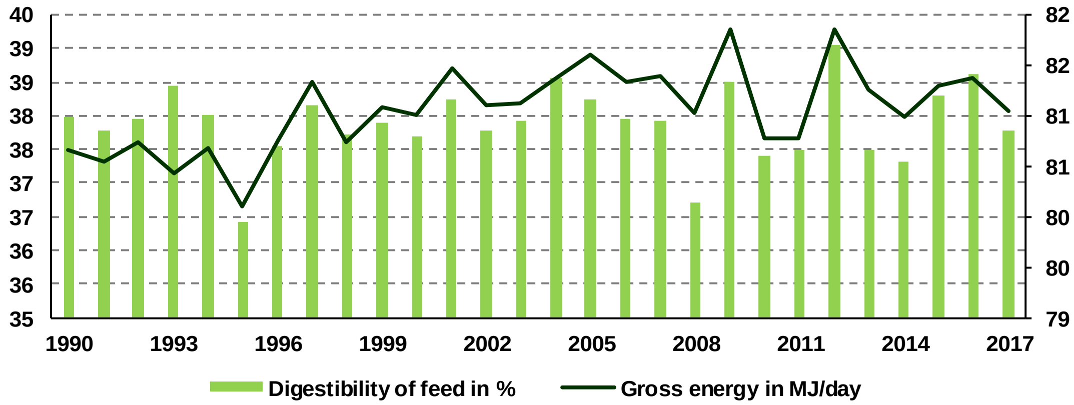
Figure 5.11: *Dairy Cattle population and daily milk production per cow*



Swine

The pig farming system is divided into two types breeding and fattening pigs in the Slovak Republic. Breeding pigs are for reproduction purposes. Fattening pigs are mainly for the production of pork meat and fat. Pigs are housed yearly in the Slovak conditions. Housing technology can significantly affect the production of pollutants. Stall conditions are very variable in the Slovak Republic. Pigs are bred in intensive farming on rosette floors, which is one of low emission technics. Another part of pigs, mainly in semi-intensive farming, are bred 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 ration 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 5.12***).

Figure 5.12: *Trends of digestibility and gross energy intake from swine*



5.7 UNCERTAINTIES

Uncertainty analysis was not provided due to the insufficient capacities and unavailable data. Nevertheless, this important issue was involved in the improvement plan as an item with high importance.

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_{2016} as Tier 2 approach for dairy cattle, non-dairy cattle, sheep, swine, goats, horses and poultry. Nitrogen excretion rate for the swine category is calculated based on the nitrogen content of the feed according to the IPCC 2006 GL methodology.

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_{2016} was consider. The TSP, PM_{10}, and $PM_{2.5}$ were calculated by the EMEP/EEA GB_{2016}. 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 is based on the survey, which analysed manure management practices. A questionnaire survey in farms was performed with the cooperation with the NPPC - VÚŽV and other research institutions during the years 2014 – 2017. 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 numbers of days on pasture for cattle, sheep, goats, and horses. Manure left on pasture was estimated based on this data. Time-series was completed by extrapolation.

Allocation according to the climate conditions is 100% for cool climate for all animals based on the IPCC 2006 methodology and climate data for the Slovak Republic. Western Europe default value for nitrogen excretion was used; the reasons for this choice are described in in **Chapter 5.5**.

5.8.2 NITROGEN EXCRETION RATE

Swine

Country-specific nitrogen excretion rate used for the Swine category, was based on the Tier 2 methodology from the IPCC Guideline 2006. 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 model "Software for feeding ration optimization" from the NPPC - VÚŽV.

The Nitrogen intakes were determined from the crude protein content of each feed ingredient in the feeding ration for all sub-categories of swine. Data on crude protein were calculated according to publication Petrikovič, P. a col.: Nutrition for Pigs. Experimental feeding rations compiled with "The Animal Optimization Software" from Agrokonzulta Žamberk, Ltd. (CZ). This program uses the feed database, and Nutrition Standards developed at the NPPC - VÚŽV.

The Nitrogen intakes were determined according to equation:

$$\mathrm{N_{intake\ (T)}} = \frac{\mathrm{GE}}{18.45} * \left(\frac{\frac{\mathrm{CP\ \%}}{100}}{6.25} \right)$$

Where: $\mathbf{N_{INTAKE}}$ **(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 per 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)$^{-1}$

The results were presented in ***Table 5.11*** for swine in 2017. Cattle and sheep are also significant contributors to emissions, but data about crude protein were unavailable. Data about crude protein content for cattle and sheep plan to implement in the next submissions.

The N-excretion rates were calculated according to equation 10.32 of the IPCC 2006 GL:

$$\mathrm{Nex_{(T)}} = \mathrm{N_{INTAKE\ (T)}} * (1 - \mathrm{N_{RETENTION\ (T)}})$$

Where: $\mathbf{N_{EXT}}$ annual N excretion rates in kg N/head/yr, $\mathbf{N_{INTAKE}}$ **(T)** the annual N intake per head of animal of species/category T, kg N /head/yr, $\mathbf{N_{RETENTION}}$ **(T)** fraction of annual N intake that is retained by animal of species (according to the Table 10.20 of IPCC 2006 GL)

Table 5.10: *Country-specific regional parameters for 3B3 Swine for the period for 1990*

3B3 SWINE CATEGORY							
1990		SOWS	FATTENING TO 20 KG	FATTENING 20-50 KG	FATTENING 50-80 KG	FATTENING 80-110 KG	FATTENING FROM 110KG
CRUDE PROTEIN	%	15.67	13.47	13.47	16.05	14.56	14.56
N-EXCRETION	KG N/HEAD/ YEAR	20.56	10.97	10.98	15.19	11.38	11.39
EMISSION FACTOR FOR 3.B.3	KG N_2O HEAD/ YEAR	0.16	0.09	0.09	0.13	0.09	0.09

***Table 5.11:** Country-specific regional parameters for 3B3 Swine for the period for 2017*

3B3 SWINE CATEGORY							
2017		SOWS	FATTENING TO 20 KG	FATTENING 20-50 KG	FATTENING 50-80 KG	FATTENING 80-110 KG	FATTENING FROM 110KG
CRUDE PROTEIN	%	16.56	13.31	13.31	15.87	13.91	13.91
N-EXCRETION	KG N/HEAD/YEAR	22.32	10.92	11.14	15.01	11.35	11.29
IMPLIED EMISSION FACTOR FOR 3.B.3	KG N_2O HEAD/ YEAR	0.18	0.10	0.09	0.12	0.09	0.09

Other animals

The base of the calculation is the determination of body weight. All animals have specific body weight. This parameter was estimated, and is country specific. The regional differences were considered for cattle, sheep and swine categories; each region has specific body mass. The body weight parameter is consistent across the time-series for all animal species. Data were provided by the NPPC - VÚŽV. AWMS share derived from the measured amount of nitrogen. Annual nitrogen excretion rates was determined for cattle, sheep, goats, horses, and poultry subcategories.

N-excretion rates for animals' categories were calculated based on the IPCC 2006 GL, equation 10.30:

$$\mathrm{NEX_T} = \mathrm{N_{rate(T)}} * \frac{\mathrm{TAM}}{1000} * 365$$

Where: **N_{EXT}** = annual N-excretion for each livestock spices respectively category in kg N per animal; **$N_{RATE(T)}$** = default N-excretion rate in kg N (100 kg/animal mass)/day (IPCC 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:

$$\mathrm{N_2O_{EM}} = \left[\sum\left[\sum(\mathrm{N} * \mathrm{N_{EX}} * \mathrm{AWMS})\right] * \mathrm{EF}\right] * \frac{44}{28}$$

Where: **N_2O_{EM}** = direct N_2O emissions from manure management in kg N_2O; **N** = number of livestock species respectively category, **N_{EX}** = annual average N-excretion/head of species respectively category in kg N/animal, **AMWS** = percentage of total annual nitrogen excretion for each livestock category, that is managed in manure management systems in the country, **EF** = default emission factor for direct N_2O emissions from the manure management system in kg N_2O-N/kg N in the manure management system, **44/28** = conversion of N_2O-N emissions to N_2O emissions

***Table 5.12:** Country-specific regional parameters for 3B1a Dairy cattle for the period for 2017*

CATEGORIES		NEX	BODY MASS	LIQUID SYSTEM	SOLID SYSTEM	PASTURE	ANAEROBIC DIGESTERS
		kg N head/year	kg	%			
DAIRY CATTLE	DAIRY COWS BRATISLAVA REGION	105.12	600	31.67	66.87	0.73	0.73
	DAIRY COWS TRNAVA REGION	105.12	600	13.82	81.02	2.58	2.58
	DAIRY COWS TRENČÍN REGION	105.12	600	12.89	75.95	9.76	1.40
	DAIRY COWS NITRA REGION	105.12	600	10.22	82.33	3.37	4.09
	DAIRY COWS ŽILINA REGION	104.23	595	6.96	69.65	12.07	11.31
	DAIRY COWS BANSKÁ BYSTRICA	105.00	599	7.17	70.98	13.37	8.48
	DAIRY COWS PREŠOV REGION	103.86	593	4.43	85.97	7.15	2.46
	DAIRY COWS KOŠICE REGION	104.64	597	11.64	67.18	9.02	12.15

Table 5.13: *Country-specific regional parameters for 3B1a Dairy cattle for the period for 1990*

CATEGORIES		NEX	BODY MASS	LIQUID SYSTEM	SOLID SYSTEM	PASTURE	ANAEROBIC DIGESTERS
		kg N head/year	KG	%			
DAIRY CATTLE	DAIRY COWS BRATISLAVA	105.12	600	42.85	56.86	0.29	-
	DAIRY COWS TRNAVA REGION	105.12	600	18.57	79.79	1.64	-
	DAIRY COWS TRENČÍN REGION	105.12	600	7.12	86.92	5.97	-
	DAIRY COWS NITRA REGION	105.12	600	16.56	82.62	0.82	-
	DAIRY COWS ŽILINA REGION	104.23	595	5.93	75.34	18.73	-
	DAIRY COWS BANSKÁ BYSTRICA	105.00	599	10.67	77.88	11.44	-
	DAIRY COWS PREŠOV REGION	103.86	593	4.06	80.43	15.51	-
	DAIRY COWS KOŠICE REGION	104.64	597	2.41	86.29	11.30	-

Table 5.14: *N_{EX} and share (%) for different domestic livestock and share in AWMS in 2017*

CATEGORIES		N_{EX}	Liquid system	Solid system	Pasture	Litter	Anaerobic digesters
		N kg/head	%				
Sheep	Mature ewes (milk type)	18.62	-	49.59	50.41	-	-
	Mature ewes (beef type)	21.72	-	45.20	54.80	-	-
	Weighted average in 2017*	**19.73**	**-**	**48.02**	**51.08**	**-**	**-**
	Growing lambs (milk type)	10.8	-	49.59	50.41	-	-
	Growing lambs pregnant (milk type)	17.6	-	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	-	-
	Weighted average in 2017*	**14.34**	**-**	**48.23**	**51.77**	**-**	**-**
	Rams (milk type)	24.82	-	100.00	-	-	-
	Rams (beef type)	27.92	-	100.00	-	-	-
	Weighted average in 2017*	**25.91**	**-**	**100.00**	**-**	**-**	**-**
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	-	-
	Weighted average in 2017	**23.80**	**-**	**49.60**	**50.40**	**-**	**-**
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	-	-
	Weighted average in 2017	**47.99**	**70.00**	**-**	**30.00**	**-**	**-**
Poultry	Laying hens + cocks	1.10	85.00			15.00	-
	Broilers	0.80	-			100.00	-
	Turkeys	1.84	-			100.00	-
	Ducks	1.21	-			100.00	-
	Geese	1.82	-			100.00	-
	Weighted average in 2017	**0.96**	**39.88**		**-**	**60.12**	**-**

*Weighted average from 8 Slovak regions

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 are calculated using the Tier 2 method of the EMEP/EEA GB_{2016} and country-specific values whenever is possible.

5.8.2.2 Emissions factors NH_3 and NOx

All animals

Emission factors calculated by the calculation sheet (4.B appendix.xls) provided by the EMEP/EEA GB_{2013}. In the calculation sheet, 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 ***Table 5.12, Table 5.13,*** and ***Table 5.14***. 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.

For the remaining input data as well as for the emission factors, standards and default values provided in the EMEP/EEA GB_{2016} were applied.

Table 5.15: *Country-specific NH_3 emission factors for 3B1a Dairy cattle and background data for the period 1990-2017*

3B1a DAIRY CATTLE CATEGORY				
YEAR	BODY MASS AVERAGE*	MILK YIELD	N-EXCRETION*	IMPLIED EMISSION FACTOR FOR 3B1a
	kg/head	kg/head/year	kg N/year/head	kg NH_3/head/year
1990	597.915	6.963	104.755	11.117
1991	597.642	7.142	104.707	11.119
1992	597.763	7.613	104.728	11.120
1993	597.758	8.019	104.727	11.122
1994	597.757	8.424	104.727	11.122
1995	597.757	8.829	104.727	11.123
1996	597.758	9.233	104.727	11.123
1997	597.722	10.174	104.721	11.124
1998	597.650	11.115	104.708	11.123
1999	597.714	11.556	104.720	11.122
2000	597.709	12.236	104.719	11.123
2001	597.839	13.226	104.741	11.111
2002	597.840	13.921	104.742	11.115
2003	597.863	14.209	104.746	11.108
2004	597.878	14.361	104.748	11.107
2005	597.878	15.180	104.748	11.106
2006	597.858	15.572	104.745	11.090
2007	597.854	16.305	104.744	11.095
2008	597.877	16.523	104.748	11.091
2009	597.831	15.795	104.740	11.073
2010	597.855	15.619	104.744	11.075
2011	597.913	16.347	104.754	11.074
2012	597.902	17.220	104.752	11.065
2013	597.888	17.342	104.750	11.053
2014	597.856	17.743	104.744	11.032
2015	597.812	17.846	104.737	10.952
2016	597.754	19.411	104.727	6.028
2017	597.727	19.557	104.722	6.156

*Weighted average from 8 Slovak regions

5.8.3 ACTIVITY DATA

Basic data sources used for the evaluations of emissions 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 1990–2017 and the research results from projects and studies provided by several organizations inside the NPPC.

Activity data for dairy, non-dairy cattle, and sheep, swine are based on bottom-up statistical information at the district level (regions). The aggregation of input parameters performed as a weighted average. The ŠÚ SR provided national data of annual livestock numbers on a detailed region level in 2017 (***Table 5.16***). Data based on livestock census held on 31st December of each year. Before 2016, the number of livestock were extrapolated, because statistical data were not available up to the 1990s. After 2016 extrapolated data was replaced by officially statistical data.

The ŠÚ SR provided a complete time series of the livestock number on the regional level in 2016. Data could not be implemented immediately, due to a different regionalization in years 1990–1996 (only three regions: Západoslovenský, Stredoslovenský, and Východoslovenský) it was necessary to reallocate this older data into new regions (8 districts after 1997):

- Západoslovenský region (1990–1996) is equal to Bratislavský, Nitrianský, Trnavský, Trenčiansky regions (1997- present);
- Stredoslovenský region (1990–1996) is equal to Banskobystrický and Žilinský regions (1997 - current);
- Východoslovenský region (1990–1996) is equal to Prešovský and Košický regions (1997-current);

A reallocation was prepared by using the linear extrapolation tools to reach statistical totals as reported by the ŠÚ SR. The ŠÚ SR and SHMÚ use a standard statistical approach for extrapolations. The Eurostat reviews used standards. Good statistical practice is to describe in Eurostat guidance.[6] After 2016 submission extrapolation number of swine was reported. The SHMÚ filled the data gap by using a standard statistical approach for extrapolation (linear extrapolation in spreadsheets). In 2017 submission, the ŠÚ SR provided complete time-series with official data, which is consistent with Eurostat and FAOSTAT (**Chapter 5.4.1**). Detailed statistical information is available on the level of the region and emissions are estimated by bottom-up Tier 2. The NPPC - VÚŽV implemented the results of a questionnaire farm survey. Better classification and disaggregation of cattle, sheep and swine categories was used. Based on survey data, cattle was divided into dairy and non-dairy. Dairy cattle are estimated separately from non-dairy cattle. Dairy cows are defined as cows that produce milk only for human consumption (high producing cows). Suckling cows are defined as cows that are bred for nutrition of calves (low producing cows). Suckling cows were included in the subcategory non-dairy cattle. Category Non-dairy includes a subcategory of cattle like a breeding bull, oxen, calves, heifer pregnant, un-pregnant heifers, fattening and mentioned suckling cows. Categorization is consistent throughout the calculation cycle.

[6] http://ec.europa.eu/eurostat/documents/3859598/5921861/KS-32-11-955-EN.PDF/5fa1ebc6-90bb-43fa-888f-dde032471e15

Table 5.16: Animal population according to the districts for the year 2017

CATEGORY		NUMBER OF LIVESTOCK (HEAD)							
DISTRICT		Bratislava	Trnava	Trenčín	Nitra	Žilina	Banská Bystrica	Prešov	Košice
	Dairy cattle	4 904	20 672	13 831	20 479	22 340	18 535	20 023	9 079
Non-dairy cattle	Suckling cows	1 805	2 094	3 953	1 375	7 523	14 964	20 957	12 142
	Calves in 6 month (milk type)	1 744	9 902	5 868	9 922	7 019	6 825	6 710	2 758
	Heifer (milk type)	1 518	6 274	4 428	7 604	7 828	6 750	6 665	3 377
	Heifer (pregnant) (milk type)	1 806	5 305	3 428	6 903	5 693	4 553	4 047	1 937
	Fattening (milk type)	376	9 590	4 126	7 063	4 631	4 354	3 463	2 380
	Oxen (milk type)	0	10	16	20	325	24	13	6
	Breeding bull (milk type)	39	108	92	217	241	383	387	166
	Calves in 6 month (beef type)	642	1 003	1 677	666	2 363	5 510	7 023	3 689
	Heifer (beef type)	559	635	1 266	511	2 636	5 449	6 976	4 516
	Heifer (pregnant) (beef type)	665	537	980	464	1 917	3 676	4 236	2 591
	Fattening (beef type)	139	971	1 179	474	1 559	3 515	3 625	3 184
	Oxen (beef type)	0	1	4	1	109	20	14	8
	Breeding bull (beef type)	78	217	183	434	481	767	775	331
Sheep	Mature ewes	1 063	1 358	21 112	6 208	59 748	75 446	52 138	27 857
	Growing lambs	237	793	6 560	1 352	14 369	19 977	13 156	7 718
	Growing lambs (pregnant)	74	383	5 867	1 129	10 641	16 573	9 899	4 340
	Other mature sheep	29	43	674	184	1 759	2 301	1 551	805
Swine	Market swine	3 416	15 586	3 577	6 239	336	8 077	3 489	1 614
	Breeding swine	25 078	219 784	43 450	139 410	9 562	61 688	46 075	27 003,
Horses	Horses (0-3year)	33	59	127	447	173	293	186	164
	Stallions	47	63	100	235	166	231	268	121
	Mares	61	87	175	329	240	462	387	248
	Castrated stallions	51	103	108	168	251	281	343	138
Goats	Mature goats	468	1459	2 509	2 987	5 362	7 279	3 729	3 623
	Growing goats (pregnant)	70	281	669	849	1 042	1 822	1 004	922
	Other mature goats	55	154	249	457	505	670	533	369
Poultry	Laying hens and cocks	642 074	463 848	633 970	1708774	667 404	872 621	453 947	630 636
	Broilers	200 540	1 036 932	1 197 121	1 452 219	402 415	261 565	71 198	2 334 636
	Turkeys	1 646	12 072	3 362	102 295	5 664	7 009	3 488	851
	Ducks	6 436	28 399	10 325	66 806	7 307	27 210	14 649	2 657
	Geese	1 343	2 998	1 931	7 101	2 898	4 477	1 635	1 378

5.8.4 CATEGORY-SPECIFIC RECALCULATIONS

The recalculations were made due to the general refinement of emission inventory of NH_3, NOx as well. The lack of transparency motivated us to provide accurate and flawless emissions. Even though high effort, the deficiency of inventory was revealed and corrected. Allocation of biogas nitrogen was mistaken. Percentage of 2016 was taken into account for the whole time-series in 3B1a for NOx and NH_3 emissions. Incorrect emission factors were found in 3B4gii and 3B4giii categories for NOx emissions. Emission factor for 3Da3 was changed as well. Value from german inventory 0.024 kg NOx/ N kg was replaced by EMEP/EEA GB_{2016} 0.04 kg NOx/N kg. The german EF was used due to lack of EFs from the EMEP/EEA GB_{2013} in the past.

Desegregation of sheep category on the regions had an impact on emissions. Implementation of regional differences, the number of livestock was replaced to a number of animals by regions. A number of sheep in 2018 submission is shown in ***Table 5.17***, number of the head in 2019 submission is shown in ***Table 5.18***. Value of NEx is consistent across the time series and the regions, due to limited information on a regional level. The Slovak Republic plan implement new values of NEx according to the Tier 2 methodology from the IPCC 2006 GL.

Table 5.17: *Animal population according to the districts for the year 2016 in 2019 submission*

	CATEGORIES	BRATISLAVA	TRNAVA	TRENČÍN	NITRA	ŽILINA	BANSKÁ BYSTRICA	PREŠOV	KOŠICE
MILK SHEEP	MATURE EWES	119	401	15984	1992	46785	41662	34864	14021
	GROWING LAMBS	0	230	5551	974	10409	13645	7634	4731
	GROWING LAMBS (PREGNANT)	0	175	4661	793	7796	10365	6310	2289
	OTHER MATURE SHEEP	3	14	516	70	1365	1301	1029	408
BEEF SHEEP	MATURE EWES	539	875	6137	3793	11039	39397	15684	14773
	GROWING LAMBS	220	301	1114	476	4112	7584	4469	3695
	GROWING LAMBS (PREGNANT)	12	229	935	388	3080	5761	3694	1788
	OTHER MATURE SHEEP	14	28	177	105	353	1129	484	414

Table 5.18: *Animal population for the year 2016 in 2018 submission*

	CATEGORIES	TOTAL
MILK SHEEP	MATURE EWES	155 828
	GROWING LAMBS	43 174
	GROWING LAMBS (PREGNANT)	32 389
	OTHER MATURE SHEEP	4 706
BEEF SHEEP	MATURE EWES	92 237
	GROWING LAMBS	21 971
	GROWING LAMBS (PREGNANT)	15 887
	OTHER MATURE SHEEP	2 704

The Slovak Republic prepared revision not only for methane, but also for nitrogen emission N_2O, NH_3, and NOx. The base of calculation was to estimate feeding reactions for different subcategories of pigs. The crude protein of feed was calculated for each feed supplement. Nitrogen excretion rate was changed for years 1990–2017. Emissions factors were increase due to the implementation of more accurate Tier 2 approach for 3B3 category.

The Slovak Republic prepared an analysis of mitigation measures in the sector Agriculture.[7] The mitigation measures are difficult to estimate in the conditions of the Slovak Republic, due to lack of official statistical information. The recalculations led to a significant decrease of NH_3 emission in all animal subcategories and categories 3Da2a Animal applied into the soils. The methodology is described in **ANNEX VI*.***

The recalculation led to increase of total NOx emissions from manure management by 3% in 2016, as shown in ***Table 5.19***. The recalculation let to decrease total NH_3 emissions from manure management by 14%. ***Table 5.19*** shows a comparison of NOx and NH_3 emission between 2018 and 2019 submissions and impact on overall trends.

Table 5.19: *The effect of recalculations NH_3 and NOx emissions in 1990–2016 for swine*

CATEGORY	TOTAL NH_3 (Gg)		TOTAL NOx (Gg)	
Year of submission	**2018**	**2019**	**2018**	**2019**
1990	71.645	73.937	11.273	11.749
1991	61.931	63.966	7.396	8.406
1992	53.600	55.302	5.361	5.833
1993	47.191	49.173	4.205	4.560
1994	46.448	48.426	4.264	4.594
1995	46.211	47.204	4.297	4.613
1996	45.253	46.977	4.437	4.742
1997	45.148	46.823	4.939	5.214
1998	40.038	41.610	4.540	4.778
1999	37.692	38.854	3.827	4.056
2000	37.909	39.122	4.106	4.328
2001	39.227	40.371	4.207	4.430
2002	38.276	39.601	4.680	4.896
2003	36.751	37.826	4.347	4.553
2004	33.738	34.335	4.210	4.395
2005	33.591	34.142	4.257	4.436
2006	32.292	32.863	4.105	4.287
2007	31.866	32.204	4.492	4.670
2008	29.498	29.523	4.397	4.574
2009	29.784	29.719	3.952	4.118
2010	29.524	29.434	4.333	4.505
2011	28.117	28.077	4.542	4.717
2012	29.262	29.140	4.879	5.056
2013	28.926	28.982	5.366	5.541
2014	30.073	29.964	5.603	5.773
2015	29.823	29.709	5.416	5.586
2016	28.960	25.003	5.840	6.004
2018/2019		**-14%**		**3%**

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 contribute production of emission feathers from poultry residues skin and others. The particular matters have a filterable character.

[7] **IMPLEMENTATION OF MITIGATION MEASURES AND THEIR POTENTIAL FOR REDUCING EMISSIONS IN AGRICULTURE**, TONHAUZER, K., SZEMESOVÁ, J., IN METEOROLOGICAL JOURNAL. 21, 1 (2018), s. 23--30. ISSN 1335-339X. http://www.shmu.sk/File/ExtraFiles/MET_CASOPIS/MC_2018-1.pdf (in Slovak language)

In 2017, manure management contributed 25% and 62% to the national total PM emissions given as TSP 56% of the sectorial emissions relates to the poultry production. Total $PM_{2.5}$ from manure management decreased from 0.33 Gg in 1990 to 0.12 Gg in 2017, which is the decrease by 64% and increase by nearly 1% compared to the previous year. Total PM_{10} from manure management decreased from 1.31 Gg in 1990 to 0.63 Gg in 2017, which is the decrease by 52% and increase by nearly 3.8% compared to the previous year. Total TSP from manure management decreased from 5.34 Gg in 1990 to 2.35 Gg in 2017, which is the decrease by 56% and increase by nearly 2.2% compared to the previous year.The decreasing trend of the number of animals influenced emissions trend.

5.8.5.1 Methodological issues

Emission estimation is based on the Tier 1 methodology of the EMEP/EEA GB_{2016}. The PM emissions are related to the annual average population (AAP) and to the time the animal is housed (***Table 5.22***). The PM emission from grazing animals is considered as 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 5.20: *Time to spend animals into grassland*

CATEGORIES	GRASSING TIME
	days
DAIRY CATTLE	150
CALVES	148
HEFERS UNPREGNANT	9
HEFERS PREGNANT	9
FATTENING	0
OXEN	0
SUCKLING COWS	200
CALVES	290
HEFERS UNPREGNANT	225
HEFERS PREGNANT	225
FATTENING	0
OXEN	0
BREEDING BULLS	90
SOWS 180 KG	0
WEARNERS	0
FATTENING PIGS	0
LAYING HENS INCLUDING	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}, $PM_{2.5}$, TSP emissions from manure management were calculated using by the default Tier 1 emissions factors for each category of farm animals (***Table 5.21***). The same emissions factors were used for all years.

Table 5.21: *Default emissions PM and TSP factors*

CATEGORIES	EMISSION FACTOR PM_{10}	EMISSION FACTOR $PM_{2.5}$	EMISSION FACTOR TSP
	kg/head/year-1	kg/head/year-1	kg/head/year-1
DAIRY CATTLE	0.63	0.41	1.38
CALVES	0.16	0.1	0.34
HEFERS UNPREGNANT	0.27	0.18	0.59
HEFERS PREGNANT	0.27	0.18	0.59
FATTENING	0.27	0.18	0.59
OXEN	0.27	0.18	0.59
SUCKLING COWS	0.27	0.18	0.59
CALVES	0.16	0.1	0.34
HEFERS UNPREGNANT	0.27	0.18	0.59
HEFERS PREGNANT	0.27	0.18	0.59
FATTENING	0.27	0.18	0.59
OXEN	0.27	0.18	0.59
BREEDING BULLS	0.27	0.18	0.59
SOWS 180 KG	0.17	0.01	0.62
WEARNERS	0.05	0.0002	0.27
FATTENING PIGS	0.14	0.006	1.05
LAYING HENS INCLUDING	0.04	0.003	0.19
BROILERS	0.02	0.002	0.04
TURKEYS	0.11	0.02	0.11
DUCKS	0.14	0.02	0.14
GEESE	0.24	0.03	0.24
HORSES	0.06	0.14	0.48
GOATS	0.22	0.02	0.14
MATURE EWES	0.06	0.02	0.14
GROWING LAMBS	0.06	0.02	0.14
GROWING LAMBS	0.06	0.02	0.14
RAMS	0.06	0.02	0.14
MATURE EWES	0.06	0.02	0.14
GROWING LAMBS	0.06	0.02	0.14
GROWING LAMBS	0.06	0.02	0.14
RAMS	0.06	0.02	0.14

5.8.5.3 Activity data

The number of livestock describes the **Chapter 5.8.3.**

5.8.5.4 Category-specific recalculations

The primary driver of recalculation of TSP and PM emissions in whole time series was insufficient adherence to the methodology according to EMEP/EEA GB_{2016} (***SK-3B-2018-0002***). The Agriculture is not a significant contributor of mentioned emissions and emissions are under the threshold of significance. Therefore, the technical correction was not assigned. The used methodological described **Chapter 5.8.6.1**.

The recalculation led to increasing total $PM_{2.5}$ emissions from manure management by 72.05% in 2016 as shown in ***Table 5.22***. Due to lack of estimations in 3B1a Dairy cattle, 3B2 Sheep, 3B4d Goats, 3B4e Horses categories, emissions was recalculated. The recalculation let to decrease of the total TSP by 30% and PM_{10} emissions from manure management by 0.45%. ***Table 5.22*** shows a comparison of TSP, $PM_{2.5}$ emission between 2018 and 2019 submissions and impact on overall trends.

Table 5.22: *The impact of recalculations of TSP, $PM_{2.5}$, PM_{10} emissions in manure management in 1990–2016*

CATEGORY	TOTAL PM_{10} (Gg)		TOTAL $PM_{2.5}$ (Gg)		TOTAL TSP (Gg)	
Year of submission	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
1990	1.259	1.312	0.197	0.330	9.588	5.333
1991	1.145	1.193	0.163	0.294	9.292	5.030
1992	1.035	1.084	0.140	0.257	8.464	4.527
1993	0.983	1.012	0.120	0.223	8.356	4.374
1994	1.103	1.120	0.154	0.229	8.078	4.435
1995	1.000	1.023	0.131	0.217	8.148	4.340
1996	0.970	0.999	0.121	0.210	7.803	4.216
1997	0.976	0.982	0.120	0.211	7.003	4.014
1998	0.869	0.882	0.110	0.188	5.929	3.508
1999	0.822	0.837	0.098	0.179	5.994	3.384
2000	0.835	0.851	0.101	0.178	5.842	3.371
2001	0.916	0.939	0.120	0.181	6.299	3.788
2002	0.849	0.867	0.106	0.172	5.986	3.495
2003	0.822	0.838	0.093	0.164	5.742	3.365
2004	0.756	0.765	0.087	0.153	4.876	2.962
2005	0.755	0.763	0.088	0.151	4.743	2.921
2006	0.727	0.733	0.083	0.143	4.769	2.870
2007	0.706	0.709	0.082	0.141	4.464	2.721
2008	0.630	0.629	0.071	0.133	3.760	2.405
2009	0.684	0.679	0.076	0.133	3.967	2.572
2010	0.664	0.659	0.072	0.130	3.797	2.501
2011	0.610	0.606	0.069	0.125	3.308	2.305
2012	0.630	0.626	0.072	0.127	3.553	2.394
2013	0.598	0.601	0.071	0.124	3.292	2.279
2014	0.625	0.622	0.069	0.124	3.538	2.323
2015	0.636	0.633	0.070	0.123	3.582	2.385
2016	**0.610**	**0.607**	0.069	0.118	3.278	2.295
2018/2019		**-0.46%**		**72.05%**		**-29.99%**

5.8.6 NMVOC EMISSIONS

The main source of NMVOC emissions occurs from the enteric fermentation of ruminants. Especially, NMVOC emissions arise during stomach fermentation of partially digestible and non-digestible fats, carbohydrates and proteins. NMVOC are emitted during breathing or as flatus. The storage of silage manure is another source of NMVOC emissions.

Cattle is the main contributor of NMVOCs from all farm animals (67%), followed poultry (26%), pigs (5%) and another animal. Weather conditions, as high temperature, wind speed, and wind direction affects the amount of emissions. These parameters were no taken into consideration in NMVOC emission balance.

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 ration and gross feed intake. Dairy cattle and non-dairy cattle have been calculated using Tier 2 methodology by EMEP/EEA GB_{2016}.

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_{2016}.

This methodology distinguishes emission factors 'with silage feeding' from cattle categories, emission estimate are reliable. $Frac_{silage}$ used in the Slovak inventory was calculated from 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 (suckling cows. calves 6 months. heifer. pregnancy heifer. breeding bull. oxen. fattening) and followed parameters (***Table 5.23*)**.

NMVOC for cattle is based on the following equations [1]:

$$E_{NMVOC\,i} = N_A.\left(E_{NMVOC.storr\ silage\ i} + E_{NMVOC.silage\ feeding\ i+} + E_{NMVOC.\ house\ i} + E_{MVOC.applic.i} + E_{NMVOC.pasture\ i}\right)$$

$$E_{NMVOC.silage\ store\ i} = MJ_i.x_{house\ i}\left(EF_{NMVOC.silage\ feeding\ \ i}.Frac_{silage}\right)$$

$$E_{NMVOC.\ \ silage\ feeding\ i} = MJ_i.x_{housing\ i}.\left(EF_{NMVOC\ feed\ silage\ i}.Frac_{silage}\right)$$

$$E_{NMVOC\ house\ i} = MJ_i.x_{house\ i}.\left(EF_{NMVOC\ silage}\right)$$

$$E_{NMVOC\ manure\ store\ i} = E_{NMVOC\ \ house\ i}.x_{house\ i}.\left(\frac{E_{NH_3\ storage\ i}}{E_{NH_3\ house\ i}}\right)$$

$$E_{NMVOC\ application\ i} = E_{NMVOC\ \ house\ i}.x_{house\ i}.\left(\frac{E_{NH_3\ appli\ i}}{E_{NH_3\ house\ i}}\right)$$

$$E_{NMVOC\ graz\ i} = MJ_i.(1 - x_{house\ i}).EF_{NMVOC.graz\ i}$$

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 1.0.$Frac_{silage\ store}$: to 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 3.B Manure Management.

Table 5.23: Overview of parameters and emissions factors for cattle categories in 2017

CATEGORIES	SUBCATEGORY	$FRAC_{SILAG}$	MJ PER YEAR	X_{HOUSE}	IEF KG NMVOC HEAD $YEAR^{-1}$
		%	MJ/cow/year		
DAIRY CATTLE	Dairy cows	52	104 563.21	0.59	9.17
NON-DAIRY CATTLE	Calves (6 month)	-	14 612.07	0.59	0.58
	Heifer	40	36 170.73	0.98	4.42
	Heifer pregnant	33	53 323.54	0.98	5.87
	Fattening	52	37 923.23	1.00	5.39
	Oxen	58	91 175.41	1.00	14.63
	Breeding Bull	56	67 050.50	0.75	8.59
	Suckling Cows	7	75 216.16	0.45	2.01
	Calves (7 month)	0,1	23 531.86	0.21	0.07
	Heifer	14	40 161.76	0.45	2.34
	Heifer pregnant	15	59 138.48	0.45	1.97
	Fattening	60	49 567.10	1.00	7.91
	Oxen	58	90 324.23	1.00	14.64
	Breeding Bull	56	67 050.50	0.75	8.59

***all parameters are weighted average represent aggregation in level SR.**

Other animals

NMVOC emissions from other animal categories were calculated using the Tier 1 methodology and emission factors outlined in the EMEP/EEA GB_{2016}.Used emission factors summarized ***Table 5.24***. There are no evidences about adding silage into feeding ration 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

No recalculations in this submission.

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 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_{2016}. The emissions decreased by almost 6.9% compared to 2016 and by 49% compared to the base year 1990. The major reason for the overall decreasing trend is a sharp decrease in the use of synthetic fertilizers in 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 the small fluctuations caused by changes in animal population and inter-annual changes in categories, 3D1 - Inorganic Nitrogen Fertilizers.

Table 5.25: *NH_3 emissions (Gg) in agricultural soils according to the subcategories in particular years*

YEAR	3D NH_3 EMISSIONS FROM MANAGED SOILS (Gg)					
	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	11.113	35.204	0.004	0.033	1.903	48.256
1995	3.479	24.089	0.001	0.024	1.258	28.851
2000	3.633	19.736	0.002	0.028	0.993	24.392
2005	4.066	16.782	0.004	0.002	0.841	21.694
2010	4.344	14.006	0.004	0.003	0.783	19.140
2011	4.648	13.106	0.002	0.001	0.765	18.523
2012	5.050	13.444	0.005	NO	0.782	19.282
2013	5.679	13.011	0.002	0.000	0.763	19.455
2014	5.952	13.442	0.000034	NO	0.773	20.167
2015	5.739	13.376	NO	0.0006	0.762	19.878
2016	6.312	10.913	NO	0.0002	0.735	17.960
2017	6.127	9.890	NO	0.0002	0.736	16.754

Table 5.26: *NOx emissions (Gg) in agricultural soils according to the subcategories in particular years*

YEAR	3D NOx EMISSIONS FROM MANAGED SOILS (Gg)					
	3Da1 Inorganic-N fertilizers	3Da2a Animal manure applied to soils	3Da2b Sewage sludge applied to soils	3Da2c Other organic Fertilizers applied to soils	3Da3 Urine and dung deposited by grazing animal	Total emissions
1990	8.890	1.676	0.001	0.016	1.136	11.720
1995	2.783	1.070	0.0002	0.012	0.728	4.594
2000	2.906	0.853	0.001	0.014	0.539	4.313
2005	3.253	0.705	0.001	0.001	0.464	4.423
2010	3.475	0.582	0.001	0.001	0.434	4.494
2011	3.719	0.561	0.0005	0.001	0.427	4.707
2012	4.040	0.567	0.002	NO	0.438	5.046
2013	4.543	0.555	0.001	0.0001	0.431	5.531
2014	4.761	0.560	0.00001	NO	0.441	5.762

YEAR	3D NOx EMISSIONS FROM MANAGED SOILS (Gg)					
	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
2015	4.591	0.548	NO	0.0003	0.436	5.575
2016	5.049	0.523	NO	0.0001	0.422	5.994
2017	4.902	0.521	NO	0.0001	0.446	5.869

Table 5.27: *NMVOC emissions (Gg) in agricultural soils according to the subcategories in particular years*

YEAR	3.D NMVOC EMISSIONS FROM MANAGED SOILS (Gg)					
	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	NA	4.422	NA	NA	0.174	4.596
1995	NA	2.739	NA	NA	0.112	2.852
2000	NA	2.176	NA	NA	0.083	2.259
2005	NA	1.826	NA	NA	0.070	1.896
2010	NA	1.549	NA	NA	0.064	1.614
2011	NA	1.527	NA	NA	0.063	1.591
2012	NA	1.524	NA	NA	0.064	1.588
2013	NA	1.493	NA	NA	0.064	1.557
2014	NA	1.500	NA	NA	0.065	1.565
2015	NA	1.460	NA	NA	0.065	1.525
2016	NA	1.408	NA	NA	0.068	1.476
2017	NA	1.377	NA	NA	0.064	1.440

Figure 5.13: *The share of NH_3 emissions by categories within agricultural soils in 2017*

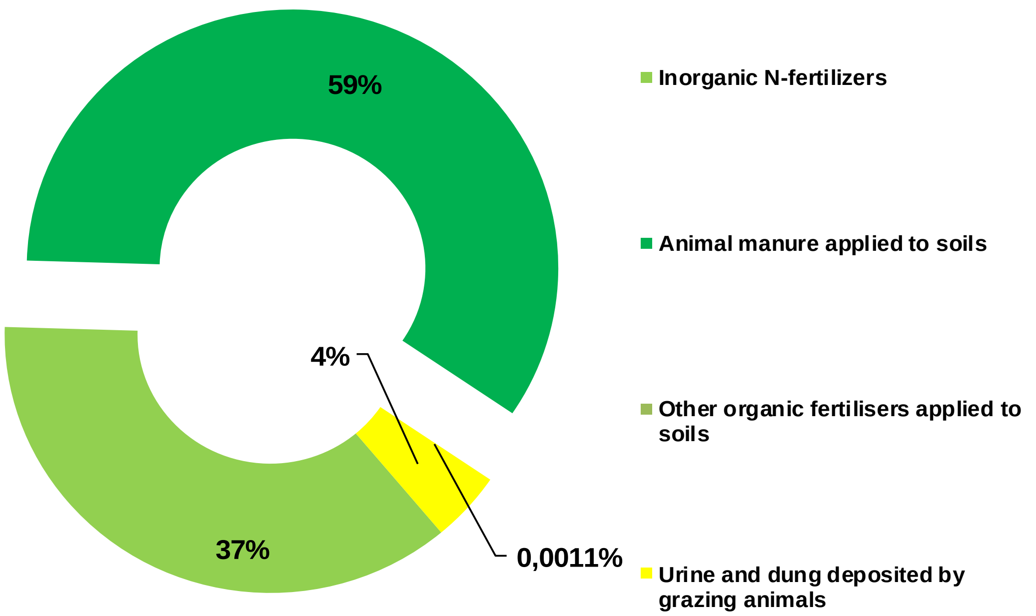
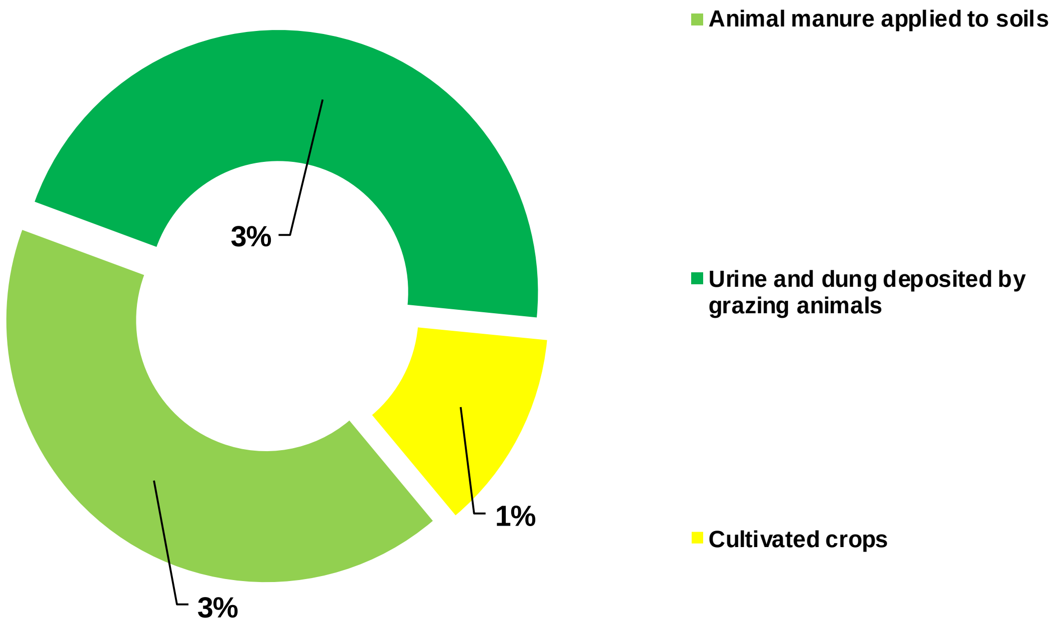


Figure 5.14: *The share of NMVOC emissions by categories within agricultural soils in 2017*



5.9.1 ACTIVITY DATA

Data of sown areas were taken from the ŠÚ SR. Data is available on 20th May every year (***Table 5.28***).

Table 5.28: *A Sown area in thousand hectares for years 1990-2017*

SOWING AREAS				
YEAR	**WHEAT**	**RYE**	**OIL PLANTS/RAPE**	**GRASS**
	ha			
1990	412 423	40 474	67 087	813 000
1995	442 874	31 162	87 883	835 000
2000	406 400	29 800	178 300	820 000
2005	375 801	32 500	215 547	524 110
2010	349 700	29 370	280 000	513 029
2011	364 000	13 358	261 600	518 230
2012	388 700	28 568	225 100	514 942
2013	368 200	35 408	254 800	513 704
2014	380 200	29 369	243 400	510 801
2015	379 400	15 175	247 400	520 581
2016	417 700	12 843	254 000	521 441
2017	374 781	10 380	292 854	517 679
TREND 1990-2017	**-9.1%**	**-74.4%**	**+336.5%**	**-36.3%**
TREND 2016-2017	**-10.3%**	**-19.2%**	**+15.3%**	**-0.7%**

5.9.2 CATEGORY-SPECIFIC RECALCULATIONS

Recalculations of categories 3Da2a – Animal manure applied to soils are connected to the methodological changes in the 3B3 Swine category. The Nitrogen excretion rates were changed due to methodological improvements – a shift from Tier 1 to Tier 2 approach. Changes in 3B2 and 3B1a had an impact on emissions, due to correction in the calculations and implementation of the regional characteristic in 3B2. Detailed information on recalculation and methodological changes of the category 3B3 - Swine is available in the **Chapters 5.8.2**. Implementation of mitigation measures in the 3Da2.especially 24 hour spreading, 12 hours spreading and direct incorporation, caused emissions decrease.

Recalculation led to decrease NOx and NH_3 in emissions compared to the previous submission from this category at 3.5% in 2016.

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. In present, the amount of synthetic fertilizers applied to the agricultural soils increased again. This fact is main driver in increasing emissions in the sector. The potential for the volatilization of ammonia emissions can vary in very large range. The best information on NH_3 emissions from cultivated soils in the Slovak Republic is based on the applied nitrogen fertilizers. Emissions also depend on the type of fertilizers, soil parameters (pH), meteorological conditions and time of fertilizers' application in relation to 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 data provided by the ŠÚ SR. The Central Control Testing and Testing Institute in Agriculture (UKSÚP) reported the data into the ŠÚ SR with accordance Act No 202/2008 Coll. on fertilizers. The farmers have duty reported the amount of applied nitrogen into 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 20th century, from 222 kt in 1990 to 122 kt in 2017 (45%). Consumption of the synthetic fertilizers increased by 51% in 2017 compared with 2005 and the decreased almost 3% in the comparison with the year 2016. Decreasing numbers of domestic livestock caused the demand for inorganic nitrogen is bigger. Missing organic nitrogen compensates a higher consumption of synthetic fertilizers. Drought and adverse climatic conditions caused annual reduction in the crop yields and reduction of fertilizer consumption.

5.9.3.2 Methodological issues

NH_3 and NOx emissions from Inorganic-N fertilizers were calculated using the Tier 1 methodology according to the EMEP/EEA GB_{2016}.

Table 5.29: *Input parameters and EFs in 3Da1 Inorganic N fertilizers in particular years*

YEAR	NITROGEN INPUT INTO SOILS	EMISSION FACTOR NH_3	EMISSION FACTOR NOx	EMISSIONS NH_3	EMISSIONS NOx
	kg/year	kg NH_3/kg N	kg NOx/kg N	Gg	Gg
1990	222 255 000	0.05	0.04	11.11	8.89
1995	69 587 000	0.05	0.04	3.48	2.78
2000	72 653 000	0.05	0.04	3.63	2.91
2005	81 317 000	0.05	0.04	4.07	3.25
2010	86 873 000	0.05	0.04	4.34	3.47
2011	92 969 000	0.05	0.04	4.65	3.72
2012	101 004 000	0.05	0.04	5.05	4.04
2013	113 581 390	0.05	0.04	5.68	4.54
2014	119 036 050	0.05	0.04	5.95	4.76
2015	114 773 000	0.05	0.04	5.74	4.59
2016	126 235 769	0.05	0.04	6.31	5.05
2017	122 541 152	0.05	0.04	6.13	4.90
TREND 1990-2017	**-45%**			**-45%**	**-45%**
TREND 2016-2017	**51%**			**51%**	**51%**

5.9.4 ANIMAL MANURE APPLIED TO THE SOILS (NFR 3Da2a) NH_3, NOX, NMVOC

Livestock number and information on animal waste management systems are described in **Chapters 5.8.1** and **5.8.3**. This application is connected with utilization NH_3, PM, 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 2019" – 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 a 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 soil as quickly as possible. After direct incorporation of manure into soils, the ammonia losses are reduced. The crops have sufficient nitrogen for grown. The Ministry of Agriculture and Rural development issue 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. First 6 hours after application evaporate of 50 % ammonia, 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_{2016} for spreading of slurry and solid manure were applied in the proportion of total ammoniacal nitrogen (TAN) according to the Table 3.9 p 29 of

EMEP/EEA GB_{2016}. Default NOx emission factor of the EMEP/EEA GB_{2016} for spreading was used. NH_3 and NOx emission were calculated using the calculation sheet (4.B appendix.xls) provided to the EMEP/EEA GB_{2013}, 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**.

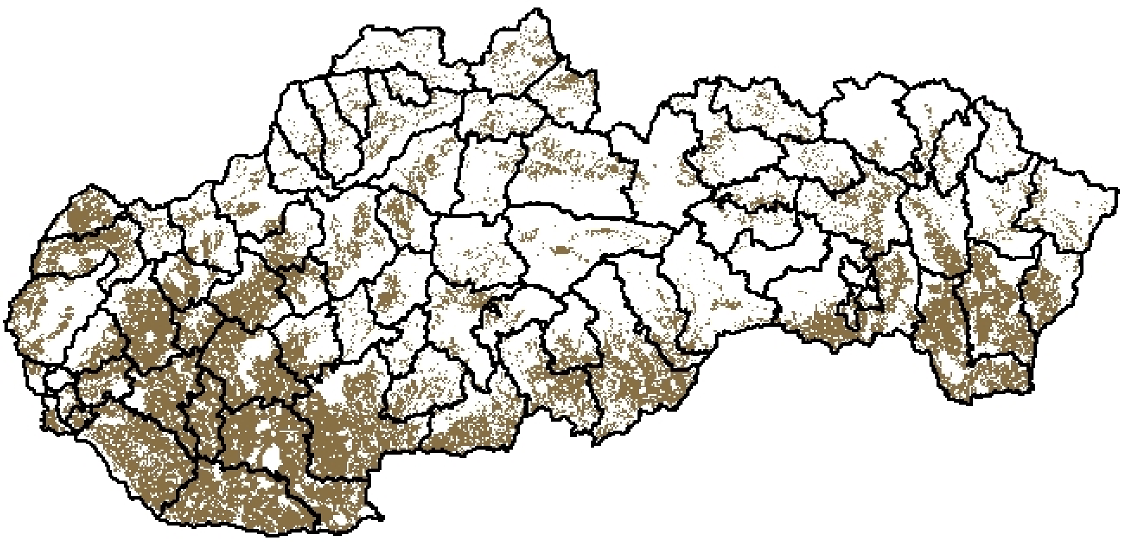
5.9.5 SEWAGE SLUDGE APPLIED TO SOILS (NFR 3Da2b)

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 afterward 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 5.44***) is based on the data provided by the Water Research Institute. Sewage sludge was applied to the soil even before the year 2010, but there is no available statistics. Missing data were extrapolated by SHMÚ. The Water Research Institute informed that sewage sludge was not applied into agricultural soils in years 2016 and 2017. The notation key NO was used in these years.

Figure 5.15: *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, NOx

Default methodology Tier 1 and default emission factors were used for the estimation of direct NH_3 and NOx emissions from sewage sludge applied to soils. The methodology was in accordance with the EMEP/EEA GB_{2016}. Percentage of pure nitrogen in sewage sludge was provided from the Soil Science and Conservation Research Institute.[8] 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: **NH_3 $_{\text{sewage sludge}}$, NO $_{\text{sewage sludge}}$:** Emissions from sewage sludge applied into the soil in kg. $N_{\text{Sewage sludge}}$: the amount of sludge from wastewater treatment in kg. **P_N:** Weight percentage of nitrogen from sewage sludge (3.31%).
$EF_{NO.\ NH3}$: Emissions factors for NH_3 and NO kg NO respectively NH_3.

Table 5.30: *Input parameters and EFs in 3Da2b - Sewage Sludge in particular years*

YEARS	AMOUNT OF SEWAGE SLUDGE	NITROGEN INPUT INTO SOILS	EMISSION FACTORS NH_3	EMISSION FACTORS NOx	EMISSIONS NH_3	EMISSIONS NOx
	kg/year	kg NH_3/kg N	kg NH_3/kg N	kg NOx/kg N	Gg	Gg
1990	817 114	27 046	0.13	0.04	0.0035	0.0011
1995	137 909	4 565	0.13	0.04	0.0006	0.0002
2000	399 606	13 227	0.13	0.04	0.0017	0.0005
2005	877 203	29 035	0.13	0.04	0.0038	0.0012
2010	923 000	30 551	0.13	0.04	0.0040	0.0012
2011	358 000	11 850	0.13	0.04	0.0015	0.0005
2012	1 254 000	41 507	0.13	0.04	0.0054	0.0017
2013	518 000	17 146	0.13	0.04	0.0022	0.0007
2014	8 000	265	0.13	0.04	0.0000	0.0000
2015	NO	NO	0.13	0.04	NO	NO
2016	NO	NO	0.13	0.04	NO	NO
2017	NO	NO	0.13	0.04	NO	NO
TREND 1990-2017	**-100%**	**-100%**			**-100%**	**-100%**
TREND 2005-2017	**-100%**	**-100%**			**-100%**	**-100%**

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 2017.

5.9.6.1 Activity data

N content of the composted waste for emission estimation was used instead of data on compost applied to agricultural soils. Activity data, compost consumption, (***Table 5.31***) is based on the data provided by the UKSÚP. Compost was applied to the soil even before the year 2005, but there are no available statistics. Missing data was extrapolated by SHMÚ.

[8]*Guideline for sewage sludge application (In Slovak):*http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

5.9.6.2 Methodological issues – Methods – NOx, NH_3

Default methodology Tier 1 according to EMEP/EEA GB_{2016} 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. Percentage of nitrogen in used compost was provided by the Soil Science and Conservation Research Institute.[9] Amount of compost applied to soils provided the UKSÚP. Emissions were estimated using these equations:

$$A_{compost} = N_{compost} * P_N$$
$$NO_{compost} = A_{compost} * EF_{NO}$$
$$NH_{3\ compost} = A_{compost} * EF_{NH3}$$

Where: $\mathbf{N_{compost}}$ is the input of pure nitrogen in compost applied into the soil in kg. $\mathbf{N_{compost}}$ is the amount of compost from composting plant. $\mathbf{P_N}$ is 1 tonne of compost = 7 kg N

Table 5.31: *Input parameters, EFs and emissions in 3Da2c - Other organic fertilizers applied to soils*

YEARS	AMOUNT OF COMPOST	NITROGEN INPUT INTO SOILS	EMISSION FACTORS NH_3	EMISSION FACTORS NOx	EMISSIONS NH_3	EMISSIONS NOx
	kg/year	kg NH_3/kg N	kg NH_3/kg N	kg NOx/kg N	Gg	Gg
1990	58 059	406 413	0.08	0.04	0.0325	0.0163
1995	43 130	301 907	0.08	0.04	0.0242	0.0121
2000	50 641	354 489	0.08	0.04	0.0284	0.0142
2005	3 552	24 864	0.08	0.04	0.0020	0.0010
2010	4 999	34 993	0.08	0.04	0.0028	0.0014
2011	2 261	15 827	0.08	0.04	0.0013	0.0006
2012	NO	NO	0.08	0.04	NO	NO
2013	500	3 500	0.08	0.04	0.0003	0.0001
2014	NO	NO	0.08	0.04	NO	NO
2015	1 015	7 105	0.08	0.04	0.0006	0.0003
2016	318	2 226	0.08	0.04	0.0002	0.0001
2017	327	2 286	0.08	0.04	0.0002	0.0001
Trend 1990-2017	**-99%**	**-99%**	**0%**	**0%**	**-99%**	**-99%**
Trend 2005-2017	**-91%**	**-91%**	**0%**	**0%**	**-91%**	**-91%**

5.9.7 URINE AND DUNG DEPOSITED BY GRAZING ANIMALS (NFR 3Da3)

Pasture is typical for some livestock categories. Animals 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, 41% of non-dairy cattle stays 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 5.20***.

[9] *Guideline for sewage sludge application (In Slovak):* http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

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 5.7***. 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_{2016}. Emission of urine and dung deposited by grazing animals is based on nitrogen excreted from farm animals, a number of days the animals are on the pasture and the emission factors.

Table 5.32: *Input parameters, EFs and emissions in 3Da2c- Other organic fertilizers applied to soils*

YEARS	NITROGEN EXCRETED DURING PASTURE	EMISSION FACTORS NMVOC	EMISSION FACTORS NOx	EMISSIONS NH_3	EMISSIONS NOx	EMISSIONS NMVOC
	kg/year	kg NMVOC kg/MJ feed intake	kg NOx/kg N	Gg	Gg	Gg
1990	17 633 939	0.04	0.0000069	1.903	1.136	0.174
1995	12 103 891	0.04	0.0000069	1.258	0.728	0.112
2000	7 708 795	0.04	0.0000069	0.993	0.539	0.083
2005	6 985 932	0.04	0.0000069	0.841	0.464	0.070
2010	8 069 410	0.04	0.0000069	0.783	0.434	0.064
2011	8 001 969	0.04	0.0000069	0.765	0.427	0.063
2012	8 524 766	0.04	0.0000069	0.782	0.438	0.064
2013	8 533 742	0.04	0.0000069	0.763	0.431	0.064
2014	8 851 839	0.04	0.0000069	0.773	0.441	0.065
2015	8 791 437	0.04	0.0000069	0.762	0.436	0.065
2016	8 537 077	0.04	0.0000069	0.735	0.422	0.068
2017	8 447 592	0.04	0.0000069	0.736	0.446	0.064
Trend 1990-2017	**-52%**			**-61%**	**-61%**	**-63%**
Trend 2005-2017	**21%**			**-12%**	**-4%**	**-10%**

5.9.7.3 Methodological issues –Methods - NMVOC

Cattle

All references for calculation are in **Chapter 5.8.6.2**.

5.11 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. The NMVOCs emitted have proven difficult to quantify in atmospheric samples. Factors that can influence the emission of NMVOCs include temperature and light intensity, plant growth stage, water stress, air pollution, and senescence. NMVOC emissions from crop production are reported under the NFR 3De category.

5.11.1 ACTIVITY DATA

Data of sown areas were taken from the ŠÚ SR. Data is available 20th May every year.

5.11.2 METHODOLOGICAL ISSUES - METHODS

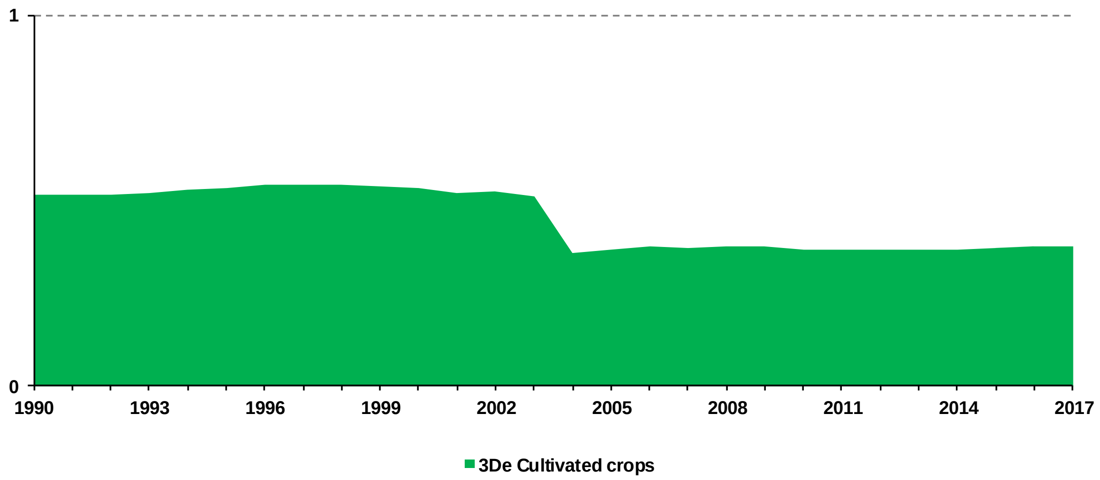
The EMEP/EEA GB_{2016} Tier 1 methodology was used. Default emission factor was applied (Table 3-1) according to EMEP/EEA GB_{2016}.

Calculations were prepared in accordance with the following equation:

$$\mathrm{E_{NMVOC}} = \mathrm{S_{Area}} * \mathrm{EF_{NMVOC}}$$

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 5.16: *Trend of NMVOC emissions from NFR 3De cultivated crops*



5.11.3 CATEGORY-SPECIFIC RECALCULATIONS

The recalculations of NMVOC emissions were made for the years 2001-2016, due to correction of activity data. The consistent grassland area 860 084 hectares was replaced by the official statistical data for mentioned years. The 3De category is not a significant contributor of mentioned emissions and emissions are under the threshold of significance. The changes describe ***Table 5.36***.

The recalculation led to decreased of emission from the Cultivated crops (NFR 3De) by 39%.

Table 5.36: *The impact of recalculations of NMVOC emissions in 3De category in 1990-2016*

CATEGORY	NMVOC EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE, HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCT (Gg)		AREA OF GRASSLAND IN HA	
EF (kg/head) in 2016	*0.06*	*0.06*	2018	2019
Year of submission	2018	2019		

CATEGORY	NMVOC EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE, HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCT (Gg)		AREA OF GRASSLAND IN HA	
1990	5.111	5.111	813 000	813 000
1991	4.609	4.609	808 000	808 000
1992	3.997	3.997	810 000	810 000
1993	3.604	3.604	832 000	832 000
1994	3.428	3.428	835 000	835 000
1995	3.385	3.385	835 000	835 000
1996	3.273	3.273	840 000	840 000
1997	3.275	3.275	842 000	842 000
1998	2.974	2.974	846 000	846 000
1999	2.858	2.858	829 631	829 631
2000	2.792	2.792	820 000	820 000
2001	2.752	2.709	860 084	783 905
2002	2.733	2.698	860 084	798 668
2003	2.611	2.574	860 084	794 733
2004	2.471	2.277	860 084	514 478
2005	2.453	2.264	860 084	524 110
2006	2.348	2.166	860 084	535 537
2007	2.315	2.129	860 084	528 502
2008	2.277	2.094	860 084	531 584
2009	2.197	2.009	860 084	523 609
2010	2.175	1.981	860 084	513 029
2011	2.151	1.959	860 084	518 230
2012	2.147	1.954	860 084	514 942
2013	2.118	1.924	860 084	513 704
2014	2.126	1.930	860 084	510 801
2015	2.085	1.895	860 084	520 581
2016	1.998	1.852	860 084	521 441
2018/2019		**-7%**		**-39%**

5.10 PM AND TSP EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE, HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCTS (NFR 3Dc)

Particular matters raised during agricultural soils plowing. They have a diameter of less than 10 or 2.5 micrometers, which is about 3% of the diameter of human hair. They are small, therefore they are dangerous for health. During breathing, particular matters easier penetrate the lungs. The particular matters have a filterable character.

5.10.1 METHODOLOGICAL ISSUES - METHODS

Pollution $PM_{2.5}$, PM_{10}, and TSP were calculated using the Tier 1 methodology from EMEP/EEA GB_{2016}.

Emissions were calculated with the following equation:

$$\mathrm{E_{PM}} = \mathrm{EF_{PM,TSP}} * \sum \mathrm{S_{area}}$$

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}).$\boldsymbol{S_{area}}$ Annual sown area of the crop in ha

5.10.2 ACTIVITY DATA

Data of sown areas were taken from the ŠÚ SR. Data is available 20th May every year.

5.10.3 CATEGORY-SPECIFIC RECALCULATIONS

The recalculations of TSP, PM emissions were made for years 2001-2016, due to correction of activity data. The consistent grassland area 860 084 hectares was replaced by the official statistical data for the mentioned years. The 3Dc category is not a significant contributor, emissions are under the threshold of significance. The changes are described in the ***Tables 5.33, 5.34*** and ***5.35***.

The recalculation led to decrease of emission from Farm-level Agricultural Operations Including Storage, Handling and Transport of Agricultural Products (NFR 3Dc) by 39%.

Table 5.33: *The impact of recalculations of TSP emissions in 3Dc in 1990–2016*

CATEGORY	TSP EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE, HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCT (Gg)		AREA OF GRASSLAND IN HA	
EF (kg/head) in 2016	*1.56*	*1.56*	2018	2019
Year of submission	2018	2019		
1990	2.079	2.079	813 000	813 000
1991	2.096	2.096	808 000	808 000
1992	2.103	2.103	810 000	810 000
1993	1.993	1.993	832 000	832 000
1994	2.076	2.076	835 000	835 000
1995	2.179	2.179	835 000	835 000
1996	2.238	2.238	840 000	840 000
1997	2.223	2.223	842 000	842 000
1998	2.233	2.233	846 000	846 000
1999	2.240	2.240	829 631	829 631
2000	2.238	2.238	820 000	820 000
2001	2.370	2.251	860 084	783 905
2002	2.353	2.257	860 084	798 668
2003	2.215	2.113	860 084	794 733
2004	2.268	1.729	860 084	514 478
2005	2.315	1.791	860 084	524 110
2006	2.327	1.821	860 084	535 537
2007	2.326	1.809	860 084	528 502
2008	2.381	1.869	860 084	531 584
2009	2.411	1.886	860 084	523 609
2010	2.370	1.828	860 084	513 029
2011	2.339	1.805	860 084	518 230
2012	2.344	1.805	860 084	514 942
2013	2.369	1.828	860 084	513 704
2014	2.360	1.815	860 084	510 801
2015	2.343	1.814	860 084	520 581
2016	2.303	1.881	860 084	521 441
2018/2019		-18%		-39%

Table 5.34: *The impact of recalculations of PM_{10} emissions in 3Dc category in 1990–2016*

CATEGORY	PM_{10} EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE. HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCT (Gg)		AREA OF GRASSLAND IN HA	
EF (kg/head) in 2016	*1.56*	*1.56*	2018	2019
Year of submission	2018	2019		
1990	2.079	2.079	813 000	813 000
1991	2.096	2.096	808 000	808 000
1992	2.103	2.103	810 000	810 000
1993	1.993	1.993	832 000	832 000
1994	2.076	2.076	835 000	835 000
1995	2.179	2.179	835 000	835 000
1996	2.238	2.238	840 000	840 000
1997	2.223	2.223	842 000	842 000
1998	2.233	2.233	846 000	846 000
1999	2.240	2.240	829 631	829 631
2000	2.238	2.238	820 000	820 000
2001	2.370	2.251	860 084	783 905
2002	2.353	2.257	860 084	798 668
2003	2.215	2.113	860 084	794 733
2004	2.268	1.729	860 084	514 478
2005	2.315	1.791	860 084	524 110
2006	2.327	1.821	860 084	535 537
2007	2.326	1.809	860 084	528 502
2008	2.381	1.869	860 084	531 584
2009	2.411	1.886	860 084	523 609
2010	2.370	1.828	860 084	513 029
2011	2.339	1.805	860 084	518 230
2012	2.344	1.805	860 084	514 942
2013	2.369	1.828	860 084	513 704
2014	2.360	1.815	860 084	510 801
2015	2.343	1.814	860 084	520 581
2016	2.303	1.881	860 084	521 441
2018/2019		-18%		-39%

Table 5.35: *The impact of recalculations of $PM_{2.5}$ emissions in 3Dc category in 1990-2016*

CATEGORY	$PM_{2.5}$ EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE. HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCT (Gg)		AREA OF GRASSLAND IN HA	
EF (kg/head) in 2016	*0.06*	*0.06*	2018	2019
Year of submission	2018	2019		
1990	0.080	0.080	813 000	813 000
1991	0.081	0.081	808 000	808 000
1992	0.081	0.081	810 000	810 000
1993	0.077	0.077	832 000	832 000
1994	0.080	0.080	835 000	835 000
1995	0.084	0.084	835 000	835 000
1996	0.086	0.086	840 000	840 000
1997	0.085	0.085	842 000	842 000
1998	0.086	0.086	846 000	846 000
1999	0.086	0.086	829 631	829 631

CATEGORY	$PM_{2.5}$ EMISSIONS FROM FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE. HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCT (Gg)		AREA OF GRASSLAND IN HA	
2000	0.086	0.086	820 000	820 000
2001	0.091	0.087	860 084	783 905
2002	0.091	0.087	860 084	798 668
2003	0.085	0.081	860 084	794 733
2004	0.087	0.066	860 084	514 478
2005	0.089	0.069	860 084	524 110
2006	0.090	0.070	860 084	535 537
2007	0.089	0.070	860 084	528 502
2008	0.092	0.072	860 084	531 584
2009	0.093	0.073	860 084	523 609
2010	0.091	0.070	860 084	513 029
2011	0.090	0.069	860 084	518 230
2012	0.090	0.069	860 084	514 942
2013	0.091	0.070	860 084	513 704
2014	0.091	0.070	860 084	510 801
2015	0.090	0.070	860 084	520 581
2016	0.089	0.072	860 084	521 441
2018/2019		**-39%**		**-39%**

5.12 AGRICULTURE OTHER INCLUDING USE OF PESTICIDES (NFR 3Df)

Notation key: NA; No emissions are reported in the categories.

These activities are carried out in the Slovak Republic. There is no available emissions factors and methodology for types of used pesticides. Chemical substances mentioned in the EMEP/EEA GB_{2016} were forbidden in consonance with Stockholm Convention on Persistent Organic Pollutants and these substances are not used in pesticides in the territory of the Slovak Republic.

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 were used. The prohibition of activity results from the law mentioned bellow:

- Act No 223/2001 Coll. on wastes and on amendment and implement of some acts in wording of the Act No 553/2001 Coll. the Act No 96/2002 Coll., the 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 on the amendment and implement of some acts
- Act No 40/1964 Coll. Civil code and on amendment and implement of some acts

CHAPTER 6: WASTE (NFR 5)

6.1 OVERVIEW OF THE SECTOR

This chapter represents emissions from the activities involved in the NFR categories listed in ***Table 6.1***. Waste sector emits all reported pollutants (ammonia, sulphur oxides, heavy metals, particulate matters, black carbon, carbon oxides, persistent organic pollutants, non-methane organic pollutants, nitrogen oxides) due to the variety of activities and diverse waste treatment manners. Emissions from waste incineration with energy use were allocated in the energy sector (**NFR 1A**).

Table 6.1: *Categories included in the Waste sector (NFR 5)*

NFR CODE	LONGNAME
5A	Biological treatment of waste - Solid waste disposal on land
5B1	Biological treatment of waste - Composting
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities
5C1a	Municipal waste incineration
5C1bi	Industrial waste incineration
5C1bii	Hazardous waste incineration
5C1biii	Clinical waste incineration
5C1biv	Sewage sludge incineration
5C1bv	Cremation
5C1bvi	Other waste incineration
5C2	Open burning of waste
5D1	Domestic wastewater handling
5D2	Industrial wastewater handling
5D3	Other wastewater handling
5E	Other waste
6A	Other (included in national total for entire territory)

The main source of activity data is national statistics represented by data from 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 6.5**) and incineration without energy recovery (**Chapter 6.7**) – included in the inventory , other disposal – not involved)

c) **Waste temporary stored in place of origin** – not included in inventory.

According to the annual statistics of Statistical Office of the Slovak Republic[1], total municipal waste produced in the Slovak republic in 2017 was 2 136.95 kt. Amount of municipal waste produced increased compared to the previous year (9%). Generation of the municipal waste per capita in Slovak republic is still below the European average. However, the predominant waste treatment is still landfilling (61%) and there is still insufficiency in recovery of waste (39%). In 2016, prevailed waste recovery treatment was incineration with energy recovery (36% of recovered waste, 12% of all waste); in 2017, it was composting (39% of recovered waste, 15% of all waste).

[1]Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

In year 2017, total industrial and other waste was produced in amount of 10 115.23 kt. The amount increased by 16% compared to the year 2016. The largest share represents waste from construction and demolition (31.5 %) which has increased by 36% annually due to significant year-on-year growth in construction output in all three construction segments - residential, non-residential and civil engineering. The most significant increase was recorded in the overall growth of engineering constructions, whose production grew by 11.7% year-on-year[2]. Stimulating of the economy had an influence on the amount of produced industrial waste.

In general, in most of the waste categories, **condensable component of PMs** is not included in emission factors.

6.2 TRENDS IN WASTE SECTOR

Waste sector is in general the minor source of the air pollutants. However, based on the analysis of key categories, emissions in this sector has impact significantly national totals of Hg, Cd, PCDD/PCDF and HCB emissions (***Table 6.2***).

Emissions of air pollutants (excluding NMVOC and NH_3) in this sector are emitted into the air by waste incineration plants. Trend in these categories is relative stable, except of a period 2005-2011, when emission limits for large and medium sources was implemented. Wastewater handling and composting are main contributors of ammonia emissions in this sector. Ratio of population using connected 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 decreasing in long term, due to improvement of disposal practice. Summary values for waste categories are given in the ***Table 6.2***. The overall trend dramatically decline since 1990 due to the continual development of the legislative[3].

Table 6.2: *The overview of the significant pollutants in the Waste sector and their trends*

	NOx [kt]	NMVOC [kt]	SOx [kt]	NH_3 [kt]	$PM_{2,5}$ [kt]	Hg [t]	PCDD/F [g I-TEQ]	HCB [kg]	PCBs [kg]
1990	0.1074	1.3664	0.0081	1.2492	0.1392	0.1163	107.1030	0.5282	1.1786
1995	0.0729	0.9406	0.0063	1.1550	0.1463	0.1154	96.2475	0.4076	0.7754
2000	0.0714	0.9034	0.0058	0.9979	0.1393	0.0945	64.9081	0.4031	0.7514
2005	0.0998	1.1017	0.0078	0.7857	0.1519	0.1164	49.7302	0.5595	1.0590
2010	0.0958	1.0673	0.0061	0.5350	0.1794	0.0338	9.9841	0.4720	0.9882
2011	0.0452	0.6183	0.0033	0.3970	0.1981	0.0266	5.9300	0.3444	0.4059
2012	0.0707	0.8316	0.0047	0.3968	0.1935	0.0279	7.8996	0.3666	0.6966
2013	0.0638	0.8134	0.0044	0.3513	0.1849	0.0295	7.2111	0.3469	0.6132
2014	0.0611	0.7178	0.0043	0.3593	0.1618	0.0288	6.7318	0.3319	0.5816
2015	0.0557	0.6681	0.0040	0.4078	0.1884	0.0324	6.7830	0.4256	0.5081
2016	0.0446	0.4982	0.0034	0.3373	0.1943	0.0295	5.8353	0.3488	0.3933
2017	0.0536	0.61723	0.0039	0.3543	0.2034	0.0350	6.8270	0.4161	0.5042
1990/2017	**-50%**	**-55%**	**-51%**	**-72%**	**46%**	**-70%**	**-94%**	**-21%**	**-57%**
2005/2017	**-46%**	**-44%**	**-50%**	**-55%**	**34%**	**-70%**	**-86%**	**-26%**	**-52%**
2016/2017	**20%**	**24%**	**17%**	**5%**	**5%**	**18%**	**17%**	**19%**	**28%**

Several categories were recalculated thought the whole time series. 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 energy sector,

[2] Slovak construction Yearbook – https://slovak.statistics.sk/
[3] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1991/238/

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 2019 REPORTING	ALLOC./ NK
5A	T1	ŠÚ SR	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
5B1	T2	ŠÚ SR	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
5B2	T1	ŠÚ SR	-	Em $_{TOTAL}$ = AD* EF$_{(GB2016)}$	1A5a
	T1	ŚÚ SR	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
5C1a	T1	ŠÚ SR	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$/	
	T1*/T3	NEIS**	NEIS: 5.1	Em $_{TOTAL}$ = 100% NEIS	1A1a
5C1bi	T1	ŠÚ SR	-	Em $_{TOTAL}$ = AD * Ef$_{(GB2016)}$	
	T1*/T3	NEIS**	NEIS: 5.1	Em $_{TOTAL}$ = 100% NEIS	1A2gviii
5C1bii	-	-	-	-	5C1bi
5C1biii	T2*	ŠÚ SR	-	Em $_{TOTAL}$ = AD*(EF$_{GB2016}$-(1-OAE))	
	T3	NEIS**	NEIS: 5.1	Em $_{TOTAL}$ = 100% NEIS	1A2gviii
5C1biv	-	-	-	-	NO
5C1bv	T1	Operators	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
5C1bvi	-	-	-	-	NO
5C2	-	-	-	-	NO
5D1	T1/T2	ŠÚ SR	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
5D2	T1	ŚÚ SR		Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
5D3					NO
5E	T2	FAI MI	-	Em $_{TOTAL}$ = AD * EF$_{(GB2016)}$	
6A	-	-	-	-	NO

* for POPs and heavy metals with energy recovery
** with Energy Recovery
FAI MI - Fire Appraisal Institute of the Ministry of Interior
OAE –overall abatement efficiency

6.3 CATEGORY 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$_{2016}$.

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 and is archived by QA/QC manager.

Verification of activity data used for estimation of emissions from solid waste disposal to SWDS is performed by comparing reported year data to previous year's data. 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 with the National Strategy of Biodegradable Waste Management provided by the Ministry of Environment of the Slovak Republic. Activity data were ALSO compared with the data from previous submission.

Verification of activity data and estimated emissions from ISW incinerators is ensured by comparing data available from the statistical publication "Waste in the Slovak Republic" and data used for estimation from previous year.

Verification of activity data and estimated emissions from Clinical waste incinerators is ensured by comparing data available from the Statistical Yearbook "Waste", from RISO database and EUROSTAT. Data from the period 1990-2000 are extrapolated consistent to GHG inventory.

Due to inconsistency in amount of Clinical and veterinary waste incinerated without energy recovery between the RISO database and national statistics (shown in ***Table 6.4***, ***Figure 6.1***) in years 2005 – 2011 only the ratio between clinical (hospital) and veterinary waste was used to identify amount of clinical waste only. For the years 1990-2004 extrapolated ratio was applied.

Figure 6.1: *Comparison of data of hospital and veterinary waste incineration (without energy recovery)*

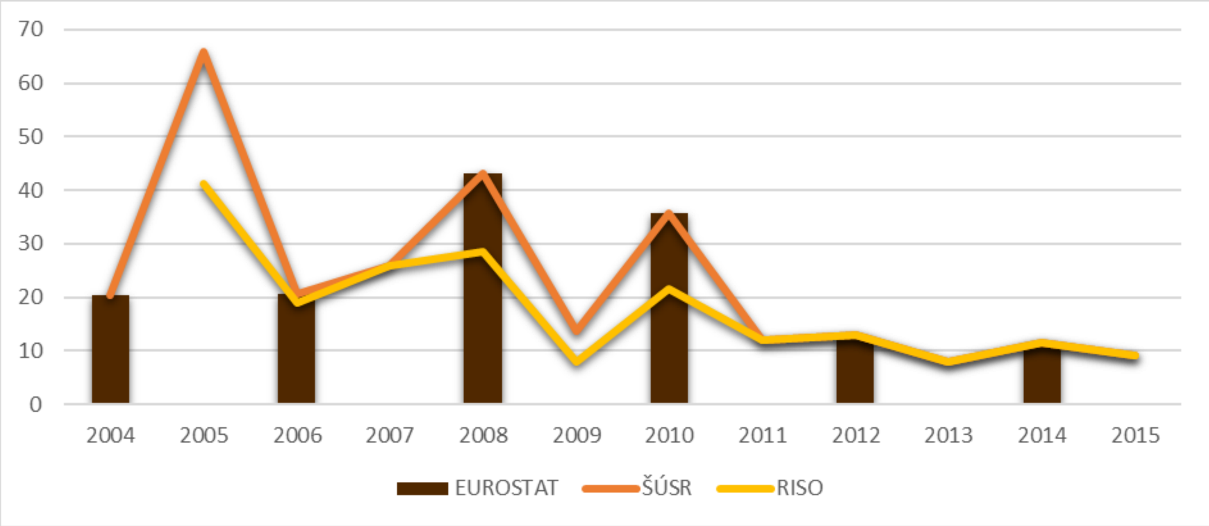


Table 6.4: *Comparison of data of hospital and veterinary waste incineration from ŠÚSR, RISO database and EUROSTAT in kt (without E recovery)*

SOURCE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ŠÚSR	66.0	20.6	25.9	43.2	13.7	35.6	12.0	12.9	8.0	11.6	9.2	15.0
RISO	41.3	18.9	25.9	28.4	7.8	21.6	12.0	12.9	8.0	11.6	9.2	15.0
EUROSTAT		20.6		43.1		35.6		12.8		11.5		15.0

Activity data for Hospital and veterinary waste incinerated with energy recovery are consistent. Clinical waste was not used for energy production until 2008 (***Table 6.5***, ***Figure 6.2***).

Figure 6.2: *Comparison of data of hospital and veterinary waste incineration (with energy recovery)*

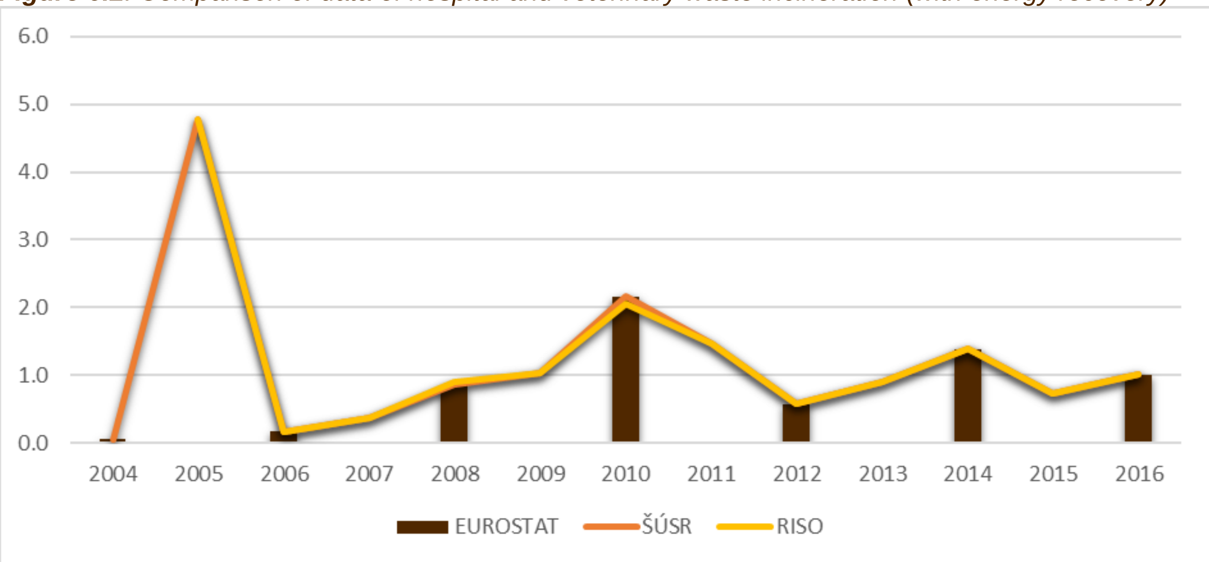


Table 6.5: *Comparison of hospital and veterinary waste incineration from ŠÚSR, RISO database and EUROSTAT in kt (with energy recovery)*

SOURCE	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ŠÚSR	0.1	4.8	0.2	0.4	0.9	1.0	2.2	1.5	0.6	0.9	1.4	0.7	1.0
RISO		4.8	0.2	0.4	0.9	1.0	2.1	1.5	0.6	0.9	1.4	0.7	1.0
EUROSTAT	0.1		0.2		0.9		2.2		0.6		1.4		1.0

Verification of activity data and estimated emissions from Cremation is ensured by comparing data by comparing reported year data from last submission.

Verification of activity data from Domestic and Industrial wastewater handling is ensured by comparing data with data published by Statistical Office of Slovak Republic on website and data reported in the previous submission.

Activity data are available from the Statistical Yearbook "Odpady v Slovenskej republike (Waste in the Slovak Republic)".

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 (VÚVH) and from the national censuses.

Data on use of retention tanks are based on population censuses done in years 1991, 2001 and 2011, these censuses are also used to verify population distribution to individual wastewater pathways. Additional information was collected from the SHMÚ and from the Association of Wastewater Treatment Experts. The data available in statistical reports are verified by a comparison of the same category and previous years.

Verification of activity data from Other waste is ensured by comparing data with data published by Statistical Office of Slovak Republic on website and by comparing data with previous year submission.

6.4 CATEGORY-SPECIFIC IMPROVEMENTS AND IMPLEMENTATION OF RECOMMENDATIONS

The reviews of Waste Chapter by TERT resulted in one recommendation recommendations. This is described below and referenced to relevant paragraphs of this chapter. Improvements are implemented in line with the Improvement Plan for the year 2019.

The recommendation Nr. ***SK-5-2018-0001*** asks justification in the category Clinical waste incineration for the difference between CS EF for HCB and the default value and to investigate the types of abatement technologies applied in Slovakia to adjust the CS EFs and reinforce the justification for the methodology used. This is described in the **Chapter 6.7.4.2**.

6.5 SOLID WASTE DISPOSAL ON LAND (NFR 5A)

6.5.1 OVERVIEW OF THE CATEGORY

The first legislation act, governing disposal of waste in Slovakia was adopted in 1992. Act No. 238/1991 Coll.[4] stipulated basic requirements for operation of waste disposal sites and Governmental Regulation No. 606/1992[5] in the Annex 5 defined three classes of waste disposal sites and technical requirements for their construction. Next legislative regulation on solid waste management and disposal entered into

[4] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1991/238/
[5] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/1992/606/vyhlasene_znenie.html

force on 1st July 2001. The Act No 223/2001 Coll.[6] and Decree of the Ministry of Environment No. 283/2001 Coll.[7] contain new instruments for waste disposal minimization, monitoring of waste sites and landfill gas generation. Demand to increase share of recycled waste resulted in adoption of the Act No. 79/2015 Coll.[8] 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.[9]describes technical parameters of landfill. New landfills must be provided with building of the isolation by bio-membrane or geotextile, drainage system and degassing system. These measurements decline the release of the emissions in atmosphere. In the 2016, new legislation restricting the landfill of bio-waste entered into force[10]. As shown in ***Table 6.6***, this act caused a significant reduction in landfilling of these types of waste.

Table 6.6: *ISW categories with share of the biodegradable in kt*

YEAR	02	03	04	15	17	18	19
1990	471.00	107.88	10.59	23.83	888.05	0.40	543.32
1995	306.81	70.27	6.90	15.53	578.48	0.26	353.92
2000	296.77	67.97	6.67	15.02	559.55	0.25	342.34
2005	37.13	76.18	7.16	49.77	696.94	0.46	382.02
2010	21.26	28.37	4.50	70.27	633.28	2.43	338.67
2011	6.88	30.34	8.19	68.44	914.60	2.18	296.68
2012	51.68	33.35	7.46	63.45	659.18	2.39	303.34
2013	92.00	35.01	4.72	65.21	1633.24	1.65	269.88
2014	29.97	25.31	4.39	70.24	861.15	1.97	217.30
2015	65.63	22.78	6.17	55.84	659.13	1.05	319.89
2016	0.72	0.01	2.23	6.63	164.64	0.01	87.12
2017	7.08	32.40	2.39	4.81	405.27	0.72	289.67

02 - Wastes from agriculture, horticulture, forestry, hunting and fishing
03 - Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture
04 - Wastes from the leather, fur and textile industries
15 - Waste packaging, absorbents, cloths, filter materials and protective clothing
17 - Construction and demolition wastes
18 - Wastes from human or animal health care or related research
19 - Wastes from waste management facilities ,waste water treatment plants and the preparation of water for human consumption and for industrial use
Note: Data for 1990-2001 were extrapolated using ISW landfilling trend

[6] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/223/20160101
[7] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/283/20011201.html
[8] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/79/20170101
[9] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/372/20160101.html
[10] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/79/20170101

Figure 6.3: *NMVOCs emission trend in the category Solid waste disposal on land*

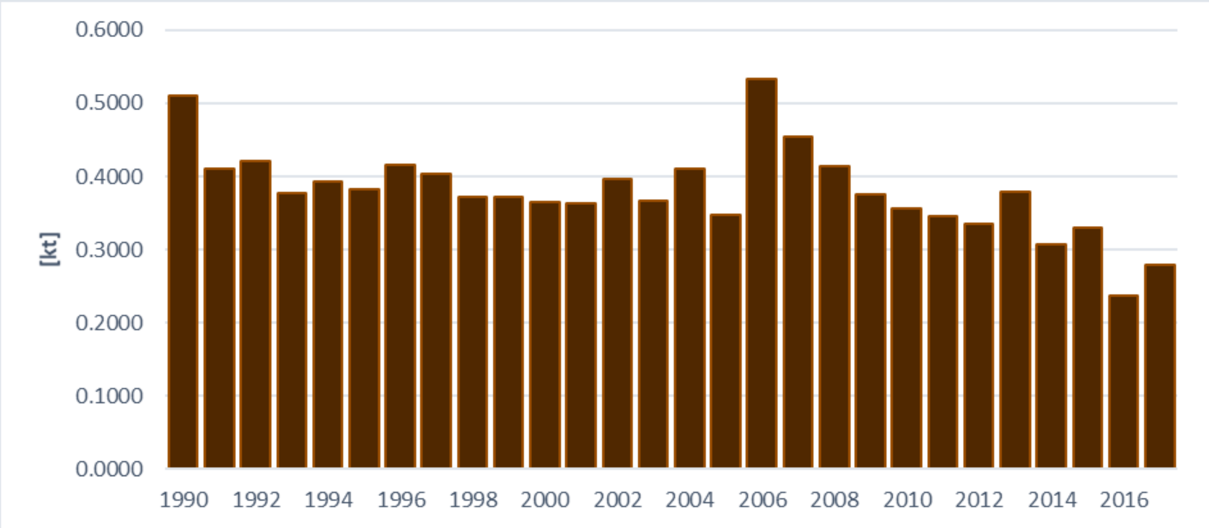
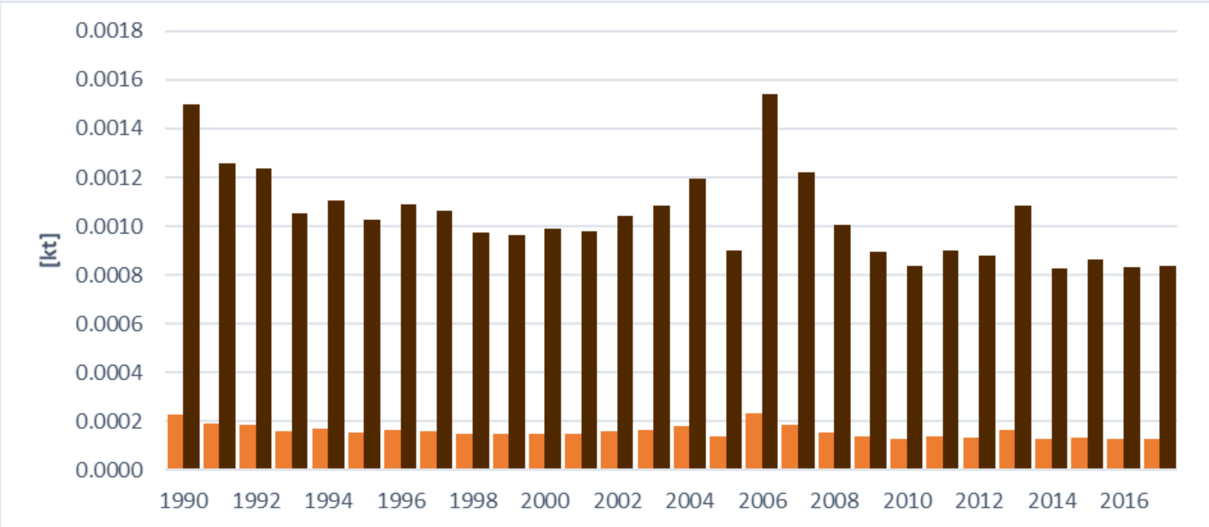


Figure 6.4: *PMs emission trend in the category Solid waste disposal on land*



In comparison with base year, emissions of NMVOC in this category (***Figure 6.3*** and ***Figure 6.4***) have moderately decreasing character due to stricter legislation. Emissions of PMs decreased in long term, although last four years is emission trend stable. Decrease in year 2005 was caused by the regression in construction and demolition activities. Emission totals and activity data are displayed in the ***Table 6.7.***

Table 6.7: *Overview of the activity data, emissions and trends in the category Solid waste disposal on land*

	WASTE DISPOSED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BIO- WASTE DISPOSED [kt]	NMVOCs [kt]
1990	6 854.6	0.0002	0.0015	0.0032	327.3	0.5106
1995	4 689.8	0.0002	0.0010	0.0022	245.3	0.3827
2000	4 512.7	0.0001	0.0010	0.0021	234.3	0.3655
2005	4 114.9	0.0001	0.0009	0.0019	223.0	0.3478
2010	3 808.8	0.0001	0.0008	0.0018	228.0	0.3557
2011	4 114.9	0.0001	0.0009	0.0019	222.0	0.3464
2012	4 014.8	0.0001	0.0009	0.0019	215.0	0.3355
2013	4 938.1	0.0002	0.0011	0.0023	242.8	0.3788
2014	3 765.7	0.0001	0.0008	0.0017	196.3	0.3063
2015	3 933.5	0.0001	0.0009	0.0018	210.8	0.3289

	WASTE DISPOSED [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BIO- WASTE DISPOSED [kt]	NMVOCs [kt]
2016	3 789.3	0.0001	0.0008	0.0018	151.9	0.2369
2017	3 830.22	0.0001	0.0008	0.0018	178.30	0.2781
1990/2017	**-44%**	**-44%**	**-44%**	**-44%**	**-46%**	**-46%**
2016/2017	**1%**	**1%**	**1%**	**1%**	**17%**	**17%**

6.5.2 METHODOLOGICAL ISSUES

Activity data for this category was obtained from publications Waste in Slovak Republic[11]. Amount of solid waste deposited to landfill sites was used. For the calculations, ***Equation 1*** was applied. Activity data in period 1990-1997 are not available; therefore, extrapolated data were used.

Equation 6.1: *Total emissions of the pollutant in the category Solid waste disposal on land*

$$Em_{TOTAL} = (Deposited\ municipal\ waste + Deposited\ industrial\ waste) * EF_{(GB2016)}$$

For calculation of NMVOCs, only amount of biodegradable solid waste disposed on landfill sites was used, as recommended during the capacity building webinar in 2017. Amount of biodegradable ISW landfilled in specific waste categories was determined using default values of degradable organic compound from IPCC 2006 Guidelines (***Table 6.8***).

Table 6.8: *Default values of share of degradable organic compound in the ISW landfilled*

WASTE GROUPS CONTAINING BIODEGRADABLE WASTE	DOC	MAIN WASTE TYPE
02 Wastes from agriculture, horticulture, forestry, hunting and fishing	0.15	Food waste
03 Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture	0.01	Other
04 Wastes from the leather, fur and textile industries	0.24	Textile
15 Waste packaging, absorbents, cloths, filter materials and protective clothing	0.01	Other
17 Construction and demolition wastes	0.04	Construction and demolition
18 Wastes from human or animal health care or related research	0.15	Clinical waste
19 Wastes from waste management facilities ,waste water treatment plants and the preparation of water for human consumption and for industrial use	0.09	Sludge

By MSW landfilled, dynamic ratio of biodegradable waste, consistent with GHGs inventory, was used in calculations (***Table 6.9***).

Table 6.9: *Share of biodegradable organic compound in the MSW landfilled*

YEAR	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
Ratio	0.123	0.127	0.127	0.124	0.118	0.117	0.116	0.114	0.112	0.110	0.106	0.106

Tier 1 emission factors from EMEP/EEA Guidebook 2016 were used (***Table 6.10***). **Condensable component of PMs** is not included in EF.

Table 6.10: *Emissions factors in the category Solid waste disposal on land*

POLLUTANT	NMVOC	TSP	PM_{10}	$PM_{2.5}$
Unit	[kg/t]	[g/t]	[g/t]	[g/t]
Value	1.56	0.463	0.219	0.033

6.5.3 COMPLETENESS

The ammonia and carbon monoxide emissions were reported as not estimated due to no emission factor. Notation key for these pollutants is NE.

[11] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

6.5.4 SOURCE SPECIFIC RECALCULATIONS

NMVOCs emissions were recalculated due to increase consistency with GHGs inventory. Dynamic ratio of degradable organic part of waste for MSW and default values from IPCC 2006 Guidelines for ISW were used. ***Table 6.11*** shows difference between 2017 and 2018 submission and percentage change.

Table 6.11: *Previous and revised amount of the landfilled biodegradable waste*

YEAR	PREVIOUS [kt]	REFINED [kt]	CHANGE [%]
1990	674.79	327.31	-51%
1991	584.96	262.74	-55%
1992	565.84	270.11	-52%
1993	471.73	241.38	-49%
1994	497.64	252.17	-49%
1995	453.85	245.32	-46%
1996	472.73	266.47	-44%
1997	462.16	258.59	-44%
1998	423.65	238.02	-44%
1999	414.03	238.51	-42%
2000	439.01	234.28	-47%
2001	434.65	232.37	-47%
2002	450.04	253.79	-44%
2003	462.02	235.00	-49%
2004	528.52	263.39	-50%
2005	358.16	222.97	-38%
2006	709.94	342.22	-52%
2007	520.84	291.20	-44%
2008	388.60	265.41	-32%
2009	320.47	240.19	-25%
2010	282.87	227.99	-19%
2011	327.00	222.05	-32%
2012	315.21	215.05	-32%
2013	425.93	242.82	-43%
2014	286.23	196.33	-31%
2015	289.27	210.85	-27%
2016	264.94	151.86	-43%

6.6 BIOLOGICAL TREATMENT OF WASTE (NFR 5B)

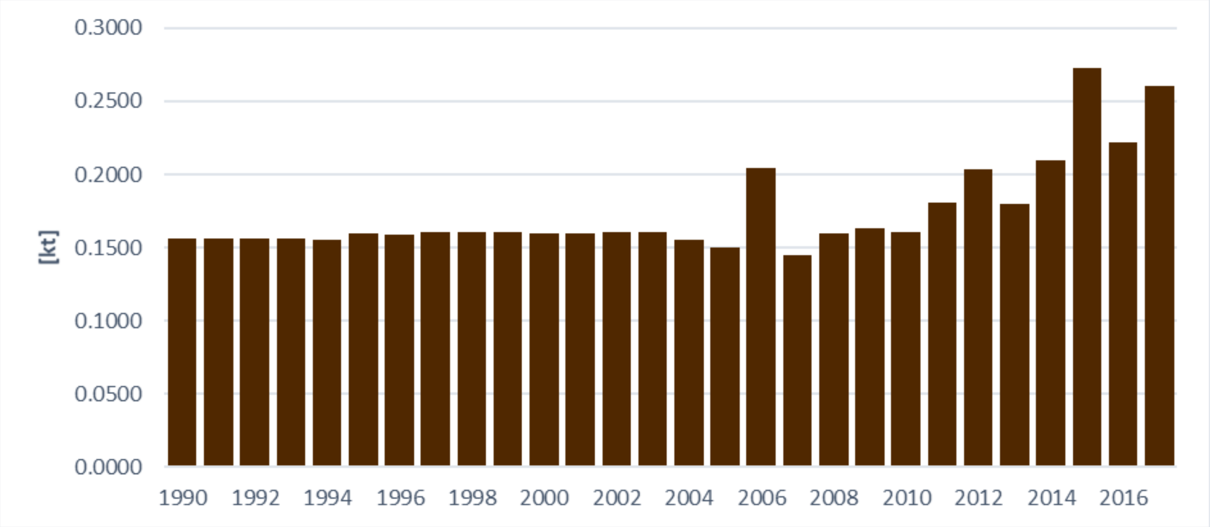
6.6.1 COMPOSTING (NFR 5B1)

6.6.1.1 Overview of the category

In 2006 Act No. 223/2001 Coll. [12]came into force, which prohibits the landfilling of biodegradable waste from gardens and parks, including the cemeteries and other green waste. The change in legislation also brought about the obligation of municipalities to introduce and ensure implementation of separate collection of biodegradable municipal waste except of that originating from the operator of the cantinas. Emission trend of NH_3 is shown in ***Figure 6.5***.

[12] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2001/223/20160101

Figure 6.5: *NH_3 emission trend in the category Composting of waste*



In the year 2004, there were four large or medium composting plants and their number increased in 2017 to 17. 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. While 24% of municipalities participated in waste composting in 2002, this number increased to 90% in 2016. Emission totals and activity data, are displayed in ***Table 6.12***.

Table 6.12*: Overview of the activity data, emissions and trends in the category Composting of waste*

	COMPOSTED WASTE [kt]	**NH_3 [kt]**
1990	649.00	0.1558
1995	664.46	0.1595
2000	665.35	0.1597
2005	624.15	0.1498
2010	669.26	0.1606
2011	752.39	0.1806
2012	849.32	0.2038
2013	750.52	0.1801
2014	873.22	0.2096
2015	1135.48	0.2725
2016	925.74	0.2222
2017	1 084.74	0.2603
1990/2017	**67%**	**67%**
2016/2017	**17%**	**17%**

6.6.1.2 Methodological issues

Activity data provided by Statistical Office of Slovak Republic in publications Waste in Slovak Republic [13]was used. Amount of composted municipal solid waste are published since 1992. The missing data for 1990 and 1991 were extrapolated. Data on industrial waste composting are collected and published since 1997. Methodology and emission factors of Tier 2 – Compost production from GB_{2016} was applied (***Table 6.13***).

[13] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

__Table 6.13:__ Emission factors in the category Composting of waste

POLLUTANT	NH_3
Unit	[kg/t]
Value	0.24

6.6.1.3 Completeness

CO was reported as NE. No data about composting plants, which compost only park and garden waste. BC was reported as NE due to absence of methodology. Particle matter (TSP, PM_{10}, $PM_{2.5}$) were reported as NE to maintain consistency in the methodological approach. CS EF for PMs used in the last submission was based on the average value of emissions reported by operators.

6.6.1.4 Source specific recalculations

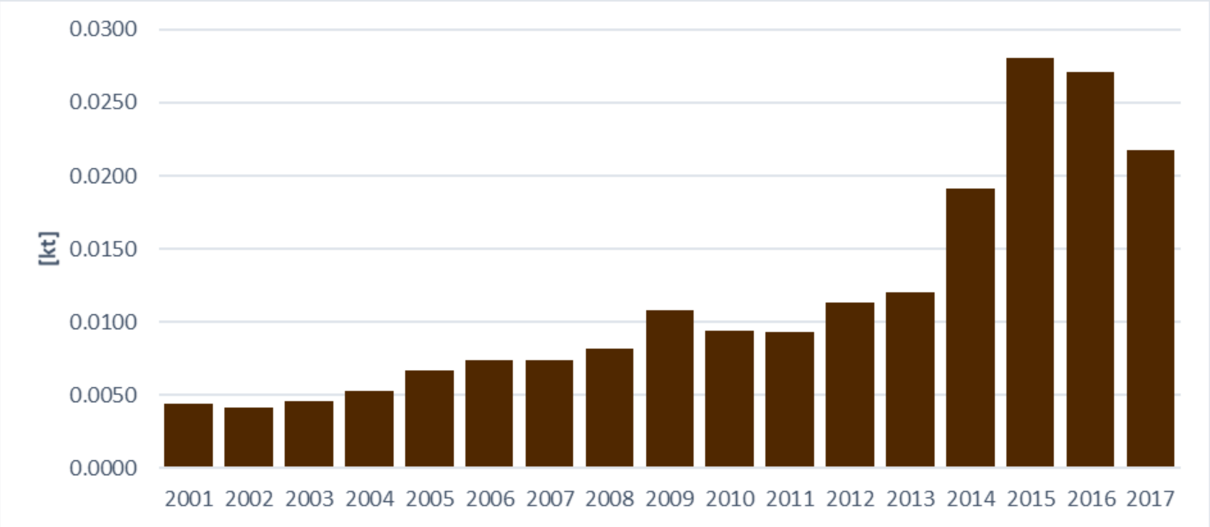
No recalculations in this submission.

6.6.2 ANAEROBIC DIGESTION AT BIOGAS FACILITIES (NFR 5B2)

6.6.2.1 Overview of the category

No biogas facilities operated in Slovak Republic until the year 2000. In 2009, only five biogas facilities were recorded. After the Act No. 309/2009 Coll.[14] on Support of Renewable Energy Sources and High Efficiency Combined Heat and Power (CHP) Generation entered into force, development of biogas facilities were significant.

__Figure 6.6:__ NH_3 emissions in the category Anaerobic digestion at biogas facilities



Ninety-nine facilities in 2014 and 110 in 2017 operated. After the Decree No. 221/2013 Coll.[15], which provides price regulation in the electricity sector, entered into force, significant increase in 2014 was noticed (***Figure 6.6***). Decrease in 2017 was caused by limitation of donations into this activity and stricter legiclation. ***Table 6.14*** shows NH_3 emission trend in this category.

[14] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2009/309/20150801
[15] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2013/221/vyhlasene_znenie.html

Table 6.14: *Overview of the activity data, emissions and trends in the category Anaerobic digestion at biogas facilities*

	NITROGEN INTO BIOGAS FACILITY [kt]	NH_3 [kt]
2001	0.13	0.0044
2005	0.19	0.0066
2010	0.27	0.0094
2011	0.27	0.0093
2012	0.32	0.0113
2013	0.35	0.0120
2014	0.55	0.0191
2015	0.81	0.0281
2016	0.78	0.0271
2017	0.63	0.0217
2001/2017	**394%**	**394%**
2016/2017	**-20%**	**-20%**

6.6.2.2 Methodological issues

Biggest part of biogas facilities are energy producers, so emission from these sources were allocated into **1A5a**. Only sources without energy recovery were included in this category. As activity data amount of nitrogen, entering into biogas facility was used. This amount was balanced from nitrogen cycle used in agricultural sector. Default emission factor from EMEP/EEA GB_{2016} was used.

6.6.2.3 Completeness

Notation keys were changed in comply with EMEP/EEA GB_{2016}.

6.6.2.4 Source specific recalculations

No recalculations in this submission.

6.7 WASTE INCINERATION AND OPEN BURNING OF WASTE (5C)

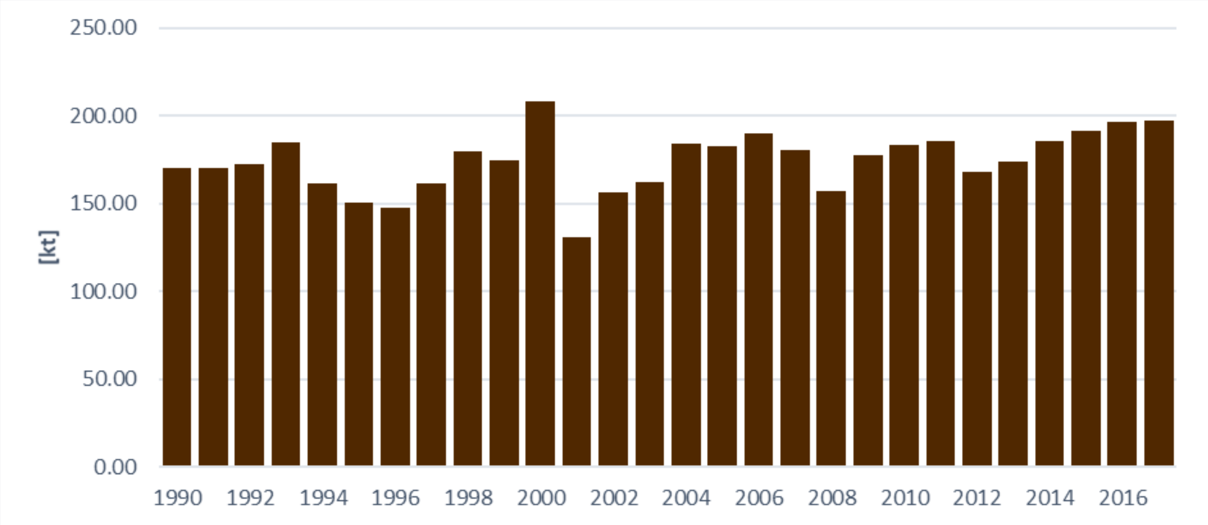
6.7.1 MUNICIPAL WASTE INCINERATION (NFR 5C1a)

6.7.1.1 Overview of the category

There are two large municipal waste incinerators in the country, in Bratislava and in Košice. The MSW incinerator in Bratislava was put in operation in 1978 and significantly modernised in 2002. Currently installed capacity is 135 Gg/y, the incinerator can be characterised as continuously operated stoker. The MSW incinerator in Košice with capacity 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 energy sector, category **1A1a**.

Trend of amount of incinerated municipal waste is displayed in ***Figure 6.7***. As shown, amount of incinerated municipal waste has slightly increasing trend since 1990, due to the gradual prioritization of MSW incineration before landfilling.

Figure 6.7: *Trend in amount of total municipal waste incinerated with energy recovery*



6.7.1.2 Methodological issues

Activity data on incinerated MSW are based on input into individual incinerators. Collection companies delivering waste monthly inform municipalities on method of treatment of their waste, and total amount of incinerated waste report municipalities to the Statistical Office of the Slovak Republic annually. Data on total municipal waste incinerated[16] were used to calculate emissions in this category. Although there is identification of "incineration with energy recovery" and "incineration without energy recovery" since 2002. The information from the MSW incinerator operators were used for the indication of proper option.

For reporting of emissions of NO_X, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10} data from the NEIS database were applied. Municipal waste incineration (MWI) sources assigned to the category 5.1 (according to the Annex No. 6 of Decree No. 410/2012 Coll.[17] 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 database are also applied to separate the installation combusted industrial waste.

Default emission factors from $EMEP/EEAGB_{2016}$ for heavy metals and country specific for POPs were used in calculations of emissions. Values of emission factors are given in ***Table 6.15*** below. Emission factors for PCDD/F and HCB are related to the period of reconstruction of the facility (Bratislava - 2002, Košice - 2005). For the period after the reconstruction, the lower EF is determined, due to the installation of advanced flue gas cleaning technologies.

Table 6.15: *Emission factors in the category Municipal waste incineration*

POLLUTANT	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Unit	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]
Value	58	4.6	18.8	6.2	16.4	13.7	21.6	11.7	24.5

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCB
Unit	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]	[mg/t]
Value before reconstruction	0.06	0.7	19	19	0.17	38.87	3	5.3
Value after reconstruction	0.0004	0.7	19	19	0.17	38.87	0.1	5.3

[16] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/
[17] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2012/410/

6.7.1.3 Completeness

Category is not occurring in the Slovak Republic, therefore notation key NO instead of IE (no incineration of municipal waste without energy recovery) were used. Emissions from MSW incineration with energy recovery were reported in energy sector under **1A1a**.

6.7.1.4 Source specific recalculations

Recalculations of this category were included in category **1A1a**.

6.7.2 INDUSTRIAL WASTE INCINERATION (NFR 5C1bi)

6.7.2.1 Overview of the category

The industrial waste incineration sector has undergone significant changes since 1990, but detailed research of their impact has not been done, yet. The key drivers of these changes were stricter legislation, the new standards (EU approximation) and commercialisation of waste services. This led to replacing small incineration units in factories by regional incinerators. In addition, existing large incinerators were modernised to comply with the new standards or were decommissioned.

From the total of 17 non-MSW incinerators and co-incineration plants, only a few have installed capacity exceeding 2 t/hour. The following companies are using largest waste incineration facilities:

- Slovnaft Inc., Bratislava (3.7 t/hour);
- Duslo Inc., Šaľa (1.26 t/hour);
- Light Stabilizers Ltd., Strážske (0.18 t/hour);
- Fecupral Ltd.., Prešov (0.15 t/hour);
- Archiv SB Ltd., Liptovský Mikuláš (0.15 t/hour).
- FCC Environment Ltd., Kysucké Nové Mesto

Co-incineration on waste derived fuels occurs in the following plants:

- Holcim Inc., Rohožník;
- Holcim Inc., Turňa nad Bodvou;
- Carmeuse Ltd., Košice-Šaca;
- Cemmac Inc., Horné Sŕnie;
- Považská cementáreň Inc., Ladce.

Part of these plants are incinerating waste with energy recovery. These emissions are allocated in **1A2gviii**. In this category, emissions from sources without energy recovery are included. This category is key category for emissions pf PCDD/F and HCB. ***Table 6.16*** shows activity data, emissions of most significant pollutants and their trends.

Table 6.16: *Overview of activity data, emissions and emission trends of most significant pollutants in the category Industrial waste incineration without E recovery*

	IW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	113.91	0.0991	0.8429	0.0054	0.0005	0.0008	0.0011	0.000016	0.0080
1995	73.55	0.0640	0.5443	0.0035	0.0003	0.0005	0.0007	0.000010	0.0051
2000	66.97	0.0618	0.5258	0.0033	0.0003	0.0005	0.0007	0.000010	0.0050
2005	100.37	0.0873	0.7427	0.0047	0.0004	0.0007	0.0010	0.000014	0.0070
2010	94.59	0.0823	0.6999	0.0044	0.0004	0.0007	0.0009	0.000013	0.0066
2011	35.35	0.0308	0.2616	0.0017	0.0001	0.0002	0.0004	0.000005	0.0025

	IW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	BC [kt]	CO [kt]
2012	65.80	0.0572	0.4869	0.0031	0.0003	0.0005	0.0007	0.000009	0.0046
2013	57.32	0.0499	0.4242	0.0027	0.0002	0.0004	0.0006	0.000008	0.0040
2014	54.28	0.0472	0.4017	0.0026	0.0002	0.0004	0.0005	0.000008	0.0038
2015	44.42	0.0386	0.3287	0.0021	0.0002	0.0003	0.0004	0.000006	0.0031
2016	33.89	0.0295	0.2508	0.0016	0.0001	0.0002	0.0003	0.000005	0.0024
2017	44.30	0.0385	0.3278	0.0021	0.0002	0.0003	0.0004	0.000006	0.0031
1990/2017	**-61%**	**-61%**	**-61%**	**-61%**	**-61%**	**-61%**	**-61%**	**-61%**	**-61%**
2016/2017	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**

	Pb [t]	Cd [t]	Hg [t]	As [t]	Ni [t]	PCDD/F [g I-TEQ]	PAHs [t]	HCB [kg]	PCB [kg]
1990	0.1481	0.0114	0.0064	0.0018	0.0159	31.3246	0.0044	0.3417	1.1391
1995	0.0956	0.0074	0.0041	0.0012	0.0103	20.2260	0.0029	0.2206	0.7355
2000	0.0924	0.0071	0.0040	0.0011	0.0099	5.3290	0.0028	0.2132	0.7105
2005	0.1305	0.0100	0.0056	0.0016	0.0141	7.5275	0.0039	0.3011	1.0037
2010	0.1230	0.0095	0.0053	0.0015	0.0132	7.0939	0.0037	0.2838	0.9459
2011	0.0460	0.0035	0.0020	0.0006	0.0049	2.6515	0.0014	0.1061	0.3535
2012	0.0855	0.0066	0.0037	0.0011	0.0092	4.9347	0.0026	0.1974	0.6580
2013	0.0745	0.0057	0.0032	0.0009	0.0080	4.2989	0.0022	0.1720	0.5732
2014	0.0706	0.0054	0.0030	0.0009	0.0076	4.0708	0.0021	0.1628	0.5428
2015	0.0577	0.0044	0.0025	0.0007	0.0062	3.3314	0.0017	0.1333	0.4442
2016	0.0441	0.0034	0.0019	0.0005	0.0047	2.5417	0.0013	0.1017	0.3389
2017	0.0576	0.0044	0.0025	0.0007	0.0062	3.3221	0.0017	0.1329	0.4430
1990/2017	**-61%**	**-61%**	**-61%**	**-61%**	**-61%**	**-89%**	**-61%**	**-61%**	**-61%**
2016/2017	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**	**31%**

Figure 6.8: *Amount of the incinerated waste without E and with E recovery*

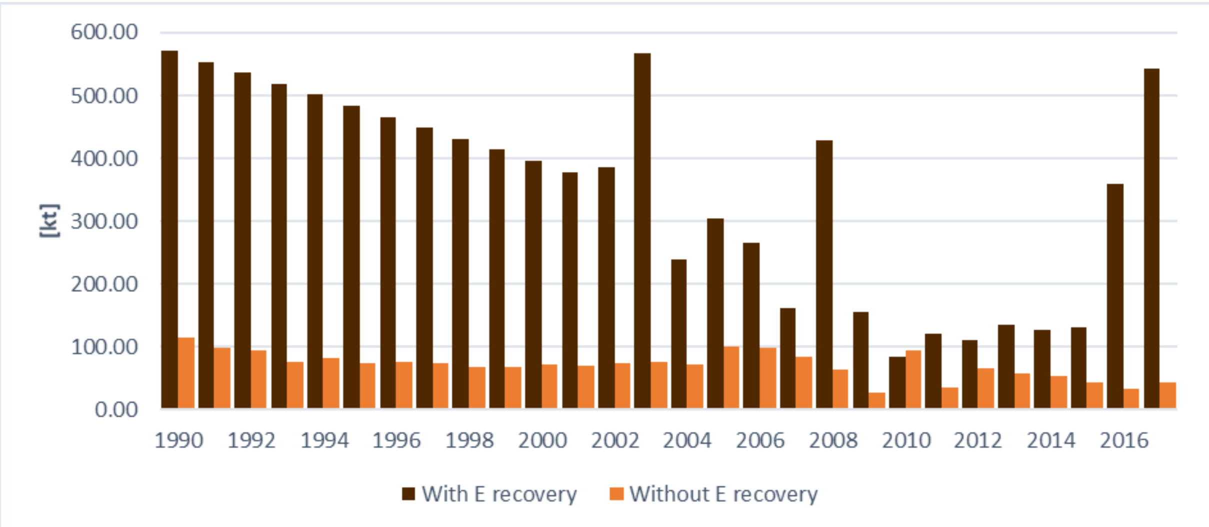


Figure 6.8 displays trend of waste incinerated with and without energy recovery through the period 1990-2016. Emission trend of PCDD/F (***Figure 6.9***) shows rapid dump in 2000 due to modernization of technology, decrease in 2009 and increase in 2010 was caused dampening and subsequent recovery of operation related to economic crisis (***Figure 6.10***).

Figure 6.9: *PCDD/F emission trend - Industrial waste incineration without E recovery*

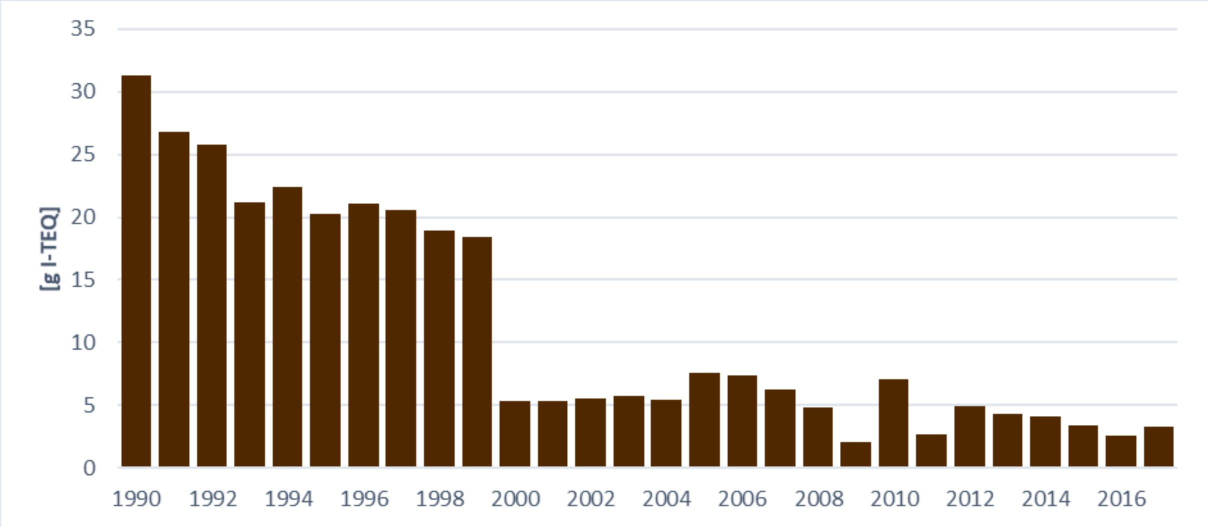
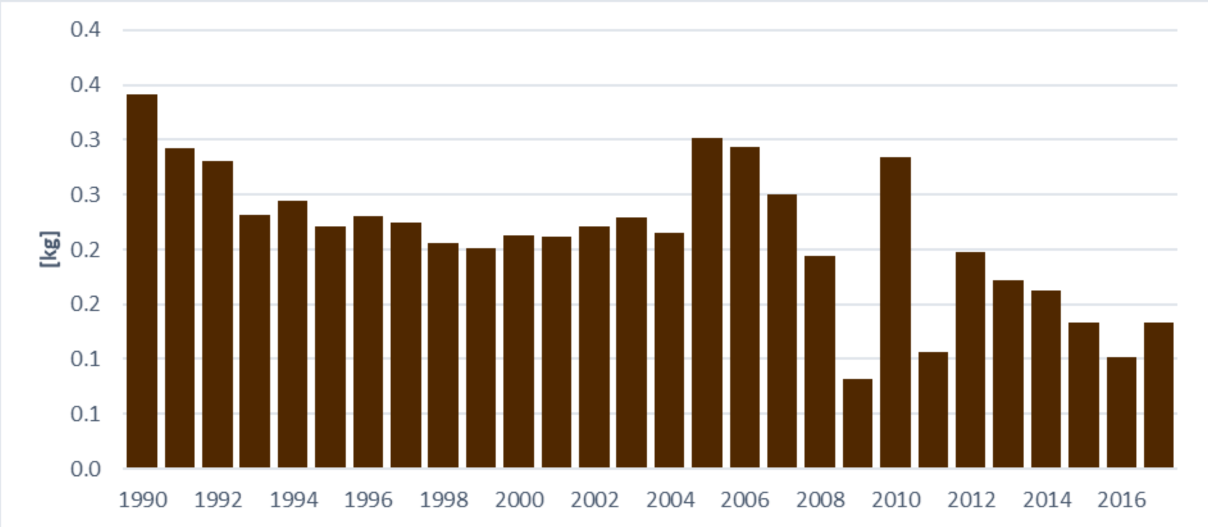


Figure 6.10: *HCB emission trend - Industrial waste incineration without E recovery*



6.7.2.2 Methodological issues

For air pollutants (NO_X, NMVOC, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10}) from sources with energy recovery emissions were taken from NEIS database. Likewise the municipal waste incineration (MWI), sources assigned to the category 5.1 (according to the Annex No 6 of Decree No 410/2012 Coll.[18] 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. Heavy metals and POPs are reported using for the statistical activity data. Emission factors for heavy metals were taken from the EMEP/EEA GB_{2016} and for POPs country specific emission factor were used (Most, et al, 1992). The values of emission factors for sources with energy recovery for POPs and heavy metals are same as for sources without energy recovery.

For industrial waste incineration sources without energy recovery, statistical activity data[19] from Statistical Office of Slovak Republic were used (industrial waste excluding clinical waste). POPs emissions were calculated using country specific emission factors (Most, et al, 1992), for other air pollutants default emission factors from EMEP/EEA GB_{2016} were used (***Table 6.17***). Emission factors for PCDD/F and HCB are related to the period of reconstruction of the facility. For the period after the

[18] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2012/410/

[19] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

reconstruction (after 2000), the lower EF is determined, due to the installation of advanced flue gas cleaning technologies.

Condensable component of PMs is not included in EFs.

Table 6.17: *Emission factors in the category Industrial waste incineration without E recovery*

POLLUTANT	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC
Unit	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	[kg/t]	%of $PM_{2.5}$
Value	0.87	7.4	0.047	0.004	0.007	0.01	0.035

POLLUTANT	CO	Pb	Cd	Hg	As	Ni	Se
Unit	[kg/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
Value	**0.07**	**1.3**	**0.1**	**0.056**	**0.016**	**0.14**	**0.06**

POLLUTANT	PCDD/F	B(a)P	B(b)F	B(k)F	I()P	PAHs	HCB	PCB
Unit	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
Value in 1990-2000	**0.275**	**0.7**	**19**	**19**	**0.17**	**38.87**	**3**	**10**
Value in 2001-2016	**0.075**	**0.7**	**19**	**19**	**0.17**	**38.87**	**3**	**10**

6.7.2.3 Completeness

Emissions from Industrial waste incineration with energy recovery are reported in energy sector under **1A2gviii**. Notation key NE was used for Cr, Cu, Se and Zn to maintain a consistent approach in the methodology.

6.7.2.4 Source specific recalculations

In order to improve the methodology for clinical waste and its more accurate identification of amount of clinical waste, activity data for industrial waste changed (includes veterinary waste now). Amount of clinical waste incinerated with energy recovery was negligible until 2008, therefore it was removed from calculations. Recalculation of amount of industrial waste is shown in ***Table 6.18***.

Table 6.18: *Previous and refined amount of incinerated industrial waste with and without energy recovery*

YEAR	IW WITHOUT ENERGY RECOVERY [kt]		CHANGE [%]	IW WITH ENERGY RECOVERY [kt]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED	
1990	84.96	113.91	34%	681.31	571.18	-16%
1991	67.82	97.64	44%	655.00	553.68	-15%
1992	63.94	93.64	46%	628.33	536.18	-15%
1993	46.74	77.06	65%	602.01	518.69	-14%
1994	53.06	81.52	54%	575.65	501.19	-13%
1995	45.26	73.55	62%	549.25	483.69	-12%
1996	48.08	76.75	60%	522.82	466.19	-11%
1997	46.54	74.88	61%	496.31	448.69	-10%
1998	40.33	68.66	70%	469.85	431.19	-8%
1999	39.12	66.97	71%	443.48	413.70	-7%
2000	44.08	71.05	61%	417.03	396.20	-5%
2001	44.13	70.50	60%	390.55	378.70	-3%
2002	47.45	73.61	55%	385.17	385.30	0%
2003	51.13	76.58	50%	554.82	567.95	2%
2004	52.98	71.73	35%	238.16	238.22	0%
2005	36.97	100.37	171%	299.22	304.00	2%
2006	78.19	97.77	25%	265.19	265.35	0%
2007	58.73	83.24	42%	161.38	161.75	0%
2008	22.69	64.79	185%	428.22	428.28	0%

YEAR	IW WITHOUT ENERGY RECOVERY [kt]		CHANGE [%]	IW WITH ENERGY RECOVERY [kt]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED	
2009	15.22	27.37	80%	154.44	154.65	0%
2010	60.86	94.59	55%	81.99	83.42	2%
2011	25.72	35.35	37%	120.56	121.29	1%
2012	54.52	65.80	21%	111.41	111.44	0%
2013	51.06	57.32	12%	134.44	134.80	0%
2014	44.37	54.28	22%	126.14	126.60	0%
2015	38.15	44.42	16%	131.12	131.20	0%
2016	21.31	33.89	59%	360.15	360.22	0%

6.7.3 HAZARDOUS WASTE INCINERATION (NFR 5C1bii)

6.7.3.1 Overview of the category

Emissions are allocated in the category 5C1bi and the notation key IE was used.

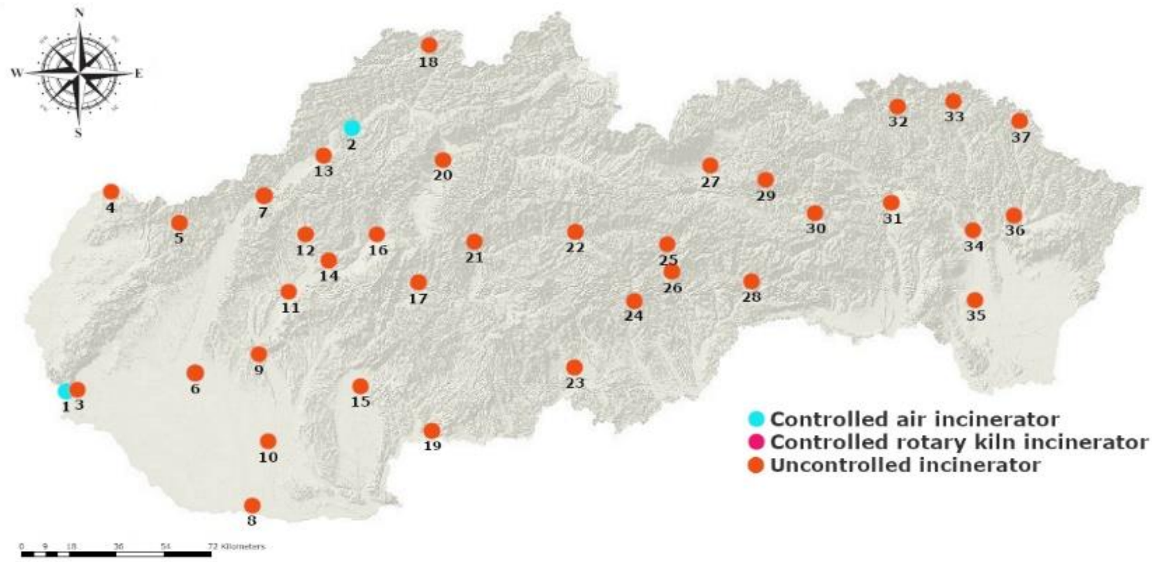
6.7.4 CLINICAL WASTE INCINERATION (NFR 5C1biii)

6.7.4.1 Overview of the category

Number of clinical waste incineration plants in the Slovak Republic decreased significantly between the years 2005/2006 due to stricter legislation[20] and emission limits connected to accession of the Slovak Republic to European Union in the year 2005. Older plants without any (or minimal) abatement technology, non-compliant with emission limits stopped operation. From the 2006 to 2010 only reconstructed plants or new plants with air pollution control technologies operated. Figures below show spatial distribution and technological state of the plants in year 2000, 2005, 2010 and 2015 (***Figure 6.11 – 6.15***).

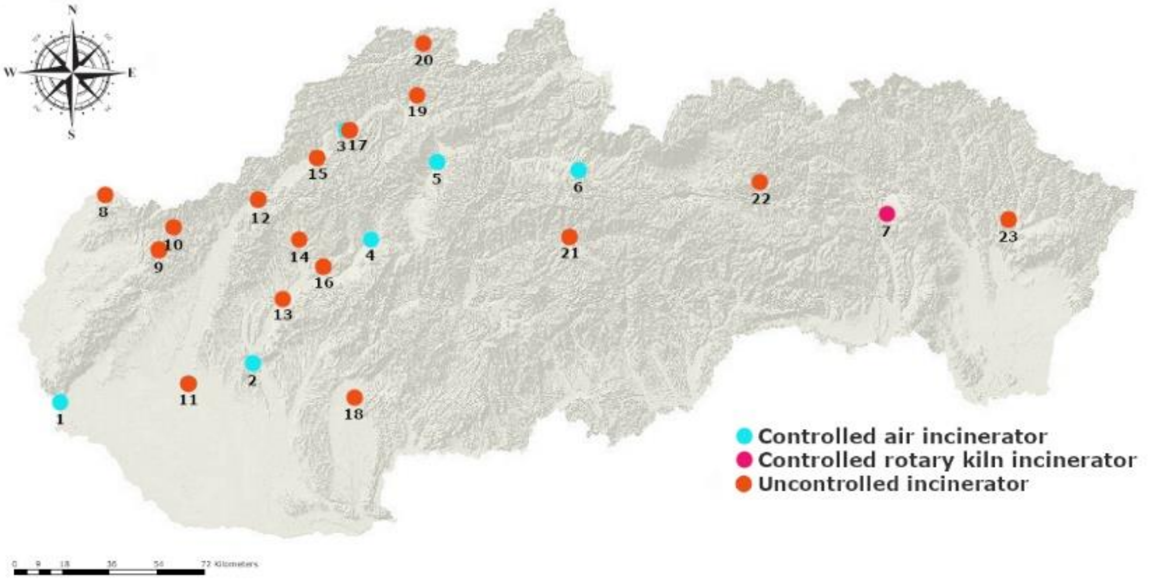
[20] Act 245/2003 Coll. on Integrated Prevention and Control of Environmental Pollution and on the amendment and amendment of certain Acts (only in Slovak)
Act 532/2005 Coll. amending Act no. 245/2003 Coll. on integrated pollution prevention and control, and on the amendment of certain laws as amended, and on amendments to certain laws (only in Slovak)
Act 571/2005 Coll. amending Act no. 478/2002 Coll. on the protection of the air and amending Act no. 401/1998 Coll. on Air Pollution Charges as amended (Air Act), as amended, and on amendments to certain laws (only in Slovak)
DECREE of the Ministry of the Environment of the Slovak Republic 575/2005 Z. amending Decree of the Ministry of the Environment of the Slovak Republic no. 706/2002 Coll. 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

__Figure 6.11__: Clinical waste incineration plants without E recovery in 2000



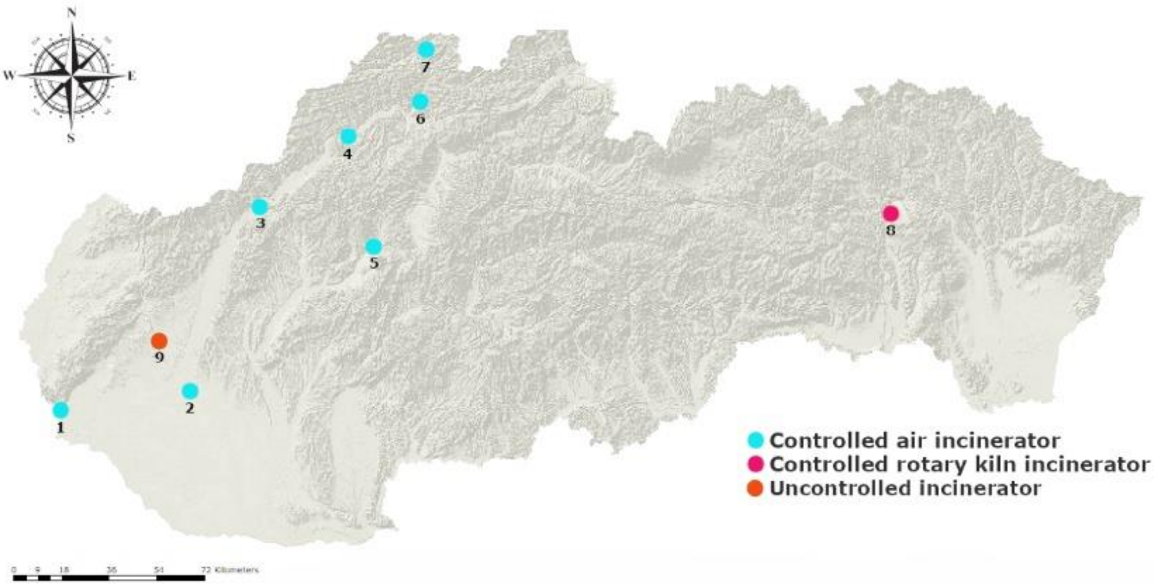
1. Hospital in Bratislava	11. Hospital in Topoľčany	21. Hospital in Banská Bystrica	31. Hospital in Prešov
2. Hospital in Považská Bystrica	12. Hospital in Bánovce nad Bebravou	22. Hospital in Brezno	32. Hospital in Bardejov
3. Hospital in Podunajské Biskupice	13. Hospital in Ilava	23. Hospital in Lučenec	33. Hospital in Svidník
4. Hospital in Skalica	14. Hospital in Partizánske	24. Hospital in Hnúšťa	34. Hospital in Vranov nad Topľou
5. Hospital in Myjava	15. Hospital in Levice	25. Specialized medical institution psychological Predná Hora	35. Hospital in Trebišov
6. Hospital in Galanta	16. Hospital in Bojnice	26. Hospital in Revúca	36. Hospital in Humenné
7. Hospital in Trenčín	17. Hospital in Žiar nad Hronom	27. Hospital in Poprad	37. Hospital in Medzilaborce
8. Hospital in Komárno	18. Hospital in Čadca	28. Hospital in Rožňava	
9. Hospital in Nitra	19. Hospital in Šahy	29. Hospital in Levoča	
10. Hospital in Nové Zámky	20. Faculty hospital in Martin	30. Hospital in Krompachy	

***Figure 6.12**: Clinical waste incineration plants without E recovery in 2005*



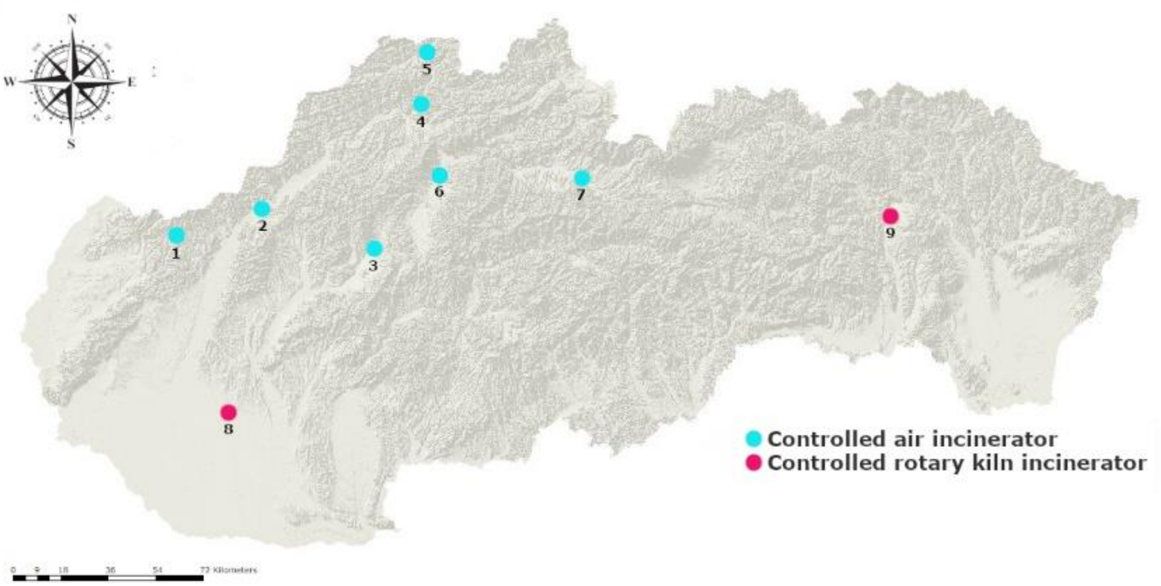
1. Faculty hospital in Bratislava	7. Fecupral Ltd., Prešov	13. Hospital in Topoľčany	19. KLF-ENERGETIKA Inc., Kysucké Nové Mestp
2. Hospital in Nitra	8. Hospital in Skalica	14. Hospital in Bánovce nad Bebravou	20. Hospital in Čadca
3. Hospital in Považská Bystrica	9. AREPO-EKO Inc., Myjava	15. Hospital in Ilava	21. Hospital in Brezno
4. Hospital in Bojnice	10. Hospital in Myjava	16. Hospital in Partizánske	22. Hospital in Levoča
5. Faculty hospital in Martin	11. Hospital Galanta	17. HELPECO Ltd., Považská Bystrica	23. AGB Ekoservis Ltd., Humenné
6. SA-INVEST Ltd., Liptovský Mikuláš	12. Hospital Trenčín	18. Hospital in Levice	

***Figure 6.13**: Clinical waste incineration plants without E recovery in 2010*



1. University Hospital in Bratislava	4. Hospital in Považská Bystrica	7. Hospital in Čadca
2. CO-Medika Ltd., Galanta	5. Hospital in Bojnice	8. Fecupral Ltd., Prešov
3. Faculty hospital in Trenčín	6. A.S.A. Ltd., Kysucké Nové mesto	9. Faculty hospital with health centre Trnava

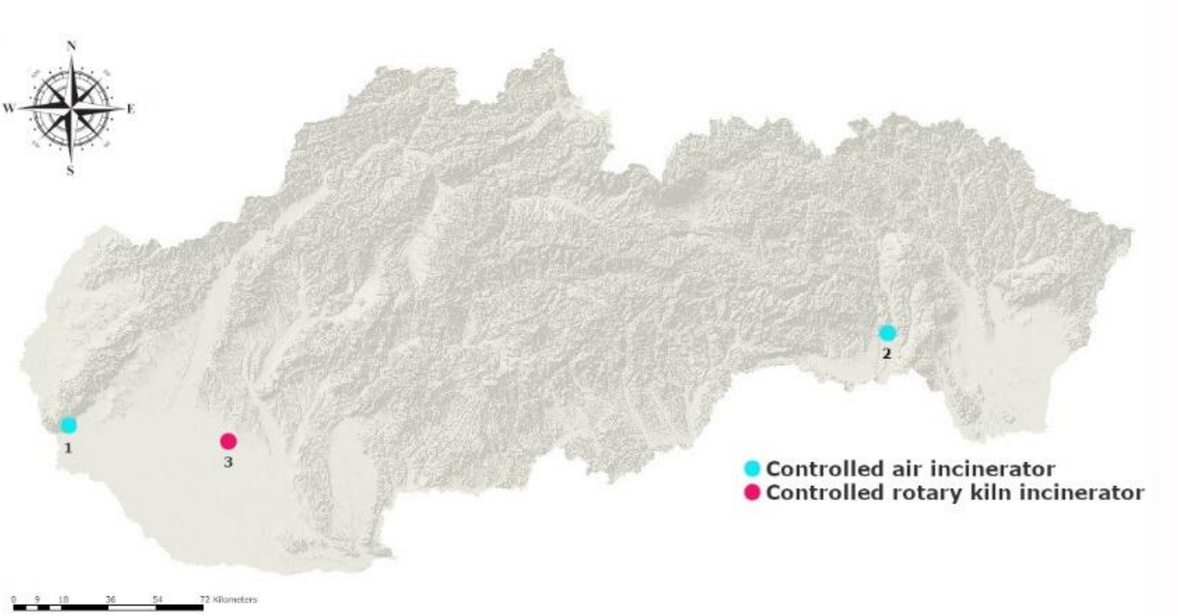
Figure 6.14: Clinical waste incineration plants without E recovery in 2015



1. Hospital in Myjava	4. FCC Environment CEE Ltd., Kysucké Nové Mesto	7. Archív SB Ltd., Liptovský Mikuláš
2. Faculty hospital inTrenčín	5. Hospital with health centre Čadca	8. Duslo Inc., Šaľa
3. Hospital with health centre Bojnice	6. Faculty hospital with health centre Martin	9. Fecupral Ltd., Prešov

Clinical waste was not incinerated with energy recovery until 2007, from 2008 three operators started to burn clinical waste as a part of a fuel for energy production (***Figure 6.13***). Until 2015, only other clinical waste was incinerated in these plants, since 2016 one operator burns hazardous clinical waste too (Duslo Inc., Šaľa).

Figure 6.15: Clinical waste incineration plants with E recovery in 2016



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 on 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 oxidation of nitrogen in the waste, and oxidation of atmospheric nitrogen. ***Table 6.19*** shows emissions release to the air from this activity using methodology described below. ***Figures 6.16-6.18*** shows increase in 2004 and subsequently rapid decrease in 200, which were caused by adoption of strict legislation and emission limits for this activity related to enter of the Slovak Republic to European Union.

Table 6.19: *Overview of the activity data, emissions and emission trends in the category Clinical waste incineration without E recovery*

	CW INCINERATED [kt]	NOx [kt]	NMVOC [kt]	SOx [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	1.86	0.0033	0.0013	0.0020	0.0427	0.0010	0.0028
1995	1.86	0.0033	0.0013	0.0020	0.0428	0.0010	0.0028
2000	1.89	0.0034	0.0013	0.0016	0.0335	0.0008	0.0027
2005	2.57	0.0046	0.0018	0.0020	0.0413	0.0010	0.0037
2010	1.86	0.0034	0.0013	0.0003	0.0060	0.0001	0.0027
2011	2.37	0.0043	0.0017	0.0002	0.0052	0.0001	0.0034
2012	1.67	0.0030	0.0012	0.0002	0.0036	0.0001	0.0024
2013	1.73	0.0031	0.0012	0.0002	0.0035	0.0001	0.0023
2014	1.67	0.0030	0.0012	0.0002	0.0035	0.0001	0.0023
2015	2.90	0.0052	0.0020	0.0003	0.0063	0.0001	0.0041
2016	2.45	0.0044	0.0017	0.0003	0.0051	0.0001	0.0034
2017	2.81	0.0051	0.0020	0.0005	0.0051	0.0001	0.0033
1990/2017	**52%**	**52%**	**52%**	**-76%**	**-88%**	**-88%**	**20%**
2016/2017	**15%**	**15%**	**15%**	**62%**	**-1%**	**-1%**	**-1%**

	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	PCDD/F [g I-TEQ]
1990	0.0668	0.0056	0.1002	0.0002	0.0007	0.0111	0.0006	74.2128
1995	0.0669	0.0056	0.1004	0.0002	0.0007	0.0112	0.0006	74.3621
2000	0.0510	0.0043	0.0785	0.0002	0.0006	0.0094	0.0005	57.9707
2005	0.0620	0.0053	0.0957	0.0002	0.0007	0.0122	0.0007	40.4131
2010	0.0034	0.0005	0.0091	0.0000	0.0001	0.0047	0.0005	0.7454
2011	NO	0.0003	0.0051	0.0000	0.0000	0.0056	0.0007	0.9461
2012	NO	0.0002	0.0042	0.0000	0.0000	0.0038	0.0005	0.6694
2013	NO	0.0002	0.0057	0.0000	0.0000	0.0037	0.0005	0.6919
2014	NO	0.0002	0.0051	0.0000	0.0000	0.0037	0.0004	0.6685
2015	NO	0.0003	0.0073	0.0000	0.0000	0.0066	0.0008	1.1605
2016	NO	0.0003	0.0071	0.0000	0.0000	0.0054	0.0007	0.9807
2017	NO	0.0003	0.0133	0.0001	0.0000	0.0053	0.0006	1.1256
1990/2017	**-**	**-95%**	**-87%**	**-62%**	**-95%**	**-53%**	**16%**	**-98%**
2016/2017	**-**	**-3%**	**86%**	**161%**	**6%**	**-3%**	**-3%**	**15%**

Figure 6.16: *Hg emission trend in the category Clinical waste incineration without E recovery*

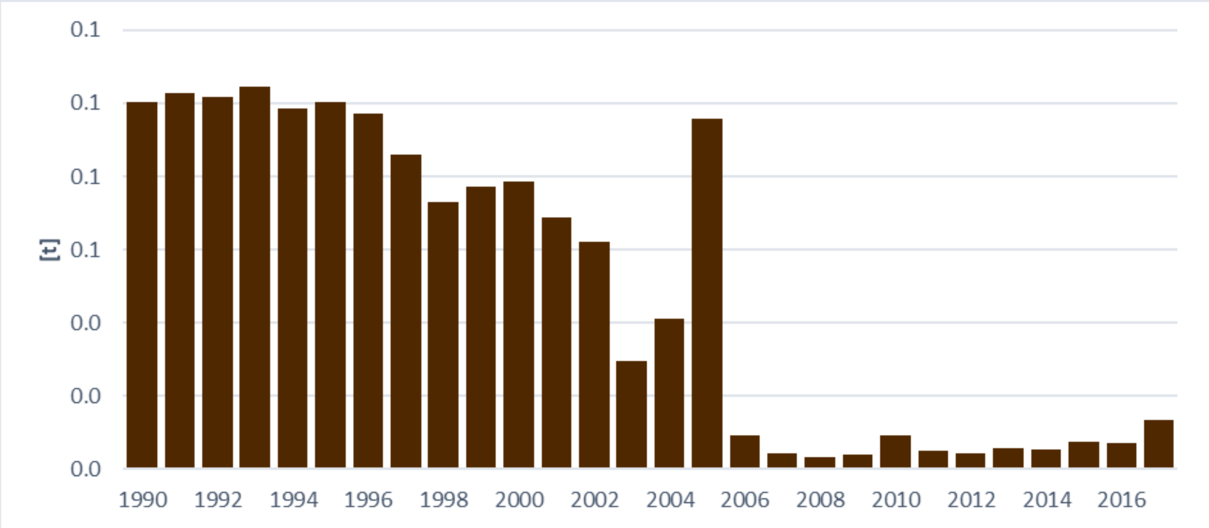


Figure 6.17: *PCDD/F emission trend in the category Clinical waste incineration without E recovery*

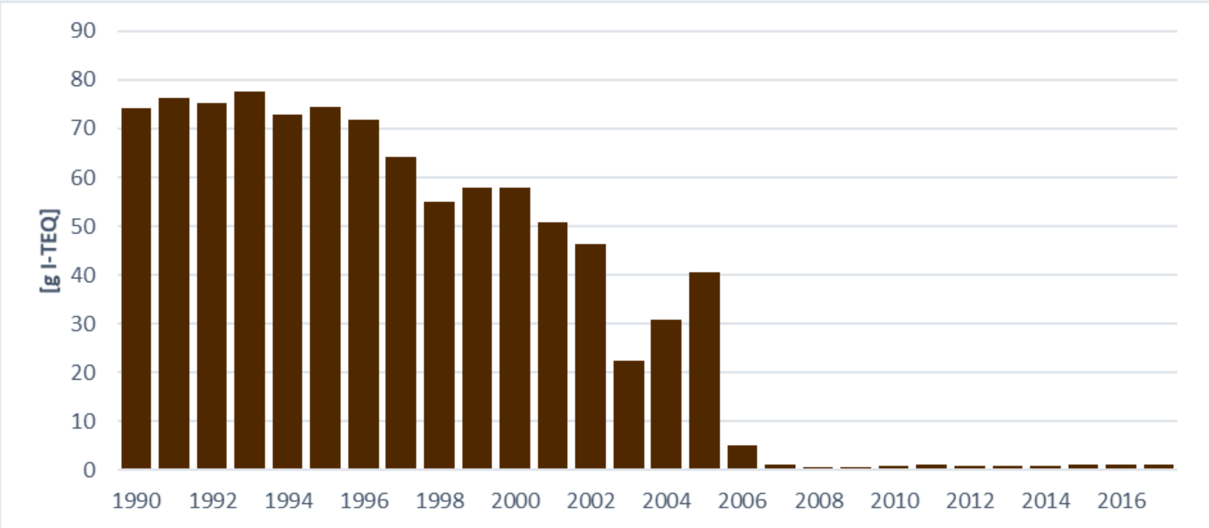
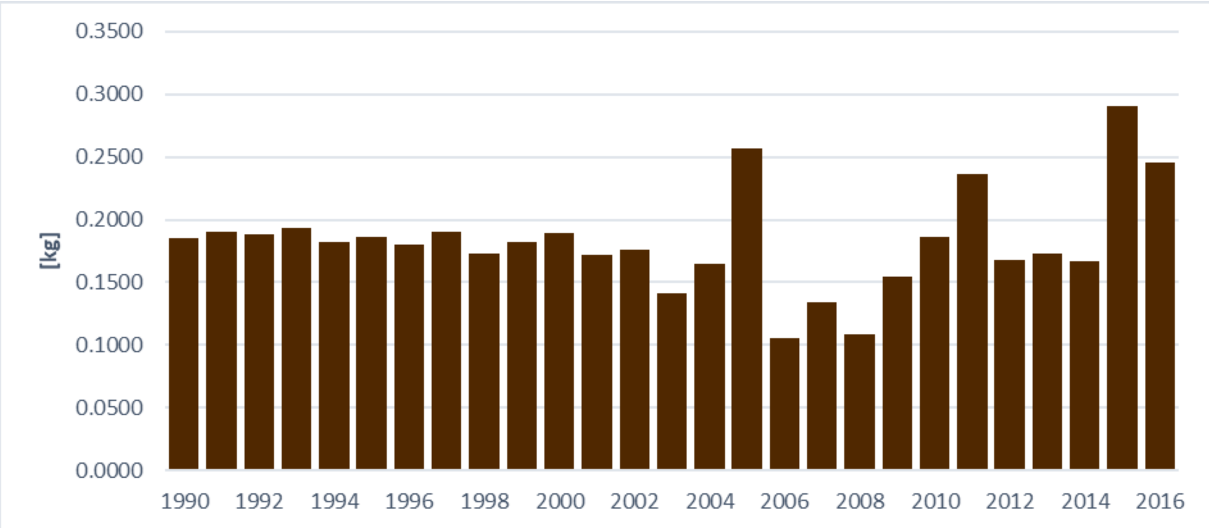


Figure 6.18: *HCB emission trend in the category Clinical waste incineration without E recovery*

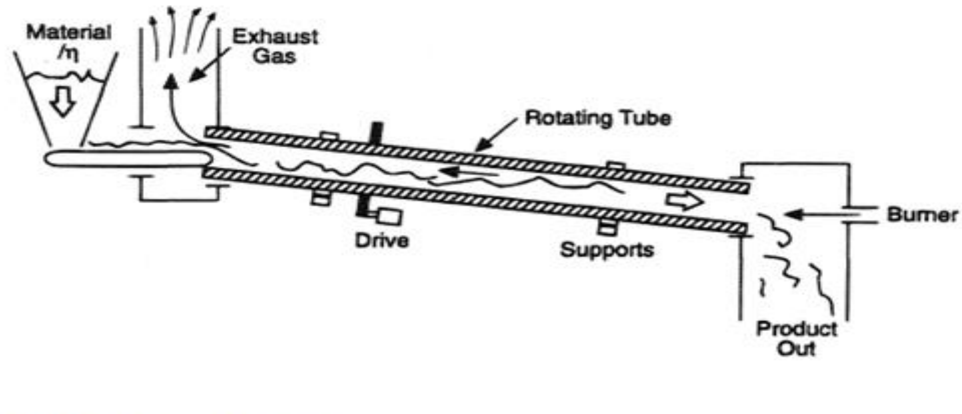


6.7.4.2 Methodological issues

National statistics are main source of activity data in this category – waste from medical and veterinary care incinerated without energy recovery from annual publications Waste in the Slovak Republic 2002 - 2017[21]. Historical years were extrapolated in consistency with the GHG inventory. Due to different classification of waste categories, inconsistency with the EUROSTAT data was recorded. For the first time, extraction of waste from medical care from the category Wastes from human or animal health care or related research was provided, using data reported by operators to NEIS database (National Emission Informative System) for the years 2005-2017. Historical data were extrapolated using trend of the category hospital and veterinary wastes. For the category Clinical waste incineration with energy recovery, data from RISO (Regional information system of waste) database were used.

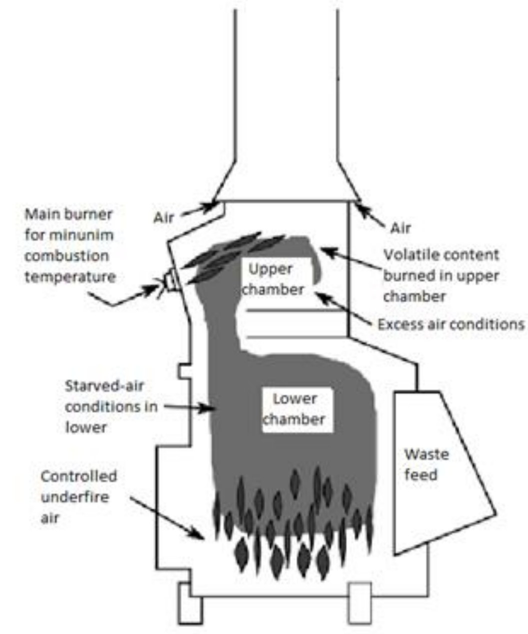
In the 2016 EMEP/EEA GB, there are described two types of abatement technologies. **Rotary kiln (*Figure 6.19*)** is defined as technology where waste is fed into a slightly inclined, rotating, refractory-lined drum, which acts as a grate surface. The rotating action of the drum mixes it with air supplied through the walls.

Figure 6.19: *Scheme of rotary kiln*



Source: https://www.911metallurgist.com/blog/rotary-kiln-lining

Figure 6.20: *Scheme of controlled air incinerator*



Source: http://managemedmedicalwastedisposal.com/blog/date/2016/09

Controlled air incinerator (modular-starved air incinerators) 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 elevated to ~1000 °C by support burners to ensure complete gas (***Figure 6.120***).

Data about technology used to incinerate clinical waste and abatement technologies are available from the year 2000, when were these data published as a part

[21] Waste in the Slovak Republic – Yearbook – available since 2008 https://slovak.statistics.sk/

of Waste Management Program for the period 2001-2005[22]. This program is updated every 5 years[23].

Emission estimates were calculated using tier 2 approach. Emission factors were taken from the 2016 EMEP/EEA GB (Table 3-2). Technology specific information were collected from operators and Waste management Programs, and plants using controlled rotary kiln and controlled air incineration were identified. ***Table 6.20 and 6.21*** shows analysis of distribution of clinical waste burned by combustion technologies in period 1990-2017.

Table 6.20*: 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	
1990-1996	100%			
1997	83%	17%		17% minimal APC
1998	78%	22%		22% minimal APC
1999	78%	22%		22% minimal APC
2000	75%	20%	5%	25% minimal APC
2001	72%	23%	5%	28% minimal APC
2002	63%	32%	5%	37% minimal APC
2003	35%	58%	7%	65% minimal APC
2004	43%	51%	6%	57% minimal APC
2005	67%	29%	4%	33% minimal APC
2006	11%	80%	9%	89% good APC
2007	1%	92%	7%	99% good APC
2008		90%	10%	100% good APC
2009		94%	6%	100% good APC
2010	5%[24]	90%	5%	95% good APC
2011		96%	4%	100% good APC
2012		93%	7%	100% good APC
2013		87%	13%	100% good APC
2014		89%	11%	100% good APC
2015		93%	7%	100% good APC
2016		90%	10%	100% good APC
2017				100% good APC

(dark orange)	No abatement
(yellow)	Default value of abatement efficiency (GB_{2016})

Table 6.21*: Distribution of incinerated hospital waste with energy recovery by combustion technologies*

YEAR	% OF WASTE BURNED IN CONTROLLED WI		% OF WASTE BURNED IN WI WITH AIR POLLUTION CONTROL (APC)
	CONTROLLED AIR WI	ROTARY KILN WI	
2008	99%	1%	100% good APC
2009	98%	2%	100% good APC
2010	99%	1%	100% good APC
2011	99%	1%	100% good APC
2012	100%	0%	100% good APC
2013	99%	1%	100% good APC
2014	100%	0%	100% good APC
2015	97%	3%	100% good APC

[22] http://hsr.rokovania.sk/data/att/17918_subor.rtf
[23] http://www.minzp.sk/oblasti/odpady-obaly/poh/poh-2006-2010/programy/
http://www.minzp.sk/sekcie/temy-oblasti/odpady-obaly/poh/poh-2011-2015/
http://www.minzp.sk/sekcie/temy-oblasti/odpady-obaly/poh/poh-sr-2016-2020/
[24] Test operation of one source (Clinical waste incineration plant by Hospital in Trnava)

YEAR	% OF WASTE BURNED IN CONTROLLED WI		% OF WASTE BURNED IN WI WITH AIR POLLUTION CONTROL (APC)
	CONTROLLED AIR WI	ROTARY KILN WI	
2016	52%	48%	100% good APC
2017			100% good APC
	Default value of abatement efficiency (GB_{2016})		

Operators of clinical waste was assigned to combustion technology on base of data from Waste Management Programs and NEIS database. Data from NEIS database about amount of clinical waste burned in each incineration plants did not correspondent to data from national statistics, therefore, to assign the amount of waste to a particular operator, the relative value of the outgoing data from the NEIS was used. On this basis, amount of waste was assigned to technology according to ratio set for each year. Information about the type of air pollution control technology are available in Waste Management Programs and/or NEIS database.

Emission factors and efficiencies of abatement technologies, which were used in calculations for incineration with/without energy recovery, are shown in ***Table 6.22***.

Table 6.22: *Emission factors and abatement technology efficiencies in the category 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	0	88	-	59	99	-	100	100	73	-	98	100	99
% Efficiency controlled air	-	-	-	92	90	-	100	96	97	99	96	59	0

Note: *Not valid for these pollutants in category Clinical waste incineration with energy recovery

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 1997-2006	93	-	-	-
% Efficiency 2007-2017	99	-	-	-

Due to general change of methodological approach used in this category, recommendation Nr. ***SK-5-2018-0001*** was not fully implemented, although research about abatement technology and combustion technology was provided. Emission factors used in this category are in comply with emission factors from EMEP/EEA GB_{2016}.

6.7.4.3 Completeness

All rising pollutants are recorded and reported Emissions occurring in clinical waste combustion with energy recovery are reported under **1A2gviii**. Due to change of methodology approach emissions of $PM_{2.5}$ and PM_{10}, were reported as not estimated (no EF in the new methodology).

6.7.4.4 Source specific recalculations

This category was recalculated to increase methodology level from T1 to T2 as it was identified as key category for PCDD/F and HCB. Due to this change, further investigations connected with recommendation Recalculations of emissions are displayed in ***Table 6.24***. Clinical waste was separated from waste category Wastes from human or animal health care or related research (***Table 6.23***).

Table 6.23: Previous and refined amount of incinerated clinical waste with and without energy recovery

YEAR	CW WITHOUT ENERGY RECOVERY [kt]		CHANGE [%]	CW WITH ENERGY RECOVERY [kt]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED	
1990	30.80	1.86	-94%	3.13	NO	-
1991	31.73	1.91	-94%	2.91	NO	-
1992	31.58	1.88	-94%	3.05	NO	-
1993	32.26	1.94	-94%	2.84	NO	-
1994	30.28	1.82	-94%	2.67	NO	-
1995	30.15	1.86	-94%	2.54	NO	-
1996	30.47	1.80	-94%	2.43	NO	-
1997	30.25	1.91	-94%	2.41	NO	-
1998	30.06	1.73	-94%	2.34	NO	-
1999	29.67	1.82	-94%	2.18	NO	-
2000	28.86	1.89	-93%	2.09	NO	-
2001	28.09	1.72	-94%	2.04	NO	-
2002	27.92	1.76	-94%	0.13	NO	-
2003	26.86	1.41	-95%	13.13	NO	-
2004	20.38	1.64	-92%	0.05	NO	-
2005	65.96	2.57	-96%	4.78	NO	-
2006	20.64	1.06	-95%	0.16	NO	-
2007	25.85	1.34	-95%	0.37	NO	-
2008	43.18	1.09	-97%	0.85	0.79	-7%
2009	13.69	1.54	-89%	1.03	0.82	-21%
2010	35.59	1.86	-95%	2.17	0.74	-66%
2011	12.00	2.37	-80%	1.47	0.74	-50%
2012	12.94	1.67	-87%	0.08	0.05	-36%
2013	7.99	1.73	-78%	0.90	0.54	-40%
2014	11.57	1.67	-86%	1.39	0.93	-33%
2015	9.17	2.90	-68%	0.73	0.66	-11%
2016	15.03	2.45	-84%	1.01	0.94	-7%

***Table 6.24**: Previous and refined emissions of air pollutants in the category Clinical waste incineration*

YEAR	NOx [kt]		CHANGE [%]	NMVOC [kt]		CHANGE [%]	SOx [kt]		CHANGE [%]	TSP [kt]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED	
1990	0.0708	0.0033	-95%	0.0708	0.0013	-98%	0.0166	0.0020	-88%	0.5236	0.0427	-92%
1991	0.0730	0.0034	-95%	0.0730	0.0013	-98%	0.0171	0.0021	-88%	0.5393	0.0438	-92%
1992	0.0726	0.0034	-95%	0.0726	0.0013	-98%	0.0171	0.0021	-88%	0.5369	0.0433	-92%
1993	0.0742	0.0035	-95%	0.0742	0.0014	-98%	0.0174	0.0021	-88%	0.5484	0.0446	-92%
1994	0.0696	0.0033	-95%	0.0696	0.0013	-98%	0.0164	0.0020	-88%	0.5148	0.0419	-92%
1995	0.0693	0.0033	-95%	0.0693	0.0013	-98%	0.0163	0.0020	-87%	0.5125	0.0428	-92%
1996	0.0701	0.0032	-95%	0.0701	0.0013	-98%	0.0165	0.0020	-88%	0.5180	0.0413	-92%
1997	0.0696	0.0034	-95%	0.0696	0.0013	-98%	0.0163	0.0018	-89%	0.5143	0.0371	-93%
1998	0.0691	0.0033	-95%	0.0691	0.0012	-98%	0.0162	0.0016	-90%	0.5110	0.0311	-94%
1999	0.0682	0.0034	-95%	0.0682	0.0013	-98%	0.0160	0.0017	-89%	0.5044	0.0336	-93%
2000	0.0664	0.0034	-95%	0.0664	0.0013	-98%	0.0156	0.0016	-90%	0.4906	0.0335	-93%
2001	0.0646	0.0031	-95%	0.0646	0.0012	-98%	0.0152	0.0014	-91%	0.4775	0.0293	-94%
2002	0.0642	0.0032	-95%	0.0642	0.0012	-98%	0.0151	0.0013	-91%	0.4746	0.0268	-94%
2003	0.0618	0.0025	-96%	0.0618	0.0010	-98%	0.0145	0.0007	-95%	0.4566	0.0132	-97%
2004	0.0469	0.0048	-90%	0.0469	0.0011	-98%	0.0110	0.0009	-92%	0.3465	0.0182	-95%
2005	0.1517	0.0046	-97%	0.1517	0.0018	-99%	0.0356	0.0020	-94%	1.1214	0.0413	-96%
2006	0.0475	0.0019	-96%	0.0475	0.0007	-98%	0.0111	0.0002	-98%	0.3510	0.0046	-99%
2007	0.0595	0.0024	-96%	0.0595	0.0009	-98%	0.0140	0.0002	-99%	0.4395	0.0032	-99%
2008	0.0993	0.0020	-98%	0.0993	0.0008	-99%	0.0233	0.0001	-99%	0.7341	0.0023	-100%
2009	0.0315	0.0028	-91%	0.0315	0.0011	-97%	0.0074	0.0002	-98%	0.2328	0.0034	-99%
2010	0.0819	0.0034	-96%	0.0819	0.0013	-98%	0.0192	0.0003	-98%	0.6051	0.0060	-99%
2011	0.0276	0.0043	-85%	0.0276	0.0017	-94%	0.0065	0.0002	-96%	0.2039	0.0052	-97%
2012	0.0298	0.0030	-90%	0.0298	0.0012	-96%	0.0070	0.0002	-97%	0.2201	0.0036	-98%
2013	0.0184	0.0031	-83%	0.0184	0.0012	-93%	0.0043	0.0002	-95%	0.1358	0.0035	-97%
2014	0.0266	0.0030	-89%	0.0266	0.0012	-96%	0.0063	0.0002	-97%	0.1968	0.0035	-98%
2015	0.0211	0.0052	-75%	0.0211	0.0020	-90%	0.0049	0.0003	-93%	0.1558	0.0063	-96%
2016	0.0346	0.0044	-87%	0.0346	0.0017	-95%	0.0081	0.0003	-96%	0.2556	0.0051	-98%

***Table 6.24**: Previous and refined emissions of air pollutants in the category Clinical waste incineration - continuation*

YEAR	BC [kt]		CHANGE [%]	CO [kt]		CHANGE [%]	Pb [t]		CHANGE [%]	Cd [t]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED	
1990	0.0120	0.0010	-92%	0.0059	0.0028	-52%	0.2464	0.0104	-96%	0.2464	0.0056	-98%
1991	0.0124	0.0010	-92%	0.0060	0.0029	-53%	0.2538	0.0107	-96%	0.2538	0.0057	-98%
1992	0.0123	0.0010	-92%	0.0060	0.0028	-53%	0.2527	0.0106	-96%	0.2527	0.0056	-98%
1993	0.0126	0.0010	-92%	0.0061	0.0029	-53%	0.2581	0.0109	-96%	0.2581	0.0058	-98%
1994	0.0118	0.0010	-92%	0.0058	0.0027	-52%	0.2423	0.0102	-96%	0.2423	0.0055	-98%
1995	0.0118	0.0010	-92%	0.0057	0.0028	-51%	0.2412	0.0104	-96%	0.2412	0.0056	-98%
1996	0.0119	0.0010	-92%	0.0058	0.0027	-53%	0.2438	0.0101	-96%	0.2438	0.0054	-98%
1997	0.0118	0.0009	-93%	0.0057	0.0029	-50%	1.9096	0.0668	-97%	0.2420	0.0048	-98%
1998	0.0118	0.0007	-94%	0.0057	0.0026	-55%	1.9670	0.0686	-97%	0.2405	0.0041	-98%
1999	0.0116	0.0008	-93%	0.0056	0.0027	-52%	1.9581	0.0678	-97%	0.2373	0.0043	-98%
2000	0.0113	0.0008	-93%	0.0055	0.0027	-51%	2.0001	0.0698	-97%	0.2309	0.0043	-98%
2001	0.0110	0.0007	-94%	0.0053	0.0025	-54%	1.8775	0.0657	-97%	0.2247	0.0038	-98%
2002	0.0109	0.0006	-94%	0.0053	0.0025	-52%	1.8690	0.0669	-96%	0.2234	0.0034	-98%
2003	0.0105	0.0003	-97%	0.0051	0.0020	-61%	1.8891	0.0647	-97%	0.2149	0.0016	-99%
2004	0.0080	0.0004	-95%	0.0039	0.0023	-40%	1.8756	0.0570	-97%	0.1631	0.0022	-99%
2005	0.0258	0.0010	-96%	0.0125	0.0037	-70%	1.8637	0.0486	-97%	0.5277	0.0053	-99%
2006	0.0081	0.0001	-99%	0.0039	0.0015	-63%	1.8394	0.0511	-97%	0.1652	0.0004	-100%
2007	0.0101	0.0001	-99%	0.0049	0.0019	-62%	1.7892	0.0510	-97%	0.2068	0.0002	-100%
2008	0.0169	0.0001	-100%	0.0082	0.0015	-82%	1.7414	0.0445	-97%	0.3455	0.0001	-100%
2009	0.0054	0.0001	-99%	0.0026	0.0022	-16%	1.7311	0.0399	-98%	0.1095	0.0002	-100%
2010	0.0139	0.0001	-99%	0.0068	0.0027	-60%	1.6652	0.0177	-99%	0.2847	0.0005	-100%
2011	0.0047	0.0001	-97%	0.0023	0.0034	50%	1.2638	0.0254	-98%	0.0960	0.0003	-100%
2012	0.0051	0.0001	-98%	0.0025	0.0024	-4%	4.0897	0.0620	-98%	0.1036	0.0002	-100%
2013	0.0031	0.0001	-97%	0.0015	0.0023	51%	1.2800	0.0042	-100%	0.0639	0.0002	-100%
2014	0.0045	0.0001	-98%	0.0022	0.0023	3%	1.6029	0.0005	-100%	0.0926	0.0002	-100%
2015	0.0036	0.0001	-96%	0.0017	0.0041	135%	2.6774	NO	-	0.0733	0.0003	-100%
2016	0.0059	0.0001	-98%	0.0029	0.0034	17%	0.8489	NO	-	0.1203	0.0003	-100%

Table 6.24: Previous and refined emissions of air pollutants in the category Clinical waste incineration - continuation

YEAR	Hg [t]		CHANGE [%]	As [t]		CHANGE [%]	Cr [t]		CHANGE [%]	Cu [t]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED	
1990	1.3244	0.1002	-92%	0.0062	0.0002	-97%	0.0616	0.0007	-99%	3.0183	0.0111	-100%
1991	1.3642	0.1029	-92%	0.0063	0.0002	-97%	0.0635	0.0008	-99%	3.1091	0.0114	-100%
1992	1.3580	0.1016	-93%	0.0063	0.0002	-97%	0.0632	0.0008	-99%	3.0950	0.0113	-100%
1993	1.3872	0.1046	-92%	0.0065	0.0002	-97%	0.0645	0.0008	-99%	3.1615	0.0116	-100%
1994	1.3021	0.0985	-92%	0.0061	0.0002	-97%	0.0606	0.0007	-99%	2.9676	0.0109	-100%
1995	1.2963	0.1004	-92%	0.0060	0.0002	-97%	0.0603	0.0007	-99%	2.9542	0.0112	-100%
1996	1.3102	0.0971	-93%	0.0061	0.0002	-97%	0.0609	0.0007	-99%	2.9860	0.0108	-100%
1997	1.3008	0.0860	-93%	0.0061	0.0002	-97%	0.0605	0.0006	-99%	2.9647	0.0103	-100%
1998	1.2925	0.0729	-94%	0.0060	0.0001	-98%	0.0601	0.0005	-99%	2.9458	0.0081	-100%
1999	1.2757	0.0773	-94%	0.0059	0.0001	-98%	0.0593	0.0006	-99%	2.9074	0.0095	-100%
2000	1.2409	0.0785	-94%	0.0058	0.0002	-97%	0.0577	0.0006	-99%	2.8280	0.0094	-100%
2001	1.2077	0.0686	-94%	0.0056	0.0001	-98%	0.0562	0.0005	-99%	2.7525	0.0084	-100%
2002	1.2006	0.0621	-95%	0.0056	0.0001	-98%	0.0558	0.0005	-99%	2.7362	0.0080	-100%
2003	1.1549	0.0294	-97%	0.0054	0.0001	-99%	0.0537	0.0002	-100%	2.6321	0.0050	-100%
2004	0.8765	0.0409	-95%	0.0041	0.0001	-98%	0.0408	0.0003	-99%	1.9976	0.0063	-100%
2005	2.8364	0.0957	-97%	0.0132	0.0002	-99%	0.1319	0.0007	-99%	6.4643	0.0122	-100%
2006	0.8877	0.0090	-99%	0.0041	0.0000	-99%	0.0413	0.0001	-100%	2.0232	0.0028	-100%
2007	1.1117	0.0041	-100%	0.0052	0.0000	-100%	0.0517	0.0000	-100%	2.5337	0.0031	-100%
2008	1.8569	0.0032	-100%	0.0086	0.0000	-100%	0.0864	0.0000	-100%	4.2320	0.0024	-100%
2009	0.5888	0.0037	-99%	0.0027	0.0000	-100%	0.0274	0.0000	-100%	1.3419	0.0036	-100%
2010	1.5305	0.0091	-99%	0.0071	0.0000	-100%	0.0712	0.0001	-100%	3.4880	0.0047	-100%
2011	0.5158	0.0051	-99%	0.0024	0.0000	-100%	0.0240	0.0000	-100%	1.1756	0.0056	-100%
2012	0.5566	0.0042	-99%	0.0026	0.0000	-99%	0.0259	0.0000	-100%	1.2686	0.0038	-100%
2013	0.3435	0.0057	-98%	0.0016	0.0000	-98%	0.0160	0.0000	-100%	0.7829	0.0037	-100%
2014	0.4977	0.0051	-99%	0.0023	0.0000	-99%	0.0231	0.0000	-100%	1.1343	0.0037	-100%
2015	0.3941	0.0073	-98%	0.0018	0.0000	-99%	0.0183	0.0000	-100%	0.8983	0.0066	-99%
2016	0.6465	0.0071	-99%	0.0030	0.0000	-99%	0.0301	0.0000	-100%	1.4733	0.0054	-100%

***Table 6.24**: Previous and refined emissions of air pollutants in the category Clinical waste incineration - continuation*

YEAR	Ni [kt]		CHANGE [%]	PCDD/F [g I-TEQ]		CHANGE [%]	PAHs [t]		CHANGE [%]	HCB [kg]		CHANGE [%]
	PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED		PREVIOUS	REFINED	
1990	0.0616	0.0006	-99%	25.1015	74.2128	196%	0.0012	0.0000	-100%	0.0014	0.1855	13110%
1991	0.0635	0.0006	-99%	25.8560	76.2443	195%	0.0012	0.0000	-100%	0.0014	0.1906	13076%
1992	0.0632	0.0006	-99%	25.7394	75.2793	192%	0.0012	0.0000	-100%	0.0014	0.1882	12968%
1993	0.0645	0.0006	-99%	26.2920	77.5146	195%	0.0013	0.0000	-100%	0.0015	0.1938	13073%
1994	0.0606	0.0005	-99%	24.6797	72.9522	196%	0.0012	0.0000	-100%	0.0014	0.1824	13108%
1995	0.0603	0.0006	-99%	24.5685	74.3621	203%	0.0012	0.0000	-100%	0.0014	0.1859	13424%
1996	0.0609	0.0005	-99%	24.8327	71.8974	190%	0.0012	0.0000	-100%	0.0014	0.1797	12837%
1997	0.0605	0.0006	-99%	24.6554	64.2133	160%	0.0012	0.0000	-100%	0.0014	0.1907	13722%
1998	0.0601	0.0004	-99%	24.4982	55.0903	125%	0.0012	0.0000	-100%	0.0014	0.1732	12532%
1999	0.0593	0.0005	-99%	24.1793	57.8890	139%	0.0012	0.0000	-100%	0.0014	0.1819	13349%
2000	0.0577	0.0005	-99%	23.5188	57.9707	146%	0.0011	0.0000	-100%	0.0013	0.1888	14250%
2001	0.0562	0.0005	-99%	14.0435	50.7615	261%	0.0011	0.0000	-100%	0.0013	0.1716	13297%
2002	0.0558	0.0005	-99%	13.9602	46.1918	231%	0.0011	0.0000	-100%	0.0013	0.1761	13729%
2003	0.0537	0.0004	-99%	13.4290	22.2832	66%	0.0010	0.0000	-100%	0.0012	0.1409	11401%
2004	0.0408	0.0005	-99%	10.1919	30.8760	203%	0.0008	0.0000	-100%	0.0009	0.1643	17573%
2005	0.1319	0.0007	-99%	32.9812	40.4131	23%	0.0026	0.0000	-100%	0.0030	0.2570	8445%
2006	0.0413	0.0003	-99%	10.3223	5.0199	-51%	0.0008	0.0000	-100%	0.0009	0.1055	11112%
2007	0.0517	0.0004	-99%	12.9268	1.0684	-92%	0.0010	0.0000	-100%	0.0012	0.1342	11285%
2008	0.0864	0.0003	-100%	21.5918	0.4347	-98%	0.0017	0.0000	-100%	0.0020	0.1087	5418%
2009	0.0274	0.0004	-98%	6.8464	0.6161	-91%	0.0005	0.0000	-100%	0.0006	0.1540	24570%
2010	0.0712	0.0005	-99%	17.7962	0.7454	-96%	0.0014	0.0000	-100%	0.0016	0.1864	11382%
2011	0.0240	0.0007	-97%	5.9980	0.9461	-84%	0.0005	0.0000	-100%	0.0005	0.2365	43139%
2012	0.0259	0.0005	-98%	6.4725	0.6694	-90%	0.0005	0.0000	-100%	0.0006	0.1674	28252%
2013	0.0160	0.0005	-97%	3.9942	0.6919	-83%	0.0003	0.0000	-100%	0.0004	0.1730	47386%
2014	0.0231	0.0004	-98%	5.7871	0.6685	-88%	0.0004	0.0000	-100%	0.0005	0.1671	31566%
2015	0.0183	0.0008	-96%	4.5830	1.1605	-75%	0.0004	0.0000	-100%	0.0004	0.2901	69316%
2016	0.0301	0.0007	-98%	7.5170	0.9807	-87%	0.0006	0.0000	-100%	0.0007	0.2452	35665%

***Table 6.24**: Previous and refined emissions of air pollutants in the category Clinical waste incineration - continuation*

YEAR	PCB [kg]		CHANGE [%]
	PREVIOUS	REFINED	
1990	0.3080	0.0371	-88%
1991	0.3173	0.0381	-88%
1992	0.3158	0.0376	-88%
1993	0.3226	0.0388	-88%
1994	0.3028	0.0365	-88%
1995	0.3015	0.0372	-88%
1996	0.3047	0.0359	-88%
1997	0.3025	0.0381	-87%
1998	0.3006	0.0346	-88%
1999	0.2967	0.0364	-88%
2000	0.2886	0.0378	-87%
2001	0.2809	0.0343	-88%
2002	0.2792	0.0352	-87%
2003	0.2686	0.0282	-90%
2004	0.2038	0.0329	-84%
2005	0.6596	0.0514	-92%
2006	0.2064	0.0211	-90%
2007	0.2585	0.0268	-90%
2008	0.4318	0.0217	-95%
2009	0.1369	0.0308	-78%
2010	0.3559	0.0373	-90%
2011	0.1200	0.0473	-61%
2012	0.1294	0.0335	-74%
2013	0.0799	0.0346	-57%
2014	0.1157	0.0334	-71%
2015	0.0917	0.0580	-37%
2016	0.1503	0.0490	-67%

6.7.5 SEWAGE SLUDGE INCINERATION (NFR 5C1biv)

6.7.5.1 Overview of the category

Sewage sludge incineration without energy recovery is not occurring in the Slovak Republic, therefore notation key NO was used. There has been one operator, which has combusted sewage sludge with energy recovery since 2012, hence these emissions are reported in energy sector.

6.7.6 CREMATION (NFR 5C1bv)

6.7.6.1 Overview of the category

Annual increase of 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, $PM_{2.5}$, PM_{10} emissions driven by the activity data. As shown in ***Table 6.25***, ***Figure 6.21*** and ***Figure 6.22***, cremation have increasing trend in Slovakia, though in 2016 slight decrease was recorded.

Table 6.25: *Overview of activity data, emissions and emission trends in the category Cremation*

	HUMAN BODIES CREMATED [body]	NOx [kt]	NMVOC [kt]	SOx [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]	CO [kt]
1990	6010	0.0050	0.0001	0.0007	0.0002	0.0002	0.0002	0.0008
1995	6965	0.0056	0.0001	0.0008	0.0002	0.0002	0.0003	0.0009
2000	7528	0.0062	0.0001	0.0009	0.0003	0.0003	0.0003	0.0011
2005	9542	0.0079	0.0001	0.0011	0.0003	0.0003	0.0004	0.0013
2010	12332	0.0102	0.0002	0.0014	0.0004	0.0004	0.0005	0.0017
2011	12332	0.0102	0.0002	0.0014	0.0004	0.0004	0.0005	0.0017
2012	12686	0.0105	0.0002	0.0014	0.0004	0.0004	0.0005	0.0018
2013	13102	0.0108	0.0002	0.0015	0.0005	0.0005	0.0005	0.0018
2014	13233	0.0109	0.0002	0.0015	0.0005	0.0005	0.0005	0.0019
2015	14398	0.0119	0.0002	0.0016	0.0005	0.0005	0.0006	0.0020
2016	12991	0.0107	0.0002	0.0015	0.0005	0.0005	0.0005	0.0018
2017	12 072	0.0100	0.0002	0.0014	0.0004	0.0004	0.0005	0.0017
1990/2017	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**
2016/2017	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**

	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	0.0000	0.0142	0.0001	0.0001	0.0001	0.0002	0.0002	0.0015
2010	0.0004	0.0001	0.0184	0.0002	0.0002	0.0002	0.0002	0.0002	0.0020
2011	0.0004	0.0001	0.0184	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	0.0004	0.0001	0.0195	0.0002	0.0002	0.0002	0.0002	0.0003	0.0021
2014	0.0004	0.0001	0.0197	0.0002	0.0002	0.0002	0.0002	0.0003	0.0021
2015	0.0004	0.0001	0.0215	0.0002	0.0002	0.0002	0.0002	0.0003	0.0023
2016	0.0004	0.0001	0.0194	0.0002	0.0002	0.0002	0.0002	0.0003	0.0021
2017	0.0004	0.0001	0.0180	0.0002	0.0002	0.0002	0.0002	0.0002	0.0019
1990/2017	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**
2016/2017	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**

	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	0.1623	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0025
1995	0.1821	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0028
2000	0.2033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0031
2005	0.2576	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0039
2010	0.3330	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0051
2011	0.3330	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0051
2012	0.3425	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0052
2013	0.3538	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0054
2014	0.3573	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0054
2015	0.3887	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0059
2016	0.3508	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0053
2017	0.3259	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0049
1990/2017	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**	**101%**
2016/2017	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**	**-7%**

Figure 6.21: Hg emission trend in the category Cremation

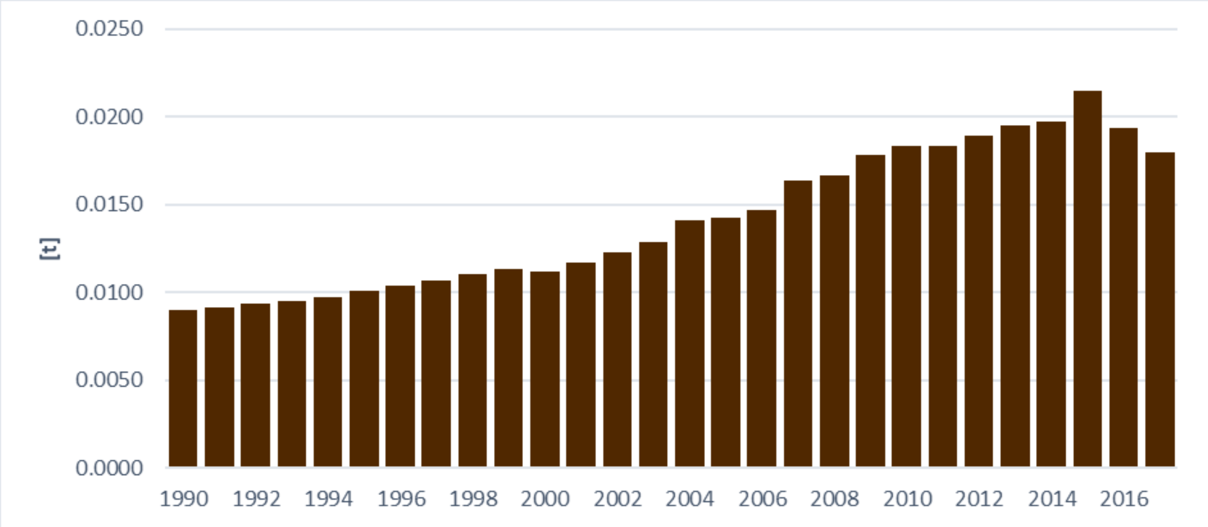
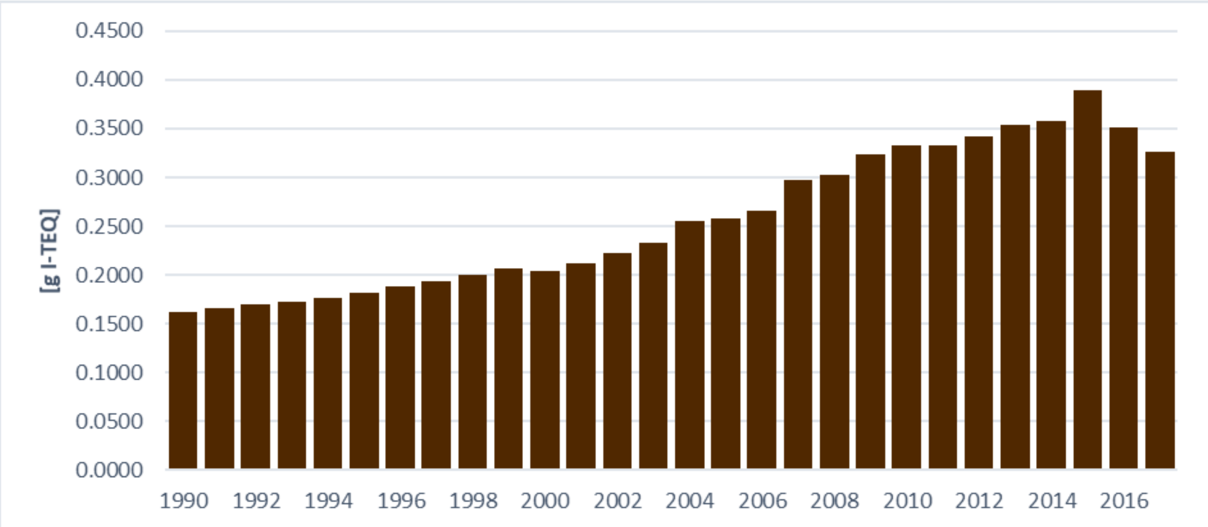


Figure 6.22: PCDD/F emission trend in the category Cremation



6.7.6.2 Methodological Issue

The source of activity data for air pollutants came from operators of Cremation facilities, which report numbers of bodies incinerated in their crematories. Historical data (1990-2000) are not available, therefore, extrapolation was used.

For the emissions, calculation the statistical activity data were used with the default EMEP/EEA GB_{2016} emission factors. The values are given in tables below (***Table 6.26***).

Inclusion/exclusion of the condensable component of PMs is unknown.

Table 6.26: *Emission factors in the category 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

Table 6.26: Emission factors in the category Cremation - continuation

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

6.7.6.3 Completeness

All rising pollutants are recorded and reported.

6.7.6.4 Source specific recalculations

Country specific emission factor for PCDD/F were changed to EEA/EMEP GB_{2016} T1 EF because it was related to incorrect unit (mg/t instead of µg/body). Therefore recalculation was provided in this submission (***Table 6.27***).

***Table 6.27**: Previous and refined emissions of air pollutants in the category Cremation*

YEAR	PCDD/F [g I-TEQ]		
	PREVIOUS	REFINED	CHANGE [%]
1990	0.0601	0.1623	170%
1991	0.0614	0.1657	170%
1992	0.0627	0.1692	170%
1993	0.0640	0.1727	170%
1994	0.0652	0.1761	170%
1995	0.0674	0.1821	170%
1996	0.0696	0.1880	170%
1997	0.0719	0.1940	170%
1998	0.0741	0.2000	170%
1999	0.0763	0.2059	170%
2000	0.0753	0.2033	170%
2001	0.0786	0.2121	170%
2002	0.0825	0.2228	170%
2003	0.0863	0.2329	170%
2004	0.0945	0.2552	170%
2005	0.0954	0.2576	170%
2006	0.0984	0.2657	170%
2007	0.1100	0.2970	170%
2008	0.1120	0.3025	170%
2009	0.1198	0.3234	170%
2010	0.1233	0.3330	170%
2011	0.1233	0.3330	170%
2012	0.1269	0.3425	170%
2013	0.1310	0.3538	170%
2014	0.1323	0.3573	170%
2015	0.1440	0.3887	170%
2016	0.1299	0.3508	170%

6.7.7 OPEN BURNING WASTE (5C2)

6.7.7.1 Overview of the category

This activity is against the law of the Slovak Republic (Decree No. 410/2012 Coll.[25] as amended). It is forbidden to perform open burning of waste. Notation key NO is used.

[25] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2012/410/

6.8 WASTEWATER HANDLING (NFR 5D)

6.8.1 DOMESTIC WASTEWATER HANDLING (NFR 5D1)

6.8.1.1 Overview of the category

Council Directive 91/271/EEC[26] concerning urban waste-water treatment as well as obligations rising from in 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 restore the hardware already functioning sewage treatment plants.

Generally, about two thirds of population are discharging wastewater through sewers and one third is using retention tanks. Wastewater collection and treatment in Slovakia is developing toward modern, advanced WWT plants with removal of nitrogen and phosphorus. Sludge from wastewater treatment is anaerobically stabilised on-site in majority of the WWT plants.

This category involve also emissions from using of latrines in Slovakia. Number of households without connection to public sewage system decreased significant in comparison to base year. ***Table 6.28*** and ***Figure 6.18*** show emission trend of NH_3.

Table 6.28: *Overview, activity data and emission trends in the category Domestic wastewater handling*

	DOMESTIC WASTEWATER DISCHARGED [th. m^3]	POPULATION USING DRY TOILLETES [inhabitants]	NMVOC [kt]	NH_3 [kt]
1990	462 220.19	683 413	0.0069	1.0935
1995	502 507.00	622 186	0.0075	0.9955
2000	461 531.00	523 866	0.0069	0.8382
2005	387 150.32	393 272	0.0058	0.6292
2010	454 069.00	228 103	0.0068	0.3650
2011	364 941.00	129 462	0.0055	0.2071
2012	337 545.00	113 559	0.0051	0.1817
2013	400 954.00	99 471	0.0060	0.1592
2014	377 445.00	81 638	0.0057	0.1306
2015	362 142.00	67 001	0.0054	0.1072
2016	385 463.00	55 007	0.0058	0.0880
2017	424 269.00	45 172	0.0064	0.0723
1990/2017	**-8%**	**-93%**	**-8%**	**-93%**
2016/2017	**10%**	**-18%**	**10%**	**-18%**

As shown in the ***Table 6.28***, ***Figure 6.23*** emissions of NMVOC decreased from 1996 to 2008, since 2009 emissions have slightly increasing trend due to increase of households connected to public sewage system and water supply. ***Figure 6.24*** displays decreasing emission trend of NH_3, due to decrease of inhabitants using dry toilettes.

[26] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31991L0271&from=EN

Figure 6.23: NMVOC emission trend in the category Domestic wastewater handling

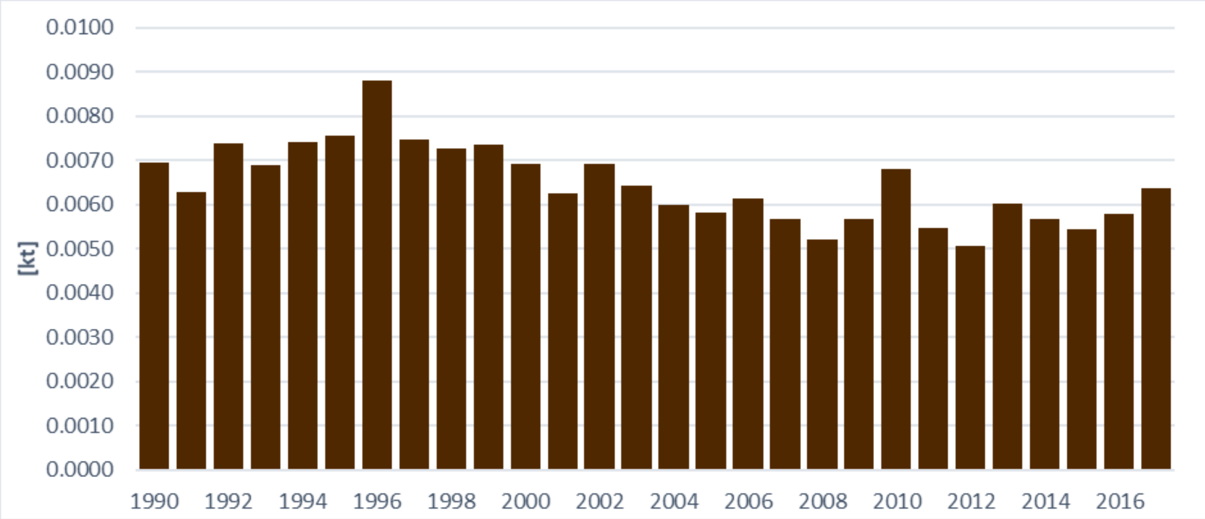
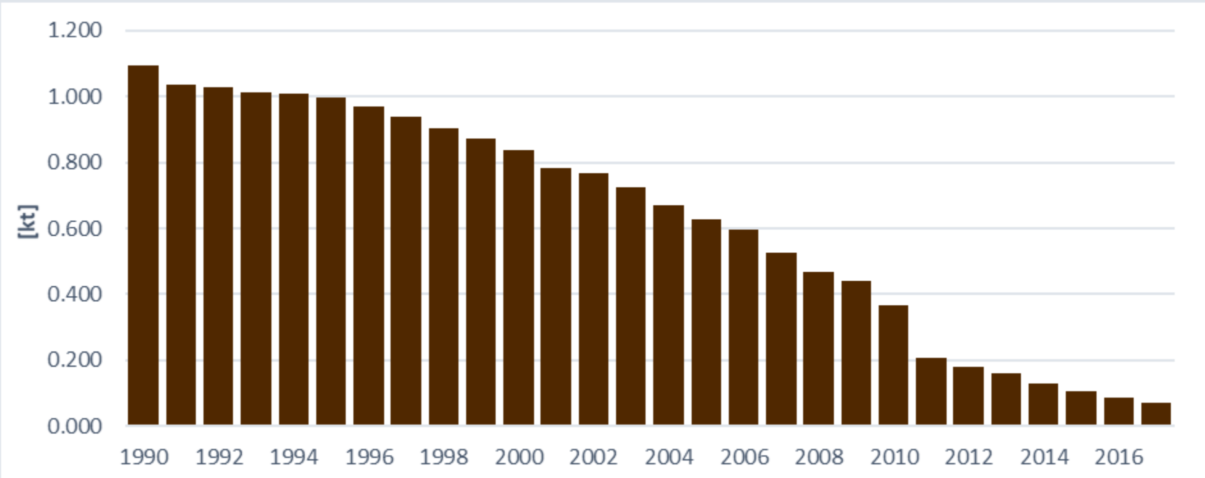


Figure 6.24: *NH_3 emission trend in the category Domestic wastewater treatment*



6.8.1.2 Methodological issues

Source of activity data is national statistical data of volume of handled wastewater released into watercourses. EMEP/EEA GB_{2016} (T1) were used to calculate emissions of NMVOC and NH_3 emitted into air during wastewater handling. In table below, emission factor used to calculate emissions are shown. Notation keys from EMEP/EEA GB_{2016} were applied for other pollutants.

For the usage of dry toilettes, principle of calculation consisted of determining the percentage of use of dry toilettes in Slovakian households (based on information from censuses 2001 and 2011). Activity data were then calculated by multiplying of this percentage by middle year population in Slovak Republic. This parameter have been multiplied with T2 emissions factors for dry toilettes form EMEP/EEA $Guidebook_{2016}$ (***Table 6.29***).

Table 6.29: *Emission factors in the category Domestic wastewater handling*

POLLUTANT	NMVOC	NH_3
Unit	[mg/m^3[	[kg/person]
Value	15	1.6

6.8.1.3 Completeness

Sources of NH_3 an NMVOC emissions are well covered. Notation key for BC was changed in comply with EMEP/EEA GB_{2016}.

6.8.1.4 Source specific recalculations

Emissions of NMVOC were recalculated due to change of activity data used from wastewater released into the public sewage system to handled wastewater released to the watercourses. Emissions of NH_3 from latrines were recalculated for the years 2013-2016 due to change of as shown in ***Table 6.30.*** Emissions from the category latrines were reallocated to this category (2018 submission allocated in 5D3), what caused significant increase of emissions.

Table 6.30: *Previous and refined emissions in the category Domestic wastewater treatment*

YEAR	NMVOC [kt]			NH_3 [kt]		
	PREVIOUS	REFINED	CHANGE [%]	PREVIOUS	REFINED	CHANGE [%]
1990	0.0075	0.0069	-7%	0.0288	1.093	3695%
1991	0.0074	0.0063	-16%	0.0286	1.036	3518%
1992	0.0074	0.0074	0%	0.0284	1.029	3518%
1993	0.0073	0.0069	-6%	0.0283	1.014	3488%
1994	0.0073	0.0074	2%	0.0281	1.009	3494%
1995	0.0072	0.0075	4%	0.0279	0.995	3470%
1996	0.0076	0.0088	16%	0.0293	0.972	3220%
1997	0.0075	0.0075	0%	0.0288	0.939	3165%
1998	0.0073	0.0073	0%	0.0280	0.906	3134%
1999	0.0071	0.0074	4%	0.0273	0.872	3088%
2000	0.0072	0.0069	-4%	0.0279	0.838	2907%
2001	0.0070	0.0063	-10%	0.0268	0.783	2824%
2002	0.0066	0.0069	5%	0.0255	0.766	2899%
2003	0.0064	0.0064	0%	0.0246	0.723	2841%
2004	0.0064	0.0060	-6%	0.0246	0.672	2629%
2005	0.0067	0.0058	-13%	0.0257	0.629	2351%
2006	0.0065	0.0061	-5%	0.0250	0.595	2284%
2007	0.0063	0.0057	-9%	0.0241	0.527	2082%
2008	0.0061	0.0052	-15%	0.0237	0.467	1873%
2009	0.0063	0.0057	-10%	0.0242	0.442	1731%
2010	0.0075	0.0068	-9%	0.0287	0.365	1170%
2011	0.0061	0.0055	-10%	0.0235	0.207	782%
2012	0.0057	0.0051	-11%	0.0220	0.182	725%
2013	0.0066	0.0060	-9%	0.0255	0.159	523%
2014	0.0065	0.0057	-12%	0.0249	0.131	425%
2015	0.0061	0.0054	-11%	0.0235	0.107	356%
2016	0.0064	0.0058	-10%	0.0248	0.088	255%

6.8.2 INDUSTRIAL WASTEWATER HANDLING (NFR 5D2)

6.8.2.1 Overview of the category

Water consumption for industrial purposes and resulting discharge of wastewater have significantly decreased in the period 1990–2017. This decrease is caused by general modernisation of Slovak industries and stricter standards for discharge of industrial wastewater to public sewers or to watercourses.

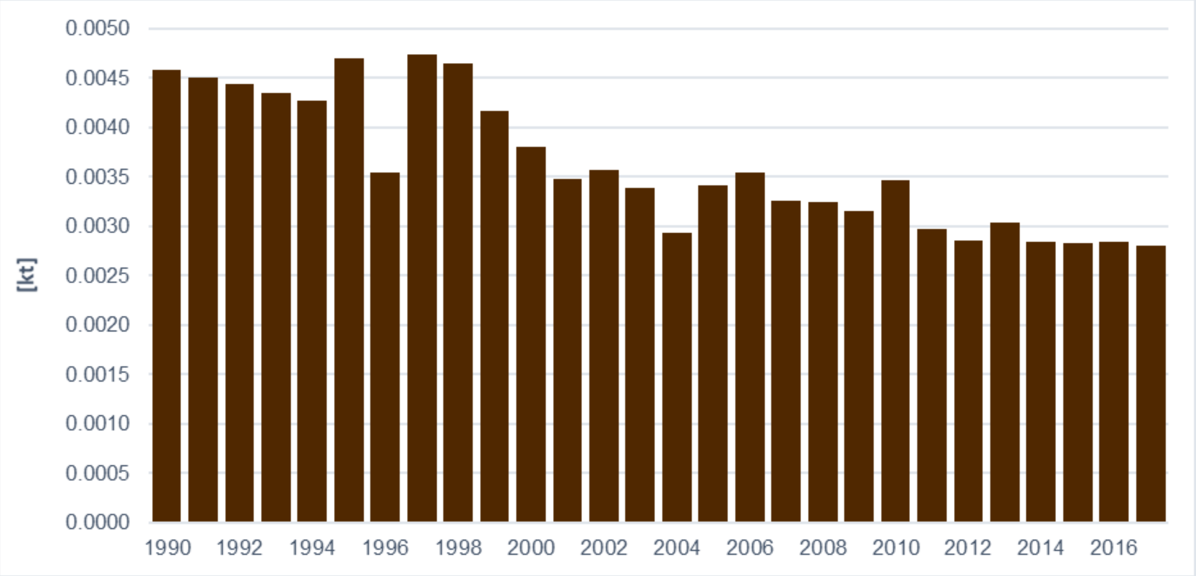
Table 6.31: *Overview of emissions and trends in the category Industrial wastewater handling*

	INDUSTRIAL WASTEWATER DISCHARGED [th.m^3]	NH_3 [kt]
1990	305 371.48	0.0046
1995	313 699.00	0.0047
2000	253 214.00	0.0038

	INDUSTRIAL WASTEWATER DISCHARGED [th.m³]	NH_3 [kt]
2005	227 446.85	0.0034
2010	189 387.00	0.0028
2011	188 578.00	0.0028
2012	189 571.00	0.0028
2013	187 218.00	0.0028
2014	305 371.48	0.0046
2015	313 699.00	0.0047
2016	253 214.00	0.0038
2017	227 446.85	0.0034
1990/2017	**-39%**	**-39%**
2016/2017	**-1%**	**-1%**

In ***Table 6.31*** and ***Figure 6.25***, activity data, emissions and their trends are displayed. Emissions of NH_3 decreased substantially in the year 1996, and from 1998 to 2004 due to stricter regulation of wastewater discharged to watercourses[27]

Figure 6.25: *NMVOC emission trend in the category Industrial wastewater handling*



6.8.2.2 Methodological issues

Amount of industrial wastewater discharged to watercourses was used as the activity data to estimate emissions of NMVO. Tier 2 emission factor for industrial wastewater handling from EMEP/EEA GB_{2016} was used and its value is **15mg/m³**.

6.8.2.3 Completeness

NH_3 and PMs are reported as NE due to change of approach used to calculate emissions and absence of emission factors in EMEP/EEA GB_{2016}. Notation key for BC was changed in comply with EMEP/EEA GB_{2016}.

6.8.2.4 Source specific recalculations

Due change of the methodology used to report measured emissions, recalculations were provided in whole time series (***Table 6.32***).

[27] https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2002/184/vyhlasene_znenie.html
https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2004/364/

Table 6.32: *Previous and refined emissions in the category Industrial wastewater handling*

YEAR	NH_3 [kt]		
	PREVIOUS	REVISED	CHANGE [%]
1990	0.0107	0.0046	-57%
1991	0.0102	0.0045	-56%
1992	0.0097	0.0044	-55%
1993	0.0093	0.0044	-53%
1994	0.0085	0.0043	-50%
1995	0.0077	0.0047	-39%
1996	0.0064	0.0035	-45%
1997	0.0061	0.0047	-22%
1998	0.0061	0.0046	-24%
1999	0.0058	0.0042	-28%
2000	0.0029	0.0038	30%
2001	0.0025	0.0035	40%
2002	0.0039	0.0036	-8%
2003	0.0050	0.0034	-32%
2004	0.0038	0.0029	-23%
2005	0.0036	0.0034	-5%
2006	0.0047	0.0035	-24%
2007	0.0048	0.0033	-33%
2008	0.0027	0.0032	19%
2009	0.0029	0.0031	9%
2010	0.0029	0.0035	19%
2011	0.0026	0.0030	15%
2012	0.0028	0.0029	1%
2013	0.0029	0.0030	3%
2014	0.0028	0.0028	3%
2015	0.0032	0.0028	-11%
2016	0.0072	0.0028	-61%

6.8.3 OTHER WASTEWATER HANDLING (NFR 5D3)

6.8.3.1 Overview of the category

This activity is not occurring in the Slovak Republic, therefore notation key NO was used. In the previous submission, emissions from using dry toilets were reported in this category. These emissions were moved to the category 5D1 according to allocation in EMEP/EEA GB_{2016}.

6.9 OTHER WASTE (NFR 5E)

6.9.1 OVERVIEW OF THE CATEGORY

This chapter covers emissions from:

- Car fires
- Detached house fires
- Industrial building fires
- Apartment building fires

In ***Table 6.33*** and ***Table 6.34*** overview of statistical activity data and emission trends are displayed.

***Table 6.33**: Overview of the activity data in the category Other waste*

YEAR	CAR FIRE [NO. OF FIRES]	DETACHED HOUSES [NO. OF FIRES]	APARTMENT BUILDINGS [NO. OF FIRES]	INDUSTRIAL BUILDINGS [NO. OF FIRES]
1990	612	102	719	594
1995	644	107	757	626
2000	587	97	592	960
2005	660	98	764	706
2010	837	139	989	615
2011	784	125	1 119	603
2012	785	159	1 098	561
2013	822	128	1 061	519
2014	772	152	915	494
2015	822	135	1 094	514
2016	812	122	1 139	496
2017	814	119	1 197	521

***Table 6.34:** Overview of emissions in the category Other waste*

	$PM_{2.5}$ [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
1990/2017	**47%**	**47%**	**47%**	**46%**	**47%**	**47%**	**47%**	**47%**	**47%**	**46%**
2016/2017	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**

6.9.2 METHODOLOGICAL ISSUES

Activity data were obtained from the fire statistics provided by Fire Appraisal Institute of the Ministry of Interior (***Table 6.33***). Emissions from fires were calculated multiplying of activity data (number of fires) with emission factor from EMEP/EEA GB_{2016} (***Table 6.35***). Historical data (1990-1998) were extrapolated.

***Table 6.35:** Emission factors for calculation of emissions in category Other waste*

POLLUTANT	TSP,PMs	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

6.9.3 COMPLETENESS

All rising pollutants were recorded and reported.

6.9.4 SOURCE SPECIFIC RECALCULATIONS

No recalculations in this submission.

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CHAPTER 7: OTHER AND NATURAL EMISSIONS (NFR 6, NFR 11)

7.1 OTHER SOURCES (NFR 6A)

7.1.1 OVERVIEW OF THE CATEGORY

No other activities are 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.

Main reasons of forest fires are negligence and underestimation of risk, pyromania (a disease tendency to armpit) and attempt to benefit financially on 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 practiced in order 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 [28]

Forest fires are important sources of large number of particulates and trace gases are 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	0.256	0.116	0.009	0.010	1.096	1.340	2.070	0.099	9.119
1995	0.179	0.035	0.003	0.003	0.816	0.998	1.542	0.073	6.375
2000	0.625	0.464	0.035	0.040	2.294	2.803	4.332	0.206	22.302
2005	0.609	0.264	0.020	0.023	2.500	3.055	4.722	0.225	21.729
2010	0.465	0.096	0.007	0.008	2.075	2.536	3.919	0.187	16.574
2011	0.557	0.201	0.015	0.017	2.328	2.845	4.397	0.210	19.874
2012	1.063	0.842	0.064	0.072	3.587	4.384	6.775	0.323	37.931
2013	0.352	0.135	0.010	0.012	1.451	1.773	2.741	0.131	12.554
2014	0.524	0.096	0.007	0.008	2.357	2.881	4.452	0.212	18.692

[28] 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]
2015	0.588	0.176	0.013	0.015	2.516	3.075	4.752	0.226	20.977
2016	0.487	0.087	0.007	0.008	2.190	2.676	4.136	0.197	17.352
2017	0.541	0.149	0.011	0.013	2.336	2.855	4.412	0.210	19.283

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	0.609	0.037	0.049	0.021	0.014	0.120	0.011	0.073
1995	0.454	0.027	0.036	0.015	0.010	0.089	0.008	0.054
2000	1.274	0.076	0.102	0.043	0.029	0.251	0.022	0.153
2005	1.389	0.083	0.111	0.047	0.032	0.274	0.024	0.167
2010	1.153	0.069	0.092	0.039	0.027	0.227	0.020	0.138
2011	1.293	0.078	0.103	0.044	0.030	0.255	0.023	0.155
2012	1.993	0.120	0.159	0.068	0.046	0.393	0.035	0.239
2013	0.806	0.048	0.064	0.027	0.019	0.159	0.014	0.097
2014	1.309	0.079	0.105	0.045	0.030	0.258	0.023	0.157
2015	1.398	0.084	0.112	0.048	0.032	0.275	0.025	0.168
2016	1.216	0.073	0.097	0.041	0.028	0.240	0.021	0.146
2017	1.298	0.078	0.104	0.044	0.030	0.256	0.023	0.156

7.3.2 METHODOLOGICAL ISSUES

Slovak National Forest Centre provided activity data about wood burned (forest wildfires and controlled forest fires in Slovakia) and 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. There is an inconsistency in calculation of emissions because in the case of PMs, the total amount of burned wood (wildfires and controlled fires) was used, but the data on the affected area is known only for wildfires, so other pollutants were calculated using this information as activity data. Activity data for the period 1990-2001 were changed in comparison with last submission due to consistency with GHGs inventory. Tier 2 emissions factors for temperate forests from EMEP/EEA GB_{2016} 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 $IPCC_{2006}$ Guidebook, ***Chapter 2.4: Non-CO_2 Emissions*** [6]. POPs were calculated using country specific emission factors (Most, et al, 1992). ***Table 7.3*** shows emission factors used to estimate emissions in this category. Emissions of NMVOC, NH_3, SOx, $PM_{2,5}$, PM_{10}, TSP and BC were reported for the first time.

Table 7.2*: Activity data used in the category 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	927.25	134.10	120.76	254.85
2005	527.96	81.92	195.83	277.75
2010	191.96	31.64	198.87	230.51
2011	402.55	66.98	191.69	258.67
2012	1 683.46	283.61	114.95	398.55
2013	270.26	45.88	115.35	161.22
2014	191.73	32.56	229.33	261.89
2015	352.57	60.08	219.45	279.53
2016	174.88	29.94	213.36	243.29
2017	297.66	51.03	208.49	259.52

Table 7.3: Emission factors in the category 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 last submission.

7.3.5 SOURCE SPECIFIC RECALCULATIONS

Emissions in this category were recalculated due to change in activity data and higher tier methodology. ***Table 7.4*** show change in emissions compared to last submission.

Table 7.4: *Previous and refined NOx, CO, SOx, NMVOC and NH_3 emissions in the category Forest fires*

YEAR	NOx [kt[			NMVOC [kt]			SOx [kt]			NH_3 [kt]			CO [kt]		
	P	R	%	P	R	%	P	R	%	P	R	%	P	R	%
1990	0.039	0.256	562%	0.116	0.116	0%	0.008	0.009	14%	0.008	0.009	14%	1.158	9.119	687%
1991	0.016	0.211	1213%	0.048	0.104	115%	0.003	0.008	145%	0.003	0.008	145%	0.483	7.539	1461%
1992	0.041	0.293	608%	0.124	0.237	91%	0.008	0.018	118%	0.008	0.018	118%	1.242	10.448	741%
1993	0.074	0.547	643%	0.221	0.577	161%	0.015	0.044	198%	0.015	0.044	198%	2.211	19.517	783%
1994	0.041	0.149	268%	0.122	0.019	-84%	0.008	0.001	-82%	0.008	0.001	-82%	1.217	5.326	338%
1995	0.029	0.179	512%	0.088	0.035	-60%	0.006	0.003	-54%	0.006	0.003	-54%	0.876	6.375	627%
1996	0.073	0.248	241%	0.218	0.108	-51%	0.015	0.008	-44%	0.015	0.008	-44%	2.183	8.856	306%
1997	0.062	0.194	211%	0.187	0.018	-91%	0.012	0.001	-89%	0.012	0.001	-89%	1.867	6.907	270%
1998	0.114	0.190	67%	0.342	0.016	-95%	0.023	0.001	-95%	0.023	0.001	-95%	3.419	6.777	98%
1999	0.056	1.238	2123%	0.167	1.248	647%	0.011	0.095	752%	0.011	0.095	752%	1.671	44.167	2543%
2000	0.090	0.625	592%	0.271	0.464	71%	0.018	0.035	95%	0.018	0.035	95%	2.712	22.302	722%
2001	0.031	0.291	853%	0.092	0.080	-13%	0.006	0.006	-1%	0.006	0.006	-1%	0.915	10.371	1033%
2002	0.060	0.486	717%	0.179	0.298	67%	0.012	0.023	90%	0.012	0.023	90%	1.785	17.330	871%
2003	0.157	0.947	504%	0.470	0.784	67%	0.031	0.060	90%	0.031	0.060	90%	4.701	33.768	618%
2004	0.015	0.329	2094%	0.045	0.069	54%	0.003	0.005	76%	0.003	0.005	76%	0.450	11.737	2508%
2005	0.053	0.609	1054%	0.158	0.264	67%	0.011	0.020	90%	0.011	0.020	90%	1.584	21.729	1272%
2006	0.018	0.385	2063%	0.053	0.089	67%	0.004	0.007	90%	0.004	0.007	90%	0.534	13.733	2472%
2007	0.068	0.633	831%	0.204	0.340	67%	0.014	0.026	90%	0.014	0.026	90%	2.040	22.583	1007%
2008	0.012	0.398	3219%	0.036	0.059	64%	0.002	0.004	87%	0.002	0.004	87%	0.360	14.203	3845%
2009	0.051	0.587	1051%	0.153	0.255	67%	0.010	0.019	90%	0.010	0.019	90%	1.530	20.937	1268%
2010	0.019	0.465	2326%	0.057	0.096	67%	0.004	0.007	90%	0.004	0.007	90%	0.575	16.574	2785%
2011	0.040	0.557	1284%	0.121	0.201	67%	0.008	0.015	90%	0.008	0.015	90%	1.208	19.874	1546%
2012	0.168	1.063	532%	0.505	0.842	67%	0.034	0.064	90%	0.034	0.064	90%	5.051	37.931	651%
2013	0.027	0.352	1202%	0.081	0.135	67%	0.005	0.010	90%	0.005	0.010	90%	0.811	12.554	1448%
2014	0.019	0.524	2633%	0.058	0.096	67%	0.004	0.007	90%	0.004	0.007	90%	0.575	18.692	3150%
2015	0.035	0.588	1568%	0.106	0.176	67%	0.007	0.013	90%	0.007	0.013	90%	1.058	20.977	1883%
2016	0.017	0.487	2682%	0.052	0.087	67%	0.003	0.007	90%	0.003	0.007	90%	0.525	17.352	3207%

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

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.

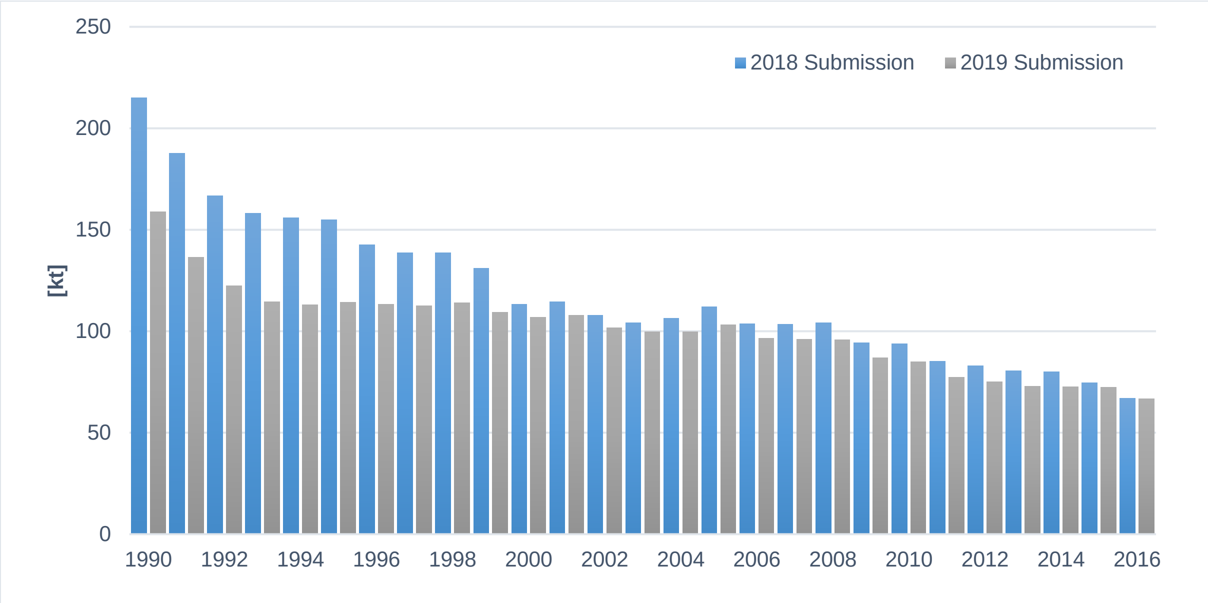
8.1.1 NOx (as NO_2)

Impact of recalculations on NOx emission total in this submission is shown in the ***Figure 8.1***.

The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Net calorific values used for expression in energy units of natural gas has been harmonized in entire timelines with statistics and reference approach of GHG inventory. Propane-butane, which was appeared inconsistently as gaseous fuel as well as liquid in annual dataset in database, was harmonized to liquid fuel due to the majority of data and check with GHG inventory. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.

New methodology for residential heating caused slight decrease in emission totals.

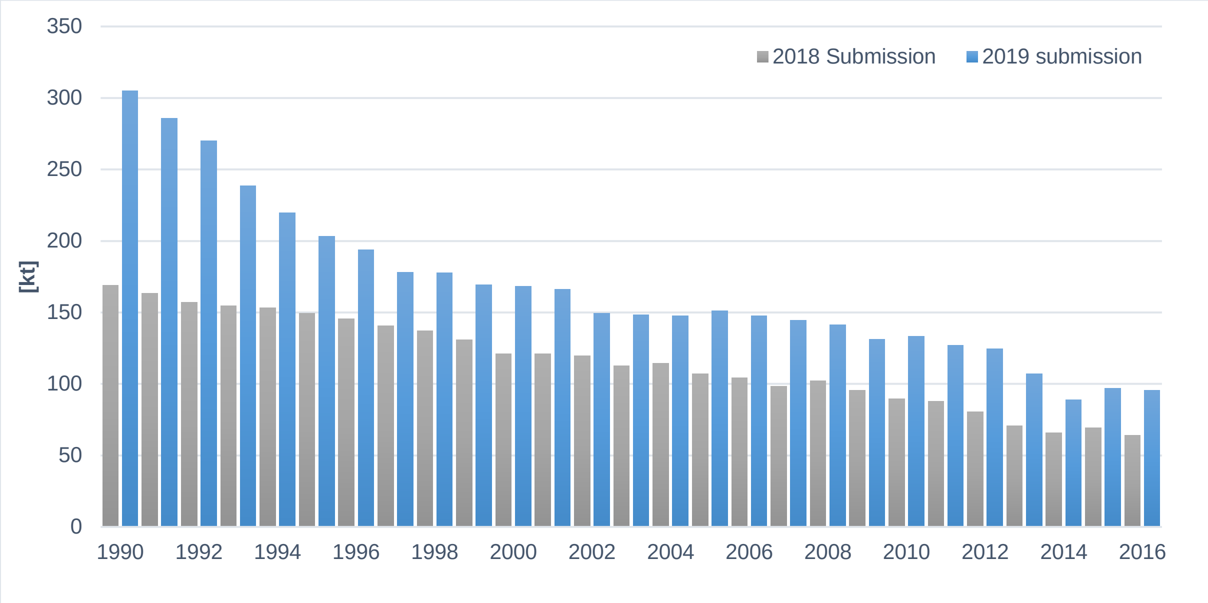
Figure 8.1: *Comparison of NOx emission total between 2018 final submission and 2019 final submission*



8.1.2 NMVOC

New methodology for residential heating (NFR 1A4bi) caused significant increase of emissions of NMVOC (***Figure 8.2***). Emissions from this category increased by 282% (2016) and according this new methodology and domestic heating produced 45% of total NMVOC emissions in 2016. In the 2016 Submission for the year 2016 it was only 17%. The methodology for households' heating is based on the principle of total energy demand (TED) per m^2 of occupied area with the implementation of aging structure of housing units linked to the energy construction standards and the implementation of climate factor. More detailed information are presented the **Chapter 3.9.3.2**.

Figure 8.2: *Comparison of NMVOC emission total between 2018 final submission and 2019 final submission*

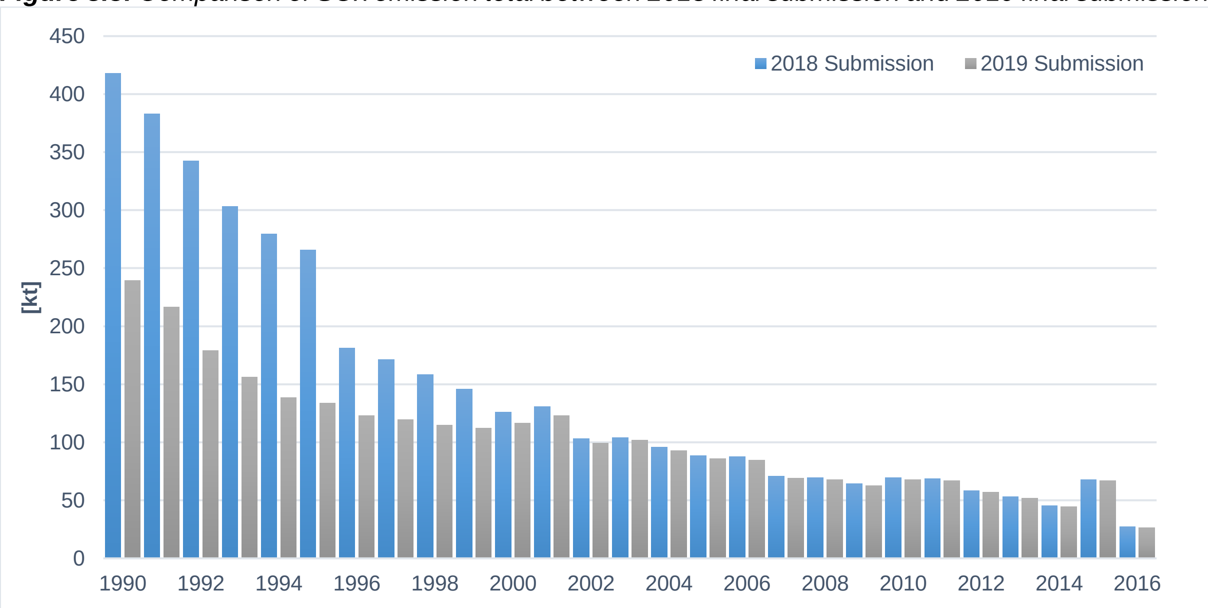


8.1.3 SOx (as SO_2)

Impact of recalculations on SOx emission total in this submission is shown in the ***Figure 8.3***.

The fuels data have been enhanced by the harmonization of NCV used for certain types of fuels. Net calorific values used for expression in energy units of natural gas has been harmonized in entire timelines with statistics and reference approach of GHG inventory. Propane-butane, which was appeared inconsistently as gaseous fuel as well as liquid in annual dataset in database, was harmonized to liquid fuel due to the majority of data and check with GHG inventory. Historical data of fuel consumption 1990-1990 were estimated with the trend of fuel consumption individual categories in relation of trends in GHG and statistics.

Figure 8.3: *Comparison of SOx emission total between 2018 final submission and 2019 final submission*

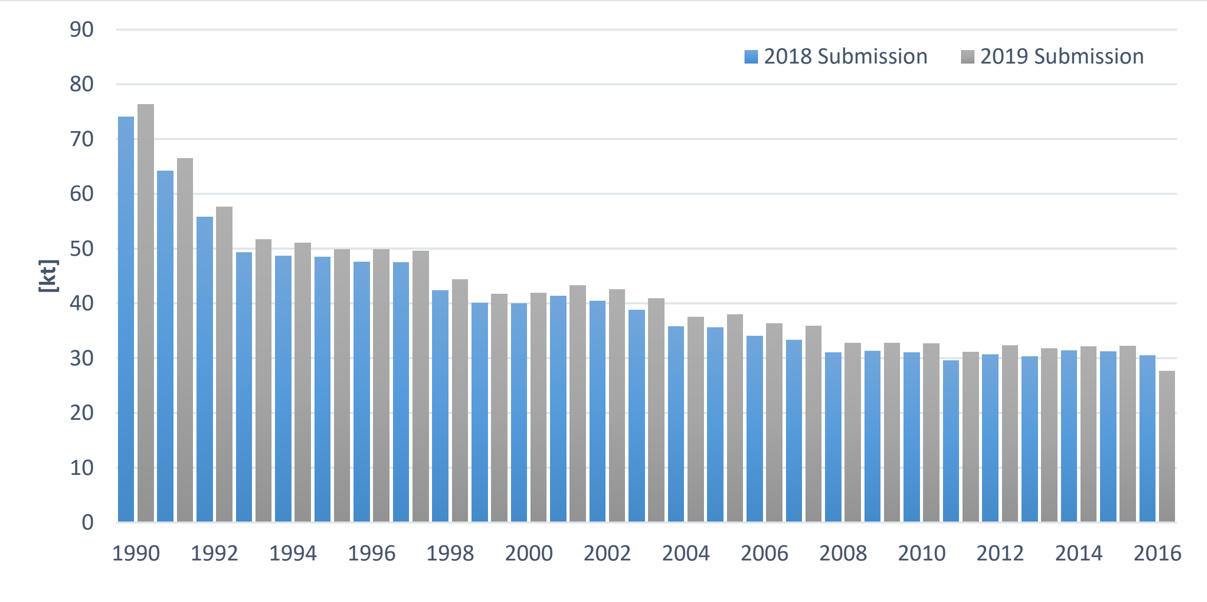


8.1.4 NH_3

Due to recalculation of the category 3B3 Manure management –Swine (implementation of higher Tier methodology nitrogen excretion rate was changed for years 1990–2017. Abatement technology efficiencies were added to the calculations in agriculture sector for the years 2016 and 2017 which caused decrease of emissions.

Also, calculation of NH_3 from residential heating was added to the national emission inventory for the first time. This action increased emissions of NH_3 in the whole time series.

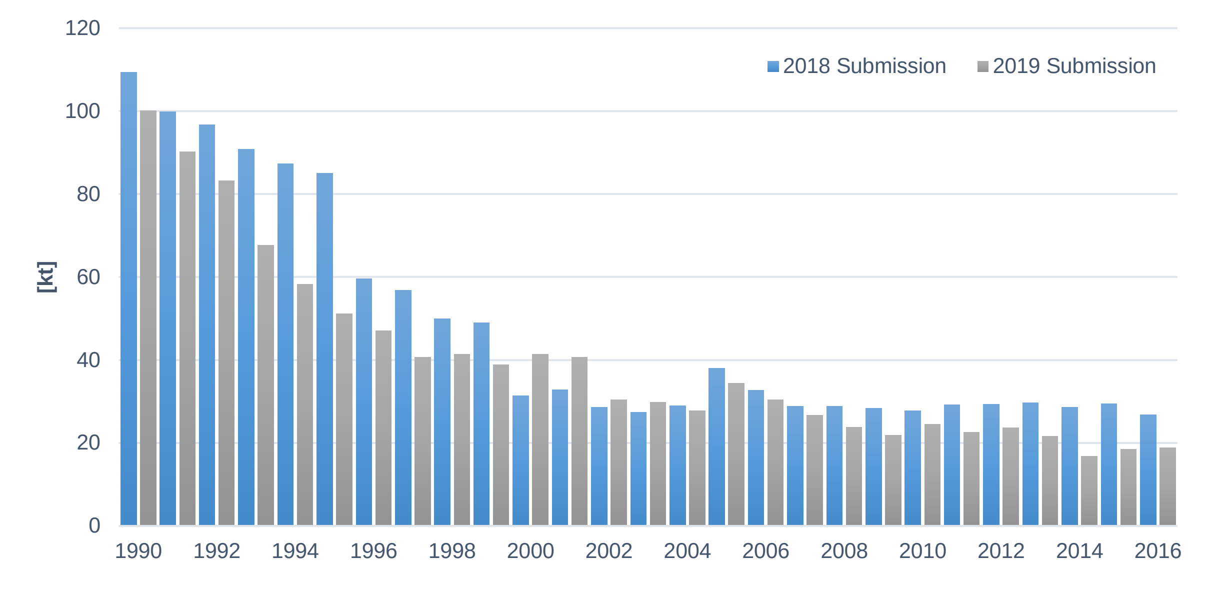
Figure 8.4: *Comparison of NH_3 emission total between 2018 final submission and 2019 final submission*



8.1.5 $PM_{2.5}$

New methodology for residential heating (NFR 1A4bi) caused major changes of emissions total of $PM_{2.5}$ (***Figure 8.5***). Emissions from this category decreased by 36% in the year 2016 and according this new methodology and domestic heating produced 78% of total $PM_{2.5}$ emissions in 2016. In the 2016 Submission for the year 2016 it was 86%. The methodology for households' heating is based on the principle of total energy demand (TED) per m² of occupied area with the implementation of aging structure of housing units linked to the energy construction standards and the implementation of climate factor. More detailed information are presented the **Chapter 3.9.3.2**.

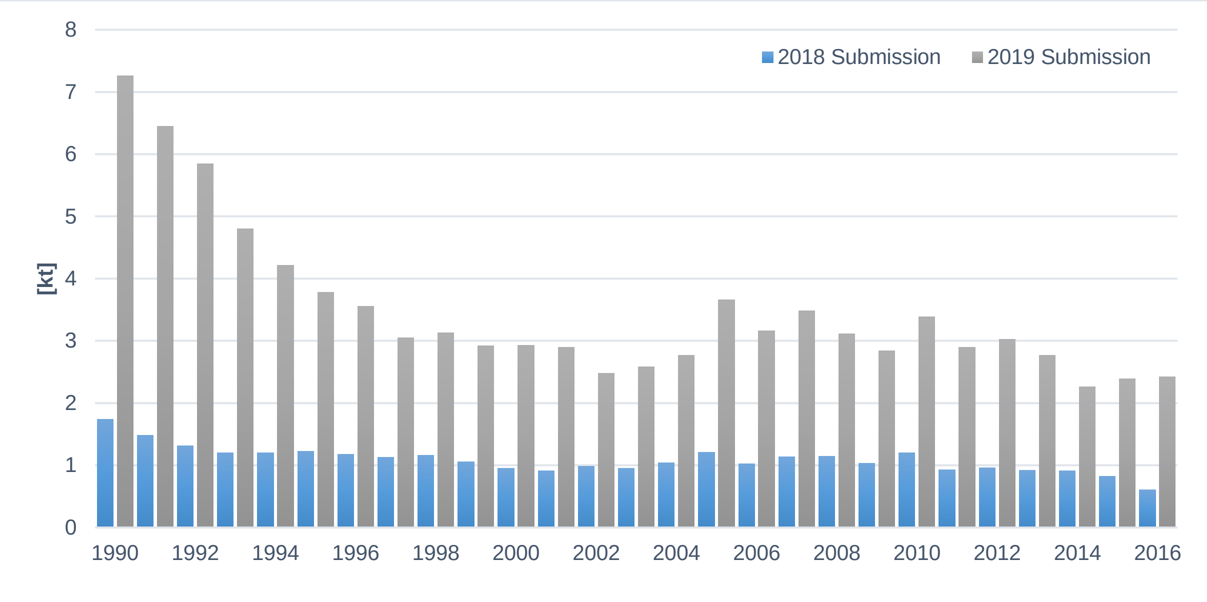
Figure 8.5: *Comparison of $PM_{2.5}$ emission total between 2018 final submission and 2019 final submission*



8.1.6 TSP, PM_{10}, BC

Changes of emission totals of PM_{10} and TSP have the same reason and trend as by $PM_{2.5}$. BC emissions were for the first time balanced within the category 1A4bi Residential: Stationary that led to significant increase of emission total of this pollutant (***Figure 8.6***).

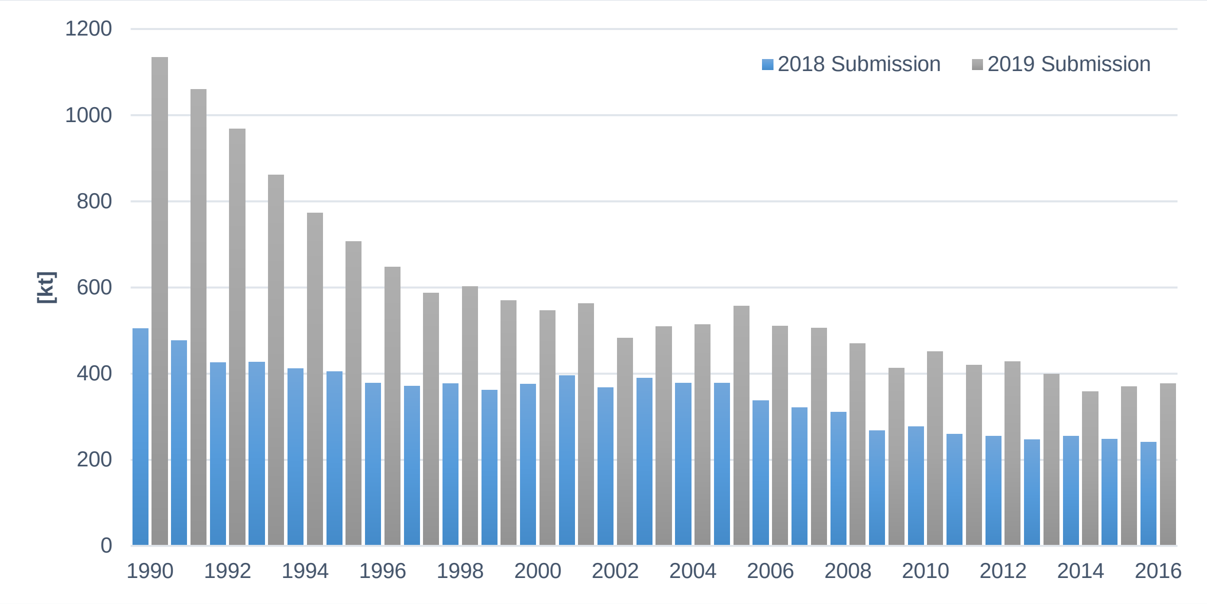
Figure 8.6: *Comparison of BC emission total between 2018 final submission and 2019 final submission*



8.1.7 CO

New methodology for residential heating (NFR 1A4bi) caused significant increase of emissions of NMVOC (***Figure 8.7***). Emissions from this category increased by 383% (2016) and according this new methodology and domestic heating produced 44% of total CO emissions in 2016. In the 2016 Submission for the year 2016 it was only 14%. The methodology for households' heating is based on the principle of total energy demand (TED) per m^2 of occupied area with the implementation of aging structure of housing units linked to the energy construction standards and the implementation of climate factor. More detailed information are presented the **Chapter 3.9.3.2**.

__Figure 8.7:__ Comparison of CO emission total between 2018 final submission and 2019 final submission



8.1.8 Priority heavy metals (Pb, Cd, Hg)

Recalculations of historical data of fuel consumption (1990-1990) led to decrease of emission totals in that period. Also, new methodology for residential heating and clinical waste incineration led to decrease of emission, especially for Cd and Hg emission totals (***Figure 8.8*** – ***Figure 8.10***).

__Figure 8.8:__ Comparison of Pb emission total between 2018 final submission and 2019 final submission

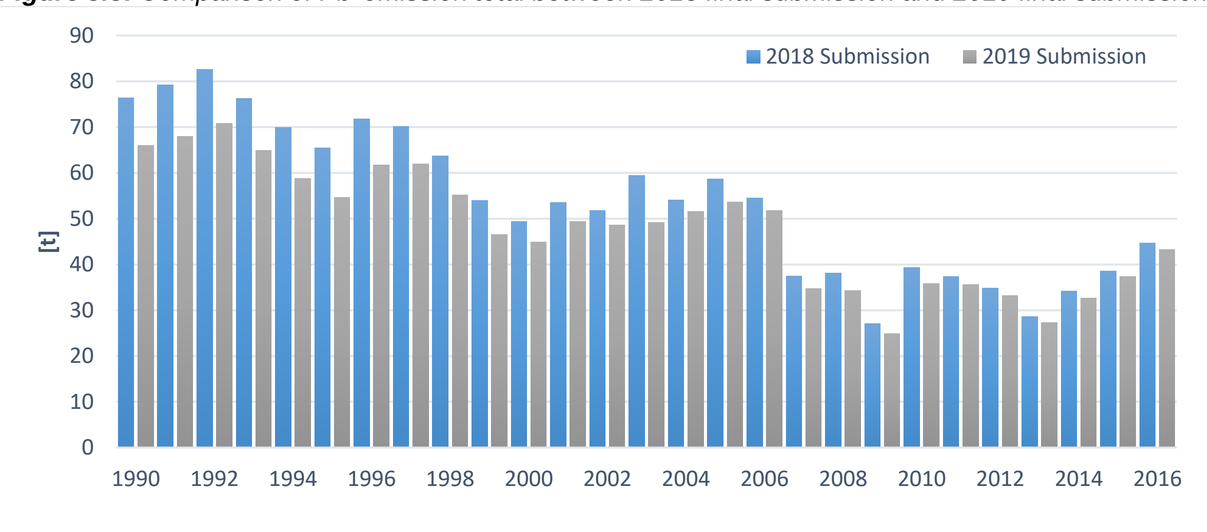


Figure 8.9: *Comparison of Cd emission total between 2018 final submission and 2019 final submission*

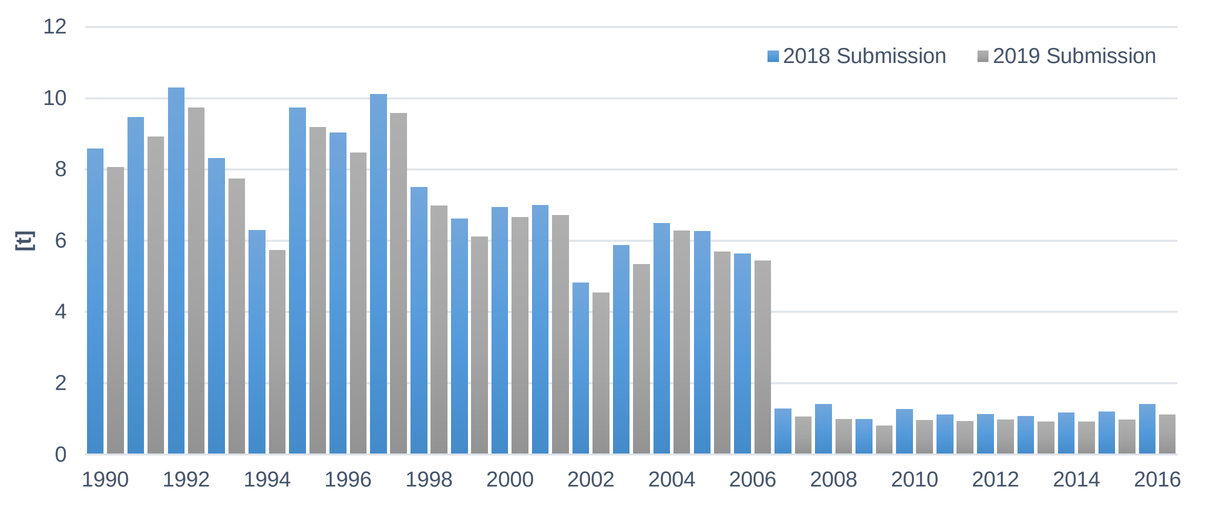
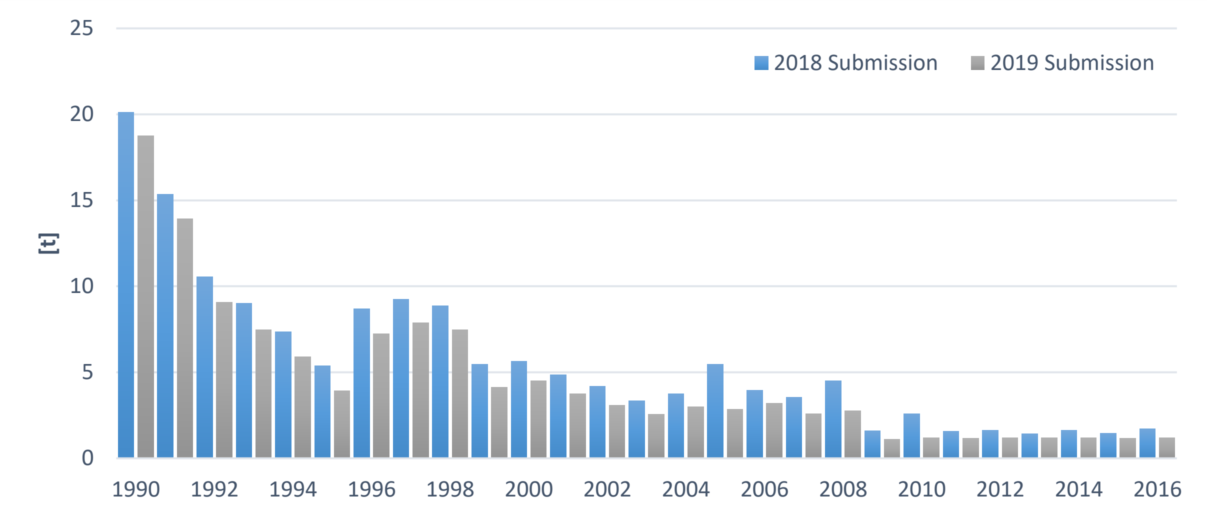


Figure 8.10: *Comparison of Hg emission total between 2018 final submission and 2019 final submission*



8.1.9 POPs

Recalculations of the category Clinical waste incineration (5C1biii) had major impact of change of emission total of DIOX between 2018 and 2019 submission. Emission totals of PAHs and PCBs were mostly impacted by recalculations and new emission factors for the category residential heating (1A4bi). Combination of both recalculations impacted emission total of HCB.

Figure 8.11: *Comparison of DIOX emission total between 2018 final submission and 2019 final submission*

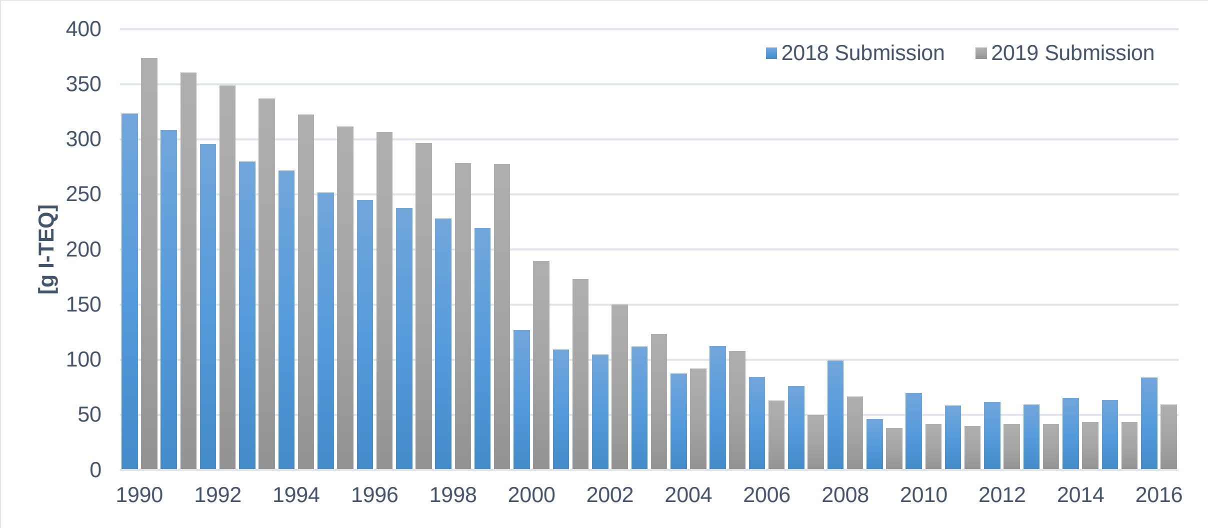


Figure 8.12: *Comparison of PAHs emission total between 2018 final submission and 2019 final submission*

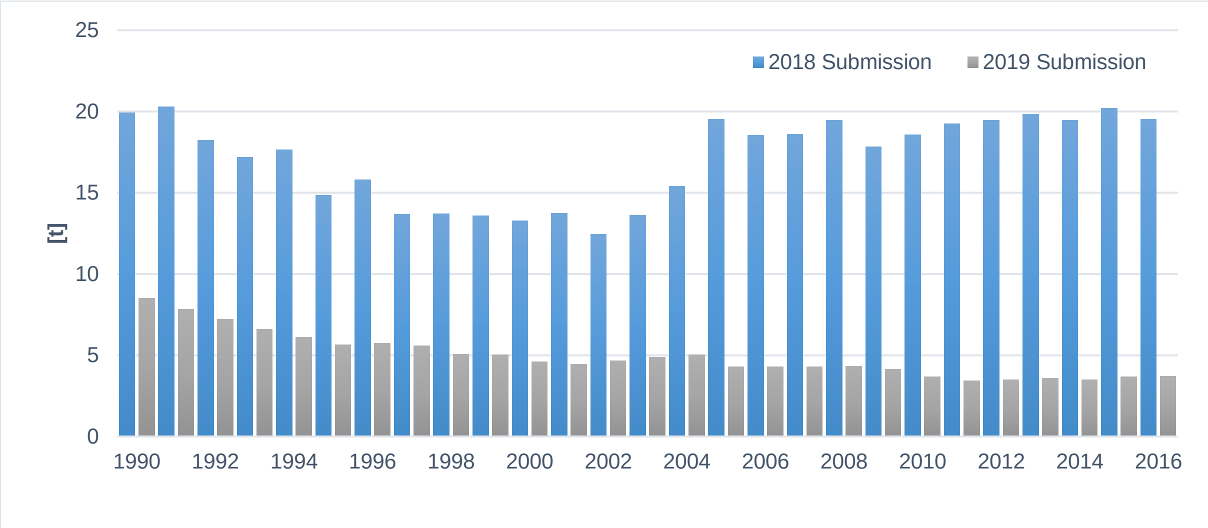


Figure 8.13: *Comparison of HCB emission total between 2018 final submission and 2019 final submission*

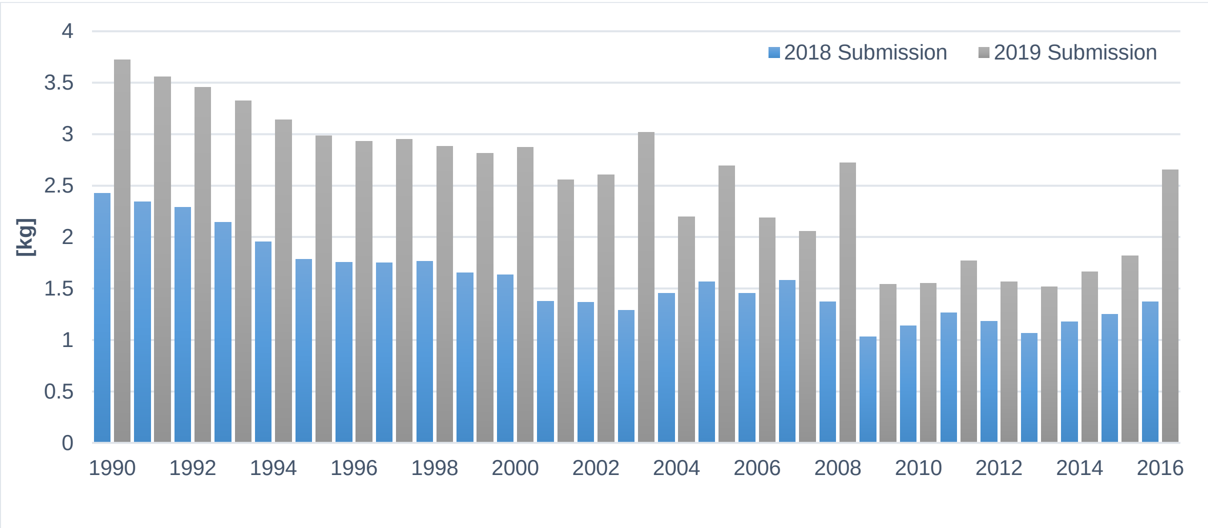
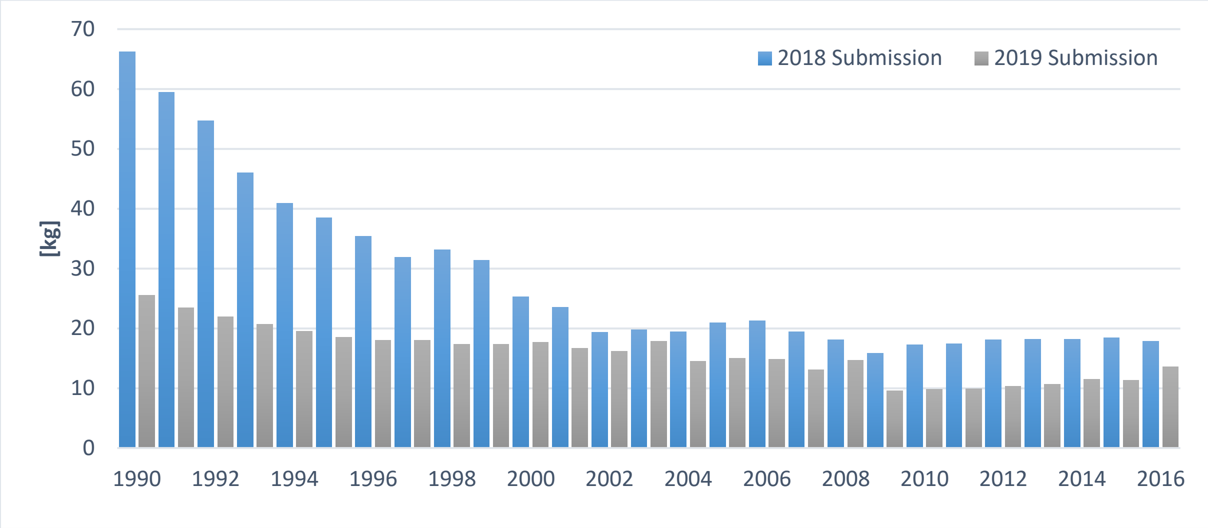


Figure 8.14: *Comparison of PCBs emission total between 2018 final submission and 2019 final submission*



8.2 RECALCULATIONS BETWEEN 1ST AND FINAL VERSION OF NATIONAL INVENTORY

There were two categories which were recalculated in the final version of the inventory:

1. Residential heating (1A4bi) was recalculated due to need of harmonization of natural gas consumption in this category. There were several inconsistencies between official statistics, GHG inventory and data obtained from gas network operator in the years 1990, 2009 and 2012-2017.

2. Industrial waste with energy recovery (allocated in 1A2gviii) was recalculated due to incorrect emission factor used for DIOX for the period 1990-1999.

These changes are shown in the ***Table 8.15*** - ***Table 8.17***.

Table 8.15: *Recalculations between 1st and final version of national inventory 2019 – main pollutants*

NOx	2019_V1	2019_V2	CHANGE %
2012	75.17	75.20	0.04%
2013	72.99	73.00	0.01%
2014	72.74	72.67	-0.09%
2015	72.32	72.37	0.08%
2016	66.60	66.70	0.15%
NMVOC	**2019_V1**	**2019_V2**	**CHANGE %**
2012	122.57	124.72	1.75%
2013	106.39	107.04	0.61%
2014	93.67	89.06	-4.92%
2015	93.04	97.09	4.35%
2016	88.54	95.48	7.85%
SOx	**2019_V1**	**2019_V2**	**CHANGE %**
2012	57.00	57.01	0.03%
2013	51.74	51.74	0.01%
2014	44.51	44.47	-0.08%
2015	66.75	66.78	0.05%
2016	26.33	26.38	0.21%

Table 8.15: *Recalculations between 1st and final version of national inventory 2019 – main pollutants - continuation*

NH_3	2019_V1	2019_V2	CHANGE %
2012	32.19	32.28	0.30%
2013	31.76	31.79	0.09%
2014	32.37	32.16	-0.63%
2015	32.04	32.22	0.56%
2016	27.37	27.68	1.13%
$PM_{2.5}$	**2019_V1**	**2019_V2**	**CHANGE %**
2012	23.00	23.70	3.08%
2013	21.42	21.63	1.00%
2014	18.26	16.74	-8.28%
2015	17.15	18.47	7.70%
2016	16.59	18.86	13.68%
PM_{10}	**2019_V1**	**2019_V2**	**CHANGE %**
2012	27.61	28.34	2.63%
2013	25.94	26.16	0.84%
2014	22.90	21.35	-6.77%
2015	21.70	23.05	6.25%
2016	21.28	23.61	10.94%
BC	**2019_V1**	**2019_V2**	**CHANGE %**
2012	2.95	3.03	2.59%
2013	2.74	2.76	0.84%
2014	2.42	2.26	-6.72%
2015	2.25	2.39	6.34%
2016	2.18	2.42	11.26%
CO	**2019_V1**	**2019_V2**	**CHANGE %**
2012	419.22	427.56	1.99%
2013	396.37	398.90	0.64%
2014	376.57	358.65	-4.76%
2015	354.46	370.23	4.45%
2016	349.68	376.79	7.75%

Table 8.16: *Recalculations between 1st and final version of national inventory 2019 – heavy metals*

Pb	2019_V1	2019_V2	CHANGE %
2012	33.18	33.20	0.06%
2013	27.33	27.34	0.02%
2014	32.69	32.65	-0.12%
2015	37.36	37.40	0.10%
2016	43.22	43.29	0.15%
Cd	**2019_V1**	**2019_V2**	**CHANGE %**
2012	0.96	0.97	0.03%
2013	0.92	0.92	0.01%
2014	0.94	0.91	-0.06%
2015	0.95	0.98	0.04%
2016	1.07	1.12	0.07%
Hg	**2019_V1**	**2019_V2**	**CHANGE %**
2012	1.18	1.18	0.04%
2013	1.18	1.18	0.01%
2014	1.22	1.20	-0.09%
2015	1.15	1.16	0.08%

2016	1.17	1.19	0.13%
As	**2019_V1**	**2019_V2**	**CHANGE %**
2012	18.92	18.92	0.02%
2013	13.11	13.11	0.01%
2014	23.51	23.51	-0.04%
2015	27.52	27.53	0.03%
2016	30.64	30.64	0.05%
Cr	**2019_V1**	**2019_V2**	**CHANGE %**
2012	4.51	4.55	0.46%
2013	4.65	4.66	0.14%
2014	4.57	4.49	-0.94%
2015	4.53	4.61	0.81%
2016	4.65	4.78	1.33%
Cu	**2019_V1**	**2019_V2**	**CHANGE %**
2012	39.38	39.39	0.03%
2013	27.00	27.00	0.01%
2014	37.01	36.98	-0.06%
2015	46.47	46.49	0.04%
2016	52.30	52.33	0.07%
Ni	**2019_V1**	**2019_V2**	**CHANGE %**
2012	11.94	11.94	0.04%
2013	12.66	12.67	0.01%
2014	13.07	13.06	-0.09%
2015	12.68	12.69	0.08%
2016	13.24	13.25	0.13%
Se	**2019_V1**	**2019_V2**	**CHANGE %**
2012	10.96	10.96	0.02%
2013	9.06	9.06	0.01%
2014	9.26	9.26	-0.04%
2015	11.47	11.47	0.03%
2016	12.33	12.34	0.05%
Zn	**2019_V1**	**2019_V2**	**CHANGE %**
2012	54.60	54.85	0.46%
2013	54.53	54.61	0.14%
2014	57.67	57.13	-0.94%
2015	59.05	59.53	0.81%
2016	62.20	63.03	1.33%

Table 8.17: *Recalculations between 1st and final version of national inventory 2019 – POPs*

PAHs	2019_V1	2019_V2	CHANGE %
2012	3.49	3.52	1.05%
2013	3.58	3.62	1.25%
2014	3.50	3.55	1.40%
2015	3.67	3.73	1.52%
2016	3.69	3.74	1.39%
2017	3.99	4.06	1.63%

Table 8.17: *Recalculations between 1st and final version of national inventory 2019 – POPs - continuation*

HCB	2019_V1	2019_V2	CHANGE %
2012	1.56	1.57	0.46%
2013	1.52	1.53	0.59%
2014	1.66	1.67	0.60%
2015	1.82	1.83	0.60%
2016	2.65	2.66	0.37%
2017	3.41	3.42	0.38%
PCBs	**2019_V1**	**2019_V2**	**CHANGE %**
2012	10.35	10.35	0.001%
2013	10.64	10.64	0.001%
2014	11.51	11.51	0.001%
2015	11.30	11.30	0.001%
2016	13.61	13.61	0.001%
2017	15.88	15.88	0.001%
DIOX	**2019_V1**	**2019_V2**	**CHANGE %**
1990	259.26	373.50	44.06%
1991	249.79	360.53	44.33%
1992	241.22	348.45	44.46%
1993	233.19	336.92	44.49%
1994	222.23	322.47	45.10%
1995	214.84	311.58	45.03%
1996	213.25	306.48	43.72%
1997	206.59	296.33	43.44%
1998	192.20	278.43	44.87%
1999	194.82	277.55	42.47%
2012	41.44	41.58	0.35%
2013	41.70	41.88	0.43%
2014	43.12	43.32	0.46%
2015	43.36	43.58	0.51%
2016	59.39	59.59	0.33%

CHAPTER 9: PROJECTIONS OF EMISSIONS

The complexity and dynamic changes of the economic development in recent years have significantly complicated the preparation of projections of air pollutant emissions, particularly with respect to continual changes of estimated development of macro-economic indicators for the near future. Comprehensiveness is very important part of projections calculation and therefore a joint GHG and air pollutant emission projections was used. The modelling of emission projections was provided in consistency with the GHG emission projections reported on 15th March 2017 under the regulation (EU) No 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and also in consistency with the 7. National communication of the Slovak republic on climate Change under the UNFCCC and Kyoto protocol. Actualized emissions projections for base scenario with measures was prepared for purpose of national air pollution control programmes.

The year 2016 was determined as the base year for modelling of emissions projections for actualized scenario for which verified data sets were available from the national emission inventory. Actualization was based on changes of key parameters in the most emission intensive categories. Changes were driven by the new data from the new energy model (CPS – Compact Primes for Slovakia), which came from the study of low carbon development by the Ministry of Environment of the Slovak Republic in cooperation with the World Bank and E3modelling. Important changes were also applied on 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	5 489	5 501	5 492	5 467	5 449
EU ETS carbon price	EUR/EUA	7.5	15.0	22.5	33.5	42.0	50.0
International coal import prices	EUR/MWh	7.2	8.9	10.7	12.8	13.5	14.1
International oil import prices	EUR/MWh	30.0	46.8	53.1	58.5	61.0	64.6
International gas import prices	EUR/MWh	24.2	29.5	32.1	35.2	37.8	39.1

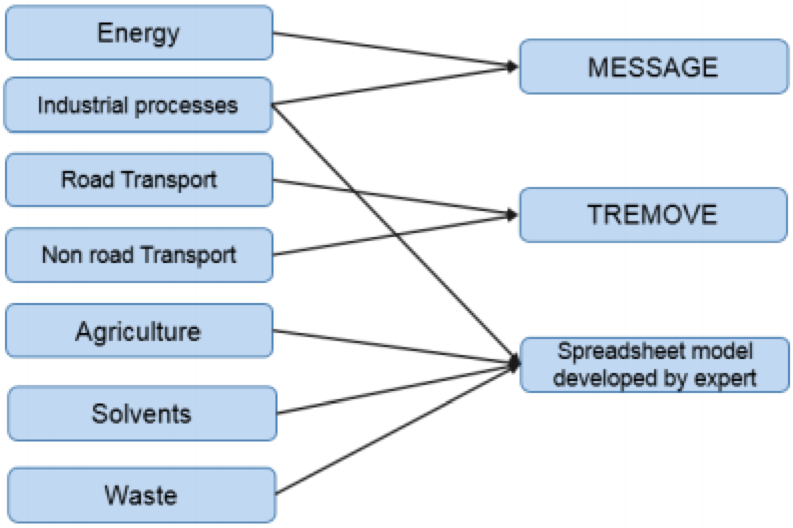
Even use of wide range of input data and improvement of methodological approach at activity projection in relevant sectors, the results are influenced by the uncertainties of future development, preferably in the case of the macro-economic data and elasticity of the final energy consumption. These uncertainties 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 energy sector will be influenced by the main pollutant and GHG emission caps in new EU ETS regime. The important role plays the decision 406/2009/EC on effort sharing in the sectors not included to the emission trading.

9.1 TOOLS AND METHODS

General approach in emissions projections calculation is based on the use of the same methodology as in the emission inventory with projected parameters. Data from the new CPS model was used for some projected parameters and indicators due to lack of national information for the future trends

The emission modelling was prepared by software MESSAGE (energy + industry)[1],[2] software TREMOVE (transport)[3],[4] as well as the specific calculations in MS EXCEL environment (agriculture, waste, industry). As you can see in ***Figure 9.1***. The air protection legislation was implemented directly into the both models, considering existing and future requirements on the emission concentration limits.

Figure 9.1*: Models and tools used in individual sectors*



MESSAGE is an optimization model with linear programming. The program seeks an optimal solution for a selected period. The model is flexible and allows seeking a minimum optimal function for whatever parameters (not only energy systems). The mathematical description is complex. The optimization function seeks minimum costs to meet demands for the final consumption supply from primary and imported energy sources. The model also allows inserting certain constraints that simulate regulation of the system based upon the source limits, price regulation, and emission impact. The electricity network creates an integrated part and curves of load could be adjusted for individual periods. It also supports modelling of combined electricity and heat production

TREMOVE is the transport and emission simulation model developed for the European Commission designed to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates transport demand, the modal split, vehicle fleets, vehicle stock renewal, the emission of air pollutants and the welfare level under different policy scenarios. All relevant transport modes are modelled, including aviation.

9.2 KEY CHANGES IN ACTUALIZED PROJECTIONS

Residential heating – Probably most crucial sector cover most of $PM_{2.5}$ emissions and considerable amount of NOx and NMVOC emissions. Based on the new information from questionnaire survey, datasets were improved and on this base estimations of natural improvement in structure of households heating equipment were implemented. In this scenario was not included any measure which would force equipment changes. Change rate was extrapolated on based of the historical data collected by the survey.

[1] http://www.iiasa.ac.at/web/home/research/researchPrograms/Energy/MESSAGE.en.html
[2] Energy supply model MESSAGE. https://pure.iiasa.ac.at/1542/
[3] https://www.tmleuven.be/en/navigation/TREMOVE
[4] http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/976840315_slovakia-nc7-1-7nc_svk.pdf

Energy efficiency – New action plan of energy efficiency was taken in place in 2017 – 4th Action plan of energy efficiency for the years 2017-2019 with outlook to 2020. This action plan replaced 3rd action plan which was less ambitious.

Transport – Actualization based on new consumption data from CPS model.

Industry – Changes in industry was driven by new estimated sectoral demand from CPS and based on information from producers. Many emission reduction measures have been in place since recent years, so these measures cannot bring further savings. Considerable improvement is expected in production of chemicals and iron and steel.

Energy – Actualization was similar as in industry sector. However, there is significant decrease of emission caused by planned measures by key producers.

Agriculture – Key sector in case of NH_3 emissions. New estimations of future livestock numbers and fertilizers use were obtained in cooperation with Research Institute of Agriculture and Food Economics. Based on the new information from National Emission Information System, existing measures for biggest agricultural producers were applied to the calculations.

9.3 POLICIES AND MEASURES

Projections of air pollutant emissions were prepared for the years 2015-2030 within the following scenarios:

With measures scenario (WEM) – projections reflect all measures implemented or adopted before the date of preparation of the projections (31 August 2018).

With additional measures scenario (WAM) – projections include WEM policies and measures and all other measures planned for 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 Efficiency Action Plan for the period 2017-2019 with the outlook for 2020: Energy efficiency improvement and reducing the energy consumption of the industrial sector. Improving the thermal performance of buildings - family houses, residential buildings, office buildings, hotels and restaurants, public buildings. Table below shows effect of energy savings (MWyr) in chosen categories.

***Table 9.2**: Energy savings according Energy Efficiency Action Plan*

AP EE - ENERGY SAVED (MWYR)		2015	2016	2017	2018	2019	2020	2025	2030
1A1a	Public electricity and heat production	95.92	191.83	260.93	330.04	399.14	468.24	468.24	468.24
1A4a	Commercial/institutional: Stationary	34.97	69.94	96.21	122.48	148.75	175.02	175.02	175.02
1A4b	Residential: Stationary	14.93	29.85	41.43	53.01	64.58	76.16	76.16	76.16

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.

Emission trading, the new allocation: The ETS stimulates 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 pollutant for particular combustion plants.

Assessment of the future structure of appliances used for household heating: Based on the data from Statistical survey

Hybrid transport in cities: Buying low floor hybrid buses in selected cities

Modal shift to public transport: The measure consists of the implementation of specific projects to modernisation public transportation. Free travel for students and citizens of retirement age.

Transport Policy of the Slovak Republic into 2015: Energy savings are achieved by reducing fuel consumption by users of the road infrastructure in the new technically superior infrastructure in comparison with the original technically outdated road infrastructure. Ensure speedy completion of the motorway network included in the TEN-T routes

Government Regulation of the Slovak Republic No. 246/2006 Coll. on the minimum quantity of fuels produced from renewable sources in the petrol and diesel fuels placed on the market in the Slovak Republic: Continuously increasing of the share of bioethanol and biodiesel blended with gasoline and diesel. It is planned to increase the use of CNG - filling station infrastructure support.

Strategy of Development of Electromobility

Use of BAT level technologies in Industry

The Rural Development Programme for the period of 2014–2020: The programme will increase the competitiveness of agriculture and forestry. It will ensure appropriate management of natural resources and encourage farming practices which are climate-friendly.

Conception of the Agricultural Development of the Slovak Republic for the years 2013–2020: The concept of agricultural development plans an increase in animal numbers for the years 2013-2020.

Manure management and New manure management - Laying down the rules for the granting of agricultural aid in respect to the direct payments schemes: Measures in manure manipulation and processing in enteric fermentation. Measures to implement better technologies of manure manipulation and processing in enteric fermentation.

Agricultural soils - laying down the rules for the granting of agricultural aid in respect to the direct payments schemes: Efficient use and appropriate timing of nitrogen inputs from mineral fertilizers.

Act on waste introduces emphasis on the separation of packaging's and recyclables

Waste Management Program of the Slovak Republic for 2011–2015

Strategy on the Reduction of the Biodegradable Waste Deposition to Landfills

Measures in WAM scenario was proposed in close cooperation with the World Bank team, who helps with next steps to increase air quality in Slovakia. Measures are focused on transport, residential and agricultural sectors. List of proposed measures:

Replacement of old diesel vehicles – Subsiding of new vehicles sales, decreasing numbers of old vehicles.

Introducing subsidies for alternatively-fuelled vehicles - replacement of an average 2016 diesel vehicle (a weighted average of diesels in the fleet in 2016) with either a battery electric, or with a plug-in hybrid electric vehicle.

Setting stricter requirements for periodical technical controls – Stricter check on NOx emissions during the vehicle inspection.

Frequency of technical controls of vehicles older than 8 years to be raised from current once every two years to once a year.

Roadside emission controls – raising frequency of controls.

Unification of tax rate for petrol and diesel over a period of 5 years.

Incentives for replacement of unsuitable boilers: subsidy scheme - The program is based on replacing high emissions boilers by new ones that are more energy efficient.

Introduction of differentiated registration fees for different categories of devices – promotion of more environmentally friendly devices.

Connect households using wood or coal to natural gas - The policy under consideration is one where households currently using old stoves will be required by law to connect to a gas network but with a subsidy provided for doing so.

Fuel standards - mandating the use of wood that has a moisture content of less than 25%.

Introduction a "control system" (based on the Czech model) – each household that uses solid fuel would have an obligation to have their device regularly inspected.

Awareness raising campaigns and education.

Manure storage and application to soil - Currently, the legislative requirements related to the reduction of ammonia emissions from agricultural activities only apply to large farms. The aim of the measure is to extend the obligation to comply with the requirements related to ammonia emission reduction to all medium sized farms.

9.4 GENERAL RESULTS AND COMMITMENTS

Actualization of the emission projection led to some changes in comparison with previous reported projections. In table below are presented national totals of air pollutant emissions and 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***
NO_X	103.30	72.32	62.00	60.78	60.68	*66.11*	*51.65*
NMVOC	151.17	93.04	87.27	81.83	76.34	*123.96*	*102.79*
SO_X	86.00	66.75	22.27	20.20	19.87	*36.98*	*15.48*
NH_3	37.94	32.04	25.30	25.18	25.41	*32.25*	*26.56*
$PM_{2.5}$	34.35	17.15	17.23	16.07	15.05	*21.98*	*17.52*

Table 9.4*: WAM scenario emission projection trends and targets*

TOTAL EMISSIONS OF SLOVAKIA (kt)	**2005**	**2015**	**2020**	**2025**	**2030**	***TARGET 2020***	***TARGET 2030***
NO_X	103.30	72.32	62.00	60.78	60.68	*66.11*	*51.65*
NMVOC	151.17	93.04	55.89	51.07	50.48	*123.96*	*102.79*
SO_X	86.00	66.75	22.02	17.07	16.75	*36.98*	*15.48*
NH_3	37.94	32.04	24.56	24.47	24.70	*32.25*	*26.56*
$PM_{2.5}$	34.35	17.15	16.57	14.63	12.93	*21.98*	*17.52*

Figure 9.2*: Emission projections trends for main pollutants*

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ANNEXES

ANNEX I: KEY CATEGORY ANALYSIS

Table A1.1: *Level assessment of the key categories analysis of air pollutants in the Slovak Republic in 2017 (cumulative total at least 80%)*

NOx	1A3biii (17%)	1A3bi (15%)	3Da1 (7%)	1A1a (6%)	1A3bii (6%)	1A4bi (5%)	2C1 (5%)	2A1 (5%)	1A4ai (4%)	1A4cii (4%)	1A2a (3%)	1A1b (2%)	1A3c (2%)
SOx	1A1a (32%)	2C1 (23%)	2C7c (12%)	1A4bi (6%)	1A2a (6%)	2B10a (5%)							
NH_3	3Da2a (37%)	3Da1 (23%)	3B4gi (8%)	1A4bi (5%)	3B4gii (5%)	3B3 (5%)							
NMVOC	1A4bi (45%)	2D3d (12%)	2D3a (7%)	1B1a (6%)	2D3e (3%)	1A3bi (3%)	1A4ai (2%)						
PM_{10}	1A4bi (64%)	3Dc (8%)	2A5b (3%)	1A3bvi (3%)	1A3bi (2%)	2C1 (2%)							
$PM_{2.5}$	1A4bi (78%)	1A3bi (2%)											
BC	1A3bi (60%)	1A3bi (15%)	1A3bii (7%)										
CO	1A4bi (43%)	2C1 (28%)	1A3bi (7%)	1A4cii (6%)									
Pb	2C7a (38%)	1A2a (30%)	2A3 (17%)										
Cd	1A2a (24%)	2C7a (22%)	1A4bi (17%)	1A4ai (9%)	1A2gviii (8%)								
Hg	1A2a (50%)	1A4bi (12%)	1A1a (5%)	2K (4%)	2B10a (4%)	2A1 (4%)	1A2gviii (4%)						
As	2C7a (96%)												
Cr	1A2a (27%)	2A3 (17%)	1A4bi (14%)	2C7c (12%)	1A3bvi (6%)	1B1b (5%)							
Cu	2C7a (77%)	1A3bvi (14%)											
Ni	1A2a (34%)	2C7c (24%)	2C1 (13%)	2C3 (13%)									
Se	2A3 (53%)	2C7a (37%)											
Zn	1A2a (17%)	2C7a (13%)	2D3i (12%)	2C7c (12%)	2C1 (7%)	1A4ai (7%)	1A4bi (6%)	2A3 (6%)					
DIOX	1A2gviii (54%)	1A2a (16%)	2C1 (6%)	1B1b (6%)									
PAHs	1B1b (40%)	2C3 (31%)	1A1b (8%)	1A2e (3%)									
HCB	1A2gviii (54%)	1A2b (20%)	5C1biii (8%)										
PCB	1A2gviii (36%)	1A2a (32%)	2C2 (12%)										

Note: Different colours used to highlight sectors - 1, 2, 3, 5

Table A1.2: *Trend assessment of the key categories analysis of air pollutants in the Slovak Republic in 2017 (cumulative total at least 80%)*

NOx	1A1a (23%)	1A3bi (14%)	1A3ei (10%)	1A4cii (6%)	1A3bii (5%)	2A1 (4%)	1A4ai (4%)	1A2d (4%)	2C2 (4%)	1A4bi (3%)	3Da1 (3%)	1A3c (3%)
SOx	2C7c (22%)	1A2d (14%)	1A4bi (13%)	1A1a (11%)	2B10a (9%)	1A2a (8%)	2C1 (6%)					
NH_3	3D2a (19%)	3Da1 (18%)	3B3 (13%)	1A4bi (10%)	3B1b (10%)	3B4gi (18%)	3B4gii (6%)					
NMVOC	1A4bi (21%)	2D3a (11%)	2D3d (11%)	2D3g (9%)	2D3h (7%	1B1a (6%)	1A3bi (6%)	1A4ai (4%)	2B10a (2%)	1A3bv (2%)	1A4cii (2%)	
PM_{10}	1A1a (17%)	3Dc (15%)	1A2a (9%)	1A4bi (8%)	2A1 (6%)	1A3bvi (6%)	2C2 (5%)	2A5b (4%)	2A6 (3%)	1A3bvii (3%)	1A3bi (3%)	2G (2%)
$PM_{2.5}$	1A1a (21%)	1A2a (13%)	1A4bi (11%)	2C2 (6%)	1A3bi (6%)	1A3bvi (5%)	2A6 (5%)	2G (4%)	2A1 (4%)	5E (3%)	1A3bvii (3%)	
BC	1A4bi (36%)	1A3bi (24%)	2G (11%)	1A4cii (8%)	2C2 (6%)							
CO	1A4bi (31%)	2C1 (25%)	1A3bi (14%)	1A4cii (10%)	2C7c (6%)							
Pb	2C7a (43%)	1A3bi (13%)	1A2a (12%)	2A1 (12%)								
Cd	2A3 (50%)	2C7a (13%)	1A2a (12%)	1A4bi (9%)								
Hg	2C7a (47%)	1A2a (21%)	1A4bi (7%)	1A1a (3%)	2K (3%)							
As	2C7a (39%)	1A2a (23%)	1A4bi (10%)	2C4 (10%)								
Cr	2C7c (47%)	1A2a (16%)	2A3 (11%)	1A4bi (7%)								
Cu	1A2a (32%)	1A3bvi (24%)	2C7a (18%)	1A3biii (4%)	2C7c (4%)							
Ni	2C7c (38%)	1A2a (24%)	2C3 (11%)	2C1 (9%)								
Se	1A1a (41%)	2C7a (25%)	1A2a (22%)									
Zn	1A2a (23%)	2D3i (13%)	2C7a (12%)	2C7c (8%)	1A2d (8%)	2A3 (4%)	2A1 (4%)	1A3bvi (4%)	1A1a (4%)	2C3 (3%)		
DIOX	5C1biii (33%)	1A2gviii (22%)	2C1 (9%)	1A2a (8%)	1B1b (7%)	5C1bi (7%)						
PAHs	2C3 (45%)	1B1b (17%)	1A5a (8%)	1A1b (6%)	2B10a (4%)	1A3bi (4%)						
HCB	1A1a (34%)	1A2b (29%)	1A2gviii (14%)	5C1bi (10%)								
PCB	1A2gviii (28%)	1A2d (27%)	2C1 (14%)	1A3c (6%)	1A5a (5%)							

Note: Different colours used to highlight sectors - 1, 2, 3, 5

Table A1.3: *Final ranking of Key Categories for the year 2017 – Contributions per pollutant for Level Assessment (LA) and Trend Assessment (TA) in %*

NFR	NOx		SOx		NH_3		NMVOC		$PM_{2.5}$		PM_{10}		CO		BC		Pb		Cd		Hg		As		Cr		Cu		Ni		Se		Zn		DIOX		PAHs		HCB		PCB		SUM	RANK
	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA		
1A1a	6	23	32	11						21		17									5	3										41		4						34			211	5
1A1b	2																																				8	6					16	34
1A2a	3		6	8						13		9					30	12	24	12	50	21		23	27	16		32	34	23		22	17	23	16	8					32		468	3
1A2b																																							20	29			49	16
1A2d		4		14																														8								27	53	14
1A2e																																					3						3	49
1A2gviii																			8		4														54	22			54	14	36	28	220	4
1A3bi	15	14					3	6	2	6	2	3	7	14	15	24		13																				4					128	9
1A3bii	6	5													7																												18	30
1A3biii	17																											4															21	28
1A3bv							2	2																																			4	47
1A3bvi										5	3	6													6		14	24						4									70	12
1A3bvii										3		3																															12	36
1A3c	2																																									6	8	44
1A3ei		10																																									10	40
1A4ai	4	4					2	4											9														7										30	22
1A4bi	5	3	6	13	5	10	45	21	78	11	64	8	43	31	60	36			17	9	12	7		10	14	7							6										581	1
1A4cii	4	6						2					6	10		8																											36	20
1A5a																																						8				5	13	35
1B1a							6	6																																			12	37
1B1b																									5										6	7	40	17					75	11
2A1	5	4								4		6						12			4													4									49	17
2A3																	17			50					17	11					53		6	4									158	7
2A5b											3	4																															23	25
2A6										5		3																															11	38
2B10a			5	9																	4																	4					22	27
2B10b							2	2																																			4	48
2C1	5		23	6							2		28	25															16	9			7		6	9						14	157	8
2C2		4								6		5				6																									12		36	21
2C3																													13	11				3			31	45					103	10
2C4																								10																			10	41
2C7a																	38	43	22	13		47	96	39			77	18			37	25	13	12									480	2
2C7c			12	22										6											12	47		4	24	42			12	8									189	6
2D3a							7	11																																			18	31
2D3d							12	11																																			23	26
2D3e							3																																				3	50
2D3g								9																																			9	43
2D3h								7																																			7	45
2D3i																																	12	13									25	23
2G										4		2				11																											17	32
2K																					4	3																					7	46
3B1b						10																																					10	42
3B3					5	13																																					20	29
3B4gi					8	8																																					25	24
3B4gii					5	6																																					11	39
3Da1	7	3			23	18																																					51	15
3Da2a					37	19																																					56	13
3Dc											8	15																															39	19
5C1bi																																				7				10			17	33
5C1biii																																				33			8				41	18
5E										3																																	3	51
	81	80	84	83	83	84	82	81	80	81	82	81	84	86	82	85	85	80	80	84	83	81	96	82	81	81	91	82	87	85	90	88	80	83	82	86	82	84	82	87	80	80		

ANNEX II: INCLUSION/EXCLUSION OF CONDENSABLE COMPONENT OF PARTICULATE MATTER IN EMISSION FACTORS

Table below shows individual NFR categories, which were balanced using emission factors that include/exclude condensable component of particulate matter. Green cells represent emission factors including and yellow cells excluding condensable component. Grey cells represent categories with notation keys and red cells categories are unknown of using condensable component in emission factors of particulate matter.

Table A2.1: *Inclusion/exclusion of the condensable component from the PM10 and PM2.5 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)			

NFR	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
1A4ai	Commercial/institutional: Stationary		X	Measured emissions
1A4aii	Commercial/institutional: Mobile			
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			

NFR	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
2C7c	Other metal production (please specify in the IIR)		X	Measured emissions
2C7d	Storage, handling and transport of metal products (please specify in the IIR)			
2D3a	Domestic solvent use including fungicides			
2D3b	Road paving with asphalt		X	Measured emissions
2D3c	Asphalt roofing			
2D3d	Coating applications			
2D3e	Degreasing			
2D3f	Dry cleaning			
2D3g	Chemical products			
2D3h	Printing			
2D3i	Other solvent use (please specify in the IIR)			
2G	Other product use (please specify in the IIR)	X*		Schauer et al. (1998)[5]
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}

NFR	SOURCE	PM EMISSIONS: THE CONDENSABLE COMPONENT IS:		EF REFERENCE AND COMMENTS
		INCLUDED	EXCLUDED	
3Dd	Off-farm storage, handling and transport of bulk agricultural products			
3De	Cultivated crops			
3Df	Use of pesticides			
3F	Field burning of agricultural residues			
3I	Agriculture other (please specify in the IIR)			
5A	Biological treatment of waste - Solid waste disposal on land		X	
5B1	Biological treatment of waste - Composting		X	
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities			
5C1a	Municipal waste incineration			
5C1bi	Industrial waste incineration		X	US EPA (1996) [6]
5C1bii	Hazardous waste incineration			
5C1biii	Clinical waste incineration			
5C1biv	Sewage sludge incineration			
5C1bv	Cremation			Unknown
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: *Fuels, Electricity and Heat Balance in 2017 - in TJ*

	Anthracite	*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	-	-	-	20 461	-	-	-	-	-	-	-
Import	6 216	81 523	22 634	6 203	7 316	562	308	-	-	-	-
Export	-	-	-	-	397	-	-	1 875	-	-	-
Stock Changes	-1 370	-358	1 617	-457	-879	-18	-	-	-	-	-
Gross Inland Consumption	**4 846**	**81 165**	**24 251**	**26 207**	**6 040**	**544**	**308**	**-1 875**	**-**	**-**	**-**
Transformation Input	**2 581**	**81 165**	**13 553**	**24 456**	**46 988**	**228**	**-**	**-**	**1 039**	**1 592**	**384**
Electricity Production - Thermal Equipment	2 581	-	13 553	24 389	-	228	-	-	1 039	1 583	359
of which: Public	2 581	-	11 559	24 356	-	228	-	-	-	-	-
Autoproducers	-	-	1 994	33	-	-	-	-	1 039	1 583	359
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	61 232	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	19 933	-	-	46 988	-	-	-	-	-	-
Refineries	-	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	67	-	-	-	-	-	9	25
Transformation Output	**-**	**-**	**-**	**-**	**44 832**	**-**	**-**	**1 875**	**11 530**	**20 113**	**4 320**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	44 832	-	-	1 875	11 530	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	20 113	4 320
Refineries	-	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-**	**-**	-	**-**	-	**-**	**-**	**-**	-	-	-
Product Transferred	-	-	-	-	-	-	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-	-
Consumption of the Energy Sector	**-**	**-**	**-**	**22**	**-**	**-**	**-**	**-**	**3 443**	**11 231**	**-**
Distribution Losses	**-**	**-**	**-**	**11**	**-**	**-**	**-**	**-**	**15**	**196**	**867**

1st continuation

	Anthracite	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	**2 265**	**-**	**10 698**	**1 718**	**3 884**	**316**	**308**	**-**	**7 032**	**7 094**	**3 069**
Final Non - Energy Consumption	**817**	**-**	**-**	**-**	**1 389**	**-**	**-**	**-**	**-**	**-**	**-**
of which: Chemical Industry	-	-	-	-	-	-	-	-	-	-	-
Final Energy Consumption	**1 448**	**-**	**10 698**	**1 718**	**2 495**	**316**	**308**	**-**	**7 032**	**7 094**	**3 069**
Industry	**1 448**	**-**	**8 138**	**535**	**2 410**	**-**	**-**	**-**	**7 032**	**7 094**	**3 069**
of which: Iron and steel	1 448	-	6 952	-	1 333	-	-	-	7 032	7 094	3 069
Non - ferrous metals	-	-	-	-	142	-	-	-	-	-	-
Chemical	-	-	-	-	-	-	-	-	-	-	-
Non - metallic minerals	-	-	1 186	56	822	-	-	-	-	-	-
Mining and quarrying	-	-	-	22	-	-	-	-	-	-	-
Food, beverages and tobacco	-	-	-	390	113	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-	-
Pulp, paper and print	-	-	-	-	-	-	-	-	-	-	-
Mach. and transport equipment	-	-	-	67	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-	-
Transport	-	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Other Sectors	**-**	**-**	**2 560**	**1 183**	**85**	**316**	**308**	**-**	**-**	**-**	**-**
of which: Households	-	-	647	636	85	53	28	-	-	-	-
Agriculture	-	-	-	11	-	-	-	-	-	-	-
Commercial and public services	-	-	1 913	536	-	263	280	-	-	-	-

2nd continuation

	Natural Gas	*Crude Oil and NGL*	*Refinery Feedstock* [1/]	*Refinery Gas*	*LPG*	*Naphta*	*Gasoline*	*Kerosene*
Primary Production	4 890	336	9 430	-	-	-	-	-
Import	182 872	234 671	175	-	2 484	1 936	11 545	-
Export	-	2 352	-	-	2 990	2 948	49 869	1 429
Stock Changes	-14 566	840	-	-	46	-44	1 624	-173
Gross Inland Consumption	**173 196**	**233 495**	**9 605**	**-**	**-460**	**-1 056**	**-36 700**	**-1 602**
Transformation Input	**27 300**	**233 495**	**34 295**	**622**	**-**	**-**	**-**	**-**
Electricity Production - Thermal Equipment	18 276	-	-	622	-	-	-	-
of which: Public	16 660	-	-	622	-	-	-	-
Autoproducers	1 616	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-
Refineries	-	233 495	34 295	-	-	-	-	-
Heat Production	9 024	-	-	-	-	-	-	-
Transformation Output	**-**	**-**	**-**	**18 733**	**8 142**	**20 768**	**63 917**	**3 291**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-
Refineries	-	-	-	18 733	8 142	20 768	63 917	3 291
Heat Production	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-7 288**	**-**	**24 690**	**-**	**-1 472**	**-8 536**	**-**	**-**
Product Transferred	-7 288	-	14 682	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	10 008	-	-1 472	-8 536	-	-
Consumption of the Energy Sector	**9 899**	**-**	**-**	**15 032**	**-**	**-**	**-**	**-**
Distribution Losses	**3 473**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3rd continuation

	Natural Gas	*Crude Oil and NGL*	*Refinery Feedstock* [1/]	*Refinery Gas*	*LPG*	*Naphta*	*Gasoline*	*Kerosene*	*Natural Gas*
Final Consumption	**125 236**	**-**		**-**	**3 079**	**6 210**	**11 176**	**27 217**	**1 689**
Final Non - Energy Consumption	**16 130**	**-**		**-**	**-**	**3 956**	**11 176**	**-**	**-**
of which: Chemical Industry	16 130	-		-	-	3 956	11 176	-	-
Final Energy Consumption	**109 106**	**-**		**-**	**3 079**	**2 254**	**-**	**27 217**	**1 689**
Industry	**35 792**	**-**		**-**	**3 079**	**276**	**-**	**-**	**-**
of which: Iron and steel	6 649	-		-	-	-	-	-	-
Non - ferrous metals	1 473	-		-	-	46	-	-	-
Chemical	4 600	-		-	3 079	-	-	-	-
Non - metallic minerals	6 738	-		-	-	46	-	-	-
Mining and quarrying	100	-		-	-	46	-	-	-
Food, beverages and tobacco	3 383	-		-	-	-	-	-	-
Textile and leather	591	-		-	-	-	-	-	-
Pulp, paper and print	1 919	-		-	-	-	-	-	-
Mach. and transport equipment	7 222	-		-	-	46	-	-	-
Not elsewhere specified	3 117	-		-	-	92	-	-	-
Transport	**296**	**-**		**-**	**-**	**1 426**	**-**	**27 217**	**1689**
Other Sectors	**73 018**	**-**		**-**	**-**	**552**	**-**	**-**	**-**
of which: Households	48 150	-		-	-	368	-	-	-
Agriculture	945	-		-	-	46	-	-	-
Commercial and public services	23 923	-		-	-	138	-	-	-
Final Consumption									
Final Non - Energy Consumption									

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	42 717	1 381	1 941	3 434	504	2 437	5 181	173	4 058	4 604
Export	81 768	4 994	3 477	8 928	336	496	602	-	-	7 869
Stock Changes	421	-41	-81	1 131	-	-	-	-	70	-335
Gross Inland Consumption	**-38 630**	**-3 654**	**-1 617**	**-4 363**	**168**	**1 941**	**4 579**	**173**	**4 128**	**-3 600**
Transformation Input	**42**	-	**121**	**8 524**	**-**	**-**	**-**	**-**	**-**	**-**
Electricity Production - Thermal Equipment	42	-	121	8 524	-	-	-	-	-	-
of which: Public	42	-	121	8 484	-	-	-	-	-	-
Autoproducers	-	-	-	40	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	-
Refineries	-	-	-	-	-	-	-	-	-	-
Heat Production	-	-	-	-	-	-	-	-	-	-
Transformation Output	**122 168**	**4 304**	**1 778**	**12 887**	**-**	**-**	**-**	**-**	**2 064**	**6 404**
Electricity Production - Thermal Equipment	-	-	-	-	-	-	-	-	-	-
of which: Public	-	-	-	-	-	-	-	-	-	-
Autoproducers	-	-	-	-	-	-	-	-	-	-
Nuclear Plants	-	-	-	-	-	-	-	-	-	-
Coke Ovens	-	-	-	-	-	-	-	-	-	-
Blast Furnaces	-	-	-	-	-	-	-	-	-	-
Refineries	122 168	4 304	1 778	12 887	-	-	-	-	2 064	6 404
Heat Production	-	-	-	-	-	-	-	-	-	-
Exchanges and Transfers, Backflows	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Product Transferred	-	-	-	-	-	-	-	-	-	-
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-
Consumption of the Energy Sector	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2 064**	**-**
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	**83 496**	**650**	**40**	**-**	**168**	**1 941**	**4 579**	**173**	**4 128**	**2 804**
Final Non - Energy Consumption	**-**	**528**	**-**	**-**	**168**	**1 941**	**4 579**	**173**	**2 344**	**2 804**
of which: Chemical Industry	-	528	-	-	-	-	-	-	-	2 804
Final Energy Consumption	**83 496**	**122**	**40**	**-**	**-**	**-**	**-**	**-**	**1 784**	**-**
Industry	**716**	**-**	**40**	**-**	**-**	**-**	**-**	**-**	**1 784**	**-**
of which: Iron and steel	-	-	-	-	-	-	-	-	-	-
Non - ferrous metals	84	-	-	-	-	-	-	-	-	-
Chemical	-	-	-	-	-	-	-	-	-	-
Non - metallic minerals	295	-	-	-	-	-	-	-	1 784	-
Mining and quarrying	126	-	-	-	-	-	-	-	-	-
Food, beverages and tobacco	42	-	-	-	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-
Pulp, paper and print	-	-	40	-	-	-	-	-	-	-
Mach. and transport equipment	-	-	-	-	-	-	-	-	-	-
Not elsewhere specified	169	-	-	-	-	-	-	-	-	-
Transport	**80 252**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Other Sectors	**2 528**	**122**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
of which: Households	-	-	-	-	-	-	-	-	-	-
Agriculture	2 528	-	-	-	-	-	-	-	-	-
Commercial and public services	-	122	-	-	-	-	-	-	-	-

6th continuation

	Nuclear Heat	*Solar Heat*	*Geo-thermal Heat*	*Heat*	*Wood*	*Municipal Solid Wastes*	*Biogas*	*Industrial Wastes*	*Wind energy*	*Hydro Energy*	*Solar Electricity*	*Electricity*	*Liquid Biofuels*	*Total*
Primary Production	157 750	273	349	-	35 219	2 214	6 384	7 283	22	15 566	1 822	-	6 784	268 783
Import	-	-	-	84	227	-	-	300	-	-	-	56 027	4 626	686 139
Export	-	-	-	-	687	-	-	-	-	-	-	45 126	3 913	220 056
Stock Changes	-	-	-	-	-127	-	-	-24	-	-	-	-	-103	-12 827
Gross Inland Consumption	**157 750**	**273**	**349**	**84**	**34 632**	**2 214**	**6 384**	**7 559**	**22**	15 566	1 822	**10 901**	**7 394**	**722 039**
Transformation Input	**155 654**	**-**	**286**	**-**	**18 122**	**1 306**	**5 044**	**130**	**-**	**-**	**-**	**-**	**-**	**656 927**
Electricity Production - Thermal Equipment	-	-	-	-	15 564	1 217	5 040	129	-	-	-	-	-	93 267
of which: Public	-	-	-	-	7 579	-	1 169	-	-	-	-	-	-	73 401
Autoproducers	-	-	-	-	7 985	1 217	3 871	129	-	-	-	-	-	19 866
Nuclear Plants	155 654	-	-	-	-	-	-	-	-	-	-	-	-	155 654
Coke Ovens	-	-	-	-	-	-	-	-	-	-	-	-	-	61 232
Blast Furnaces	-	-	-	-	-	-	-	-	-	-	-	-	-	66 921
Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	267 790
Heat Production	-	-	286	-	2 558	89	4	1	-	-	-	-	-	12 063
Transformation Output	**-**	**-**	**-**	**35 684**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**81 371**	**-**	**464 180**
Electricity Production - Thermal Equipment	-	-	-	25 680	-	-	-	-	-	-	-	27 079	-	52 759
of which: Public	-	-	-	23 731	-	-	-	-	-	-	-	17 503	-	41 234
Autoproducers	-	-	-	1 949	-	-	-	-	-	-	-	9 576	-	11 525
Nuclear Plants	-	-	-	-	-	-	-	-	-	-	-	54 292	-	54 292
Coke Ovens	-	-	-	-	-	-	-	-	-	-	-	-	-	58 236
Blast Furnaces	-	-	-	-	-	-	-	-	-	-	-	-	-	24 433
Refineries	-	-	-	-	-	-	-	-	-	-	-	-	-	264 456
Heat Production	-	-	-	10 004	-	-	-	-	-	-	-	-	-	10 004
Exchanges and Transfers, Backflows	**-2 096**	**-1**	**-**	**2 097**	**-**	**-**	**-**	**-**	**-22**	-15 566	**-1 822**	**17 410**	**-7 394**	**0**
Product Transferred	-2 096	-1	-	2 097	-	-	-	-	-22	-15 566	-1 822	17 410	-7 394	0
Backflows from Petrochemical Sector	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Consumption of the Energy Sector	**-**	**-**	**-**	**5 322**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**12 244**	**-**	**59 257**
Distribution Losses	**-**	**-**	**-**	**4 518**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4 547**	**-**	**13 627**

End of table

	Nuclear Heat	Solar Heat	Geo-thermal Heat	Heat	Wood	Municipal Solid Wastes	Biogas	Industrial Wastes	Wind energy	Hydro Energy	Solar Electricity	Electricity	Liquid Biofuels	Total
Final Consumption	**-**	**272**	**63**	**28 025**	**16 510**	**908**	**1 340**	**7 429**	**-**	**-**	**-**	**92 891**	**-**	**456 408**
Final Non - Energy Consumption	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**46 005**
of which: Chemical Industry	-	-	-	-	-	-	-	-	-	-	-	-	-	34 594
Final Energy Consumption	**-**	**272**	**63**	**28 025**	**16 510**	**908**	**1 340**	**7 429**	**-**	**-**	**-**	**92 891**	**-**	**410 403**
Industry	**-**	**-**	**-**	**5 607**	**14 637**	**-**	**3**	**7 429**	**-**	**-**	**-**	**44 482**	**-**	**143 571**
of which: Iron and steel	-	-	-	-	198	-	-	-	-	-	-	9 410	-	43 185
Non - ferrous metals	-	-	-	-	-	-	-	-	-	-	-	9 414	-	11 159
Chemical	-	-	-	2 680	11	-	-	1 069	-	-	-	3 989	-	15 428
Non - metallic minerals	-	-	-	168	7	-	-	6 331	-	-	-	2 182	-	19 615
Mining and quarrying	-	-	-	-	3	-	-	-	-	-	-	148	-	445
Food, beverages and tobacco	-	-	-	199	70	-	-	-	-	-	-	1 717	-	5 914
Textile and leather	-	-	-	41	6	-	-	-	-	-	-	461	-	1 099
Pulp, paper and print	-	-	-	2271	12 921	-	3	-	-	-	-	2 869	-	20 023
Mach. and transport equipment	-	-	-	135	203	-	-	29	-	-	-	9 583	-	17 285
Not elsewhere specified	-	-	-	113	1 218	-	-	-	-	-	-	4 709	-	9 418
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2 110**	-	**112 990**
Other Sectors	**-**	**272**	**63**	**22 418**	**1 873**	**908**	**1337**	**-**	**-**	**-**	**-**	**46 299**	-	**153 842**
of which: Households	-	245	-	18 920	1 317	-	-	-	-	-	-	17 698	-	88 147
Agriculture	-	-	30	29	441	-	963	-	-	-	-	976	-	5 969
Commercial and public services	-	27	33	3 469	115	908	374	-	-	-	-	27 625	-	59 726

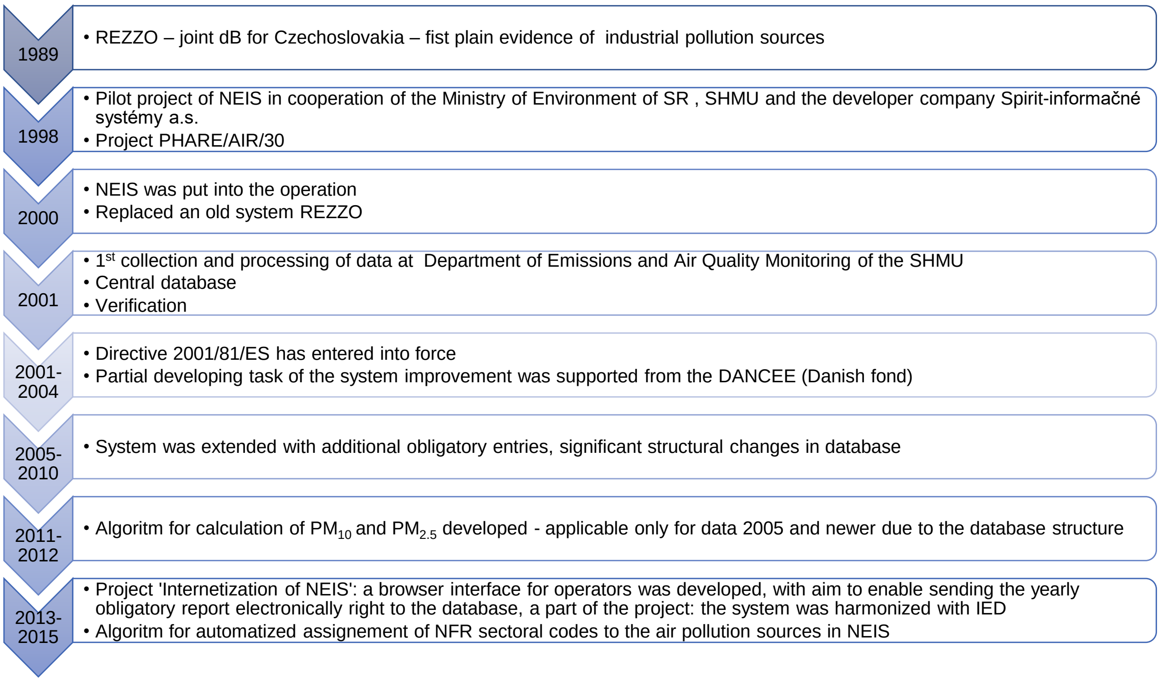
ANNEX IV: ADDITIONAL INFORMATION ON METHODOLOGY

ANNEX IV includes additional information on methodology used in NEIS database.

NEIS database is National Emission Information System for air pollutants (NO_X, SO_X, NMVOC, NH_3, HM and TSP). Information System NEIS was established in 1998. The database was developed in order to fulfil the national legislation in air quality and the requirements in pollutants fees decisions (Act No. 401/1998 on air pollution charges as amended). Since 2000, when NEIS was set into the operation, the emissions are directly collected in consistent way 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 was realized in 2001. Department of Emissions and Biofuels of the SHMÚ is in charge of processing of final data in central database. The following scheme represents the formation of database in time with important dates.

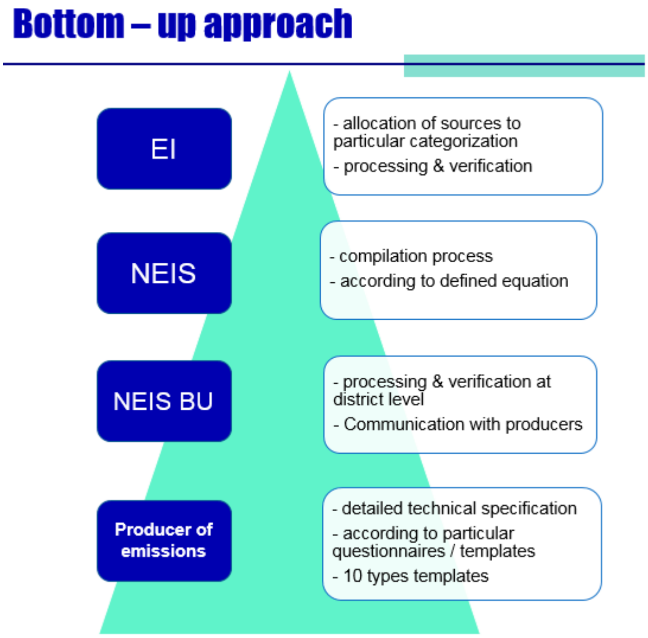
The last changes within the improvement of the NEIS was carried out since December 2013 until August 2015. Within the scope of the recent Project 'Internetization of NEIS' a browser interface was developed. The aim was to enable sending the yearly obligatory report electronically right to the database NEIS PZ WEB. The module NEIS BU on district offices is connected to this database and data is synchronized.

Figure A4.1: *Milestones in development NEIS database*



The emissions of air pollutants (NO_X, SO_X, NMVOC, NH_3, TSP, PMi and HM) are recorded and calculated on yearly bases in NEIS database. The data collection of air pollutants and emission inventory preparation is performed by standardized procedure. For the purposes of 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 in accordance with Act on air protection No. 137/2010 Coll. as amended and related regulations. The collection of annual activity data are 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 name and content of surveyed data. The forms 1- 5 require identification data of operators, sum of emissions and fees for operator and for individual sources of 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 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 range from 2000–2017 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 cca 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 total rated thermal input more than 50 MW and other technological units with a capacity above the defined limit

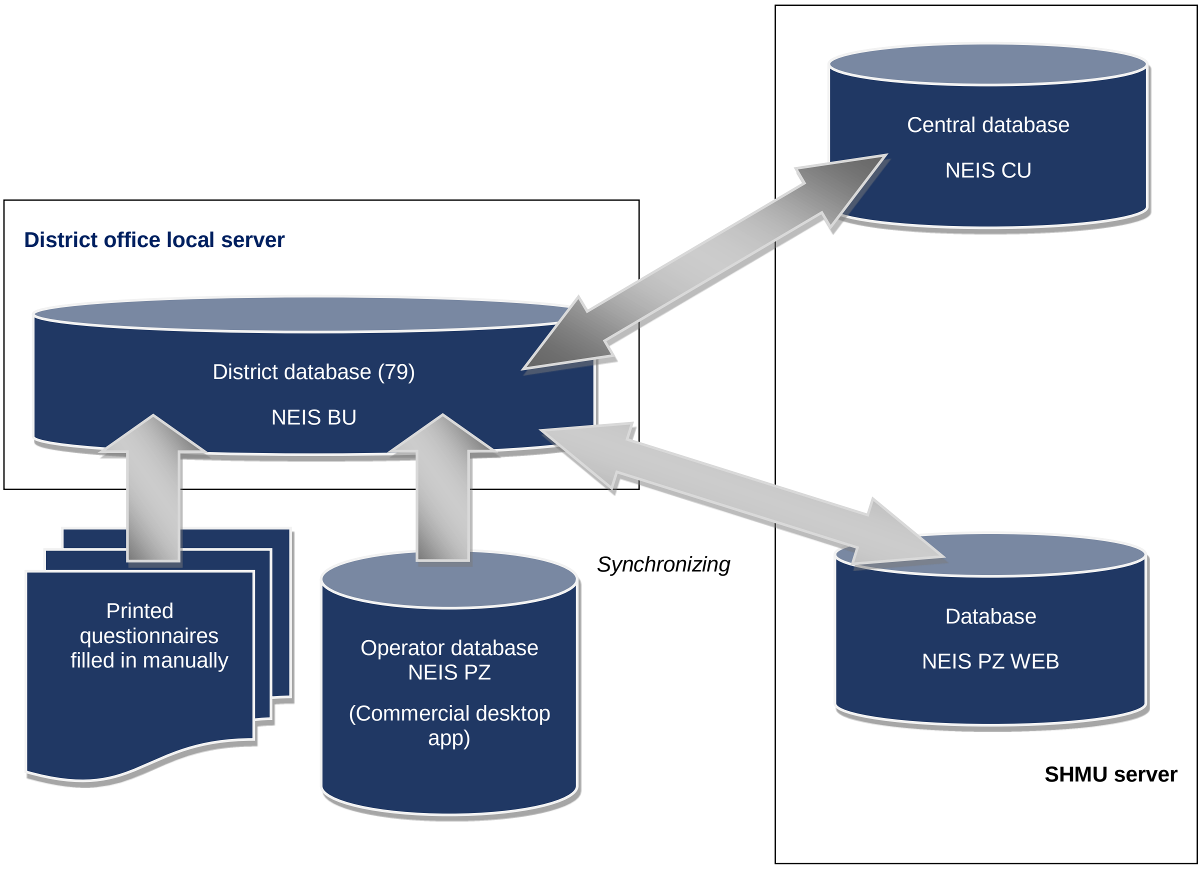
In year 2016 the system contained 905 (750 of it in operation) large sources

- 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
  - In year 2016 the system contained 12 982 (10 642 of it in operation) medium sources.

Operators of large and medium sources are obliged to annually report specific dataset about 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 on 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 air; delimited is as a functional and spatial complex of all plants and activities. In some cases this definition overlap 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 with it.

Figure A4.3: *The scheme of the connection of individual databased in NEIS*



Each source can contain one or more combustion plant 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[5],
- calculation using emission-dependence approach or EF published in technical standards, directive, guidelines or other official document of competent authority, EU and related organizations,
- other suitable approach 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.

[5] General relations as well as default EF are published in Bulletin of the Ministry of the Environment

Due to the NFR sectoral code changes it was necessary to recalculate the accessible timeline. Revision of all sources (cca 13 000 x 15 years = 195 000) expected the development of the methodology for automatized re-assignment of sectoral codes to the individual sources. The accessible timeline in NEIS (2000-2016) was revised: emissions from individual air pollution sources were re-allocated according to revised sectoral codes.

Methodology for automatized re-assignment is based on following key data:

- Air pollution source category (Decree No. 410/2012 Coll.)
- SK NACE rev.2 code of the operator

Developed algorithm checks the key data, compare thus with the assignment rules and due to result executes the assignment of the relevant NFR sectoral code. Procedure is iterated for every source-record in chosen year. It is also possible add exception.

- Small sources:
  - Stationary equipment – domestic heating equipment for combustion of solid fuels and natural gas with total rated thermal input less than 0.3 MW

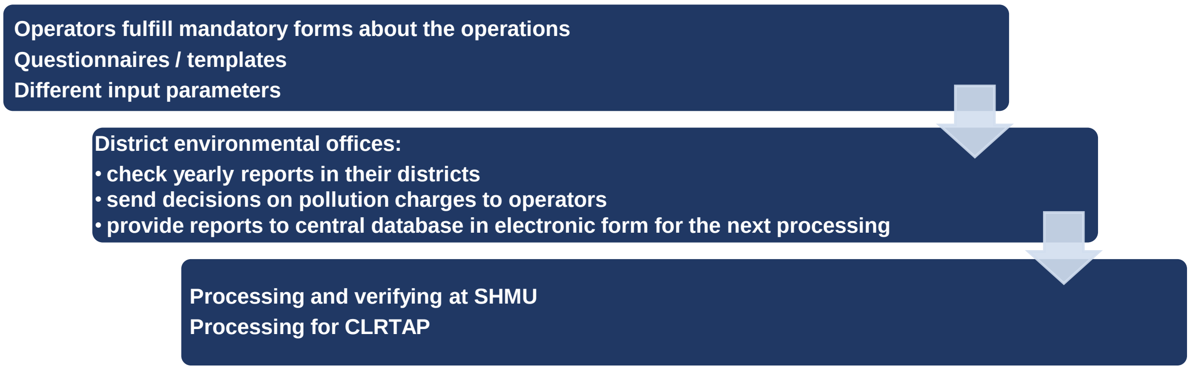
The sources below 0.3 MW (category 1A4bi – Residential: Stationary plants) are defined as small sources. These are not registered as individual point sources. The emission balance is being processed centrally (NEIS CU - central unit) and it is based on:

- Solid fossil fuels sold (data on district level) for 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 the electric energy in the households
  - Annually specified emission factor

A4.3 DATAFLOW AND PROCESSING

According to the Act No. 137/2010 Coll. as amended by the Act No. 318/2012 Coll. operators of large and medium sources are obliged to annually report specific dataset about operation. The main data is the amount of released emissions, the pollutant fee and the fuel consumption. The dataset contains also 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 result of project 'Internetization of the National emission information system'. Data from operators are collected and verified by the district offices using SW module NEIS BU. District environmental offices are obliged to prepare the annually dataset containing operational characteristics of air pollution sources in their districts and provide this to the SHMÚ central database in specified format (79 district databases) for the next processing.

__Figure A4.4:__ Scheme of process of emissions inventory compilation using the NEIS database



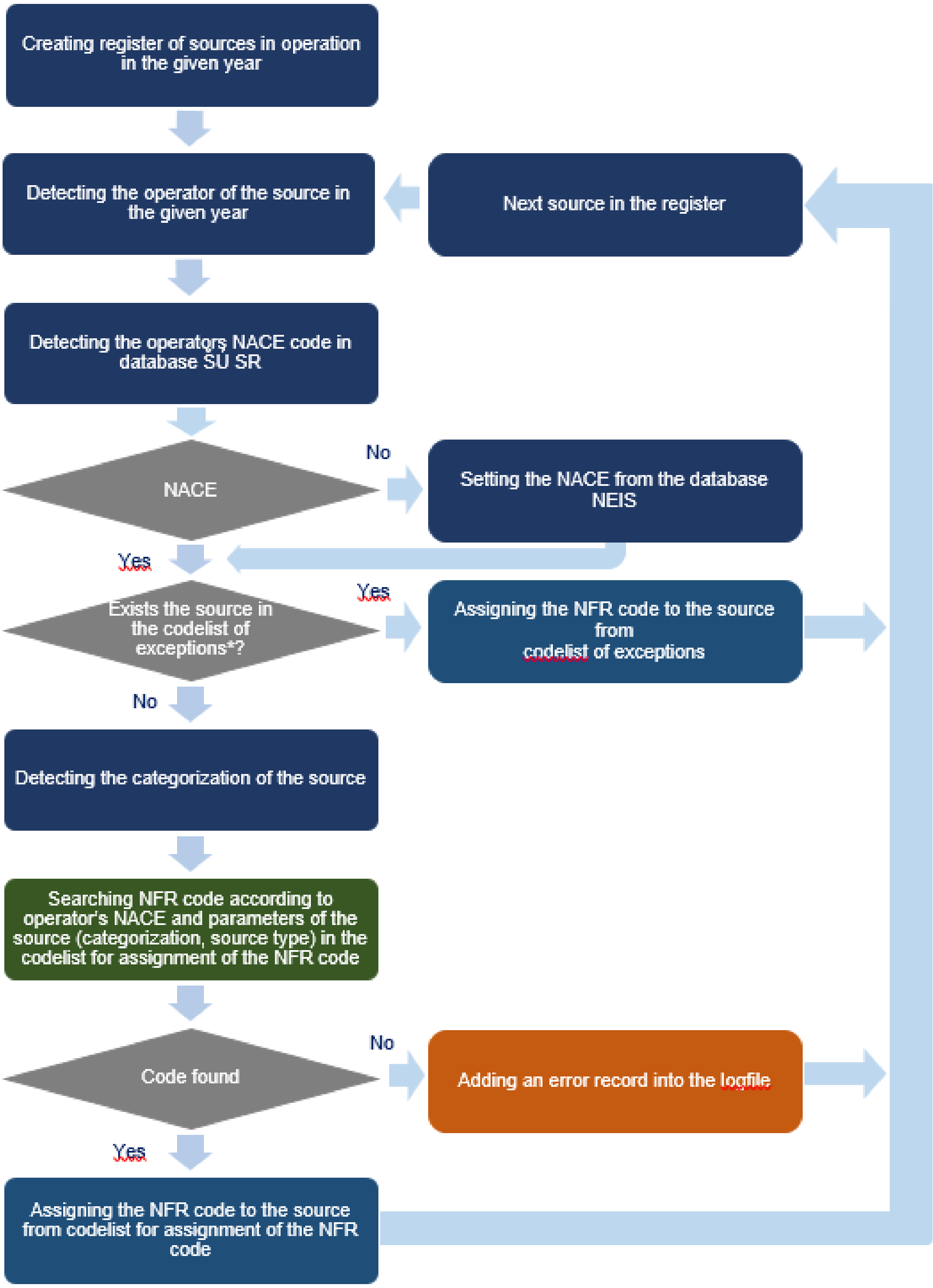
A4.4 VERIFICATION PROCESS OF NEIS DATA

Verification of input data is on yearly basis. After legislative deadline for operators to deliver the mandatory questionnaires with data either electronically – direct input to database or in written form to the district offices, the data are imported and firstly verified on 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 central database in SHMU, 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*



* In the codelist of exceptions are predefined NFR codes

A4.6 ENERGY – GENERAL EMISSION FACTORS

The general emission factors are valid for emissions from combustion before the use of abatement technologies or the additives. The final amount of released air pollutants demand of the effectiveness of abatement or degree of DESOX after the adding of additives.

Table A4.6: *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.m^3 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
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

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.m^3 gaseous fuel**					
	>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/m^3

S = for Propane – Butane is sulphur content in mg/100g

A4.7 ABATEMENT TECHNOLOGIES

Table A4.7: *List Abatement technologies reported to NEIS database*

TYPE OF SEPARATOR	NAME
F - textile	F - Textile hose
F - textile	F - Textile pocket
F - textile	F - Textile sleeve
F - textile	F - Textile chamber-cassette
F - textile	F - Textile wedge
F - textile	F - Textile non-woven felt
F - textile	F - Textile-woven with woven reinforcement
F - textile	F - Textile other
F - textile	F - Not Specified
E - electric	E - Horizontal
E - electric	E - Vertical
E - electric	E - Wet

TYPE OF SEPARATOR	NAME
E - electric	E - Wet with pre-wash
E - electric	E - with EFB bedding
E - electric	E - electric other
E - electric	E - Not Specified
S - dry aeromechanic	S - settling chamber
S - dry aeromechanic	S - anther
S - dry aeromechanic	S - jalousie
S - dry aeromechanic	S - single cyclone
S - dry aeromechanic	S - group of cyclones (parallel)
S - dry aeromechanic	S - group of cyclones (serial)
S - dry aeromechanic	S – multi-cyclone
S - dry aeromechanic	S - unspecified
S - dry aeromechanic	S - swirl counter-current
S - dry aeromechanic	S - grained layer
S - dry aeromechanic	S - rotating
S - dry aeromechanic	S - Drop separators
S - dry aeromechanic	S - Separation of dust unspecified
S - dry aeromechanic	S - other
S - dry aeromechanic	S - unspecified
M - wet	M - spraying without filling
M - wet	M - spraying with refill
M - wet	M - foam without filling
M - wet	M - foam with refill
M - wet	M - combines
M - wet	M - single cyclone
M - wet	M – multi-cyclone
M - wet	M - surge with EO
M - wet	M – Counter-current with gas washer
M - wet	M - other
M - wet absorption	M - level
M - wet absorption	M - current-Venturi
M - wet absorption	M - grained layer
M - wet absorption	M - rotating
M - wet absorption	M - condensing
M - wet absorption	M - with chemical reaction
M - wet absorption	M - with organic solvents
M - wet absorption	M - with recirculation of liquid
M - wet absorption	M - other
AD,SP - absorption and combustion	AD - adsorption of gas-solids bed, instable adsorbent
AD,SP - absorption and combustion	AD - adsorption of gas-fluid. Adsorbent bed
AD,SP - absorption and combustion	AD - gas-continuous adsorption moving bed ad
AD,SP - absorption and combustion	SP - Gas combustion - thermal three-stage (burner, mixer, aggravation), linear. Burner
AD,SP - absorption and combustion	SP - Combustion of gases - thermal three-stage, tunnel incinerator
AD,SP - absorption and combustion	SP - Gas Combustion - thermal three-stage, jet incinerator
AD,SP - absorption and combustion	SP - Combustion of gases - thermal in the sand bed
AD,SP - absorption and combustion	SP - Gas-catalytic combustion - solid bed (tapes, rods, bricks, pellets ...)
AD,SP - absorption and combustion	SP - Combustion of gas-catalytic-fluid bed (metals and their compounds on carriers)
DS - DESOX	DS - DESOX-lime-limestone wet scrubbing-WS
DS - DESOX	DS - DESOX - injection of lime milk into the flue gas-SDA

TYPE OF SEPARATOR	NAME
DS - DESOX	DS - DESOX injection of dry sorbent-DSI, additional
DS - DESOX	DS - DESOX-Wellmann-Lord with Na-WL sulphite
DS - DESOX	DS - DESOX-Walter process with ammonia-WAP
DN - DENOX	DN - DENOX-selective non-catalytic reduction - SNCR
DN - DENOX	DN - DENOX-selective catalytic reduction - SCR
DN - DENOX	RD - Reduction of gas catalytic-solid bed
DN - DENOX	RD - Reduction of catalytic-fluid gas
KMB - combine	KMB - combine-SNOX with separate cathodes, catalytic reduction of NOx, catal.ox.SO_2
KMB - combine	KMB - combine-DESONOX catalysing 1 chamber, NOx catalytic reduction, catal.ox.SO_3
KMB - combine	KMB - combine-AC-dry simultaneous adsorption on moving the activated carbon (coke) to H_2SO_4 and N_2
KMB - combine	KMB - Gas capture by condensation (also cryogenic)
KMB - combine	KMB - Gas capture and disposal not specified
BIO - biological separators	BIO - dry-biofilters
BIO - biological separators	Bio - semi-dry biofilters, with reinforcement
BIO - biological separators	BIO - wet-bioscrubbers, bioskrub

A4.8 VOC CONTENT

Table A4.8: *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	

Confidential data

ANNEX V: NECD RECOMMENDATIONS

The Slovak Republic has prioritised its effort to implement the recommendations of the 2018 Comprehensive Technical Review of the National Emission Inventories that might have an impact on the emission estimates as far as possible in the 2019 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.	PRIORITY CRITERIA TCCCA[6]	PRIORITY CRITERIA KEY CATEGORY	PRIORITY CRITERIA OVER EMISSION 2%	REVIEW RECOMMENDATION	IMPLEMENTED
SK-0B-2018-0001	Completeness	No	No	**Notation key 'NA' for National Compliance Totals:** The TERT recommend that Slovakia include in the National Total for Compliance row values that are relevant to the national total for compliance. If this is the same as the National Total then the National Total value should be inserted. Notation keys, blanks or "0"s should not be used.	Implemented/ correction implemented into the reporting template.
SK-1A1a-2018-0002	Accuracy	Yes	No	**1A1a Public Electricity and Heat Production, Hg:** The TERT recommends that Slovakia pursues the implementation of a Tier 2 methodology as soon as resources allow.	Not implemented due to lack of resources and capacity
SK-1A1b-2018-0001	Transparency	No	No	**1A1b Petroleum refining:** The TERT recommends that Slovakia update the notation key to 'IE' in the next submission and document this transparently in the IIR.	Implemented/IIR ver.1 **Chapter 3.6.2.2**
SK-1A2b-2018-0001	Consistency	No	No	**1A2b Stationary Combustion in Manufacturing Industries and Construction:** The TERT recommends that Slovakia update the historical activity data for 1A2b for the 2019 submission and ensure time series consistency.	Implemented/ IIR ver. 1 **Chapter 3.7.2.2**
SK-1A3b-2018-0001	Transparency	No	No	**1A3bi-iv lubricant consumption calculation:** The TERT recommends that this improvement is carried out for inclusion in the 2019 submission or plans are made to carry out these improvements in the following year.	Implemented/IIR ver.1 **Chapter 3.8.4.1**
SK-1A3b-2018-0002	Transparency	No	No	**1A3b Road Transport/liquid fuel/ Pb from year 2000 onwards:** The TERT recommends that Slovakia clarifies in the next IIR submission the sources of the Pb emission	Implemented/IIR ver.1 **Chapter 3.8.4.1**

[6] If is criterion TCCCA, please select option - transparency, consistency, comparability, completeness or accuracy

SERIAL NO.	PRIORITY CRITERIA TCCCA[6]	PRIORITY CRITERIA KEY CATEGORY	PRIORITY CRITERIA OVER EMISSION 2%	REVIEW RECOMMENDATION	IMPLEMENTED
				factors and makes clear whether the emissions in 1A3b are due to the fuel only or also include the lubricant contribution according to the source of factors used.	
SK-1A3b-2018-0003	Transparency	No	No	**1A3diii Road Transport: Heavy Duty Vehicles/Cd between 1999 and 2000, 1A3biv Road Transport: Mopeds & Motorcycles/ Cd between 1994 and 1995:** The TERT recommends that Slovakia looks again at the fleet composition, activity data and emission factors it uses for calculation of heavy metal emissions and either addresses any irregularities in the time series or provides a clear explanation of their cause in the next IIR submission. The TERT also understands the difficulty Slovakia has in finding detailed historical activity data to enable recalculations in COPERT 5, but recommends to continue trying to obtain this data or make assumptions to get a realistic time series trend as an improvement for the 2019 or 2020 submission.	Implemented/IIR ver.1 **Chapter 3.8.4.1**
SK-1A3b-2018-0004	Consistency	No	No	**Hg in 1990-1999 1A3bvi:** To ensure time series consistency and inventory completeness, the TERT recommends reporting emissions for all 1A3bi-iv sources for years 1990-1999 using the relevant activity data used for other pollutant emission estimates for these years and the same Hg emission factors as from 2000 for submission in the next 2019 inventory.	Implemented/IIR ver.1 **Chapter 3.8.4.1**
SK-1A3b-2018-0005	Consistency	No	No	**1A3b Road Transport/liquid fuels/1990-2016/PAHs, Dioxins:** The TERT did not find this explanation of new cars very clear and recommends that Slovakia looks again at the fleet composition, activity data and emission factors it uses for calculation of emissions of these POPs and either addresses any irregularities in the time series or provides a clear explanation of their cause in the next IIR submission. The TERT also understands the difficulty Slovakia has in finding detailed historical activity data to enable recalculations in COPERT 5, but recommends to continue trying to obtain this data or make assumptions to get a realistic time series trend as an improvement for the 2019 or 2020 submission.	Implemented/IIR ver.1 **Chapter 3.8.4.1**
SK-1A3bv-2018-0001	Transparency	Yes	No	**1A3bv Road Transport: Gasoline Evaporation/liquid fuel/years 2000-2016 of NMVOC:** The TERT recommends that to improve transparency, some explanation of the time series including comments on the temperature data used in the calculations are provided in the next submission of the IIR.	Implemented/IIR ver. 1 **Chapter 3.8.4.2**

SERIAL NO.	PRIORITY CRITERIA TCCCA[6]	PRIORITY CRITERIA KEY CATEGORY	PRIORITY CRITERIA OVER EMISSION 2%	REVIEW RECOMMENDATION	IMPLEMENTED
SK-1A4ai-2018-0001	-	Yes	No	**1A4ai Commercial/Institutional:** The TERT recommends that Slovakia ensures that its emission factors presented in Table 3.64 of the IIR are correct.	Implemented/IIR ver.1 **Chapter 3.9.1.2**
SK-1A4bi-2018-0001	Transparency	No	No	**1A4bi Residential Stationary:** The TERT recommends that Slovakia review the time series data and make any necessary amendments in the 2019 submission, or include transparency information if the trend remains.	Implemented/IIR **Chapter 3.9.3.2**
SK-1A4bi-2018-0002	-	Yes	No	**1A4bi Residential: Stationary, Cd, Hg:** The TERT recommends that Slovakia implement the Tier 2 methodology for the 2019 submission.	Implemented/IIR **Chapter 3.9.3.2**
SK-1A4cii-2018-0001	Transparency	No	No	**1A2gvii Mobile Combustion in Manufacturing Industries and Construction, 1A4aii Commercial/Institutional:** The TERT recommends that some effort is made to separate activity for these mobile machinery sources in order to improve comparability and transparency of the Slovakia inventory. The TERT recommends that Slovakia investigates this as an improvement for the next 2019 or 2020 submissions and also corrects the duplication of description of sources in the IIR.	Not implemented, research on this issue is not finalized
SK-1B2aiv-2018-0001	Completeness	No	No	**1B2aiv Fugitive Emissions Oil:** The TERT recommends that Slovakia correct the notation key in the next submission from NA to IE.	Implemented/IIR ver.1 **Chapter 3.10.5.2**
SK-2B1-2018-0001	Completeness	No	No	**Notation key 'NO' is used for emissions but for activity data 'NA':** The TERT recommends that Slovakia use the notation key 'NO' for both activity data and emissions for its next submission.	Implemented/IIR ver.1 **Chapter 4.6.2.3**
SK-2B10a-2018-0001	Transparency	No	No	**SK-2B10a-2017-0002 on flaring in Carbide production/PM2.5:** The TERT accepted the progress made and recommends Slovakia continues to implement the improvements and to fully document its developments in the IIR.	Implemented/IIR ver.1 **Chapter 4.6.5.3**
SK-2B10a-2018-0002	Transparency	Yes	No	**Recalculation explanation:** The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Slovakia provides a detailed explanation on the reallocation in its next submission.	Implemented/IIR ver.1 **Chapter 4.6.5.3**
SK-2C1-2018-0001	Transparency	No	No	**No description of the entire 2C category:** The TERT recommends that Slovakia also explains these differences in its next submission (IIR).	Implemented/IIR ver.1 **Chapter 4.7.2**

SERIAL NO.	PRIORITY CRITERIA TCCCA[6]	PRIORITY CRITERIA KEY CATEGORY	PRIORITY CRITERIA OVER EMISSION 2%	REVIEW RECOMMENDATION	IMPLEMENTED
SK-2C1-2018-0002	-	Yes	No	**Reported 'NE/HCB/Tier 1 method and EF available:** The TERT also recommends Slovakia to check in its next submission, whether or not this new estimate would lead to this category to be key for HCB emissions. If this would be the case the TERT recommends that Slovakia considers a higher Tier method for this estimate in future submissions.	Not implemented
SK-2C2-2018-0001	Completeness	No	No	**Allocating all ferroalloys productions under NFR 2C2:** The TERT recommends Slovakia to implement these improvements for the next submission.	Implemented/IIR ver.1 **Chapter 4.7.3.3**
SK-2C7a-2018-0001	-	Yes	No	**Cd for 2C7a Copper Production, for 1990, 1999 and 2000:** The TERT recommends that Slovakia provides an explanation of its methods, data sources and assumptions in its IIR.	Implemented/IIR ver.1 **Chapter 4.7.9**
SK-2C7a-2018-0002	Transparency	Yes	No	**Pb emissions of 2C7a Copper Production for the entire time series:** The TERT recommends Slovakia to include further clarification on this method, the data sources and assumptions in the IIR 2019.	Implemented/IIR ver.1 **Chapter 4.7.9**
SK-2C7c-2018-0001	Transparency	Yes	No	**Recalculation explanation:** The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Slovakia provides a detailed explanation on the reallocation in its next submission.	Implemented/IIR ver.1 **Chapter 4.7.10.2**
SK-2D3d-2018-0001	Transparency	Yes	No	**2D3d Coating Applications for NMVOC emissions for 2010 and 2015:** The TERT notes that this issue does not relate to an over- or under-estimate and recommends the member state to include the description in its next submission.	Implemented/IIR ver.1 **Chapter 4.8.8.2**
SK-2D3g-2018-0001	-	Yes	No	PAHs, for the entire time series: The TERT recommends that Slovakia implements this plan to estimate emissions a soon as possible.	Not implemented
SK-2D3h-2018-0001	Transparency	Yes	No	**Recalculation explanation:** The TERT recommends that Slovakia: a) include in its next submission a detailed description of the specific printing processes which are included in this category, the method to estimate the emissions and AD and EF, if used; b) include evidence that all the installations are included in the estimate; i.e. the large sources that are reported via NEIS as well as the smaller sources; c) include a clear explanation for the decrease in emissions since 2011 with reference to the legislation, the abatement efficiency applied to the estimate and the abatement technologies applied.	Partly implemented/IIR ver. 1 **Chapter 4.8.12.3**

SERIAL NO.	PRIORITY CRITERIA TCCCA[6]	PRIORITY CRITERIA KEY CATEGORY	PRIORITY CRITERIA OVER EMISSION 2%	REVIEW RECOMMENDATION	IMPLEMENTED
SK-2G-2018-0001	Completeness	No	No	**2G Other Product Use the TERT notes that no emission estimates:** The TERT notes that this issue is below the threshold of significance and recommends that Slovakia provides an estimate of the whole time series in its next submission.	Implemented/IIR ver.1 **Chapter 4.8.14**
SK-2G-2018-0002	Completeness	No	No	**Cd and Pb emissions for the entire time series:** The TERT recommends that the Slovakia provides a recalculation of the whole time series in its next submission.	Implemented/IIR ver.1 **Chapter 4.8.14**
SK-2H-2018-0001	Transparency	No	No	**2H Other Industry Production:** The TERT recommends that Slovakia includes relevant methodology in the IIR and any relevant recalculation in their next submission.	Implemented/IIR ver.1 **Chapter 4.9 – Chapter 4.12**
SK-2H1-2018-0001	Transparency	No	No	**Implementation explanation:** The TERT recommends that Slovakia includes the detailed description of methods, AD and EF in its next IIR.	Implemented/IIR ver.1 **Chapter 4.9.2**
SK-3B-2018-0001	Transparency	Yes	No	*3B1a Manure management - dairy cattle and pollutant NH_3 and for years 2005, 2010, 2015 and 2016:* The TERT recommends that Slovakia include the information provided to the TERT during the review in the IIR of future submissions to improve transparency.	Implemented/IIR ver.1 **Chapters 5.7**
SK-3B-2018-0002	-	Yes	No	**3B Manure Management and pollutants $PM_{2.5}$ for all years:** The TERT recommends that Slovakia include a corrected revised estimate in its next submission utilizing country specific data on housing periods as necessary.	Implemented/IIR ver.1 **Chapter 5.7.6.1**
SK-3F-2018-0001	Transparency	No	No	**3F Field Burning of Agricultural Residues, SO_2, NOx, NH_3, NMVOC, $PM_{2.5}$, PAHs, Cd, Hg, Pb, PCDD/F for all years:** The TERT recommends that Slovakia review the use of the notation key and report not occurring "NO" in the next submissions and include explanatory text in the IIR.	Implemented/IIR ver.1 **Chapter 5.12**
SK-3Da3-2018-0001	-	No	No	**3Da3 Urine and Dung Deposited by Grazing Animals, NOx for 2005, 2010 and 2015:** The TERT recommends that Slovakia includes estimated for NOx and provide appropriate explanatory text in the IIR.	Implemented/IIR ver.1 **Chapter 5.7.5**
SK-5-2018-0001	Transparency	No	No	**5C1biii Clinical Waste Incineration/ (CS) HCB EF:** The TERT recommends that Slovakia includes this information in the IIR as a justification for the difference between CS EF and the default value and to investigate the types of abatement technologies applied in Slovakia to adjust the CS EFs and reinforce the justification for the methodology used.	Methodology for this source category was changed due to increase of tier category. GB_{2016} value of emission factor was applied.

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 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 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[7] Coll. on air and Decree of the Ministry of the Environment of the Slovak Republic No 410/2012 Coll[8]. 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 abatments as well.

The emission from NEIS database is not possible to fully implement into the national emission inventories due to valid of the legislation. In addition, ammonia emissions for goats and turkeys missing entirely in the database due to lack of law. The best practice for the NH_3 estimation is nitrogen budget. Nitrogen budget is 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. All parameters and final implied emission factors differ during all time-series in the Slovak inventory approach. 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.

[7] Act of the Ministry of the Environment of the Slovak Republic no.137/2010 Coll. Of 3 March 2010

[8] 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_{2016} using country-specific parameters and national input data from the ŠU SR[9]. The ŠU SR not dispose of official information about abatements. Therefore, in the NEIS, as mentioned above, the abatement information from farms are available. The declines are available for the 2010-2017 time series, but only 2016 and 2017 were implemented, due to the incomplete database.

Table A6.1: *Efficiency of abatements*

ABATEMENTS	EFFICIENCY OF ABATEMENTS
Daily spread	25%
Grounding injection	50%
Pulling spreading	90%
Storage of manure with covering	80%
Biogas station	25%
Scrubbers	90%
Storage of liquid manure with natural crust	40%
Floating LECA balls, Hexa-Covers	60%
Incorporation within 12 hours	50%
Incorporation within 24 hours	30%

The farms from 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_{2016} as tier 2 approach for cattle, sheep, goats, swine horses and poultry. Nitrogen excretion rate for the swine category is calculated based on the nitrogen content of the feed according to the IPCC 2006 GL methodology. After emission calculations, emissions were multiplied with abatement share:

$$\mathrm{Emissions}_{\mathrm{NH_3\ without\ abatments}} = \mathrm{E} * \mathrm{P}_{\mathrm{abatements}}$$

$$\mathrm{Emissions}_{\mathrm{NH_3 with\ abatement}} = \mathrm{Emissions}_{\mathrm{NH_3 without\ abatement}} - (\mathrm{Emissions}_{\mathrm{NH_3 without\ abatementn}} * \mathrm{K}_{\mathrm{reduction}})$$

Where: $\mathbf{Emissions}_{\mathbf{NH_3 with\ abatement}}$= emissions after application of abetments v Gg, $\mathbf{K}_{\mathbf{reduction}}$= abatement efficiency $\mathbf{Emissions}_{\mathbf{NH_3 without\ abatement}}$= emissions before application of abetments v Gg, **E=**Emissions in Gg $\mathbf{P}_{\mathbf{abatements}}$= share of abatement

A6.3 RESULTS AND CONCLUSIONS

The comparison of two emission sets with abetments in ***Figure A6.1***and without abatements is visible in ***Figure A6.2***. The trend has more decrease character in ***Figure A6.1***, due to the implementation of several measures. The reason for the application was reducing the cost of air pollution feast in the farms resulting from the current legislation.

Figure A6.1: *Trend of NH_3 emissions in Gg with abatements*

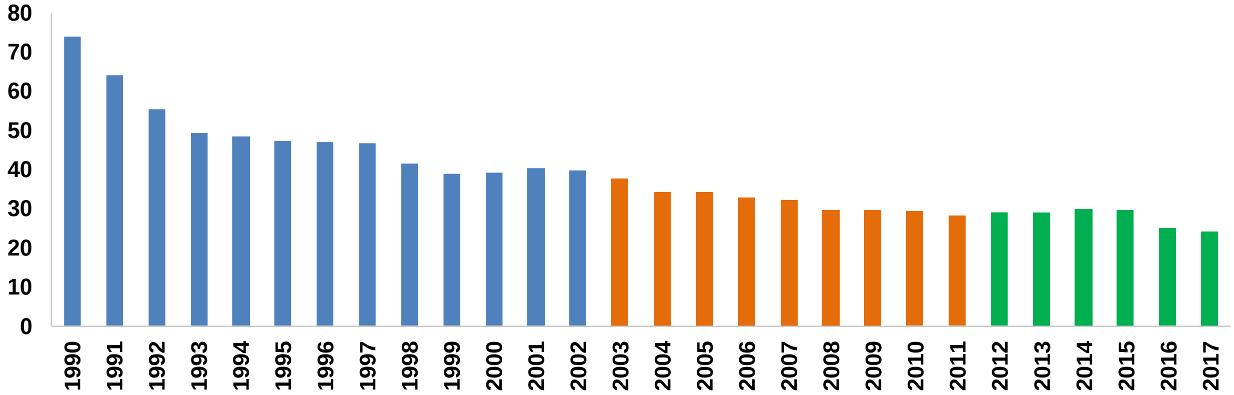


Figure A6.2: *Trend of NH_3 emissions in Gg without abatements*

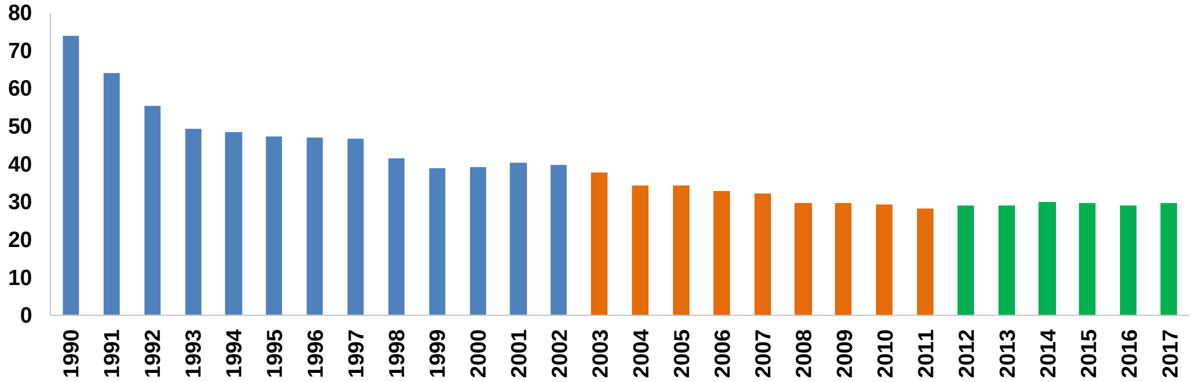


Table A6.2: *Distribution of applied abatements in 2016*

ABATEMENTS	DAIRY CATTLE	NON-DAIRY CATLE	SHEEP	BREEDING SWINE	MARKET SWINE	HORSES	LAYING HENS	BROILERS	TURKEYS
Biogas station	0.11%	0.07%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%	0.00%
Additives in the feeding ration	0.06%	0.25%	0.00%	0.88%	0.90%	0.00%	0.37%	0.57%	0.00%
Storage of manure with covering	14.69%	13.12%	7.14%	10.59%	9.14%	22.58%	2.61%	3.41%	10.71%
Storage covering with nature products (straw, sawdust)	0.23%	0.11%	0.00%	0.59%	0.18%	0.00%	8.58%	0.57%	0.00%
Storage of liquid manure with crust	5.95%	6.18%	3.90%	5.59%	7.35%	0.00%	5.22%	17.05%	5.36%
Floating LECA balls, Hexa-Covers	0.23%	0.25%	0.00%	1.18%	1.61%	0.00%	0.00%	0.00%	0.00%
Sold manure	0.97%	0.40%	0.00%	1.18%	1.25%	0.00%	0.00%	0.00%	0.00%
No measures	1.32%	2.01%	4.55%	2.94%	3.05%	3.23%	2.24%	2.84%	8.93%
Other mitigation measures	2.00%	1.15%	0.65%	2.06%	2.51%	0.00%	0.00%	0.00%	0.00%
Free spreading	5.49%	5.14%	0.00%	10.88%	13.26%	0.00%	1.49%	0.28%	0.00%
Incorporation within 24 hours	0.97%	1.22%	0.00%	1.18%	1.61%	0.00%	0.75%	1.70%	1.79%
Incorporation within 12 hours	1.09%	1.33%	1.95%	3.82%	3.58%	3.23%	49.25%	34.66%	37.50%
Deep injection	0.63%	0.29%	1.95%	8.53%	8.42%	0.00%	10.07%	0.00%	1.79%
Grounding injection	1.83%	2.09%	5.19%	1.47%	1.25%	3.23%	0.75%	1.42%	3.57%
Pulling spreading	0.17%	0.18%	0.00%	0.59%	0.54%	0.00%	0.00%	0.28%	0.00%
Sold manure	11.95%	12.33%	0.00%	12.35%	8.06%	3.23%	0.75%	1.99%	1.79%
No measures	0.80%	0.65%	0.00%	1.18%	1.61%	0.00%	0.00%	0.00%	0.00%
Other mitigation measures	16.87%	17.01%	20.78%	17.06%	15.05%	25.81%	4.10%	5.11%	3.57%
Scrubbers	7.03%	7.01%	7.14%	4.41%	3.94%	9.68%	0.75%	1.70%	0.00%
Daily spread	15.49%	17.51%	44.16%	7.94%	10.39%	29.03%	9.70%	23.01%	16.07%
No measures	12.12%	11.69%	2.60%	5.59%	6.09%	0.00%	3.36%	5.40%	8.93%

Table A6.3: *Distribution of applied abatements in 2017*

ABATEMENTS	DAIRY CATTLE	NON-DAIRY CATTLE	SHEEP	BREEDING SWINE	MARKET SWINE	HORSES	LAYING HENS	BROILERS	TURKEYS
Biogas station	0.12%	0.07%	0.00%	0.00%	0.21%	0.00%	0.00%	0.00%	0.00%
Additives in the feeding ration	0.00%	0.18%	0.00%	1.04%	0.83%	0.00%	0.37%	0.57%	0.00%
Storage of manure with covering	14.98%	12.87%	7.41%	9.34%	8.47%	16.00%	2.61%	3.41%	10.71%
Storage covering with nature products (straw, sawdust)	0.12%	0.07%	0.00%	0.69%	0.21%	0.00%	8.58%	0.57%	0.00%
Storage of liquid manure with crust	6.14%	6.56%	3.09%	3.81%	4.96%	4.00%	5.22%	17.05%	5.36%
Floating LECA balls, Hexa-Covers	0.23%	0.26%	0.00%	1.38%	1.24%	0.00%	0.00%	0.00%	0.00%
Sold manure	1.11%	0.41%	0.00%	1.38%	1.45%	0.00%	0.00%	0.00%	0.00%
No measures	1.29%	2.21%	4.94%	3.46%	3.10%	4.00%	2.24%	2.84%	8.93%
Other mitigation measures	1.87%	1.18%	0.62%	2.08%	2.27%	0.00%	0.00%	0.00%	0.00%
Free spreading	5.38%	4.94%	0.00%	10.38%	13.22%	0.00%	1.49%	0.28%	0.00%
Incorporation within 24 hours	0.99%	1.18%	0.00%	1.04%	1.45%	0.00%	0.75%	1.70%	1.79%
Incorporation within 12 hours	1.35%	1.44%	1.85%	5.19%	4.75%	4.00%	49.25%	34.66%	37.50%
Deep injection	0.53%	0.22%	1.85%	9.00%	9.30%	0.00%	10.07%	0.00%	1.79%
Grounding injection	1.87%	2.10%	6.17%	1.04%	1.24%	4.00%	0.75%	1.42%	3.57%
Pulling spreading	0.23%	0.18%	0.00%	0.69%	0.62%	0.00%	0.00%	0.28%	0.00%
Sold manure	12.23%	12.43%	0.62%	12.80%	8.26%	4.00%	0.75%	1.99%	1.79%
No measures	0.82%	0.63%	0.00%	1.38%	2.07%	0.00%	0.00%	0.00%	0.00%
Other mitigation measures	15.92%	16.15%	19.75%	16.26%	14.46%	20.00%	4.10%	5.11%	3.57%
Scrubbers	7.67%	7.52%	8.02%	4.50%	3.93%	12.00%	0.75%	1.70%	0.00%
Daily spread	15.27%	17.74%	42.59%	8.65%	11.57%	32.00%	9.70%	23.01%	16.07%
No measures	11.88%	11.65%	3.09%	5.88%	6.40%	0.00%	3.36%	5.40%	8.93%