


Informative Inventory Report

2018

Hungary

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Unit of National Emissions Inventories

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CONTENT

ES Executive Summary 5

1 General 6

1.1 National Inventory Background 6

1.2 Institutional arrangements 10

1.3 Inventory preparation process 11

1.4 Methods and data sources 12

1.5 Key Categories 15

1.6 QA/QC and verification methods 17

1.7 General uncertainty evaluation 18

1.8 General Assessment of Completeness 18

2 Explanation of key trends 20

2.1 Key trends 20

3 Energy (NFR sector 1) 29

3.1 Overview of sector 29

3.2 General methodological description 31

3.3 Energy Industries (NFR Code 1A1) 33

3.4 Manufacturing Industries and Construction (NFR Code 1A2) 44

3.5 Transport (NFR sector 1A3) 52

3.6 Other Sector (NFR sector 1.A.4) 69

3.7 Fugitive emissions from fuels – NFR sector 1.B 75

3.8 References 93

4 INDUSTRIAL PROCESSES AND PRODUCT USES (NFR sector 2) 94

4.1 Overview of sector 94

4.2 Mineral Products (NFR sector 2.A) 98

4.3 Chemical industry (NFR sector 2.B) 107

4.4 Metal Production (NFR sector 2.C) ... 116
4.5 Product uses (NFR sector 2D) ... 122
5 Agriculture (NFR sector 3.) ... 143
5.1 Sector overview ... 144
5.2 Trends in emissions ... 145
5.3 NFR 3B Manure management ... 154
5.4 NFR 3D Agricultural soils ... 183
5.5 NFR 3F Field Burning of Agricultural Residues ... 199
5.6 QA/QC and verification ... 202
5.7 Recalculations ... 207
5.8 Planned improvements ... 211
5.9 References ... 212
6 WASTE ... 214
6.1 Biological treatment of waste - Solid waste disposal on land (NFR Code 5A) ... 214
6.2 Biological treatment of waste - Composting (NFR Code 5B1) ... 216
6.3 Biological treatment of waste - anaerobic digestion at biogas facilities (NFR Code 5B2) .. 217
6.4 Waste Incineration (NFR Code 5C1) ... 218
6.5 Open burning of waste (NFR Code 5C2) ... 222
6.6 Wastewater Handling (NFR Code 5D) ... 223
6.7 OTHER Waste (NFR Code 5E) ... 225
7 Other and Natural emissions ... 227
8 Recalculations and Improvements ... 228
8.1 Recalculations ... 228
8.2 Planned improvements ... 228
9 Projections ... 229
9.1 ENERGY ... 229
9.2 INDUSTRIAL PROCESSES AND PRODUCT USE ... 232

9.3 AGRICULTURE 234

9.4 WASTE 236

10 Reporting of gridded emissions and LPS 237

11 Adjustments 248

11.1 Introduction 248

11.2 Accepted adjustments 250

12 Annex-1 Key category analysis 252

13 Annex-2 Verification 256

14 Annex-3 Responses to the NECD Review of the 2018 inventory submission 259

15 Abbreviations 262

ES EXECUTIVE SUMMARY

Hungary, as a party of the Convention on Long-range Transboundary Air Pollution (CLRTAP), is required to inventory emissions of air pollutants. The list of pollutants, the reporting years and the calculation methodologies are defined by several Protocols of the Convention.

The main purpose of this Informative Inventory Report is to describe the input data and calculation methodologies on which the emissions estimates are based thus increasing the transparency of the inventory. The full inventory is presented in table format called NFR.

The 2020 submission contains (partly recalculated) time-series for all years between 1990-2018 (2000-2018 in the case of TSP, PM10 and PM2.5).

Since the 2012 submission the latest version of the Guidebook has been used, i.e. the current submission is based on the 2019 EMEP/EEA Guidebook. Large part of the preparation of NFR and IIR has been assigned to the Unit of National Emissions Inventories of the Hungarian Meteorological Service since 2011. Thank to this fact the availability of data and possibility of verification have significantly improved, because in many cases the same data sources are needed for the preparation of air pollutant emission inventory and the greenhouse gas inventory (especially in the case of activity data). As a consequence, UNFCCC reporting of indirect greenhouse gases and CLRTAP reporting became more consistent.

In the following table the total emissions of the main pollutants are summarized. The values are mostly well below the commitments of Hungary of National Emission Ceiling Directive (Directive 2001/81/EC) for 2010 and the years after, but the commitments of Hungary within the amended Gothenburg Protocol for 2020 have not yet been reached. However, due to significant revisions of the biomass use in the residential sector, new estimates of NMVOC emissions have exceeded the ceiling. Further comparisons are presented below in chapter 1.2 of the IIR.

Table ES.1 Total emissions in Hungary

	1990	**1995**	**2000**	**2005**	**2008**	**2010**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
NOx (kt)	**245,6**	**189,9**	**186,8**	**177,5**	**160,5**	**146,1**	**128,5**	**126,1**	**124,4**	**126,5**	**119,5**	**120,6**	**120,1**
NMVOC (kt)	**311,0**	**214,5**	**194,5**	**178,1**	**142,3**	**139,0**	**143,8**	**141,2**	**130,8**	**132,8**	**134,2**	**131,2**	**125,3**
SOx (kt)	**829,8**	**614,1**	**427,3**	**43,0**	**35,9**	**30,5**	**30,6**	**29,4**	**26,1**	**24,3**	**23,2**	**27,9**	**22,9**
NH3(kt)	**134,2**	**79,2**	**84,4**	**79,5**	**72,4**	**70,9**	**71,3**	**73,2**	**74,0**	**78,2**	**79,0**	**79,7**	**78,5**
PM2.5(kt)	**NR**	**NR**	**48,1**	**40,0**	**36,2**	**49,8**	**58,2**	**58,8**	**49,6**	**51,9**	**50,0**	**47,9**	**41,5**
PM10(kt)	0,0	0,0	72,3	72,3	64,7	72,1	73,7	77,9	72,9	73,9	70,8	66,7	62,3
TSP(kt)	0,0	0,0	105,4	133,1	115,7	107,2	91,5	105,4	109,8	108,0	101,8	92,8	92,5
CO(kt)	1420,1	951,2	828,0	670,0	477,1	519,5	543,4	536,5	458,1	443,7	434,6	422,9	362,0
Pb (t)	815,4	142,8	18,8	10,6	11,1	8,3	9,3	8,8	8,4	8,9	9,0	8,7	8,2
Cd (t)	1,7	1,6	1,7	1,2	1,2	1,5	1,7	1,7	1,5	1,6	1,5	1,5	1,4
Hg (t)	3,1	2,2	2,0	1,6	1,2	1,1	1,1	1,0	1,0	1,1	1,0	1,2	1,0
PCDD/F (g I-Teq)	109,7	74,7	80,8	61,8	52,4	76,4	86,5	80,7	70,7	78,9	77,4	66,6	59,3
PAHs (t)	79,3	30,4	25,6	23,8	20,5	28,7	34,5	34,8	28,3	29,5	30,1	29,6	24,4

1 GENERAL

1.1 NATIONAL INVENTORY BACKGROUND

1.1.1 CLRTAP- CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Present Informative Inventory Report is required by the Convention on Long-range Transboundary Air Pollution ratified by Hungary in 1980.

Table 1.1 HU ratification dates of CLRTAP and its Protocols

	Signature	Ratification*	
1979 Convention (a)	13. 11. 1979	22. 09. 1980	R
	Base year	Ratification*	
1984 EMEP Protocol (b)	-	08.05.1985	Ap
1985 Sulphur Protocol (c)	*1980*	11. 09. 1986	R
1988 NO_X Protocol (d)	*1987*	12. 11. 1991	Ap
1991 VOC Protocol (e)	*1988*	10. 11. 1995	R
1994 Sulphur Protocol (f)	*1980*	11. 03. 2002	R
1998 Heavy Metals Protocol (g)	*1990*	19. 04. 2005	R
1998 POPs Protocol (h)	*1990*	07. 01. 2004	R
1999 Gothenburg (Multi-effect Protocol) (i)	*1990*	13. 11. 2006	Ap

*Notes: * R = Ratification, Ap = Approval*

(a) **Convention on Long-range Transboundary Air Pollution**, adopted 13.11.**1979 in Geneva**, entry into force 16.3.1983.

(b) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), adopted 28.9.**1984 in Geneva**, entry into force 28.1.1988.

(c) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent, adopted 8.7.**1985 in Helsinki**, entry into force 2.9.1987.

(d) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, adopted 31.10.**1988 in Sofia**, entry into force 14.2.1991.

(e) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, adopted 18.11.**1991 in Geneva**, entry into force 29.9.1997.

(f) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Further Reduction of Sulphur Emissions, adopted 14.6.**1994 in Oslo**, entry into force 5.8.1998.

(g) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Heavy Metals, adopted 24.6.**1998 in Aarhus** (Denmark), entry into force 29.12.03

(h) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants, adopted 24.6.**1998 in Aarhus** (Denmark), entry into force 23.10.03.

(i) Protocol to the 1979 Convention on Long-range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone, adopted 30.11.**1999 in Gothenburg** (Sweden), entry into force 17.05.05.

Reporting requirements

Reporting is based on Guidelines for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/97), which include NFR (Nomenclature for Reporting) reporting template and recommended structure of IIR. The latest version of the Annex IV template (NFR09 format) is used for reporting of emissions.

The latest reported year is always the year two years before the submission (e.g. in 2016 the latest reported year is 2014).

NFR Table of Hungary is available at: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2016_submissions/

The required reporting of time series by pollutants:

YEARLY: MINIMUM **(**and *ADDITIONAL)*

A. National totals:

1. Main pollutants: SO_X, NO_X, NH_3, NMVOC, CO: 1990–x-2
2. Particulate matter: $PM_{2.5}$, PM_{10}, TSP, BC: 2000–x-2
3. Heavy metals: Pb, Cd, Hg / (*As, Cr, Cu, Ni, Se, Zn):* 1990–x-2
4. POPs: 1990–x-2

B. Sector emissions:

1. Main pollutants: SO_x, NO_X, NH_3, NMVOC, CO: 1990–x-2
2. Particulate matter: $PM_{2.5,}$ PM_{10}, TSP, BC: 2000–x-2
3. Heavy metals: Pb, Cd, Hg / (*As, Cr, Cu, Ni, Se, Zn):* 1990–x-2
4. POPs: 1990–x-2
5. Activity data: 1990–x-2

The same reporting format is required by NEC Directive (National Emission Ceiling Directive (Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants).

Updated Guidelines (ECE/EB.AIR/125) for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution and updated EMEP/EEA Guidebook (EMEP/EEA 2013 a follow-up of earlier versions of CORINAIR and EMEP/EEA Guidebooks) as technical guidelines are applied from present submissions.

Update of the Guidelines affected also the Annexes, so the format and content of the Reporting Tables has also changed. HU has used the "NFR14" template and the new NFR codes as required by the ECE/EB.AIR/125. In addition, data for BC (black carbon) is also reported for the first time.

Definition of pollutants

The list and definition of the substances to report is also slightly changed between the two versions of ***Guidelines for Reporting Emission Data Under the Convention on Long-Range Transboundary Air Pollution (ECE/EB.AIR/97 and 125)*** as it is presented in the following Tables. HU reports all substances for all years where calculation method in the 2016 EMEP/EEA Guidebook is available and data availability permits.

1.2. Table: Substances for which there are existing emission reporting obligations

Annex I of ECE/EB.AIR/*97 (OLD)*	*ECE/EB.AIR/125 – **Definitions***
Sulphur oxides (SO_X) **means all sulphur compounds, expressed as sulphur dioxide (SO_2). The major part of anthropogenic emissions of sulphur oxides to the atmosphere is in the form of SO_2 and, therefore, emissions of SO_2 and sulphur trioxide (SO_3) should be reported as SO_2 in mass units. Emissions of other sulphur compounds such as sulphate, sulphuric acid (H2SO4) and non-oxygenated compounds of sulphur, e.g. hydrogen sulphide (H_2S), are less important than the emissions of sulphur oxides on a regional scale. However, they are significant for some countries. Therefore, Parties are also recommended to report emissions of all sulphur compounds as SO_2 in mass units.**	**Sulphur (SO_x)** which means all sulphur compounds expressed as sulphur dioxide (SO_2) (including sulphur trioxide (SO_3), sulphuric acid (H_2SO_4), and reduced sulphur compounds, such as hydrogen sulphide (H_2S), mercaptans and dimethyl sulphides, etc.);
Nitrogen oxides (NO_x) **means nitric oxide and nitrogen dioxide, expressed as nitrogen dioxide (NO_2).**	**Nitrogen oxides**, which means nitric oxide and nitrogen dioxide, expressed as nitrogen dioxide (NO_2);
Ammonia (NH_3)	**Ammonia (NH_3)**
Non-methane volatile organic compounds (NMVOCs) **means any organic compound, excluding methane, having a vapour pressure of 0.01 kPa or more at 293.15 K, or having a corresponding volatility under the particular conditions of use. For the purpose of these Guidelines, the fraction of creosote which exceeds this value of vapour pressure at 293.15 K should be considered as an NMVOC.**	**Non - methane volatile organic compounds (NMVOCs)** , which means, all organic compounds of an anthropogenic nature, other than methane, that are capable of producing photochemical oxidants by reaction with nitrogen oxides in the presence of sunlight;
Heavy metals **(i.e. cadmium, lead, mercury) and their compounds.**	**Cadmium (Cd)** and its compounds; **Lead (Pb)** and its compounds; **Mercury (Hg)** and its compounds;
Persistent organic pollutants: (polycyclic aromatic hydrocarbons (PAHs**), dioxins and furans (**PCDD/F**) and hexachlorobenzene (**HCB**).**	**Polycyclic aromatic hydrocarbons (PAHs)**; **Dioxins and furans " (PCDD/F)**; **PCBs;** **HCB**
	Particulate matter (PM) which is an air pollutant consisting of a mixture of particles suspended in the air. These particles differ in their physical properties (such as size and shape) and chemical composition. Particulate matter refers to: (i) **$PM_{2.5}$** or particles with an aerodynamic diameter equal to or less than 2.5 micrometers (µm); (ii) **PM_{10}** or particles with an aerodynamic diameter equal to or less than 10 (µm) ;
	Carbon monoxide (CO)

Table 1.3 HU commitments of NEC Directive and Gothenburg Protocol

	Fixed emission level for 1990	HU commitment for 2010 (and until 2020)		Hungarian emission in 2020 inventory submission								
		NEC	Gothenburg Protocol	2010	2011	2012	2013	2014	2015	2016	2017	2018
SOx(kt)	1010	500	550	**30**	**34**	**31**	**29**	**26**	**24**	**23**	**28**	**23**
NOx (kt)	238	198	198	**146**	**137**	**129**	**126**	**124**	**126**	**119**	**121**	**120**
NH3 (kt)	124	90	90	**71**	**72**	**71**	**73**	**74**	**78**	**79**	**80**	**78**
NMVOC (kt)	205	137	137	**139**	**143**	**144**	**141**	**131**	**133**	**134**	**131**	**125**

The Gothenburg Protocol was amended in 2012 to include national emission reduction commitments to be achieved in 2020 and beyond and introduces emission ceiling for fine particulate matter (PM2.5) as well. The new commitments are not absolute (Gg) emission levels anymore, but % reduction commitments relative to emission level of year 2005 within the most up-to-date (continuously recalculated) emission inventory submission. The new commitments of Hungary are presented in the following table together with the actual status of relative reduction.

Table 1.4 Base year emissions and reduction percentages for 2020 defined by the amended Gothenburg Protocol

	Hungarian emission inventory submission 2019		Gothenburg Protocol commitment	*present status of compliance*	
	Emission of year 2005	Emissions of year 2018	% reduction compared to 2005 level	*% change compared to 2005 level in 2018*	*% distance from 2020 commitment in 2018*
NO_x(kt)	**177**	**120**	**-34%**	*-32%*	*-2%*
VOC (kt)	**178**	**125**	**-30%**	*-30%*	*0%*
SO_2 (kt)	**43**	**23**	**-46%**	*-47%*	*1%*
NH_3 (kt)	**79**	**78**	**-10%**	*-1%*	*-9%*
PM2.5 (kt)	**40**	**42**	**-13%**	*4%*	*-17%*

Note: Red = at present commitment not achieved

1.2 INSTITUTIONAL ARRANGEMENTS

The minister responsible for the environment has overall responsibility for the CLRTAP reporting.

He is responsible for the necessary institutional, legal and procedural arrangements, and for the strategic development of the inventory. Since the Ministry of Environment and Water had been abolished after the elections in spring 2010, its main tasks have been taken over by the Ministry of Rural Development and from 2014 the Ministry of Agriculture. Within this ministry, a State Secretariat for Environmental Affairs was established with the following tasks: promotion of sustainable development, preservation of air, water and soil quality, and the protection of natural assets.

The preparation of the inventory has always been a joint effort of several institutions and experts. In the end of 2011, the Ministry of Rural Development has contracted the Hungarian Meteorological Service for the compilation of the NFR tables and preparation of a substantial part of the IIR (except for road transport, aviation and projections). Transport emissions were estimated by KTI Institute for Transport Sciences Non-profit Ltd.).

At the end of 2006, a Greenhouse Gas Inventory Division (GHG division) was established in the Hungarian Meteorological Service (HMS - OMSZ) for the preparation and development of the GHG inventory required by UNFCCC (United Nations Framework Convention on Climate Change). This division is responsible for most inventory related tasks, compiles the emission inventories and other reports with the involvement of external institutions and experts whenever necessary. In 2015, the name of the division was changed to Unit of National Emissions Inventories.

The Hungarian Meteorological Service is a central office under the control of the Ministry of Agriculture. The duties of the Service are specified in a Government Decree from 2005. The financial background of operation is determined in the Finances Act. HMS has introduced the quality management system ISO 9001:2000 for the whole range of its activities in 2002 to fulfill its tasks more reliably and for the better satisfaction of its partners. The Unit of National Emissions Inventories of the Hungarian Meteorological Service coordinates the work with other involved ministries, government agencies, consultants, universities and companies in order to be able to draw up the yearly inventory report and other reports to the Convention, the UNFCCC and the European Commission.

1.3 INVENTORY PREPARATION PROCESS

The annual inventory cycle is aimed to be carried out in accordance with the principles and procedures set out in the UNECE Emission Reporting Guidelines (ECE/EB.AIR/125). As a general method of preparing the inventory, the procedures described in the 2016 EMEP/EEA Guidebook are applied.

As described above, the GHG Division at the Hungarian Meteorological Service contributes largely to the inventory therefore the following synergies can be utilized. There is a well-functioning national system in relation with the UNFCCC reporting with all the necessary institutional, legal and procedural arrangements. The availability of data (and possibility of verification) has significantly expanded thank to the fact that in many cases the same data sources are needed for the preparation of air pollutant emission inventory (especially in the case of activity data) and the GHG Inventory. The government decree No. 278/2014 (replacing 528/2013. and earlier 345/2009.) delegates data provision rights relating data needed for the preparation of the GHG Inventory to the GHG Division of the HMS. It can also be built on the QA/QC activities carried out regularly by the GHG team. A high-level archiving system secures the availability of the electronic databases and all the calculations and background information.

Usually, the sectoral experts are responsible for the choice of methods and emission factors. According to the recommendations of the EMEP/EEA 2016, the calculation methods are chosen by taking into account the technologies available in Hungary whenever possible. The calculation of emissions occurs basically by using the formula: AD x EF, where the activity data (AD) can be raw material or product or energy use etc. Part of the available data (e.g. production data) can directly be entered into the formula above; others required previous processing and conversion. For example, energy data are not always available in the required depth and resolution. The default emission factors (EF) are being gradually replaced by country-specific emission factors characteristic of domestic technologies. Efforts are made to use the highest possible Tier method, especially in case of key categories. After preliminary quality control of the basic data, the necessary calculations are carried out by the core team. After other necessary QC steps, NFR table is filled in and the assigned chapters of IIR report are prepared.

The official submission is made then by the Ministry of Agriculture.

1.4 METHODS AND DATA SOURCES

General description of methodologies, emission factors and activity data

Different data sources are taken into account during preparation of NFR for activity data and emission factors as well.

The data sources for activity data include: Hungarian Central Statistical Office (HCSO), National Energy Balance, activity data reported by companies for UNFCCC reporting (CRF) purposes and other international statistics (FAOStat, EUROSTAT), and EU ETS database (verified greenhouse gas emissions database held by the National Inspectorate for Environment, Nature).

These data sources became available owing mainly to the present situation that the same HMS unit was contracted for the preparation of CLTRAP and NEC reporting as the preparation of the Greenhouse Gas Inventory. In Hungary HMS is responsible for the coordination and compilation of the GHG Inventory required by UN Framework Convention of Climate Change (UNFCCC). At the very end of 2009, a new government decree on data provision relating to GHG emissions was put into force. This decree (amended in 2014) assures the availability of data needed for the preparation of the GHG Inventory.

Emission factors used are taken from 2019 EMEP/EEA Guidebook and 2006 IPCC Guidelines.

LAIR

In several cases emission data reported directly by individual companies are taken into account during preparation of CLRTAP reporting. This database is available in the ***Hungarian Air Emissions Information System (LAIR)*** as a segment of the National Environmental Information System (OKIR) operated by the Ministry of Agriculture and updated by the Regional Inspectorates for Environment Nature.

The database is partly available for the public at: http://www.okir.hu/en/lair

The emission data of LAIR is reported yearly by companies covered by Government Decree 306/2010. (XII. 23.) and all companies covered by Directive on Integrated Pollution Prevention and Control (2008/1/EC) and 166/2006/EC Regulation on European Pollutant Release and Transfer Register (E-PRTR) (amended by Industrial Emissions Directive).

Technologies (emission sources) and the related emission limit values prescribed for companies covered by Govt. Decree 306/2010 are listed in Ministerial Decree 4/2011 (I.14) VM. This list is mainly taken from Annexes on ELVs of Gothenburg Protocol and other technology specific EU regulations.

The method and frequency of the required measurement are regulated in the Ministerial Decree 6/2011 (I.14.) VM. This decree prescribes the use of accredited laboratory and the implementation of continuous measurement systems for large emitters.

LAIR as part of the Hungarian Environmental Information System has been migrated into a new database in the beginning of 2015. From 2015 all data provisions are to be completed electronically.

The list of pollutants to be reported into the Air Emissions Information System database can be found in Annexes of Government Decree 306/2010 (XII. 23.). It contains mostly the pollutants covered by E-PRTR and IPPC (and several additional). However, there is no reporting threshold for the pollutants, the operators report only those pollutants, which are included in their environmental permit. The environmental permits are of course issued based on the legal instruments mentioned before, but the implementation (e.g. the content of the environmental permits) is not fully consistent across the regional Inspectorates for Environment Nature. This causes some inconsistencies within the country level database.

Emission of pollutants is reported in kg/year, but unfortunately no activity data or data on fuel use is available for inventory preparation process at the moment.

In addition, high precaution is needed to use the data of this system, since the list of pollutants are not the same as the needs of NRF reporting (especially for NMVOC (separate organic compound are reported and not in group), solid particles (no PM10 and PM2.5 fractions are reported but "dust"). This is probably due to the fact that IPPC and E-PRTR (replaced by IED) do not explicitly require the grouping of organic compounds and disaggregation of particulate matter emissions. Both EU regulation (IED; proposal on medium combustion plants, etc.) and updated Gothenburg Protocol Annex X contain emission limit values (ELV) only for TSP/"dust" and not for PM10 and PM2.5. Therefore, when plant specific data is used in the case of particulate matter emissions, the proportion of PM10 and PM2.5 emissions is calculated from TSP based on proportion of T1 or T2 emission factors for TSP/PM10/PM2.5.

In addition, the completeness and quality of data reported by the individual companies have to be compared with other data sources, such as national statistics, EU ETS data, etc. There are several further characteristics of the data from LAIR which requires specific attention or might be regarded as disadvantageous

- It is available only from year 2002. So, whenever LAIR data is used there is a need of change of method, splicing, extrapolation, etc. before 2002, in order to be able to report the entire time series.

- Combustion and process emissions are not always separated in LAIR. (The reporting is disaggregated by point sources, so it depends on the situation and environmental permit whether the combustion emissions and process emissions use the separate stacks or not.) In these cases, it is not possible to divide emissions between sector 1 (Combustion) and sector 2 (industrial processes) in NFR.

The advantage of the use of directly reported emissions is that it includes also the abatement techniques implemented unlike the most default factors. Also, reporting is continuously improving due to the enforcement actions of the regional Inspectorates for Environment, Nature.

Due to the above-mentioned facts, the data from this system is used only in cases when needs of NFR reporting and data available in the system exactly matches (the same pollutant and the complete group of polluters are covered) and/or the completeness and reliability of data is assured. Thus, data is verified with other data sources (sometimes with TIER1 approach of Guidebooks) or there is no other data source available. The use of directly reported emissions is prioritized in the case the above-mentioned criteria are met. It is worth mentioning that LAIR has been used for EPER/E-PRTR reporting purposes as well.

In year 2015 the LAIR database has been completely renewed and restructured. In some cases, also facility data have been updated. In these cases, old and new data have been compared and recalculations have been performed where the changes are justified.

IPPC permitting

Hungary is a Member State of the EU since 2004. So, it is important to state that air polluting facilities in Hungary are regulated based on EU requirements. For example, 2008/1/EC Directive on Integrated Pollution Prevention and Control replaced now by directive on industrial emissions 2010/75/EU (IED) which describes the use of BAT is implemented and enforced. Compliance is regularly checked by the regional Inspectorates for Environment, Nature.

In order to present the implementation of IPPC Directive in Hungary, please find below some short quotation from *Reports submitted by Member States on the implementation of directive 2008/1/EC, Directive 2000/76/EC, Directive 1999/13/EC and further development of the web platform to publish the information*

*(*http://eea.eionet.europa.eu/Public/irc/eionet-circle/reporting/library?l=/ippc/implementation_2006-2008/main_reports&vm=detailed&sb=Title

"The IPPC (unified environment utilization) permits are issued by the regional environment, nature and water authorities, currently there are 10 of them."

"The content requirements of applications for unified environmental permits of the Gov. Decree include the submission of all information mentioned in Art. 6 of the Directive.

BAT guides were prepared (full translations, Hungarian summaries and national guidelines adapted to Hungarian circumstances)." (Available at www.ippc.hu *)*

"Facilities falling within the scope of the Gov. Decree shall provide data in line with the provisions of the permit. Data shall be provided on the template form published in the official journal of the Ministry of Environment and Water or on electronic data carriers. The operators shall perform their data provision obligation in line with the provisions of the permit. The unified environmental permit contains the measurement and supervision/monitoring requirements that are necessary to follow up the environmental effects of the activity. It specifies the measurement method and frequency, the evaluation process and the method, content and frequency of the mandatory data provision to the authorities. Unless provided otherwise by the authority, the authorized person shall provide data at least annually. The data provider is liable for providing all the data and for the quality of the provided data, the accounting rules, statistical system and other registers, measurement and monitoring data. The permits for facilities falling within the scope of the decree shall contain provisions in case of extraordinary kinds of operation (e.g. start-up, immediate stop, malfunction, and cessation of the activity). It shall contain measures that are necessary to prevent extraordinary, unexpected

contaminations, and it shall contain provisions regarding the method and contents of the notification to be sent to the authorities. In case of facilities that are not subject to the Act on civil protection, the operators shall attach the description of measures applicable to operation safety and measures to be implemented in case of accidents.

The Gov. Decree prescribes that the supervising authorities shall visit the facilities falling within the scope of unified environmental permit at least once a year. During the visits, compliance with the provisions of the permit shall be checked, a record shall be taken, and the adequate measures shall be taken, if necessary."

E-PRTR

The European Pollutant Release and Transfer Register (E-PRTR) contains the reported emission data of industrial facilities including the main air pollutants. List of pollutants to be reported and requirements of reporting are regulated by 166/2006/EC Regulation of the European Union (replaced now by directive on industrial emissions 2010/75/EU (IED), which is of course applicable in Hungary too. Facilities falling under the E-PRTR regulation comply with their air pollutant release reporting requirement by the means of the LAIR system described above. Data of LAIR is then checked (and corrected if needed) by local Inspectorates for Environment, Nature and finally prepared for publication by the Ministry responsible for environment.

Hungary has a local website where E-PRTR data ("easily accessible key environmental data from industrial facilities ") is available: http://www.okir.hu/en/eprtr in addition to the European website: http://prtr.ec.europa.eu/

Unfortunately, in the case of particulate matter, heavy metals, and persistent organic pollutants the coverage, grouping, disaggregation level differs from CLRTAP reporting. In addition, pollutants are to be reported for the E-PRTR only above thresholds determined by the E-PRTR Regulation. In every case it is important to take into consideration that E-PRTR has different objectives than the CLRTAP inventory as it aims to make publicly available the environmental data of big emitters at facility level whilst CLRTAP reporting aims to provide complete, country level information.

Please find comparison of National Total results of the different databases in chapter 1.7.

1.5 KEY CATEGORIES

Please find below the definitions of the 2016 EMEP/EEA Guidebook related to key category and key category analysis:

"A key category is one that is prioritized within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants in terms of the absolute level, the trend, or the uncertainty in emissions. It is good practice for each country to identify its national key categories in a systematic and objective manner. This can be achieved by a quantitative analysis of the relationship between the magnitude of emission in any one

year (level) and the change in emission year to year (trend) of each category's emissions compared to the total national emissions."

A LEVEL assessment was performed to identify key categories using Approach 1.

In Approach 1 the "*key categories are identified using a predetermined cumulative emissions threshold. Key categories are those which, when summed together in descending order of magnitude,* ***cumulatively add up to 80 % of the total level****."*

During a level assessment, the „*contribution of each source category to the total national inventory level"* is assessed in the given year.

Equation for level assessment (Approach 1) of the 2016 EMEP/EEA Guidebook is:

Key category level assessment = |source category estimate |/ total contribution

After definition of the level, the source categories are sorted in descending order of magnitude, and the cumulative total is summed up in the following column. The key categories are where the cumulative total reaches 80% threshold.

Table 1.5 Summary of Approach 1 level key category analysis

key category analysis for the year 2018

Component	Key categories (Sorted from high to low from left to right)														Total (%)
SOx	1A1a (44.3%)	1A4bi (33.0%)	1A2a (4.9%)												82.2
NOx	1A3biii (15.2%)	3Da1 (14.1%)	1A3bi (11.1%)	1A3bii (10.3%)	1A1a (9.1%)	1A4bi (8.9%)	1A4cii (5.9%)	1A4ai (3.4%)	3Da2a (3.3%)						81.3
NH3	3Da1 (24.2%)	3Da2a (19.5%)	3B3 (10.7%)	3B1b (9.0%)	3B1a (8.2%)	3B4gii (5.8%)	1A4bi (5.0%)								82.3
NMVOC	1A4bi (21.2%)	2D3a (9.9%)	3B1b (7.7%)	3B1a (6.7%)	2D3g (5.4%)	2D3d (4.5%)	2H2 (4.4%)	2D3h (4.3%)	1A3bi (3.6%)	1A3bv (3.5%)	2B10a (3.5%)	3De (2.8%)	1A3biv (1.9%)	3B4gii (1.9%)	81.4
CO	1A4bi (66.1%)	1A3bi (15.1%)													81.2
TSP	1A4bi (38.3%)	2A5b (27.6%)	3Dc (7.0%)	2A5a (5.2%)	3B3 (2.9%)										81.0
PM10	1A4bi (54.1%)	2A5b (12.3%)	3Dc (10.4%)	2A5a (3.8%)											80.6
PM2.5	1A4bi (79.2%)	5E (2.0%)													81.2
Pb	1A4bi (26.5%)	1A3bvi (20.4%)	1A1a (15.0%)	2A3 (9.1%)	2G (8.6%)	1B1b (4.4%)									83.9
Hg	2C1 (19.4%)	1A1a (18.6%)	1A4bi (13.5%)	1A2f (10.0%)	2K (9.5%)	2D3a (5.3%)	5C1bv (4.8%)								81.2
Cd	1A4bi (54.8%)	1A1a (10.1%)	2G (4.2%)	2A3 (4.1%)	1A2gviii (3.4%)	2D3i (3.0%)	2C1 (2.9%)								82.6
DIOX	1A4bi (64.0%)	5E (14.0%)	2C1 (5.9%)												83.8
PAH	1A4bi (88.0%)														88.0
HCB	3Df (54.7%)	1A1a (19.9%)	1A4bi (12.6%)												87.3

1.6 QA/QC AND VERIFICATION METHODS

The Hungarian Meteorological Service introduced the quality management system ISO 9001:2000 in 2002. The Unit of National Emissions Inventories has an own, specific ISO procedure, which aims to fulfill the QA/QC requirements of UNFCCC reporting mostly applicable for the CLRTAP reporting as well. Internal ISO audits are conducted every year. The Met. Service passed an in-depth ISO audit in January 2013 during which the activities of the GHG Division were also audited.

ISO procedure regarding the Unit of National Emissions Inventories is used as QA/QC Plan required by the UNFCCC reporting. General elements of this QA/QC Plan are applied in the case of CLRTAP reporting too. In addition, QA/QC Plan has been updated in 2014 in order to extend the provisions regarding CLRTAP reporting too. Please find the English version of the updated QA/QC Plan in Annex 6 of National Inventory Report 2014 MAY submission, available at:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php

In many cases the Hungarian emission data have been compared to data of other EU countries and to the reporting of the EU. It is mentioned in the specific sub-chapters of present IIR, where significant differences have been found.

RepDab Report (available at www.ceip.at) is also generated as an additional QA/QC activity.

Comparison of NFR, LAIR and E-PRTR

Table A2.1 in Annex-2 presents a verification performed using the data sources mentioned in Chapter 1.5, E-PRTR, IPPC and other direct reporting) with NFR (or the relevant sectors of NFR).

It is normal that E-PRTR national totals are always lower than others due to limited scope (reporting is compulsory only above certain amount of emission).

It is also normal that in the case of NOx and CO NFR National Total is much bigger than LAIR and E—PRTR as, transport and residential combustion sectors are significant emitters. Therefore, the SUM of (1A1+ 1A2+ 1A4ai+ 2+ 5C1) NFR sectors is also included in the Table above. In the case of NH3, the SUM of NFR sectors 3B3 (Swine) and 3B4g (Poultry) is also noted in order to facilitate comparison with E-PRTR, where only swine and poultry is regulated.

However, unfortunately, the big difference between the time-series proof that plant specific reporting is very poor in the case of NMVOC and PMs. In the case of SOx, it is possible to observe the strong decline in emission between 2004 and 2005 in all cases.

Verifications with IIASA GAINS model

During the bilateral consultations with IIASA as part of the preparation for the amendment of the NEC Directive held in April-May 2014, national and sectoral totals and key categories have been compared between IIASA GAINS model and HU results.

The recalculated time series by Hungary are much closer to results of IIASA GAINS model.

After the detailed analysis of the remaining differences, further refinements were made from both sides. Several data from IIASA have been implemented for the final time series submitted by Hungary in 2014 May and reasonable suggestions were made to IIASA for correction of some emission factors or activity data.

So, this process might be regarded as a very useful verification exercise.

1.7 GENERAL UNCERTAINTY EVALUATION

A general uncertainty evaluation is one of the planned improvements.

Until country specific expert judgments and uncertainty analysis become available, we would like to quote here "some example on level uncertainty" from various EU Member States in order to emphasize the evident presence of uncertainty in emission estimations:

NOx: 10-74%

SO2: 4 – 88%

PM2.5: 15-349%

NMVOC: 10-85%

(Presented by John van Aardenne (EEA) at the TFEIP 2013 meeting, Istanbul, Turkey http://tfeip-secretariat.org/2013-tfeip-meeting-istanbul/:

European Union emission inventory report 1990–2011 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP))

1.8 GENERAL ASSESSMENT OF COMPLETENESS

Sources Not Estimated (NE)

1.6. Table: Explanation to the Notation key NE

NFR14 code	Substance(s)	Reason for not estimated
2K	POPs	No methodology
All other NE		**Notation of the Guidebook default Tables for the given pollutant(s)**

Sources Included Elsewhere (IE)

1.7. Table: Explanation to the Notation key IE

NFR14 code	Substance(s)	Included in NFR code
1A2a, 1A2b, 1A2f	All, except NO_x, SO_x, CO	Reported in Sector 2 based on suggestion of the Guidebook
1A3di(ii)	All	1A3dii
1A4aii	All	1A4ai
1A4ciii	All	1A4cii
1A5	All	1A4
Sector 2, 3	NO_x, SO_x, CO	Combustion emissions are reported in Sector 1A based on suggestion of the Guidebook.
2 A 5 c; 2 B 10 b; 2 C 7 d	All	Emissions are included in the specific sectors due to the Guidebook.

Categories: Other

1.8. Table: Sub-sources accounted for in reporting codes "other"

NFR09 code	Substance(s) reported	Sub-source description
1A2gviii	All	Lots of manufacturing industries, see Ch. 3.4.3.
1 B 1 c		Not occurring
1B2d		Not occurring
2 B 10 a	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO	Production of sulfuric acid, carbon black, ethylene, propylene, 1,2 diclorethane and vinilcloride balanced, PE (LD and HD), PP, PVC, Polistyrene, Urea, Ammonium nitrate and other fertilizers
2A6, 2C7c, 2H3, 2L		Not occurring
2 G		Not estimated
2D3g	NMVOC	Manufacture of shoes, manufacture of pharmaceutical products
2D3i	NO_x, NMVOC, PMs, HMs, POPs	Consumption of tobacco

2 EXPLANATION OF KEY TRENDS

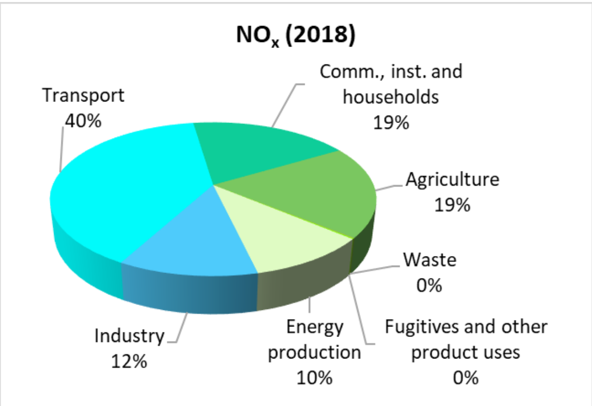
2.1 KEY TRENDS

In the following table the total emissions of the main pollutants are summarized.

Table 2.1 Total emissions in Hungary

	1990	1995	2000	2005	2008	2010	2012	2013	2014	2015	2016	2017	2018
NOx (kt)	**245,6**	**189,9**	**186,8**	**177,5**	**160,5**	**146,1**	**128,5**	**126,1**	**124,4**	**126,5**	**119,5**	**120,6**	**120,1**
NMVOC (kt)	**311,0**	**214,5**	**194,5**	**178,1**	**142,3**	**139,0**	**143,8**	**141,2**	**130,8**	**132,8**	**134,2**	**131,2**	**125,3**
SOx (kt)	**829,8**	**614,1**	**427,3**	**43,0**	**35,9**	**30,5**	**30,6**	**29,4**	**26,1**	**24,3**	**23,2**	**27,9**	**22,9**
NH3(kt)	**134,2**	**79,2**	**84,4**	**79,5**	**72,4**	**70,9**	**71,3**	**73,2**	**74,0**	**78,2**	**79,0**	**79,7**	**78,5**
PM2.5(kt)	**NR**	**NR**	**48,1**	**40,0**	**36,2**	**49,8**	**58,2**	**58,8**	**49,6**	**51,9**	**50,0**	**47,9**	**41,5**
PM10(kt)	0,0	0,0	72,3	72,3	64,7	72,1	73,7	77,9	72,9	73,9	70,8	66,7	62,3
TSP(kt)	0,0	0,0	105,4	133,1	115,7	107,2	91,5	105,4	109,8	108,0	101,8	92,8	92,5
CO(kt)	1420,1	951,2	828,0	670,0	477,1	519,5	543,4	536,5	458,1	443,7	434,6	422,9	362,0
Pb (t)	815,4	142,8	18,8	10,6	11,1	8,3	9,3	8,8	8,4	8,9	9,0	8,7	8,2
Cd (t)	1,7	1,6	1,7	1,2	1,2	1,5	1,7	1,7	1,5	1,6	1,5	1,5	1,4
Hg (t)	3,1	2,2	2,0	1,6	1,2	1,1	1,1	1,0	1,0	1,1	1,0	1,2	1,0
PCDD/F (g I-Teq)	109,7	74,7	80,8	61,8	52,4	76,4	86,5	80,7	70,7	78,9	77,4	66,6	59,3
PAHs (t)	79,3	30,4	25,6	23,8	20,5	28,7	34,5	34,8	28,3	29,5	30,1	29,6	24,4

The following Figures present the distribution of main pollutants by sectors.



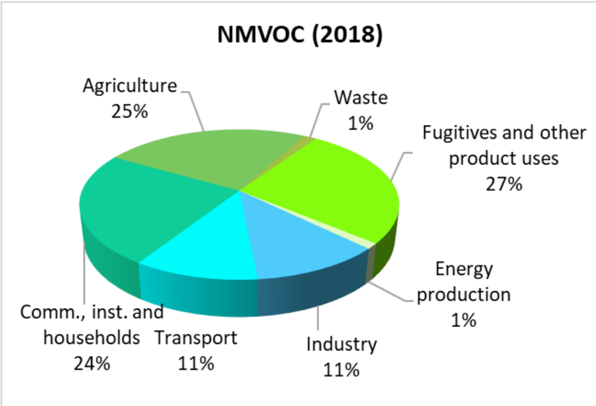


Figure 2.1 *NOx and NMVOC emissions by sectors*

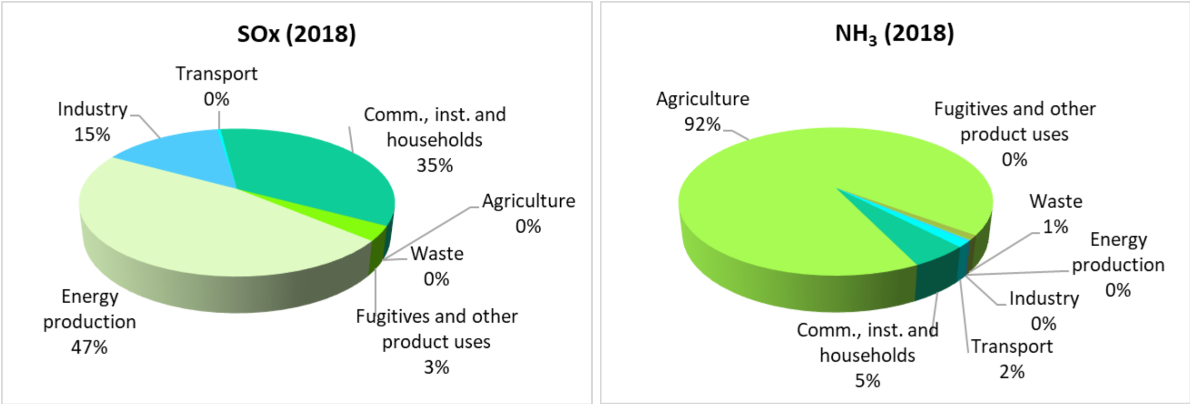


Figure 2.2 *SO_x and NH_3 emissions by sectors*

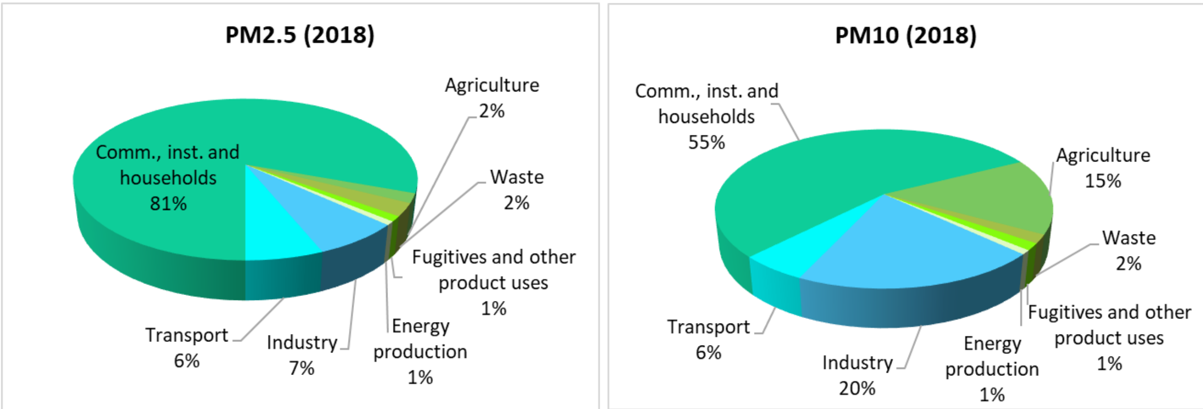


Figure 2.3 *$PM_{2.5}$ and PM_{10} emissions by sectors*

The significant reduction in emissions between 1987 and 1992 was mainly due to the economic transformation after the regime change. In addition, ongoing changes in fuel-structure, i.e. solid fuel as the most important source in the 80’s had been replaced by natural gas, led to further decrease of total emission. The spread of emission abatement technologies introduced either due to environmental regulation or economic drivers results decreasing emissions in general. The global financial and economic crises around 2008-2009 exerted a major impact on the output of the Hungarian economy, consequently on the level of emissions as well.

The substantial reduction in sulphur dioxide emissions is attributable to the decreased use of fossil fuels in general and the decreasing share of coal with higher sulphur content. After 2000, further reductions were observed due to the introduction of SO_2 precipitators in coal-fired power stations. Reduced carbon monoxide emissions compared to 1980 are obviously a consequence of decreased fuel uses and the modification of the car fleet.

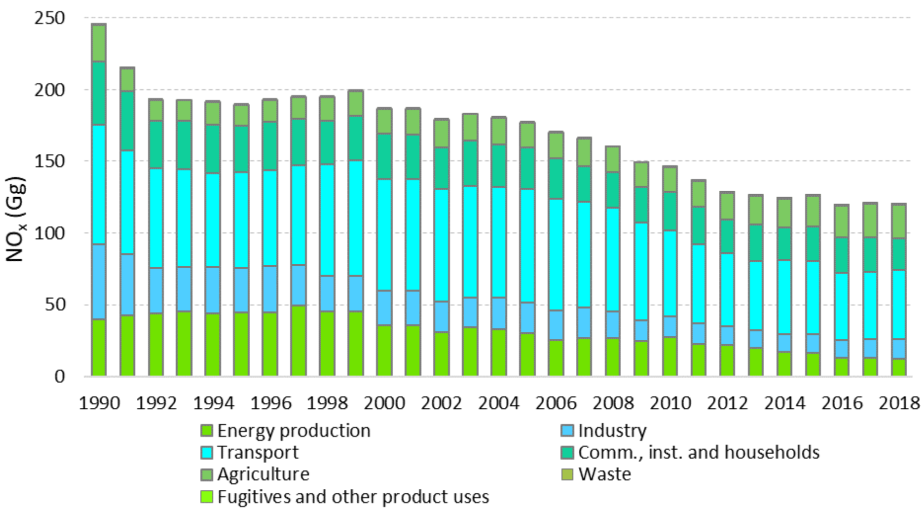


***Figure 2.4** Trend of emission of NO_x (kt)*

***2.2. Table:** Trend of emission of NO_x (kt)*

NOx	1A1 Energy production	1A2+2 Industry	1A3 Transport	1A4 Comm., inst. and households	3 Agriculture	5 Waste	1B+2D+2I-L Fugitives& product uses	SZUM
1990	40,00	52,28	82,86	44,24	25,66	0,23	0,37	245,64
1991	42,59	42,36	72,70	40,94	16,00	0,23	0,35	**215,16**
1992	43,86	31,60	69,51	32,90	14,96	0,21	0,34	**193,39**
1993	44,97	31,40	67,76	34,04	14,21	0,20	0,35	**192,93**
1994	43,67	32,56	65,59	33,68	15,94	0,19	0,32	**191,96**
1995	44,45	31,19	66,55	32,52	14,65	0,20	0,33	**189,89**
1996	44,85	32,34	66,31	34,31	14,82	0,21	0,30	**193,14**
1997	49,33	28,65	69,51	32,40	14,78	0,20	0,31	**195,18**
1998	44,99	25,45	77,61	30,02	16,62	0,20	0,32	**195,21**
1999	45,21	24,90	80,65	30,73	17,22	0,20	0,30	**199,22**
2000	35,83	23,72	78,06	31,37	17,34	0,20	0,30	**186,82**
2001	35,99	23,94	77,70	30,80	17,91	0,20	0,30	**186,84**
2002	31,06	21,17	78,16	29,55	19,09	0,19	0,27	**179,48**
2003	34,07	20,66	78,19	31,19	18,57	0,19	0,26	**183,15**
2004	33,25	21,41	77,10	30,14	18,54	0,19	0,30	**180,94**
2005	29,92	21,76	78,82	29,42	16,96	0,19	0,38	**177,45**
2006	25,67	20,50	77,37	28,33	17,94	0,17	0,16	**170,14**
2007	27,00	20,98	74,05	24,59	19,12	0,19	0,22	**166,14**
2008	26,97	18,42	72,33	24,37	17,98	0,18	0,22	**160,47**
2009	24,80	14,46	68,24	24,48	17,04	0,18	0,18	**149,37**
2010	27,30	14,53	59,82	26,77	17,31	0,20	0,17	**146,10**
2011	22,46	14,75	54,58	26,28	18,11	0,19	0,25	**136,61**
2012	22,04	13,04	51,18	23,31	18,61	0,18	0,15	**128,51**
2013	19,95	12,44	48,17	25,45	19,80	0,17	0,16	**126,14**
2014	16,89	12,81	51,31	23,07	19,94	0,18	0,20	**124,39**
2015	16,63	12,68	51,01	24,27	21,56	0,15	0,16	**126,45**
2016	12,94	12,52	46,56	24,60	22,56	0,14	0,16	**119,48**
2017	13,08	13,07	47,04	23,88	23,25	0,15	0,15	**120,63**
2018	12,26	14,00	47,63	22,62	23,24	0,15	0,17	**120,07**

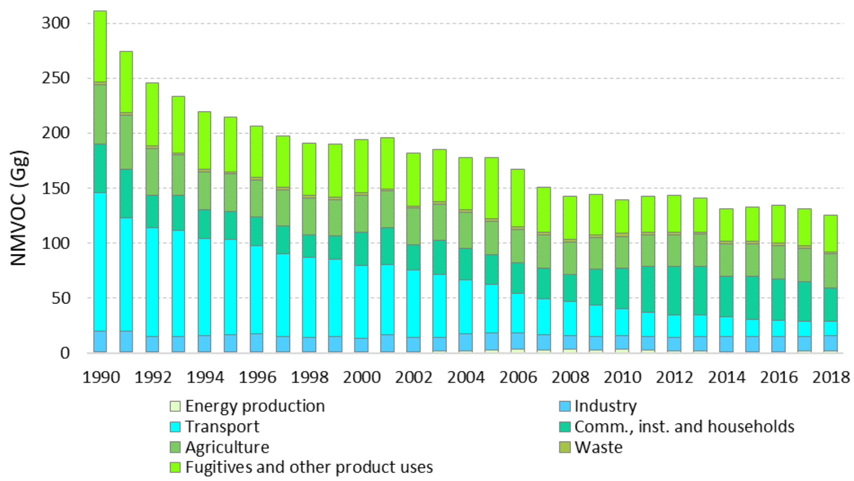


Figure 2.5 *Trend of emission of NMVOC (kt)*

Table 2.3 *Trend of emission of NMVOC (kt)*

NMVOC	**1A1 Energy production**	**1A2+2 Industry**	**1A3 Transport**	**1A4 Comm., inst. and households**	**3 Agriculture**	**5 Waste**	**1B+2D+2I-L Fugitives& product uses**	**SZUM**
1990	0,79	19,30	125,70	44,33	54,07	1,95	64,90	**311,04**
1991	0,83	18,62	103,75	43,69	49,33	1,99	55,73	**273,95**
1992	0,80	14,46	98,93	29,40	42,49	2,01	57,47	**245,56**
1993	0,80	14,06	96,45	31,89	36,74	2,02	51,36	**233,33**
1994	0,75	14,62	88,73	26,56	34,33	2,05	52,25	**219,29**
1995	0,76	15,90	86,58	25,12	34,22	2,09	49,79	**214,46**
1996	0,77	16,93	80,12	25,99	33,70	2,12	46,97	**206,60**
1997	0,84	13,74	75,73	24,82	33,29	2,15	46,87	**197,44**
1998	0,84	13,18	72,99	20,48	33,28	2,18	47,77	**190,73**
1999	0,87	13,92	70,87	20,67	32,91	2,22	48,49	**189,95**
2000	0,79	12,72	65,74	30,56	33,93	2,26	48,46	**194,46**
2001	0,80	15,40	63,96	33,57	33,48	2,27	46,21	**195,69**
2002	0,69	13,80	60,59	22,92	33,62	2,32	47,97	**181,90**
2003	1,46	12,67	57,42	30,63	33,31	2,36	47,19	**185,04**
2004	1,91	15,33	49,60	28,49	32,16	2,38	48,22	**178,09**
2005	2,36	16,20	43,76	26,98	30,70	2,41	55,69	**178,09**
2006	3,10	14,90	36,31	27,89	30,08	2,40	52,15	**166,82**
2007	3,00	13,30	33,30	27,42	30,02	2,61	41,00	**150,66**
2008	3,12	12,96	31,00	23,95	29,69	2,55	39,03	**142,31**
2009	2,99	12,20	28,05	32,61	28,98	2,56	36,69	**144,08**
2010	3,10	12,45	24,95	36,56	28,93	2,61	30,37	**138,98**
2011	2,36	12,91	21,62	41,71	28,63	2,37	33,02	**142,62**
2012	1,72	12,08	20,96	43,86	28,92	2,39	33,83	**143,76**
2013	1,61	13,33	19,31	44,68	29,01	2,17	31,11	**141,22**
2014	1,41	13,44	18,16	36,47	29,58	2,26	29,48	**130,80**
2015	1,34	13,78	15,56	38,69	30,20	1,95	31,31	**132,82**
2016	1,31	13,88	14,71	37,62	30,37	1,86	34,44	**134,19**
2017	1,43	13,77	13,98	35,99	30,11	1,91	34,03	**131,23**
2018	1,46	14,03	13,32	30,29	31,00	1,88	33,33	**125,31**

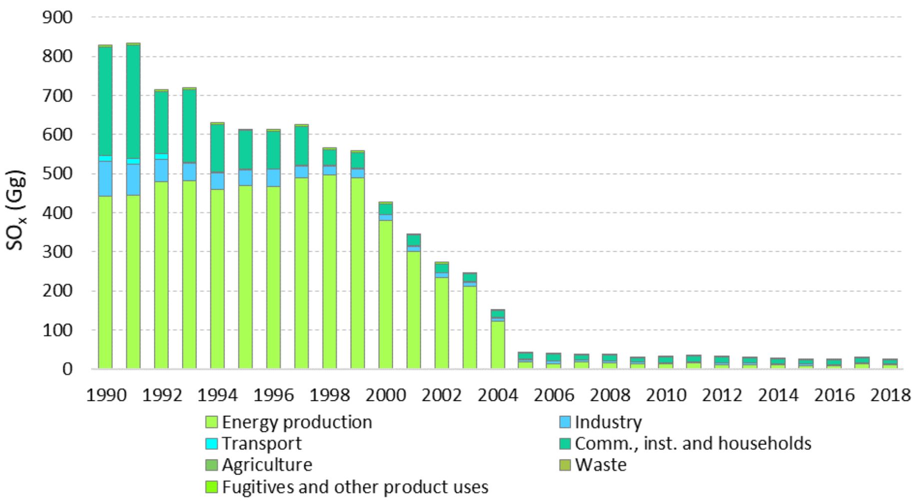


Figure 2.6 *Trend of emission of SO_x (kt)*

Table 2.4 *Trend of emission of SO_x (kt)*

SOx	1A1 Energy production	1A2+2 Industry	1A3 Transport	1A4 Comm., inst. and households	3 Agriculture	5 Waste	1B+2D+2I-L Fugitives& product uses	SZUM
1990	441,07	89,63	16,48	277,32	0,00	0,02	5,26	**829,77**
1991	444,33	78,93	14,43	290,04	0,00	0,01	4,94	**832,69**
1992	478,38	57,19	14,25	160,82	0,00	0,01	4,81	**715,47**
1993	482,15	44,29	2,31	186,26	0,00	0,01	4,98	**720,02**
1994	458,96	43,01	2,26	120,99	0,00	0,01	4,54	**629,77**
1995	469,82	39,86	2,29	97,31	0,00	0,01	4,84	**614,14**
1996	466,92	43,16	2,30	95,20	0,00	0,01	4,38	**611,97**
1997	489,14	30,62	2,43	98,82	0,00	0,01	4,53	**625,55**
1998	495,86	21,96	2,29	41,26	0,00	0,01	4,63	**566,01**
1999	488,12	23,11	1,52	41,27	0,00	0,01	4,51	**558,54**
2000	379,45	14,94	1,51	26,98	0,00	0,01	4,39	**427,28**
2001	300,09	12,71	1,74	27,40	0,00	0,01	4,42	**346,36**
2002	233,50	11,53	1,87	21,58	0,00	0,01	3,89	**272,39**
2003	212,53	9,09	1,88	20,89	0,00	0,01	1,63	**246,04**
2004	122,54	7,36	1,97	18,02	0,00	0,01	1,60	**151,50**
2005	16,88	6,10	1,23	17,17	0,00	0,01	1,62	**43,00**
2006	13,62	5,64	0,08	18,35	0,00	0,01	1,54	**39,23**
2007	17,82	5,43	0,08	11,30	0,00	0,01	1,67	**36,32**
2008	16,38	4,18	0,08	14,51	0,00	0,01	0,75	**35,91**
2009	13,81	3,25	0,07	11,79	0,00	0,01	0,86	**29,80**
2010	12,47	4,06	0,07	13,02	0,00	0,01	0,87	**30,50**
2011	15,03	3,92	0,07	14,47	0,00	0,01	0,83	**34,34**
2012	11,36	3,84	0,06	14,56	0,00	0,01	0,73	**30,57**
2013	11,64	3,19	0,06	13,80	0,00	0,01	0,73	**29,42**
2014	10,63	3,51	0,07	11,21	0,00	0,01	0,63	**26,06**
2015	9,18	3,46	0,07	10,98	0,00	0,01	0,64	**24,35**
2016	7,90	3,25	0,08	11,31	0,00	0,01	0,63	**23,18**
2017	11,86	3,41	0,08	11,86	0,00	0,01	0,63	**27,87**
2018	10,77	3,34	0,09	8,00	0,00	0,01	0,74	**22,95**

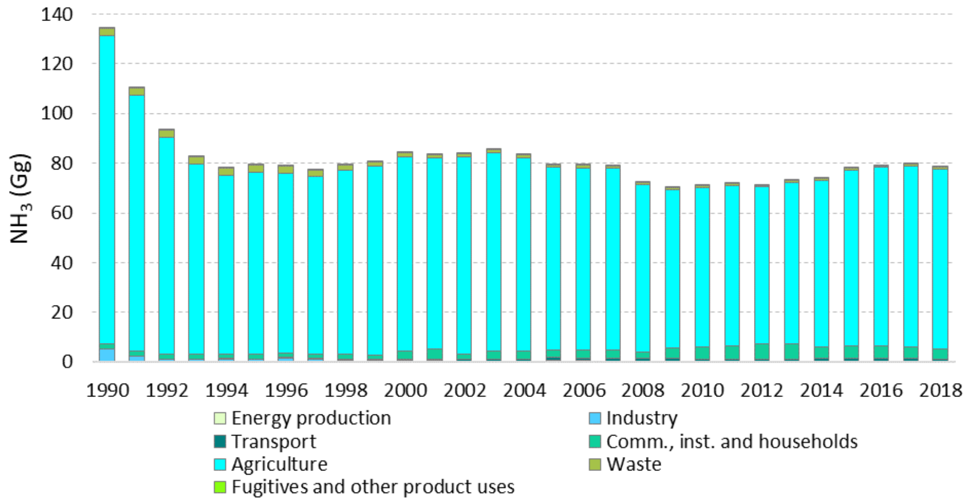


Figure 2.7 Trend of emission of NH_3 (kt)

Table 2.5 *Trend of emission of NH_3 (kt)*

NH3	1A1 Energy production	1A2+2 Industry	1A3 Transport	1A4 Comm., inst. and households	3 Agriculture	5 Waste	1B+2D+2I-L Fugitives& product uses	SZUM
1990	0,00	5,45	0,05	1,85	124,05	2,71	0,12	**134,22**
1991	0,00	2,49	0,04	1,83	103,00	2,68	0,11	**110,16**
1992	0,00	1,22	0,04	1,84	87,41	2,64	0,12	**93,27**
1993	0,00	1,09	0,08	1,92	76,77	2,64	0,13	**82,61**
1994	0,00	1,30	0,13	1,93	71,96	2,63	0,12	**78,06**
1995	0,00	1,01	0,16	1,95	73,41	2,55	0,09	**79,17**
1996	0,00	1,59	0,19	1,89	72,46	2,50	0,08	**78,72**
1997	0,00	1,31	0,25	1,82	71,34	2,35	0,08	**77,15**
1998	0,00	0,94	0,31	1,84	74,08	2,13	0,09	**79,40**
1999	0,00	0,65	0,38	1,88	75,83	1,92	0,08	**80,74**
2000	0,00	0,75	0,41	3,49	78,02	1,65	0,08	**84,40**
2001	0,00	0,56	0,56	3,98	77,02	1,29	0,09	**83,51**
2002	0,00	0,42	0,70	2,31	79,14	1,21	0,09	**83,88**
2003	0,00	0,31	0,74	3,45	79,69	1,13	0,10	**85,42**
2004	0,00	0,37	0,82	3,12	77,94	1,05	0,06	**83,36**
2005	0,00	0,55	1,25	2,91	73,72	0,96	0,07	**79,47**
2006	0,00	0,59	1,12	3,12	73,35	0,88	0,10	**79,17**
2007	0,00	0,49	1,16	3,34	73,05	0,82	0,10	**78,94**
2008	0,00	0,33	1,16	2,77	67,28	0,76	0,10	**72,40**
2009	0,00	0,35	1,15	4,13	63,85	0,71	0,11	**70,30**
2010	0,00	0,27	1,01	4,64	64,25	0,66	0,08	**70,91**
2011	0,00	0,37	0,98	5,37	64,36	0,64	0,09	**71,81**
2012	0,00	0,35	0,99	5,85	63,36	0,62	0,09	**71,26**
2013	0,00	0,40	0,87	6,01	65,13	0,73	0,07	**73,21**
2014	0,00	0,46	0,94	4,87	66,93	0,74	0,07	**74,01**
2015	0,00	0,30	1,08	5,20	70,77	0,73	0,08	**78,15**
2016	0,00	0,38	1,12	5,01	71,70	0,75	0,07	**79,05**
2017	0,00	0,44	1,06	4,73	72,62	0,75	0,07	**79,67**
2018	0,00	0,23	1,05	3,95	72,44	0,73	0,08	**78,48**

Reporting of TSP and PMs is required only starting from year 2000. The decreasing tendency of emissions between 2000 and 2008 is attributable mainly to the spread of installation of electro-filters (ESP). The increasing tendency after 2008 originates from the sector of households.

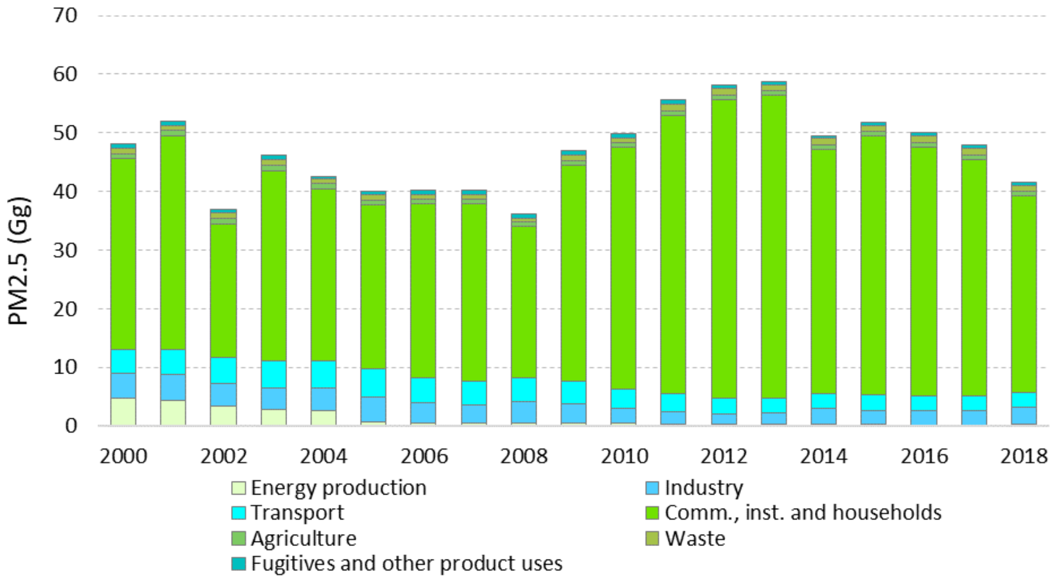


Figure 2.8 *Trend of emission of $PM_{2.5}$ (kt)*

Table 2.6 *Trend of emission of $PM_{2.5}$ (kt)*

PM2.5	1A1 Energy production	1A2+2 Industry	1A3 Transport	1A4 Comm., inst. and households	3 Agriculture	5 Waste	1B+2D+2I-L Fugitives& product uses	SZUM
2000	4,65	4,35	4,04	32,59	0,81	0,99	0,65	**48,08**
2001	4,39	4,40	4,27	36,50	0,82	0,84	0,68	**51,90**
2002	3,30	3,87	4,45	22,82	0,86	1,00	0,68	**36,99**
2003	2,87	3,66	4,59	32,44	0,87	0,98	0,73	**46,14**
2004	2,57	3,87	4,58	29,49	0,84	0,75	0,50	**42,61**
2005	0,71	4,24	4,81	27,98	0,79	0,89	0,56	**39,97**
2006	0,58	3,38	4,32	29,61	0,77	0,83	0,74	**40,23**
2007	0,57	2,93	4,19	30,21	0,77	0,74	0,74	**40,15**
2008	0,54	3,56	4,10	25,75	0,77	0,66	0,77	**36,16**
2009	0,52	3,26	3,85	36,89	0,76	0,88	0,77	**46,93**
2010	0,43	2,49	3,43	41,26	0,77	0,79	0,64	**49,81**
2011	0,34	2,17	2,99	47,46	0,78	1,19	0,67	**55,59**
2012	0,32	1,64	2,74	50,87	0,77	1,21	0,68	**58,23**
2013	0,31	1,92	2,45	51,75	0,77	1,03	0,56	**58,78**
2014	0,24	2,72	2,59	41,71	0,77	0,97	0,57	**49,57**
2015	0,23	2,47	2,70	44,06	0,77	1,06	0,59	**51,89**
2016	0,19	2,45	2,54	42,44	0,78	1,03	0,56	**50,00**
2017	0,21	2,32	2,55	40,38	0,75	1,16	0,50	**47,88**
2018	0,31	2,90	2,55	33,46	0,78	1,07	0,44	**41,52**

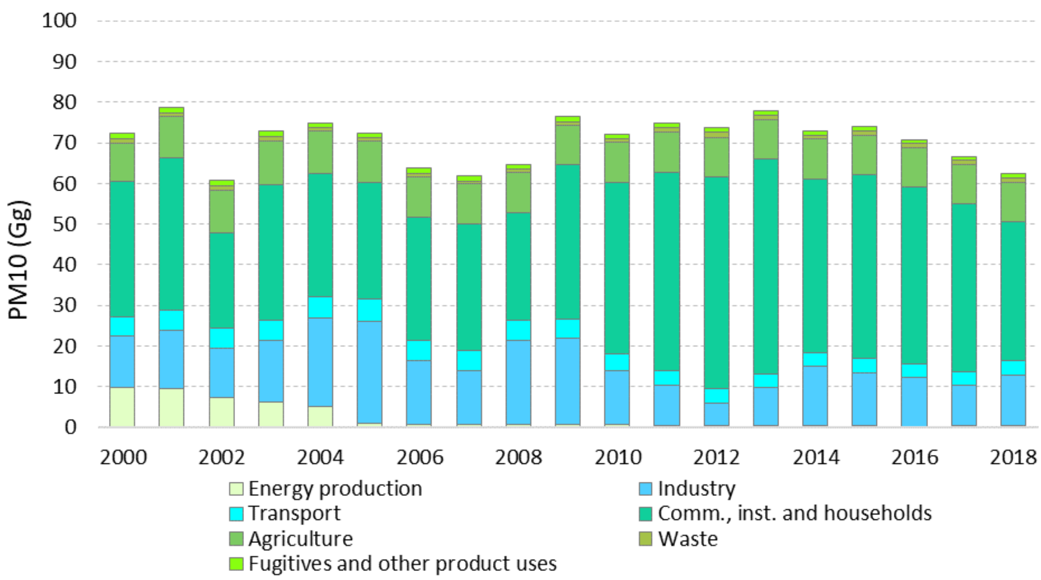


Figure 2.9 *Trend of emission of PM_{10} (kt)*

Table 2.7 *Trend of emission of PM_{10} (kt)*

PM10	1A1 Energy production	1A2+2 Industry	1A3 Transport	1A4 Comm., inst. and households	3 Agriculture	5 Waste	1B+2D+2I-L Fugitives& product uses	SZUM
2000	9,87	12,71	4,51	33,46	9,46	1,02	1,30	**72,33**
2001	9,43	14,52	4,79	37,46	10,28	0,87	1,32	**78,66**
2002	7,40	11,99	5,01	23,45	10,58	1,02	1,27	**60,72**
2003	6,22	15,07	5,18	33,31	10,73	1,01	1,33	**72,85**
2004	5,23	21,72	5,21	30,29	10,47	0,78	1,04	**74,73**
2005	1,10	24,97	5,50	28,74	10,01	0,92	1,03	**72,27**
2006	0,84	15,47	5,08	30,41	9,88	0,85	1,27	**63,80**
2007	0,80	13,19	4,98	30,99	9,90	0,76	1,27	**61,89**
2008	0,75	20,78	4,92	26,43	9,87	0,68	1,27	**64,71**
2009	0,70	21,30	4,66	37,84	9,81	0,91	1,21	**76,44**
2010	0,60	13,23	4,15	42,32	9,90	0,81	1,11	**72,13**
2011	0,50	9,90	3,67	48,68	9,80	1,22	1,16	**74,92**
2012	0,47	5,58	3,40	52,17	9,68	1,24	1,16	**73,70**
2013	0,45	9,50	3,07	53,06	9,72	1,05	1,04	**77,89**
2014	0,41	14,67	3,29	42,76	9,73	1,00	1,05	**72,92**
2015	0,38	13,13	3,47	45,16	9,64	1,08	1,07	**73,95**
2016	0,30	11,91	3,31	43,51	9,68	1,06	1,04	**70,81**
2017	0,34	10,04	3,35	41,41	9,43	1,19	0,94	**66,69**
2018	0,53	12,45	3,41	34,31	9,63	1,09	0,88	**62,30**

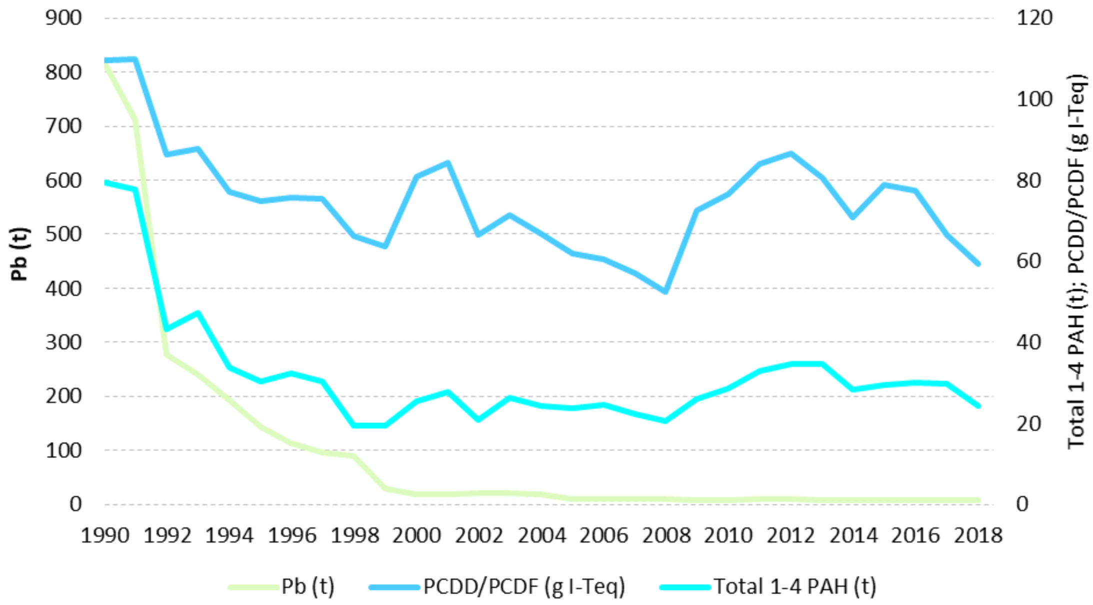


***Figure 2.10** Trend of emission of PAHs (t), dioxins (g I-Teq) and Pb (t)*

The trend of PAH emissions is mainly influenced by the shutdown of the primary aluminium production in Hungary.

In the case of dioxins, the main driver is probably the improvement of combustion and abatement technologies, especially in the case of waste and hazardous waste combustion. In addition, the organized open-air burning e.g. the stubble-field burning, the reed-burning has been forbidden, and also the open-air burning of the garden wastes is strictly limited recently.

The significant decrease of lead emissions is mainly due to the step-wise reduction of the lead content of the leaded gasoline and the effect of the introduction of the unleaded gasoline after 1990

3 ENERGY (NFR SECTOR 1)

3.1 OVERVIEW OF SECTOR

This sector covers emissions from combustion processes and fuel-related fugitive emissions from exploration, transmission, distribution and conversion of primary energy sources.

Starting with fuel combustion, for a better understanding of the principal drivers behind fossil fuel related emission trends and variations, the main characteristics of the Hungarian Energy System will be described shortly in the following. First of all, there are not enough, cheap, clean domestic energy resources of good quality in Hungary, therefore the energy demand has to be met by import to a great extent. In 2018, primary energy production amounted to 462.3 PJ which was by 25 per cent less than in 1990 and more or less at the same level as in 2005. Most importantly, uneconomical deep coal mines were closed down, but also crude oil and natural gas production decreased. In contrast, imports of energy with 1028.2 PJ in 2018 were by 55% and by 13% larger than in 1990 and 2005, respectively. As the share of production in consumption is about 41%, our import dependency is quite significant. The primary energy use of Hungary was 1126.5 PJ in 2018 which was by 7% and 5% below the levels in 1990 and 2005, respectively. Since 2014, however, primary energy consumption has increased by 12%.

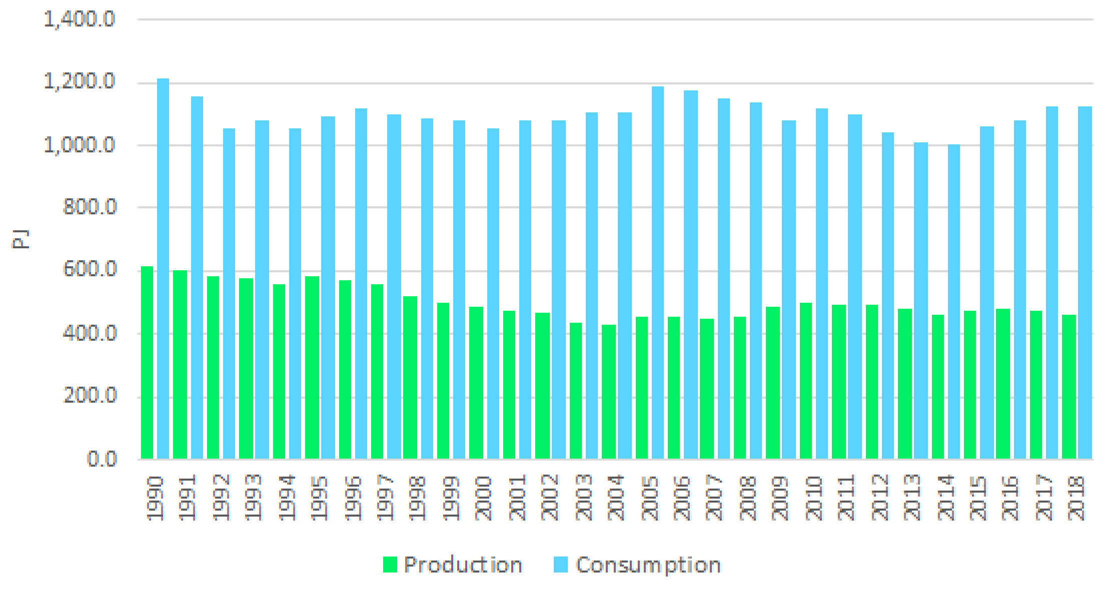


Figure 3.1 *Primary energy balance of Hungary (1990-2018)*

In 2018, final domestic electricity use amounted to 40,595 GWh, which was by 2% higher compared to the previous year and the highest in the whole time series. Since 2014, electricity consumption increased by 13%. The market penetration of the nuclear electricity started in 1983 in Hungary when the first 440 MW block of the Nuclear Power Plant in Paks was put into service. Recently, around 50 per cent of the domestic generated electricity is produced by nuclear energy whereas the share of fossil fuels decreased to 40% in 2013 and remained below that level afterwards. According to the official statistics of the Hungarian Energy and Public Utility Regulatory Authority, the share of electricity from renewable sources in gross final consumption of electricity increased from 4.4% is 2005 to 8.3% in 2018. The last few years saw significant increases in solar electricity production (from 1 GWh in 2011 to 620 GWh in 2018) and also wind power production increased to 607 GWh in 2018 from 10 GWh in 2005. At the same time, electricity produced from combustible fuels decreased from 21,710 GWh in 2005 to 14,671 GWh in 2018.

The main drivers behind the annual changes in emissions are the following: (1) yearly changes in fuel use, (2) changes in the fuel-mix, (3) changes in the chemical characteristics of fuels (e.g. sulphur content), and (4) changes in applied technologies (e.g. abatement). The first two aspects are visualized in *Fig 3.2*.

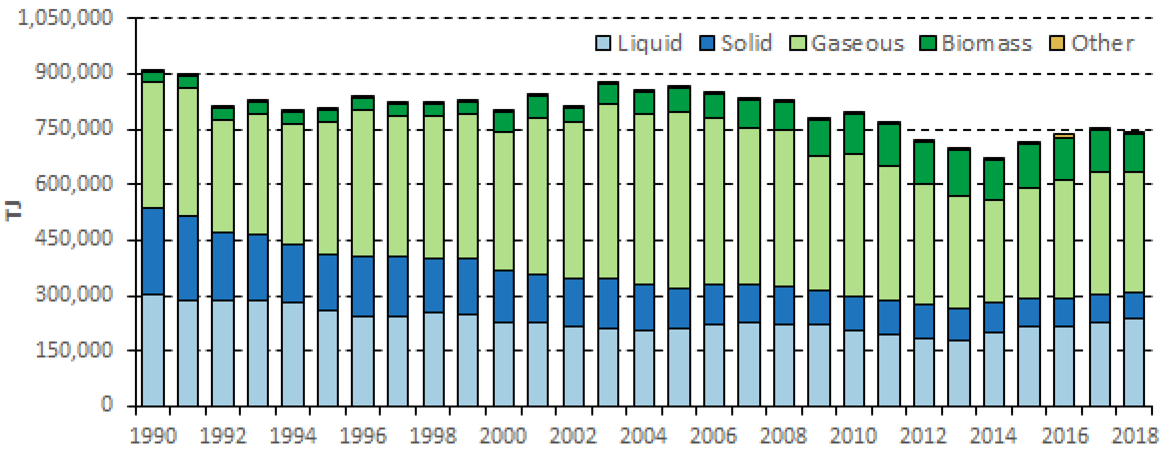
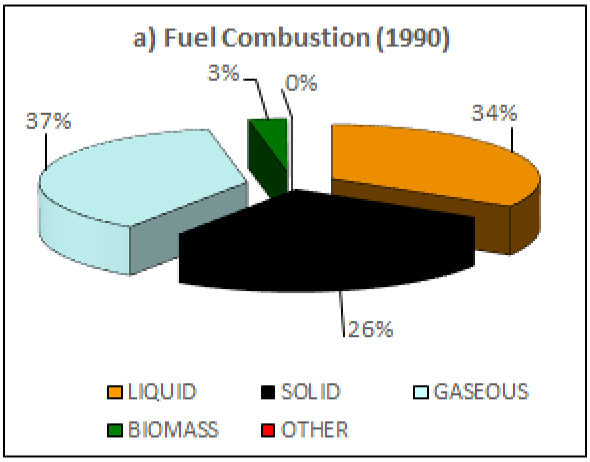


Figure 3.2 *Fuel combustion from 1990 to 2018*

This figure clearly demonstrates the effects the regime change around 1990 when the fuel use suddenly decreased by more than 20 per cent. Also, the global economic crisis made its influence felt with a 6 per cent drop between 2008 and 2009. Combustible energy consumption decreased further between 2010 and 2014 by 16%. However, the decreasing trend stopped and fuel consumption has increased again since 2014 by 12%. Beside these significant changes in overall fuel combustion, the share of the different fuel types, i.e. the fuel-mix, changed throughout these decades. The importance of liquid and solid fuels diminished whereas natural gas became the dominant fossil fuel. Biomass use increased too. Figure 3.3 compares the proportion of combusted fuel types in 1990 and 2018. It is worth mentioning that, within the period investigated, some classical types of fossil fuels have disappeared or their use decreased significantly, e.g. city-gas, heavy fuel oil (by destructive technologies it has been transformed to motor fuels and partly petrol-coke is produced from it). At the same time, the market penetration of new fuel types became significant e.g. petrol-coke, bio-ethanol, LPG and compressed natural-gas (CNG) for cars and buses, biomass for firing in power plants, biogas produced by fermentation of sludge and animal carcasses etc. All these changes were taken into consideration in our emission calculations.



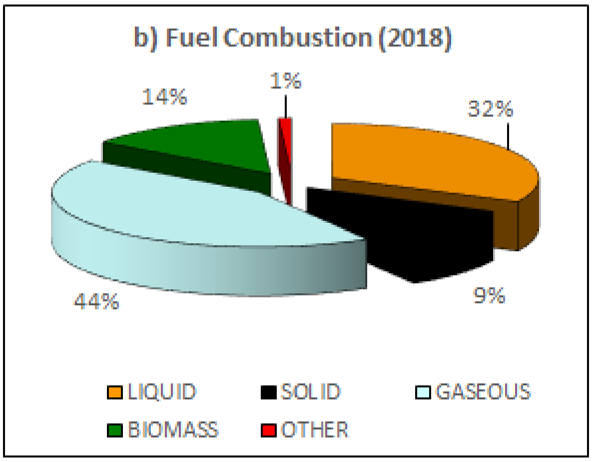


Figure 3.3 *Fuel combustion in 1990 (a) and 2018 (b)*

3.2 GENERAL METHODOLOGICAL DESCRIPTION

The emissions calculations are based on the common method of using emission factors. For 1990-2018, the methodology described in the latest EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 was used for all sectors, including this one. Whenever default emission factors were applied, these were generally taken from this very guidebook. In many cases country-specific factors seemed more appropriate. Besides, plant specific measurements were taken into account for important sources. These cases and the used country specific or measured values are documented in the relevant category level of the IIR.

Whatever the emission factors might be, the first step is to determine the relevant activity data that is the energy use of fuels per activity. For this submission, the IEA/Eurostat Annual Questionnaires have been used mostly for the entire time series. (Former inventories were partly or fully based on Hungarian Energy Statistical Yearbooks. The publication of the yearbooks ceased; the last one contained statistics for the year 2010. After consultations with the national energy statistics provider, i.e. the Hungarian Energy and Public Utility Regulatory Authority, it was decided to build recent and future inventories on IEA annual questionnaires.)

To increase consistency of the time series, we had to make some minor amendments of the allocation of fuel consumption compared to the IEA annual questionnaires, as follows:

- Based on 2011-2017 data allocations and value added volumes of industrial production for previous years, some gasoil consumption has been reallocated from road transport to non-road mobile machinery (1A2gvii);
- The time series of gasoil use in navigation has been improved by interpolation where the missing amounts were taken again from road transport;
- Some natural gas use has been reallocated between petroleum refining (1A1b) and autoproducer plants (1A2gviii) to increase consistency with fuel consumption reported by the refinery under the ETS;

- Further natural gas consumption has been reallocated between other energy industries (1A1c) and commercial/institutional (1A4a) to reflect fuel consumption in oil and gas extraction. Data on natural gas production served as basis of extrapolation here;

The fuel use and emissions of autoproducer plants (that generate electricity or heat, wholly or partly for their own use as an activity which supports their primary activity) are accounted for in this inventory mostly under other stationary combustion (1A2gviii) which means not under the relevant economic sector and not in energy industries. There are, however, some exceptions from this general approach. Coke oven gas and blast furnace gas are reallocated from autoproducers to iron and steel, and to manufacture of solid fuels. Some industrial waste incineration is reallocated to energy industries, and to the source category 1A4a (commercial/institutional). In addition, all emission from an autoproducer new power plant is allocated to the category pulp and paper. Knowing the order of magnitudes, this might not have led to large allocation errors, since in 2018 only 4 PJ of fuel combustion was allocated to autoproducer use compared to 161 PJ energy use by public power plants.

The problem of the network losses in the natural-gas transmission and distribution system should be also mentioned here. These losses are not technical ones in the reality, but the result of accounting. After discussing the situation with the experts of the natural gas industry, only about one third of the losses reported in statistical publications is taken into consideration as real loss (i.e. that is emitted into the atmosphere as methane), while the remaining two-third is assumed to be fired. This one-third figure is more or less in line with our fugitive methane emission estimate from transportation and distribution of natural gas reported to the UNFCCC. Thus, the natural gas consumption in the residential sector is not the same as reported in the IEA natural gas annual questionnaire because 50 per cent of the network losses are added to it. (As recent information from the energy statistics provider indicated that natural gas used on compressor stations was allocated to distribution losses for previous years therefore we reallocated about 1-2 PJ natural gas consumption to pipeline transport based on IEA data of total consumption, and that is why we changed our previous approach and add only 50% of the network losses to residential consumption instead of 66%.)

Gas engines, as their emission characteristics are somewhat different, are treated separately in our calculations. The Hungarian Energy and Public Utility Regulatory Authority collects data like installed capacity, the fuel used (whether it’s biogas or natural gas), fuel consumption, and where they’re operating (e.g. which company or institute). Based on these data, the fuel consumption could be distributed among different user groups or sectors for some years, however, natural gas use in gas engines is taken into account only in the energy industries source category.

The Hungarian Energy Office, the predecessor of the Hungarian Energy and Public Utility Regulatory Authority, provided also data on fuel use and emissions (SO_2, NO_x, CO) from electricity and CHP plants with installed capacity larger than 50 MWe for the period 1995-2010. This made possible to calculate emissions for every power plant separately, thus taken into consideration the specialties of the different power plants. Further official databases including emission measurements were at our disposal. The Hungarian Meteorological Service, as the greenhouse gas inventory compiler institute, has direct access to the EU ETS database with detailed plant by plant fuel use data. The National Environmental Information System is a huge database containing among others emission data from almost all fuel combustion above the threshold of 140 kW_{th}. Emission data reported in line with the LCP Directive were also used, and obviously the publicly available E-PRTR data are worth a look, even if not for the latest reported year considering the reporting deadlines.

Our approach for the current inventory was as simple as follows: if we had reliable measurement data, we used them. Otherwise emissions were calculated based on country and year specific activity data and default emission factors from the 2019 EMEP/EEA Guidebook were applied with a few exceptions, especially regarding SO_2 emissions from solid fuels, or PCDD/F emissions from waste incineration. All data used and consideration made will be described specifically in the relevant category level of this chapter.

3.3 ENERGY INDUSTRIES (NFR CODE 1A1)

This subsector includes facilities generating electricity, district heating stations, oil refineries and coking and briquetting plants.

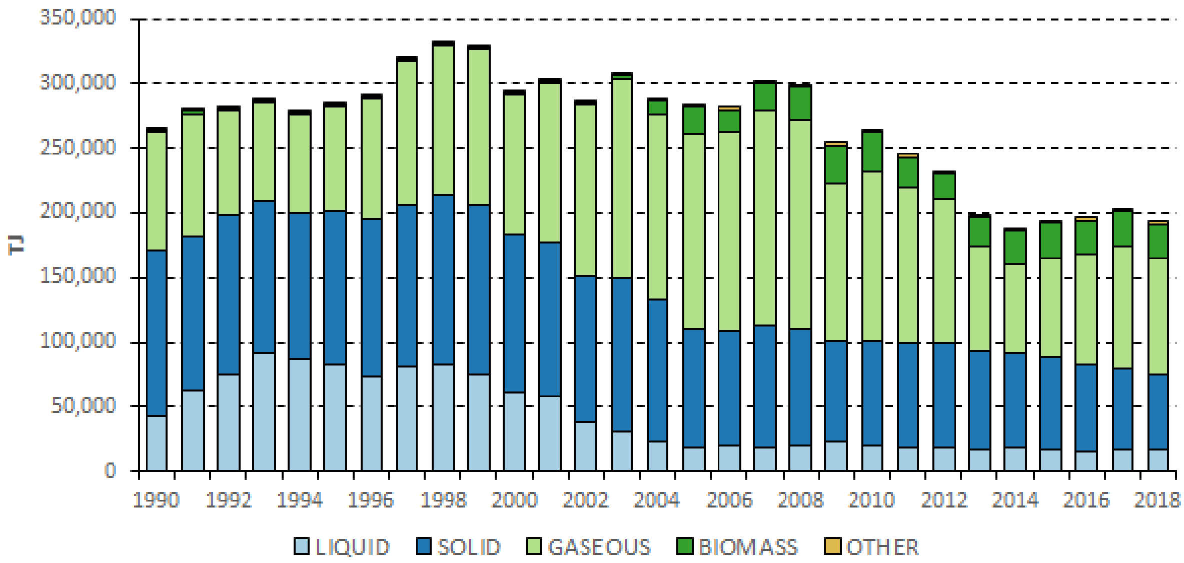


***Figure 3.4** Fuel combustion in energy industries (1990-2018)*

As it can be seen in *Figure 3.4*, total fuel consumption (without nuclear energy) in the energy industries sector shows strong fluctuations. After a significant decrease around the political and economic regime change in 1990, we could experience some increase till 1998, then a slight decrease till 2005 and a more pronounced drop after 2008 due to the global financial crisis. After 2010, until 2014, fuel consumption has reached record low values every year. In 2015, however, the decreasing trend stopped, and we observed a 6% increase in energy use. Within the inventory period, the consumption of liquid and solid fuels has decreased significantly. In contrast, the consumption of natural gas has increased until 2007 to a great extent then it shrunk substantially afterwards. The biomass use due to burning co-burning in power plants has become more and more important and exceeded in amount the liquid fuel use in 2005. In 2006 the greatest power plant of Hungary reduced biomass-use, because the amount of obligatory purchased electricity was less than in 2005, this is also illustrated on *Figure 3.4*. In 2007 the produced electricity increased by more than 11%, in parallel the fuel consumption (mainly natural gas) increased only by 9%, because the efficiency of natural gas combustion is better than that of the others. Biomass burning in power plants became again popular on favorable terms, which was induced by the EU carbon trading. In 2008, the produced electricity from fossil fuels and also the fossil fuel consumption of this sector decreased again, but the total generated electricity – including nuclear, waste and renewable sources – was a bit higher than in the previous year. In 2009, the electricity generation in Hungary was by 10% less than in 2008. The generation decrease of power plants of 50 MW and higher capacity was 11.6% while it was 2.8% in case of small power plants. The fuel-mix also changed in 2009: coal and natural gas consumption decreased, however liquid fuel use increased, but its contribution to total fuel consumption is very low. Use of nuclear, waste and renewable sources continued to increase. In 2010 domestic electricity production increased again by 4%.

In 2011, electricity production fell back by 4% which meant lower fuel use at power plants. Moreover, the decrease in fossil fuel use was more pronounced, whereas there was only a slight change in air pollution irrelevant nuclear fuel use.

In 2012, gross electricity production fell back by a further 4%. Moreover, the decrease in natural gas-based electricity production was the most pronounced (-12.5%), whereas the share of air pollutant neutral nuclear fuel has steadily grown in the last few years, and wind energy utilization showed a steep increase. In addition, electricity import grew significantly by 16% in 2012.

This trend continued and even intensified in 2013. Domestic electricity production has dropped by a further 13 per cent. At the same time, net import grew by 49 per cent!

The overall picture did not change in 2014, either. We experienced decreasing production levels (-3%) and increasing import (+13%). In fact, net import was never higher in the whole period (1980-2015) than in 2014, and electricity production was never lower since 1990 (see Fig. 3.5).

In 2015, the share of import remained at a quite high level (31%). At the same time, production increased by 3% mainly due to a 20% growth in production of natural gas fired plants.

And production increased further in 2016 by 5%. Again, we could observe a large growth in natural gas-based power production (+27%). At the same time, the share of import remained at a quite high level (28%).

And the growth in electricity production did not stop in 2017, either (3%). Natural gas firing power plants produced 20% more electricity than in 2016. The share of import did not change significantly.

The growing trend stopped in 2018, electricity production decreased by 3% whereas import grew by 11%

Fuel consumption of oil refining showed a pronounced drop around 2000 but remained more or less at the same level afterwards. In the last two years, however, increasing fuel consumption could be observed. Currently, the share of the refinery's fuel consumption is about 14% within energy industries. Less significant is manufacture of solid fuels and other energy industries with a portion of 2-4%.

3.3.1 PUBLIC ELECTRICITY AND HEAT PRODUCTION (NFR CODE 1A1A)

Reported Emissions: Main Pollutants, Particulate Matter, CO, Priority Heavy Metals, Other Heavy Metals, POPs
Measured Emissions: NO_X, SO_X, TSP, CO, (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, PCDD/F)
Methods: T1, T2, T3
Emission factors: D, PS
Key source: NOx, SOx, Pb, Hg, Cd, HCB

Public Electricity and Heat Production was responsible for about 85% of fuel use in energy industries. According to a publication of the Hungarian Energy and Public Utility Regulatory Authority ("Data of the Hungarian Electricity System 2018"), "the energy consumption of the electricity generation (condensation and cogeneration) in 2018 was 329,708 TJ, 3.34% less than in the previous year. In 2018, 52.06% of the used energy sources consisted of nuclear fuel. Natural gas made up 18,69%, while coal made up 15.18% of the energy sources. The renewable energy sources provide 9.3% of the total energy source consumption of power plants."

Domestic electricity production showed an overall increasing trend up till 2008; even during the years of the regime change around 1990, whereas import suffered a more severe drop from 28% to 6-7%. In addition to the effects of the financial crisis, an interesting incident occurred in 2009 when domestic production fell back by more than 10% whereas consumption decreased only by 6%. There was a multi-week break in the natural gas supply through Ukraine, thus the electricity generation of our natural gas firing power plants had to be substituted by import electricity and by increased production of the oil-fired power plants. After 2010, until 2014, domestic electricity production decreased every year, and it has dropped quite substantially in 2013 by 13%. In the last three years (2015-17), however, domestic production grew again altogether by 12%. The share of import is a highly variable figure: in the last decade, it changed between 8% (2001) and 18% (2004). After 2010, however, it grew constantly and has reached a share of 31% in 2014, remained at the same level in 2015 and decreased only slightly in 2017 to 28%, but increased back to 31% in 2018.

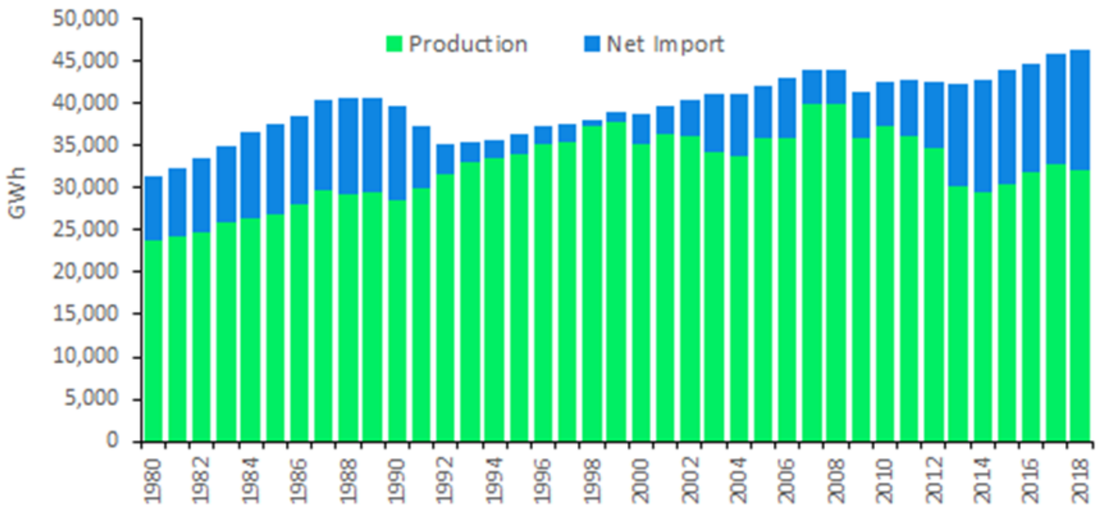


***Figure 3.5** Domestic Electricity Production and Net Import (1980-2018)*

Naturally, as domestic emissions are related to domestic production, the yearly fluctuation of production is one of the decisive factors. Not less important is the way how electricity is produced, e.g. what energy source is used. In Hungary, this sector consumes the deterministic part of our solid fossil fuel production. However, some uneconomical coal-fired power plants of low efficiency were stopped, and blocks of combined-cycle-gas turbine units were installed. For example, new 150 MW combined cycle gas-turbine units were installed (Újpest, Kelenföld, Százhalombatta, Nyíregyháza Power Plants), and aged coal fired units (Inota, Bánhida) of low efficiencies were taken out of service or blocks have been converted to the combustion of biomass (Pécs, Kazincbarcika, Ajka Power Plants). The demand for fossil fuel decreased about 150 PJ in the electricity sector between 1980 and 1990 because of the penetration of the nuclear electricity into the electricity market. This means that the fossil fuel consumption of public power plants is smaller now than it was before the introduction of nuclear electricity generation, in spite of much higher domestic electricity production. As a promising new development, increasing use of renewable sources could be observed by some public power plants. These developments are demonstrated in Figure 3.6.

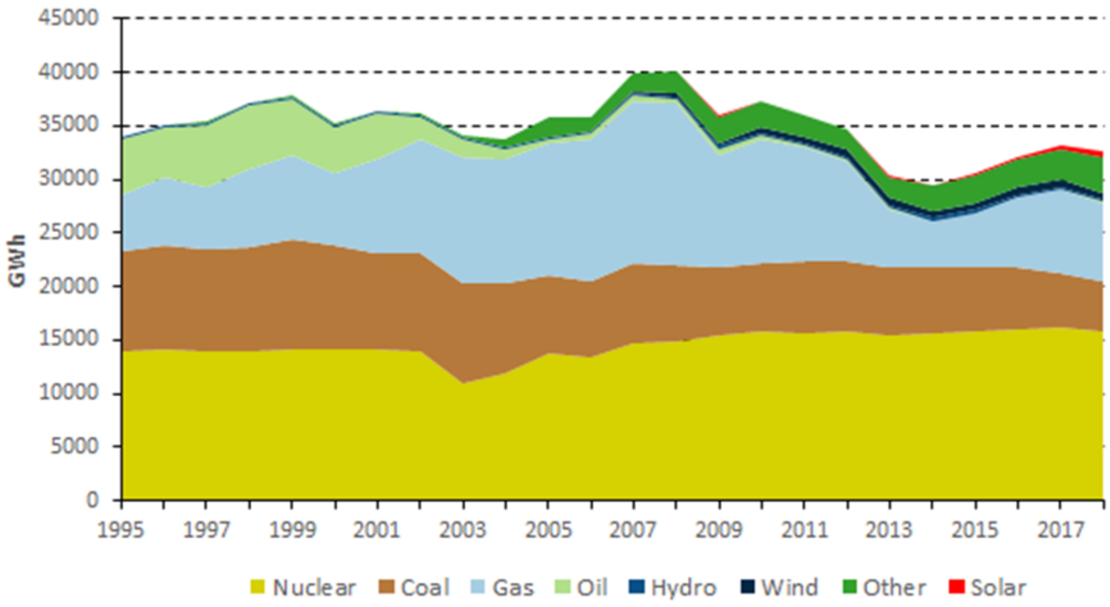


Figure 3.6 *Share of produced electricity by fuel (1995-2018)*

In 2011 there were considerable changes in several areas of the Hungarian Power System. On the generation side, AES Borsodi Energetikai Kft. (AES Borsod Heat PP Ltd), being under liquidation, ceased its electricity generation. This meant that two coal and partly biomass firing power plants were closed. However, new units were added to the system: the combined cycle power plant of E.On Erőmű Kft. (E.On Power Plant Ltd.) in Gönyű and the open cycle gas turbine power plant of BVMT Bakonyi Villamos Művek Termelő Zrt. (BVMT Bakony Power Generation Ltd.). In addition, the amendment of the operating licence of Dunamenti Erőmű Zrt. (Dunamenti Power Plant Ltd.) enabled the commercial operation of a GT3 unit.

"Since the regional supply and demand factors affect the electricity market, the utilisation of domestic power plants is strongly influenced by the fuel costs and the regional wholesale electricity prices changing country by country. The gas-fired power plants have lost significant market share also in our region due to the high and basically oil price-indexed gas prices, the drop in electricity consumption,

the collapse of CO2 allowance price system and the increase of electricity generation from renewables. Consequently, the load factor of domestic power plants was low. The traders compensated the loss of domestic generation from import. Thus, the amount of import-export balance reached 18.8% of total domestic electricity consumption in 2012."

The above words taken from a previous edition from the already referenced Statistical Data of the Hungarian Power System 2012 seem to be valid also for recent years. There were no further large power generating units connected to the Hungarian Electricity System in the last few years.

Methodological issues

Specific emphasis was given here to large combustion plants on the one hand and to gas engines on the other because for these two groups we could deviate from the general methodology of default emission factors. Usually, fuel consumption and emission data of 17-40 large (or otherwise important) plants were analyzed. These plants were responsible of all coal and biomass use, around 60-90% of all liquid fuel and natural gas use.

Based on the LCP Directive and following the Ministerial Decree 10/2003 (that was replaced by the Ministerial Decree 110/2013) on combustion installations with a net rated thermal input exceeding 50 MW, these installations have to report measured SO_2, NO_X and dust values, and in most of the cases based on continuous measurements. Reported emission data are summarized in Figure 3.7.

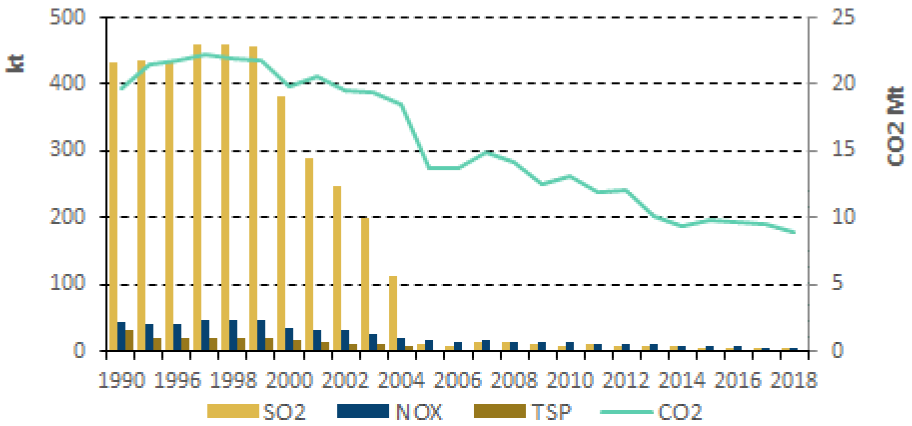


Figure 3.7a *Measured emissions from large electricity plants (1990-2018) Source: Data of the Hungarian Electricity System, 2018*

The most prominent feature in this figure is the substantial drop in SO_2 emissions. In the last decade flu-gas desulphurization plants (FGD) have been installed in two coal (lignite and brown coal) fired power plants of large capacities: in Mátra about in the year 2000 in two steps, and in Oroszlány in 2004, which resulted significant mitigation in the sulphur-dioxide emission. Thus, the SO_2 emissions connected with the operation of the public power plants shrank to a fraction of their earlier value. Similarly, electrostatic precipitators (ESPs) were installed in every solid fossil fuel power plant, and their effects may be observed in the sharp decrease in the pyrogeneous TSP emissions.

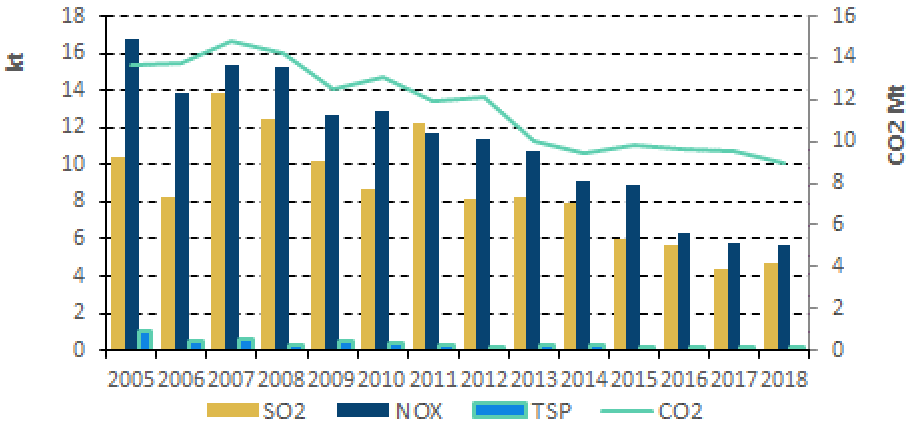


Figure 3.7b *Pollution data of power plants. Source: Data of the Hungarian Electricity System, 2018*

As reported emission values of large combustion plants can be regarded as reliable, these (NO_X, SO_2, TSP) were used in the reporting, whenever available. Besides pollutants in Fig. 3.7, electricity plants larger than 50 MWe report also CO emission to the Energy Office. In case of smaller plants, the common method of emission factors was applied.

As a large part of the reported NO_X, SO_2 and TSP emissions in this source category are based on annual emissions reported by operators on the basis of stack measurements, the issue of continuous measurements needs to be addressed here. When continuously measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the Industrial Emissions Directive (and the corresponding domestic legislation) and have used validated average values after having subtracted the value of the confidence interval. We have contacted quite almost all operators to ask them about their reporting practice. From the answers received, it seems that the reporting practice is not really consistent, some operators use validated average values to calculate annual emissions, some don't, some use half of the confidence interval etc. A few of them just change their practice in 2017. Therefore, in this submission, we have decided to use all the specific information received from the plants and in case of no information *to add half of the confidence interval* (i.e. 10% of SO_2, 10% of NO_X, 10% of CO, and 15% of dust) to adjust the emission values reported by plants applying continuous measurement.

Activity data

Energy consumption data were taken from the Hungarian IEA/Eurostat annual questionnaires. In order to see what part of fuel use from the questionnaires allocated to main activity plants is already covered by measured emissions, plant level fuel consumption data was collected from LCPs, basically from the ETS database. As gas engines show somewhat different emission characteristics, separate data on fuel use in gas engines was collected from the Hungarian Energy and Public Utility Regulatory Authority which can be seen on Figure 3.8. Gas engines are considered only in this source category.

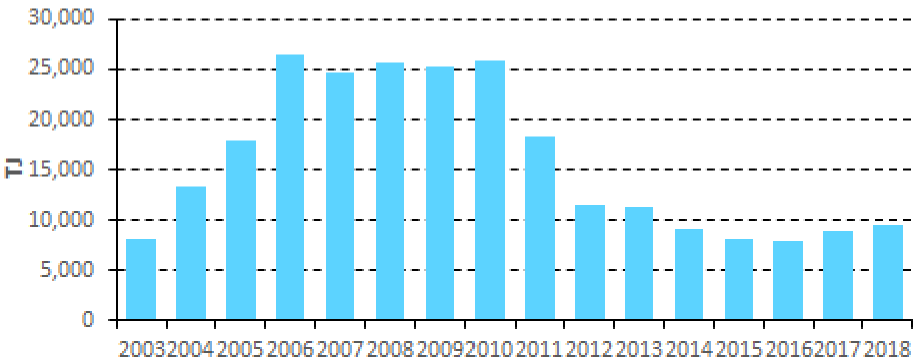


Figure 3.8 *Natural gas use in gas engines (2003-2018)*

As also waste incineration with energy recovery occurs, reported emission data (Pb, Cd, As, Cr, Cu, Ni, Se, and PCDD/F) from the largest municipal waste incinerator (FKF Plant in Budapest) were also taken into account.

Emission factors

First, it should be emphasized that emissions of the important main pollutants from combustions of sensitive fuels (e.g. solid fuels, derived gases) are mainly covered with measurements. The same applies for PCDD/F emissions from waste incineration. Especially, yearly measured NO_x, SO_x, and CO emissions were directly used from solid fuel (coal + biomass) burning power plants as our plant specific information fully covers fuel consumption from the statistics, at least for the period 2005-2018. For previous years, country specific emission factors were derived based on plant specific data. Important country specific emission factors are summarized in the following table.

Table 3.1 Summary of country specific emission factors

Pollutant	Fuel	Emission factor [kg/TJ]	Period
SO_x	domestic coal	3150	1990-1999
SO_x	domestic coal	2620-1120	2000-2004
SO_x	derived gases	70	1990-2012
NO_x	coal	180	1990-1999
NO_x	coal	139	2000-2004
NO_x	derived gases	50	1990-2013
NO_x	natural gas	57-45	2004-2013
CO	coal	175-63	1990-2004
CO	derived gases	3	1990-2013
CO	natural gas	10	2005-2013
TSP	solid fuels	105-4	2000-2013
TSP	derived gases	2	2000-2013

For all other fuel-pollutant combinations, where no measured emissions were used, Tier 1 emission factors from the 2019 EMEP/EEA Guidebook were applied. Some exceptions are highlighted in the following:

- NO_X emission factor for gas engines was taken from Table D4 of the Guidebook. The chosen value (159.4 g/GJ) is a bit higher than the new T2 EF (135 g/GJ) but is in line with the domestic regulation on emission limits from gas engines that is 500 mg/m^3 for NO_X (Ministerial Decree KTM 32/1993). This figure could be verified by emission data of four larger gas engines. Analyzing their fuel use (from EU ETS) and reported emissions, the resulting average emission factor was 152.7 g/GJ. For similar reasons, for CO emissions from gas engines, an EF of 207 g/GJ was chosen (which is lower than the T2 factor of the Guidebook).
- Country specific SOx emission factors for heavy fuel oil were derived based on the share of “high sulphur” and “low sulphur” fuel oils taken from the IEA time series. It was assumed that high sulphur oil has 3% sulphur content, whereas low sulphur oil has 1%.
- For other liquid fuels, domestic legislation was taken into account which maximized the sulphur content of liquid fuels as 0.2% from 2004 and as 0.1% from 2008.

The calculation method of $PM_{2.5}$ and PM_{10} emissions is also worth a mention. In case of measured dust data, $PM_{2.5}$ and PM_{10} emissions were derived from the TSP value using their relative share reflected in T1 default emission factors. For example, for hard coal the default emission factors for $PM_{2.5}$, PM_{10} and TSP are 3.4, 7.7 and 11.4 g/GJ, respectively (see Table 3-2 in the Guidebook). If we knew the TSP emissions from a hard coal firing power plant, then PM_{10} emission was estimated as PM_{10}=7.7/11.4*TSP.

Uncertainties and time-series consistency

As plant specific emission data and measurements have been taken into account to a large extent, and otherwise either default or country specific emission factors are used consistently for the whole time series, there might not be too serious problems with time series consistency.

Source-specific QA/QC and verification

We had more data sources at our disposal for verification purposes, such as the IEA/Eurostat questionnaires for domestic sectoral energy use, plant specific fuel consumption data from different reports, e.g. EU-ETS, LCP, data collected by Energy Office. The same applies for emission data on plant level, where we have data from the National Environmental Information System, from E-PRTR, from LCP reports, and from the Hungarian Energy Office.

Source-specific recalculations

No basic methodological change has been made but the latest IEA/Eurostat data were used.

Source-specific planned improvements

None.

3.3.2 PETROLEUM REFINING (NFR CODE 1A1B)

Reported Emissions: Main Pollutants (except NH_3), Particulate Matter, CO, Priority Heavy Metals, Other Heavy Metals, POPs
Measured Emissions: NO_X, CO, SO_X, TSP,
(Pb, Cd, Hg, Cr, Cu, Ni, PCDD/F - not available for all years).
Methods: T3, (T1)
Emission factors: D, PS
Key source: -

Methodological issues

In Hungary, practically only one operating refinery remained whose emission reports were used for this submission for the period 2002-2018. For earlier years, the classic methodology with emission factors was applied. Then, total emissions from the refinery were separated into combustion and process related emissions. More details on this sectoral split of emissions can be found in Chapter 3.7.2.2.

Activity data

The data were taken from the joint IEA/Eurostat annual questionnaires. For the calculations, primarily fuel consumption data were used but also refinery intake was taken into account especially for the sectoral split between energy and industry.

Emission factors

For main pollutants, mostly measured data were reported for the period 2002-2016. Also measured Hg emissions were taken into account for some years. For the remaining pollutants and years, T1 emission factors were used from the 2019 EMEP/EEA Guidebook.

Uncertainties and time-series consistency

No category specific information is available.

Source-specific QA/QC and verification

The environmental performance data of the MOL Group can be checked on the internet on the following link:

http://molgroup.info/en/sustainability/report-and-data

Please not that these data include not only the emissions from the Hungarian refinery but also the emissions of Slovnaft and another refinery located in Italy.

Source-specific recalculations

No methodological change took place. However, the updated emission factors for heavy metals from CONCAWE as included in the 2019 EMEP/EEA Guidebook were used.

Source-specific planned improvements

Besides main pollutants, the refinery reports also measured emission values for some heavy metals and PCDD/F. We'll consider using these data as well after quality control in future submissions. We will also check whether emissions from hazardous waste incineration (mostly oil/water separator contents are burned) are taken into account properly.

3.3.3 MANUFACTURE OF SOLID FUELS AND OTHER ENERGY INDUSTRIES (NFR CODE 1A1C)

Reported Emissions: Main Pollutants (except NH_3), Particulate Matter, CO, Priority Heavy Metals, Other Heavy Metals, POPs
Measured Emissions: NO_X, SO_2, CO, TSP
Methods: T3, T2
Emission factors: D, PS
Key source: -

A unique specialty in Hungary is the coking on contract basis. When the mining of coking coal became uneconomical, it was stopped in the early 90's, which meant that the large coking capacity installed in the country remained unutilized. Thus, coking coal was brought by foreign coke producers into the country, a part of the coke produced was exported, while another part was utilized by the domestic blast furnace for pig iron production (see *Fig. 3.9*). The by-products of the coking, the coke oven gas and of the pig iron production, the blast furnace gas are consumed by the nearby power plant. Of course, the emission connected with the coke production remains in the country and also the coke oven gas is fired here (to produce process heat for coking and to produce electricity in the nearby power plant).

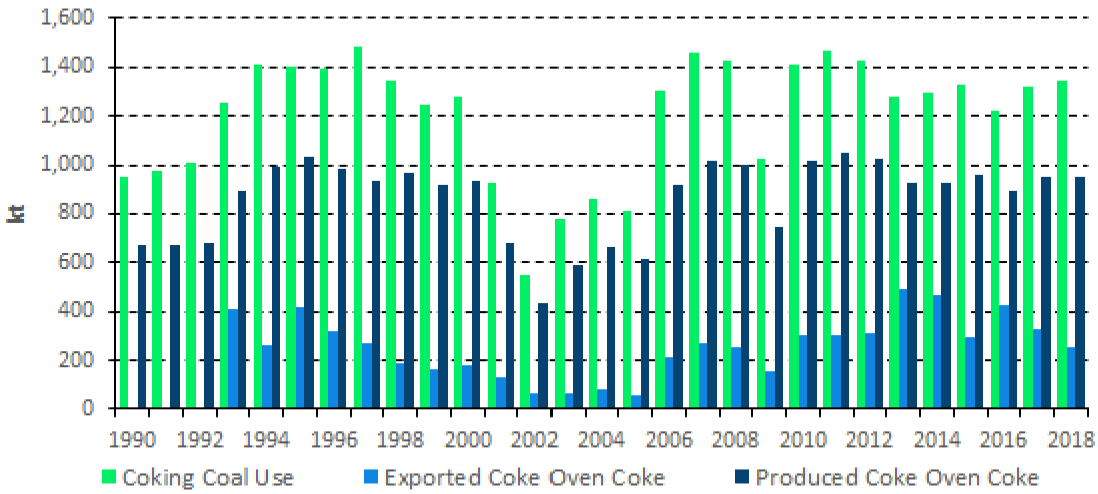


Figure 3.9 *Gas coke distillation in Hungary (1990-2018)*

Methodological issues

There is practically one coking plant in the country (ISD DUNAFERR Coking Plant) whose emission reports were used for this submission. The measured emissions were taken as they were reported (luckily, the coking plant and the nearby blast furnace plant report separately). For the remaining pollutants, Tier 2 approach was applied. For all other energy industries (e.g. coal mines, gas extraction, gasification plants) the general T1 methodology based on fuel consumption was used.

Activity data

For the Tier 2 approach coal use was needed that was taken from the joint IEA/Eurostat annual coal questionnaire (Coking Coal – Transformation Sector - Coke Ovens). In 2010, 1414 kt coking coal was used, and 30% of the produced coke oven coke was exported. We had similar data for 2011 with 1464 kt coking coal use, 1049 kt coke production out of which 303 kt was exported. In 2012, out of 1428 kt coking coal input 1026 kt coke was produced and 309 kt coke was exported. The amount of exported coke increased significantly (by 60%) in 2013, whereas iron production decreased by half. Compared to 2013, neither the production nor the export figures changed significantly in 2014. In 2015, production increased a little, whereas export decreased significantly. Export grew again in 2016 with decreased production level. In 2017 and 2018, production level was around 960 kt but export decreased significantly.

Emission factors

For all non-measured pollutants by the coking plant, default emission factors from Table 5-2 (coke manufacture with by-product recovery) were used.

Uncertainties and time-series consistency

The time series can be regarded as consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

No methodological change has taken place.

Source-specific planned improvements

None.

3.4 MANUFACTURING INDUSTRIES AND CONSTRUCTION (NFR CODE 1A2)

This subsector covers emissions from the combustion of fuels in the industrial sector. *Figure 3.10* illustrates the energy consumption of the sector. After 1990, following the economic changes, the quantity of fuels used has significantly decreased. The underlying reasons are the clearly decreased production volumes. In 2009 the global economic crisis caused a remarkable drop of 27% in fuel consumption and also the emissions of the industrial sector. The fuel mix changed, too. Combustion of coal and oil products is losing its importance among fossil fuels. In contrast, growing biomass and other fuel use can be observed. The figure below clearly demonstrates the dominance of natural gas (62% in 2018).

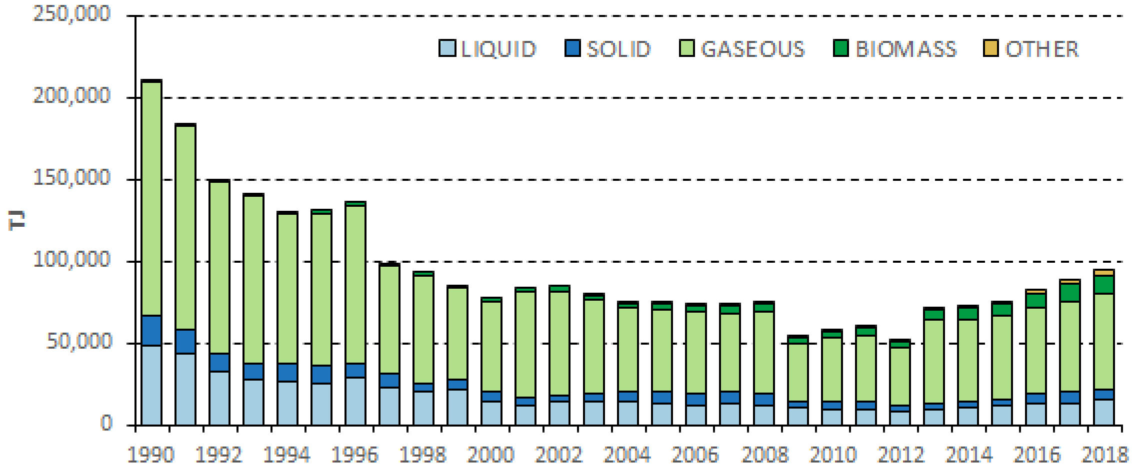


Figure 3.10 *Fuel use in manufacturing industries and consumption (1990-2018)*

Methodological issues

Generally, measured emissions were reported in source categories with larger emitters (e.g. iron and steel, cement production). Otherwise either Tier 1 approach based on fuel use or Tier 2 approach based on production data was followed. Choice of method, emission factors, and activity data will be described in the following at source category level.

3.4.1 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: IRON AND STEEL (NFR CODE 1A2A)

Reported Emissions: NO_X, SO_2, CO
Measured Emissions: NO_X, SO_2, CO
Methods: (T1). T2, T3
Emission factors: D, CS
Key source: SOx

Currently, one large emitter, ISD Dunaferr Group, is operating in the country with a blast furnace plant, steelworks, hot rolling mill, cold rolling mill, profiling works, etc. There are a few other plants as well; however, the sum of their reported emissions is about 1-2% of the total in this source category.

Methodological issues

In this submission, the general recommendation on allocation of emissions at Tier 2 methodology was followed, namely to assign NO_X, SO_2, CO emissions to combustion only. Plant specific (measured) data were reported directly for 2003-2018 which corresponded to a Tier 3 method. To our knowledge, the facility reports cover all relevant processes in the country. For previous years, country specific emission factors were derived using pig iron as activity data. In case of SOx, as the fuel-mix was totally different in the 90's as it is now (i.e. significant amount of high sulphur fuel oil was used in the 90's), emissions were calculated on the basis of fuel use (T1 method) for the period 1990-2000.

Activity data

Pig iron production data from different sources (statistical office, www.worldsteel.org, www.eurofer.org) were used. Fuel consumption data were taken from the IEA annual questionnaires.

Emission factors

The following country specific emission factors were used for the years when no plant-specific data were available (all expressed in kg/kt pig iron):

SOx: 597, NOx: 1500, CO: 51,446.

Uncertainties and time-series consistency

The time series can be regarded as consistent.

Source-specific QA/QC and verification

Different facility reports were taken into account including the National Environmental Information System and E-PRTR. In case of questionable data, the plant was contacted directly by the inventory compiler institute.

Source-specific recalculations

-

Source-specific planned improvements

The time series of the plant specific measurements will be analyzed.

3.4.2 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: NON-FERROUS METALS (NFR CODE 1A2B)

Reported Emissions: NO_X, SO_2, CO
Measured Emissions: (NO_X, CO)
Methods: T2, (T3)
Emission factors: D
Key source: -

Methodological issues

In this submission, the general recommendation on allocation of emissions at Tier 2 methodology was followed, namely to assign only NO_X, SO_2, CO emissions to combustion. As many plant specific (measured) data were taken into account as possible for the last three years but for alumina production only up till 2013.

Activity data

Tier 2 approach requires production-based activity data which were received from the Hungarian Central Statistical Office. In 2017, secondary copper and brass (2.702 Gg), secondary zinc (0.48 Gg), secondary aluminum (273 Gg) production were the relevant processes to be taken into account. As regards (secondary) aluminum and alumina production, facility level emission data was taken into account and no production data was used (NO_x and CO only). It should be noted that primary aluminum production was stopped in 2006.

Emission factors

Tier 2 emission factors were taken from Table 3-13, Table 3-17, and Table 3-18 of the 2016 EMEP/EEA Guidebook (Ch. 1.A.2 Manufacturing industries and construction).

Uncertainties and time-series consistency

Although consistency has been improved, the time series can only be regarded as consistent for the period 2003-2014 due to missing activity data.

Source-specific QA/QC and verification

None.

Source-specific recalculations

-

Source-specific planned improvements

Further improve consistency of the time series.

3.4.3 STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: CHEMICALS (NFR CODE 1A2C), PULP, PAPER AND PRINT (NFR CODE 1A2D), FOOD PROCESSING, BEVERAGES AND TOBACCO (NFR CODE 1A2E), OTHER (NFR CODE 1A2GVIII)

Reported Emissions: Main Pollutants (except NH_3), Particulate Matter, CO, Priority Heavy Metals, Other Heavy Metals, POPs
Measured Emissions: None taken into account
Methods: T1
Emission factors: D, CS
Key source: -

Methodological issues

The general Tier 1 approach was followed here, using fuel consumption as activity data with mostly default T1 emission factors.

Activity data

The IEA/Eurostat annual questionnaires were used for the whole time-series (1990-2018). In these subsectors, natural gas is the dominant fuel accounting for 70-80% of total fuel consumption.

In the Other category emissions from the following industrial activities are accounted for: Mining and Quarrying, Manufacture of electrical and optical equipment, Manufacture of transport equipment, Manufacture of textiles and textile products, Manufacture of leather and leather products, Manufacture of wood and wood products, Manufacturing goods not elsewhere classified, Construction. In addition, emissions from most autoproducer plants are included here.

Emission factors

Mostly default Tier 1 emission factors relevant for small combustion were taken from the 2016 EMEP/EEA Guidebook (Ch: Small combustion, Tables: 3-7 to 3-10) with the following exceptions.

- Country specific SOx emission factors for heavy fuel oil were derived based on the share of “high sulphur” and “low sulphur” fuel oils taken from the IEA time series. It was assumed that high sulphur oil has 3% sulphur content, whereas low sulphur oil has 1%.
- For other liquid fuels, domestic legislation was taken into account which maximized the sulphur content of liquid fuels as 0.2% from 2004 and as 0.1% from 2008.
- Domestic legislation (Regulation of the minister of environment No 23/2001) was taken into account also to derive some country specific emission factors as detailed in *Table 3.2*.
- The SO_2 emission factors for solid fuels were determined from sulphur content of the coal using the equation (EF=Sx20000/CV) from the Guidebook. It was assumed that imported hard coals and brown coals have an average sulphur content of 1% and 1.75%, respectively.

***Table 3.2** Country specific emission factors*

Pollutant	Fuel	Emission factor [kg/TJ]	Period
SO_x	imported coal	167	2002-2018
SO_x	domestic brown coal	1255	2002-2018
SO_x	domestic coal	3800	1990-2001
SO_x	other liquid fuels	93	2004-2007
SO_x	other liquid fuels	47	2008-2018
NO_x	coal	125	2002-2018
NO_x	liquid fuels	136	2002-2018
CO	coal	105	2002-2018
CO	biomass	141	2002-2018
TSP	other liquid fuel	15	2002-2018
TSP	coal	63	2002-2018
TSP	biomass	85	2002-2018

Uncertainties and time-series consistency

The time series are most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

No methodological change has taken place. However, the updated IEA/Eurostat time series have been used as activity data (fuel consumption).

Source-specific planned improvements

None.

3.4.4 NON-METALLIC MINERALS (NFR CODE 1A2F)

Reported Emissions: Main Pollutants (except NH_3), CO, Priority Heavy Metals, Other Heavy Metals, POPs
Measured Emissions: NO_X, SO_2, CO, Hg (cement production)
Methods: T3, T2
Emission factors: D, CS
Key source: Hg.

Emissions from lime, cement, asphalt, glass, mineral wool, bricks and tiles and fine ceramics production is accounted for here in this source category.

Methodological issues

Generally, Tier 2 approach was followed based on production statistics. For cement production plant-specific data were taken into account. Moreover, measured emission values (SOx, NOx, CO) reported by cement factories were directly used for the period 2008-2013, and 2016-2018. (Measured data were incomplete for the years 2014-2015 at the time of the inventory compilation therefore they were not used.) For previous years, country specific emission factors were derived (Table 3.3). As cement factories combust also industrial waste (among others fossil wastes such as rubber and plastic), facility reports of PCDD/F and Hg were especially important. However, these emission data need to be analyzed further. Except for cement production, only NO_X CO and SO_x emissions were allocated to the energy sector which is in line with the Tier 2 approach.

For cement plants that use validated average values to calculate annual emissions, reported emissions data were amended with the confidence interval as given in the IED (i.e. 20% of SO_2, 20% of NO_X, and 10% of CO).

Activity data

Production data (ceramics, bricks, mineral wool, asphalt, lime) were received from the Hungarian Central Statistical Office. Clinker data were provided by the cement factories.

Emission factors

Tier 2 emission factors were taken from Tables 3-23–3-29 of the 2016 EMEP/EEA Guidebook (Ch. 1.A.2 Manufacturing industries and construction).

There are some exceptions, though. We have analyzed the reported emission data from the five (currently only three) cement plants in the country. Based on plant specific emission data and clinker production statistics, country specific emission factors were derived as summarized in Table 3.3 below.

Table 3.3 *Country specific emission factors in cement production*

Pollutant	Country specific emission factor	Default EFs
NO_x	2500 g/Mg product	1241 g/Mg product
CO	2000-1550 g/Mg	1455 g/Mg product
Hg	0.06 g/Mg product	0.041 g/Mg product
PCDD/F	-	4.1 ng I-TEQ/Mg clinker

Uncertainties and time-series consistency

The time series can be regarded as consistent.

Source-specific QA/QC and verification

Statistical and plant specific production data were compared.

Source-specific recalculations

-

Source-specific planned improvements

None.

3.4.5 MOBILE COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: (NFR CODE 1A2GVII)

Reported Emissions: Main Pollutants, Particulate Matter, CO, Priority Heavy Metals, Other Heavy Metals, POPs (except PCDD/F, HCB, PCBs)
Measured Emissions: -
Methods: T2
Emission factors: T2
Key source: -

Methodological issues

Since the previous submission, we have implemented the Tier 2 method from the 2016 EMEP/EEA Guidebook. This method classifies the used equipment into the fuel types and layers of engine technology. The engine technology layers are stratified according to the EU emission legislation stages, and three additional layers are added to cover the emissions from engines prior to the first EU legislation stages. The used layers are as follows: <1981; 1981-1990; 1991-Stage I; Stage I; Stage II; Stage IIIA; Stage IIIB; Stage IV; Stage V. The penetration of the new technology is taken into account in the form of split (%) of total fuel consumption per engine age (irrespective of inventory year) as it can be seen for diesel-fueled non-road machinery in Table 3-3 in the Guidebook.

Activity data

All gasoil consumption from the IEA/Eurostat Annual Questionnaire has been regarded as for off-road mobile use. Although we rely mostly on the IEA/EUROSTAT Annual Questionnaires in their original form, the allocation of gasoil does not seem to be consistent for the whole time-series. (For example, gasoil consumption in the industry sector is reported in the AQ as 30 kt and 140 kt for 2010 and 2011, respectively) Therefore, some gasoil consumption had to be reallocated from road transport to industry based on 2011-2015 data allocations and value added volumes for previous years.

Emission factors

Emission factors were taken from Table 3-2 "Tier 2 emission factors for off-road machinery" from the Chapter Non-road mobile sources and machinery of the 2016 Guidebook. The only exception was SOx for which country specific factors were applied corresponding to domestic quality of gasoil (sulphur content currently max. 10 mg/kg).

Uncertainties and time-series consistency

The time series can be regarded as consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

-

Source-specific planned improvements

None.

3.5 TRANSPORT (NFR SECTOR 1A3)

This sector covers all the emissions from fuels used for transportation purposes and includes also some non-fuel related emissions (e.g. from vehicle tyre and brake wear, or road surface wear).

Looking at the whole period of our time series, a sharp decrease of 60% in transport of goods could be observed during the regime change in the early 90's. The Hungarian transport performance expressed in freight ton-kilometers had not reached the level of 1985 until 2005. Beside these significant changes of volume, also the structure of goods transport altered. Currently, the most important means of freight transport is road transportation with a share of 66%, followed by rail (18%), pipeline (13%) and waterway (3%). In 1990 we saw a completely different picture with railway and waterway being the dominant mode of transport representing 40% and 34%, respectively. The share of road transportation was 15% about 25 years ago.

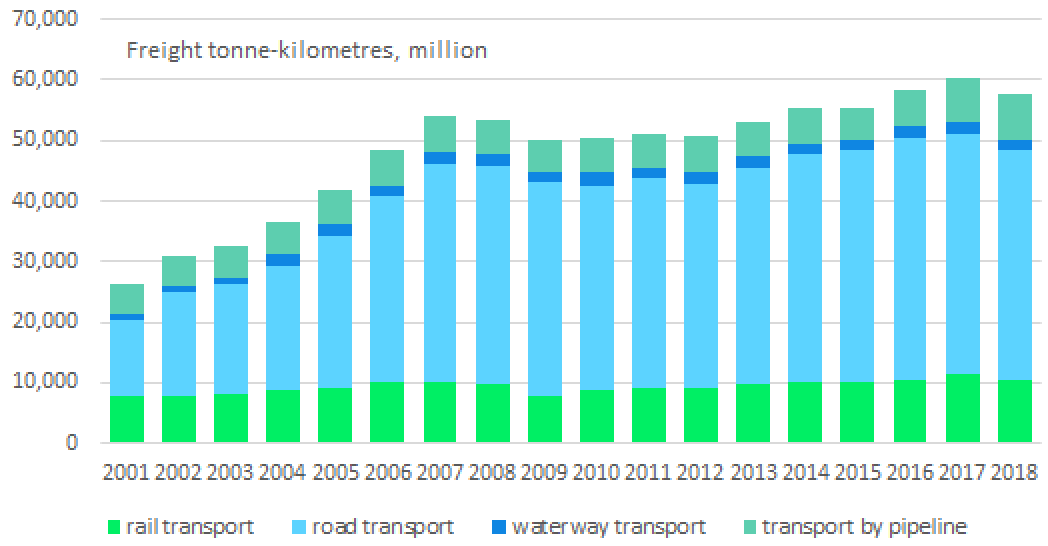


Figure 3.5.1 *Trends in goods transport (2001-2018). Source: HCSO*

Passenger transport also underwent considerable changes. The stock of passenger cars had more than doubled since 1985 and increased by 87% since 1990. Within this increase, the proportion of Eastern European cars characterized by high fuel consumption and obsolete technology decreased; for example, currently about two third of the passenger cars complies with at least the Euro 3 emission standards. At the same time, the average age of the car fleet has increased again in recent years to 14.2 years in 2018. (The lowest average age of vehicles (10.3 years) was observed in 2006, before the economic crisis.) Figure 3.5.2 summarizes the above-mentioned developments.

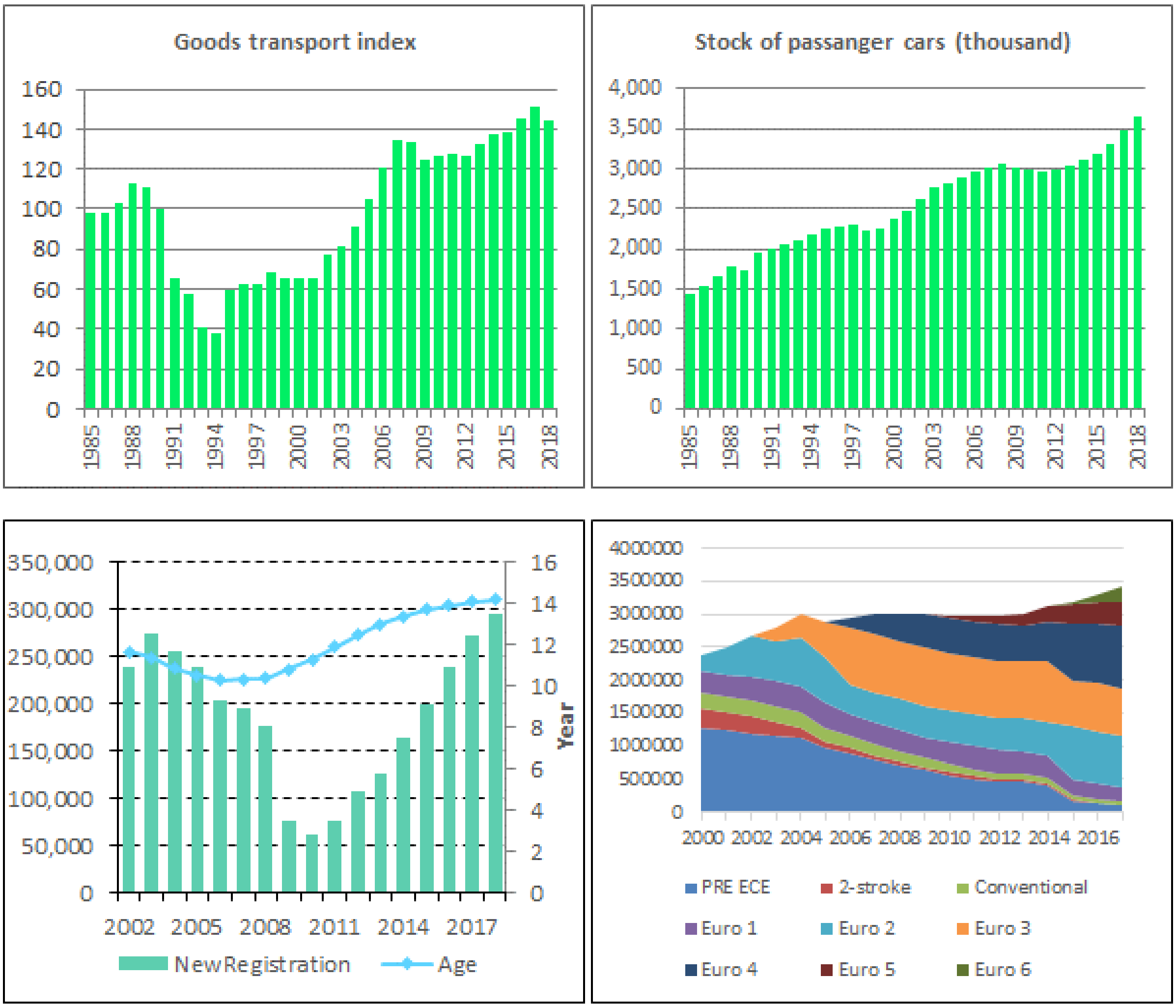


Figure 3.5.2 *General changes in the transport sector*

Electrification of the railways in Hungary eliminated mostly the solid fuel consumption. (Today there are only few lines where steam engines are used during non-scheduled vintage train trips.) Diesel oil consumption of railways decreased as well, by 75% between 1990 and 2018.

Emissions were calculated basically from the national fuel consumption data from the IEA/Eurostat annual questionnaires. National statistics usually does not have separate lines for the quantities of aviation gasoline used for in-country aviation and of the diesel oil used for international (river) navigation (both represent negligible amounts in Hungary). Fuel consumption data (i.e. both aviation gasoline and jet kerosene) of domestic aviation are taken from the Eurocontrol database that contains data on IFR flights. We can also assume (based on personal communication with the energy statistics provider) that 0.9-1.0 kt aviation gasoline is consumed for domestic flights, mostly for agricultural use. (These emissions are not included in the inventory as VFR flights are not included in the Eurocontrol database.) It is also possible that some minor amount of aviation fuel (for VFR flights) is included elsewhere in the inventories (e.g. under road transport).

According to the information received from the energy statistics provider, natural gas use related to natural gas transport was previously included under distribution losses in the energy statistics. In the inventory, however, a complete time series of emissions from pipeline transport is included separately.

Figures below illustrate the fuel consumption of the sector:

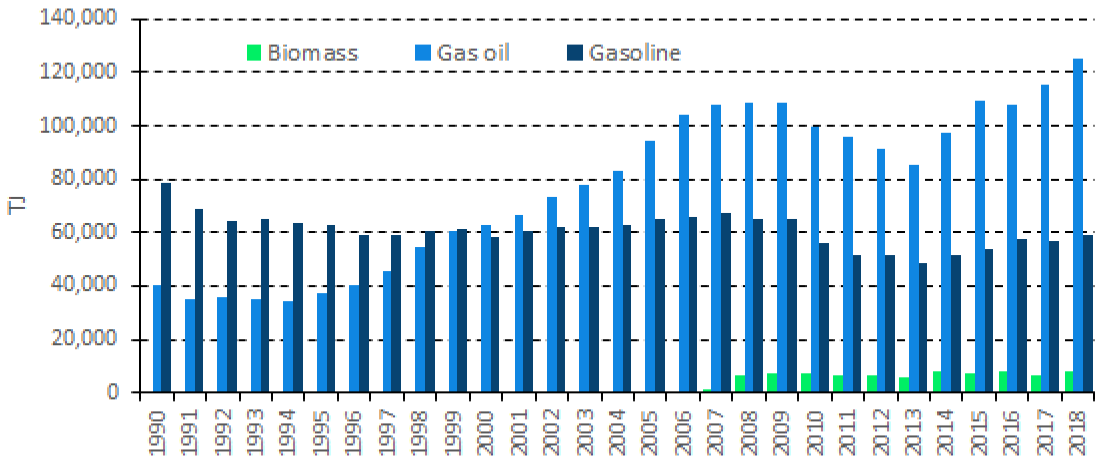


***Figure 3.5.3a** Gasoline, diesel and biomass consumption and total energy use in the Transport Sector (1990-2018)*

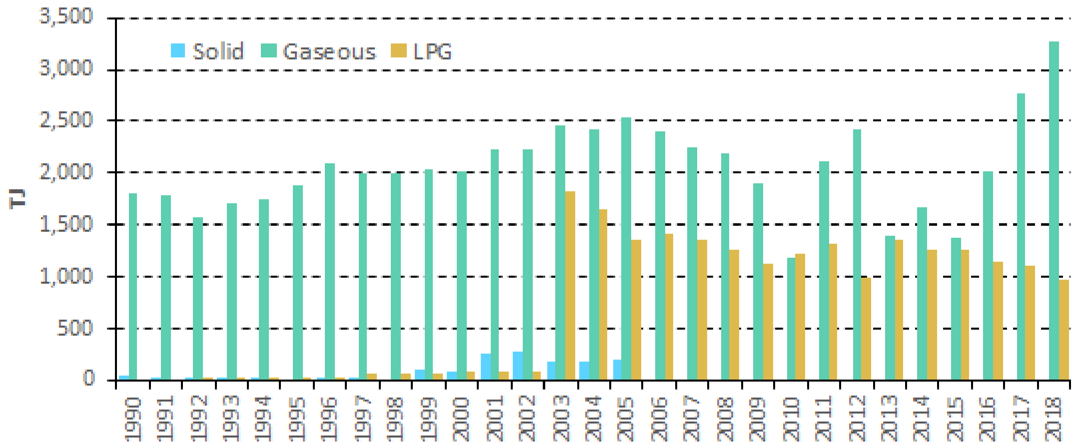


***Figure 3.5.3b** LPG, natural gas and solid fuel combustion in the Transport Sector (1990-2018)*

Figure 3.5.3 clearly shows that in contrast to the other described sectors, transport consumption had a rising overall tendency from the mid 90's until 2008. Starting in 2009 the trend of fuel consumption has changed due to the economic crisis. Both fuel consumption and mileage of vehicles (km/year) increased until 2009 and started decreasing afterwards. The increasing fuel prices (up to 2012) could also be one of the reasons of a record low gasoline consumption in the transport sector. It is worth mentioning that the mass of domestically transported goods via road transport decreased by 44% between 2008 and 2012. However, the decreasing trend stopped, fuel consumption started to grow again and goods transport increased by 13% since 2012.

In the second half of 2005 the Hungarian oil and gas company's refinery, MOL Danube Refinery, started to process bioethanol from vegetable raw material with high sugar content, also biodiesel have been used for blending. These bio components appear also in *Fig. 3.12.*

LPG has been used since 1992. It should be noted that due to the current commercial practices, in-container (household, institutional) uses are difficult to separate from traffic uses (i.e., distribution at petrol stations). This may be the reason for the sharp increase in 2003, which does not fully reflect the actual changes but is the result of a change in the approaches used for the preparation of the statistics. Accordingly, liquid fuel uses by the general public (currently including LPG only) show a significant drop in the same period.

3.5.1 ROAD TRANSPORT (NFR CODE 1A3B)

Reported Emissions: Main Pollutants, Particulate Matter, CO, Priority Heavy Metals, Other Heavy Metals, POPs
Measured Emissions: None taken into account
Methods: COPERT-5
Emission factors: COPERT-5
Key source: NO_x, NMVOC, CO, Pb

Methodological issues

For the emission calculations, the COPERT-5 (**Co**mputer **P**rogramme to Calculate **E**mission from **R**oad **T**ransport) model, specifically version 5.3.0 was used for the whole time series. The transition to the COPERT program family was a necessary step in the area of national road transport emission calculations, since most countries use this program which ensures international comparability. By using the latest version of the model, also consistency of the time series is ensured.

Activity data

The COPERT model requires quite detailed background information. To produce input data for the model for the whole time series, basically three data sources were used:

1./ The compiler institute received the COPERT outputs run by Institute for Transport Sciences for the years 2006, 2007, 2009, 2011, 2012, and 2013, 2014, 2015, 2016 and 2017 and 2018. The structure of the input data was produced in a way which fully complies with that described in the software requirement.

Generally, the input data required by the COPERT model are as follows:

- vehicle stock data, emission categorization
- mean activity, lifetime cumulative activity
- traffic situations: runtime distribution, average speed, trip characteristics
- national annual energy consumption
- country-specific environmental information: temperature, humidity, vapor pressure

As the input data were not obtained from the same source and were not always suitable for direct use, data were needed to be processed prior. The largest bulk of work was processing the vehicle stock data, since this data ensures the basis for emission calculations performed by COPERT-5. Therefore, it was crucial to perform an utmost precise work regarding the vehicle stock data, which was obtained from the Ministry of the Interior (BM). At the request of the Institute for Transport Sciences, vehicle data tables required to perform the task were extracted from the BM database. The vehicle stock classifications and emission categorizations were prepared using the following table:

Category	**Fuel**	**Engine capacity [cm^3] / Gross weight [t]**	
Passenger Cars	Gasoline Diesel Petrol Hybrid LPG Bifuel CNG Bifuel	≤800 cm^3	
		801 – 1400 cm^3	
		1401 – 2000 cm^3	
		≥2001 cm^3	
	Gasoline	2-stroke (≤1000 cm^3)	
Light Commercial Vehicles Buses	Gasoline	≤3,5 t	
	Diesel	≤3,5 t	
Heavy Duty Trucks	Gasoline	>3,5 t	
	Diesel	Rigid	3,5 – 7,5 t
			7,5 – 12 t
			12 – 14 t
			14 – 20 t
			20 – 26 t
			26 – 28 t
			28 – 32 t
			>32 t
		Articulated	14 – 20 t
			20 – 28 t
			28 – 34 t
			34 – 40 t
			40 – 50 t
			50 – 60 t
Buses[1]	Diesel	Urban	3,5 – 15 t
			15 –18 t
			>18 t
		Coach	3,5 – 18 t
			>18 t
	CNG	Urban	
L–Category	Gasoline	Mopeds 2-stroke	<50 cm^3
		Mopeds 4-stroke	<50 cm^3
		Motorcycles 2-stroke	>50 cm^3
		Motorcycles 4-stroke	<250 cm^3
		Motorcycles 4-stroke	250 – 750 cm^3
		Motorcycles 4-stroke	>750 cm^3

Table 1: Vehicle categorization required by the COPERT5 model

[1] Biodiesel buses were not take into consideration because such buses do not exist in Hungary

In the case of traffic situations, the percentage of runtime distribution and average speed values within driving conditions (urban, rural, motorway) for each vehicle category were used based on the results of previous research carried out by the Institute for Transport Sciences.

Specifying the average speed is less important in the case of rural and highway traffic as the function takes similar values between 45-105 km/h. However, determining the average speed for urban transport is more important, because of a difference of 1 km/h in the first third of the function results in a larger difference in emissions. Naturally, the functions vary from one pollutant to another, but the influence of speed is similar in each case.

Among the trip characteristics, it is important to mention the average travel time and duration. According to available statistics, European average of 12.5 km were determined by experts. The distribution of the distances traveled varies from country to country, but typically a large proportion (80%) travel only short distances (less than 15 km). It plays a significant role in the emissions of the cold start phase. The average travel distance of 12 km average travel time of 25 minutes were used.

Detailed and accurate calculations of mean activity could not have been made in previous years. Previously, data were obtained from queries extracted from the RKF (Regular Environmental Review) database provided by the Ministry of the Environment, and subsequently corrected based on the annual fuel consumption. However, in COPERT5, it is possible to provide fuel balanced mean activity, which the program automatically counts and takes into account when calculating the emissions. From 2018, there was a development research in the Institute for Transport Sciences and the project outcomes will be used for the 2019 emission calculations. From now on, the mean activity data will be more precise and the query system calculates the mileage records of the Vehicle Inspection Database for each vehicle category.

The source of the annual fuel consumption data was the national energy statistics provided by the Hungarian Energy and Public Utility Regulatory Authority (MEKH). The data published by the MEKH will also be transmitted to EUROSTAT. Energy conversions were executed following the values given in the EMEP/EEA air pollutant emission inventory guidebook 2019.

Fuel	Density [kg/m3]	Calorific values [MJ/kg]
Gasoline	750	43.774
Diesel	840	42.695
LPG	520	46.564
CNG	175	48
Biodiesel	890	37.3
Bioethanol	794	28.8

Table 2: Default density and calorific values of primary fuels determined using the EMEP/EEA air pollutant emission inventory guidebook 2019

The country-specific environmental data was obtained partly from the Hungarian Meteorological Service (OMSZ) (average monthly maximum and minimum temperatures), partly from Hungarian fuel standards (Reid vapor pressure - RVP).

2./ For all the years in the period 2000-2017 for which no domestic data were provided by the Institute for Transport Sciences, data purchased from Emisia SA, developer of the COPERT model, were used as inputs. As claimed by the data provider, *"the vehicle fleet and activity data provided by EMISIA SA for the compilation of national emission inventories with use of the COPERT model reflect our best knowledge of national situation in each country until 2013. These data have been updated using the* *road transport dataset and methodology of the TRACCS research project. More specifically, TRACCS dataset of the period 2005-2010 has been combined with the previous FLEETS research project dataset (2000-2005) and with latest official statistics available (2011-2013) to produce aligned and up to date time series for the period 2000-2013 (no projection included). The quality, completeness, and consistency of these two projects datasets, which have been extensively reviewed and cross-checked, ensure that the compiled countries data are also of good quality."*

In case of larger discrepancies between the Emisia database and domestic data, preference was always given to data from domestic sources. Again, whenever necessary, the mileage data were slightly modified to reflect better the domestic statistics on fuel sold.

3./ The compiler institute produced input data for the remaining years (i.e. 1985-1999). Quantification of the stock of each road vehicle type was based on Statistical yearbooks of Hungary and annual reports of Ministry of Economy and Transport about the Hungarian vehicle fleet. Also, personal communications with experts took place. Compared to recent years where about 200 vehicle categories were taken into account, the input database for the earlier part of the time series is less detailed containing 35 vehicle categories, and it probably has a higher uncertainty.

Emission factors

The emission factors used were mainly the default factors from the COPERT-5 model with a few exceptions. One of these exceptions is lead. It should be noted that unleaded gasoline was sold only after 1989. Since lead is poison for catalytic converters, it was assumed that real catalyst vehicle has been used after this time.

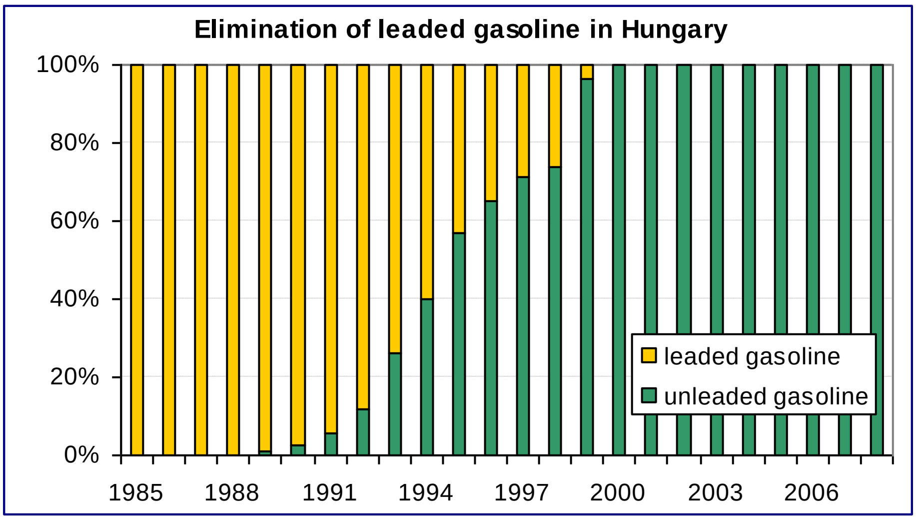


Figure 3.5.4 *Elimination of leaded gasoline in Hungary*
(Source: Hungarian Petroleum Association (MÁSZ), Annual Reports 1996-2008)

Based on information from the refinery, we applied the following values.

Table 3.4 *Country specific emission factors in road transport*

	1990-91	1992-99	2000-2005	2005-
Lead content of leaded gasoline (g/l)	0.34-0.33	0.13-0.04	NA	NA
Sulphur content of gasoline (%wt)	0.2	0.05	0.015	0.001
Sulphur content of diesel (%wt)	0.5	0.05	0.035	0.001

Uncertainties and time-series consistency

As in other countries there is a problem the calculation with transit transport. During the calculation, we were taken into account the emission of transit as a part of emission of Hungarian road transport, but it could be an uncertainty because of the fuel consumption. It is a tendency, that transit transport does not use Hungarian fuel. The size of the country gives possibility to go through it in one day, the maximum length of Hungary can be driven without fuel tanking in the area of the country. The trucks tank typically in abroad.

Using similar versions of the COPERT model has improved the time series consistency of this category.

Source-specific QA/QC and verification

None.

Source-specific recalculations

For this submission, we have used updated fuel consumption data. More importantly, a new version of the COPERT model (5.3.0) was used for the entire time series. Lead content was revised for the early period of the time series taking into account the penetration of unleaded gasoline.

Source-specific planned improvements

-

3.5.2 AIR TRANSPORT (NFR CODE: 1A3A)

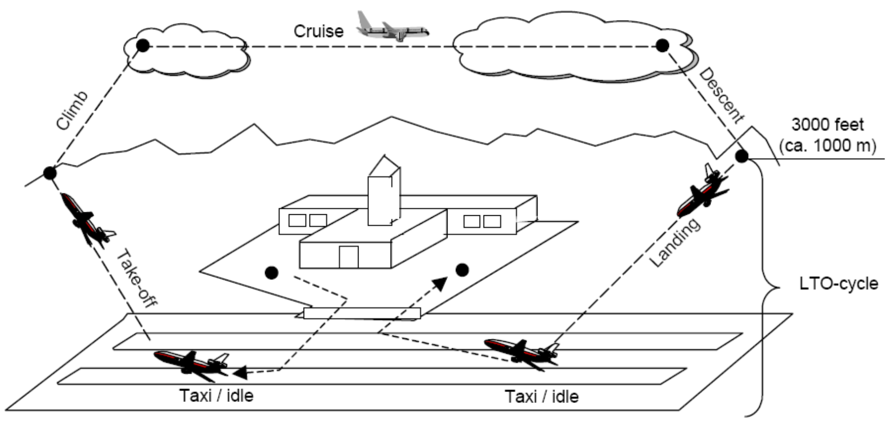
Reported Emissions: Main Pollutants (except NH_3), CO, Particulate Matter
Measured Emissions: None taken into account
Methods: LTO
Emission factors: ICAO, FOI database
Key source: -

Methodological issues

The EEA's Guide to calculating emissions from air transport recommends three different methods. The first and second calculation method *(Tier 1 and Tier 2)* is a top down method, that is, it takes as a basis the total quantity of fuel used in a given year, while the third method *(Tier 3)* is a *bottom-up* method.

For the CO_2 and SO_2 components as well as heavy metals the first method is entirely suitable, since from the fuel quantity and with a good approximation these components can be directly calculated, and they are independent from the different technological engine related solutions. PM_{10} and $PM_{2,5}$ are those pollutants that are most dependent on the type of aircraft and load, therefore, for the approximate calculation of these the first method cannot be recommended. With the help of the third calculation method the fuel consumption can be controlled. The calculations are greatly influenced by the availability of data.

Calculation of air transport emissions is carried out in accordance with international practice, on the basis of the emission factors of the so-called LTO-cycles (landings / take-offs). Based on the figure, it becomes clear that the LTO-cycle contains only land and near-land operations, since approaching the airport for landing and leaving the airport - the take-off - are assessed under ~ 1000 m (3000 ft) altitude. The considered operational phases of an aircraft are, therefore, landing (from about 1,100 m), roll-out, onset to a parking position, getting out from the parking position, approaching the runway and take-off (up to 1,100 m). Depending on the aircraft type, according to the EPA/AP-42 requirements the time taken for the LTO-cycle varies from 26 to 33 minutes.



Structure of the LTO-cycle

Each year, the European Organisation for the Safety of Air Navigation (EUROCONTROL), supporting the European Environment Agency (EEA) and Member States of the European Union (EU), under contract with DG CLIMATE ACTION, calculates:

- the mass of fuel burnt annually and
- the masses of certain gaseous and particulate emissions produced annually

by civil aviation flights starting from and/or finishing at airports in the member states of the EU.

For this submission, emissions are reported based on a methodology developed by EUROCONTROL. The calculation used in the “EUROCONTROL Method” is a mix of a Tier 3A and Tier 3b calculation. For the LTO cycle, a Tier 3a calculation is performed; average fuel consumption and emission data are assumed for (aircraft type, type of engine) combinations. For the CCD phase, a Tier 3B calculation is performed in which the amounts of fuel burnt and pollutants emitted are calculated on a flight segment by flight segment basis.

Activity data

Basically, two databases have been used. First, the IEA/EUROSTAT Annual Oil Questionnaire, especially the time series of jet kerosene consumption, has been taken into account. However, for the period 2005-2017, we have relied on the activity data and emission database of EUROCONTROL. As regards LTO phases, activity data have directly been taken from EUROCONTROL. Activity data for calculations of emissions of CCD phases reported as memo items are based also both on EUROCONTROL data and IEA data, however they might differ up to 29%.

Emission factors

As EUROCONTROL made both activity data (fuel burnt) and the resulting emissions available, emission factors built into the “EUROCONTROL Method” were used implicitly for the period 2005-2017. As for preceding years, (implied) emission factors were derived from emissions taken from EUROCONTROL and jet kerosene use as reported to the IEA. These constant emission factors were applied for the period 1990-2004.

Uncertainties and time-series consistency

The time series can be regarded as consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

Heavy metal emissions have been added.

Source-specific planned improvements

It is not planned to change the methodology.

3.5.3 RAILWAY TRANSPORT (NFR CODE 1A3C)

Last update: 2019
Reported Emissions: CO, CH, NOx, SO2, Particulate Matters, Heavy Metals, POPs
Measured Emissions: None taken into account
Methods: default (according to the Tier 2 calculation method proposed by the EMEP-EEA Guidebook 2016)
Emission factors: Tier 2
Key source: -

Methodological issues

During the previous years the Tier 1 method was applied based on the data published by the Hungarian State Railways (MÁV) and Győr-Sopron-Ebenfurt Railway (GySEV). The amount of exhaust gas emission components were calculated by the total amount of fuel used by the national rail transport and the previously determined specific emission values. For the years of 2015 and 2016 emissions were calculated from the amount of diesel fuel consumed in the rail traction taken from energy statistics and from the coal consumption of nostalgia trains published by the GySEV.

As the NOx emissions from rail have become a key category in recent years, it was necessary to apply a new calculation method (Tier 2 method) that required more detailed data for the year 2017 in comparison to the previously applied simplified method (Tier 1 method).

Activity data

Railway transport emissions are affected by many factors; these will be discussed in the following subsections. Since the currently used method of calculation is based on the fuel consumption of the rail traction, the factors described below, therefore, do not have a direct influence on the calculation.

Table 3.5.3.1 shows the total length of lines and vehicle stock of rail transport for the years 2000, 2005, 2010, 2015, 2016 and 2017. It can be defined that the length of all the operated railway lines has decreased in recent years, although not significantly. The number of locomotives during the same period also decreased to a minimum. As of 2010, unlike in previous years, the statistical yearbook no longer contains data on the proportion of rail traction (electrical - diesel).

Table 3.5.3.1

Track and vehicle stock of public railways, traction						
Name	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**
The length of the operated railway lines (km)	7 668	7 685	7 352	7 197	7 811	7 682
From which:						
two or multiple tracks	1 293	1 292	1 335	1 205	1 250	1 219
electrified	2 718	2 791	2 929	2 963	3 018	3 066
Track length of operated lines	12 739	12 735	9 178	9 358	11 424	11 531
Stock, numbers of each						
Locomotives	1 107	1 040	1 077	1 153	1 170	1 167
Railcars	339	369	431	515	498	500

Coaches	2 988	3 060	2 788	2 526	2 186	2 147
Freight cars	20 778	16 027	11 357	8 916	9 070	9 043
The proportion of the traction, [%]						
electrical	81,1	N/A	N/A	N/A	N/A	N/A
diesel	18,9	N/A	N/A	N/A	N/A	N/A

Table 3.5.3.2 shows the change of rail passenger performance. The quantity of all the number of people transported declined by about 12% over a decade, which is true for rail, although it shows an increasing tendency since 2010. Regarding the freight performance, it can be stated that although the weight of goods transported has fallen back to the year of 2001, the performance of transport was not much lower than in previous years. It can be stated that the railroad performance dropped approximately to a half. The proportion of freight performance and weight are relatively constant, and variations in the performance can be caused by changes in transport distances.

Table 3.5.3.2

Interurban passenger transport (2001–2017)				
Year	**Number of passengers carried [million people]**	**Of which train [million people]**	**Passenger-kilometer [million]**	**Of which train [million]**
2001	755,9	161,7	25 546	10 005
2002	755,9	164,6	26 102	10 531
2003	743,7	159,9	26 418	10 286
2004	737,3	162,7	27 217	10 544
2005	720,1	156,4	26 736	9 880
2006	721,7	156,8	27 733	9 584
2007	682,3	149,8	26 885	8 752
2008	691,1	144,9	25 989	8 293
2009	650,8	142,8	24 881	8 073
2010	652,8	140,5	25 059	7 692
2011	665,9	145,7	25 979	7 806
2012	669,3	147,8	23 285	7 806
2013	671,0	148,5	23 701	7 842
2014	671,9	146,1	25 056	7 738
2015	656,9	144,4	25 623	7 609
2016	648,6	146,6	26 933	7 653
2017	642,9	146,9	28 528	7 666

Domestic freight transport (2001–2017)				
Year	**Weight of freight transported [thousand tons]**	**Of which rail [thousand tons]**	**Freight-ton-kilometer [million]**	**Of which rail [million]**
2001	152 552	17 824	9 766	1 967
2002	237 732	16 560	13 413	1 788
2003	230 961	14 592	13 224	1 593
2004	228 019	15 217	13 692	1 725
2005	238 233	13 440	14 031	1 645
2006	253 388	12 078	14 928	1 491
2007	237 823	10 834	15 629	1 289
2008	251 666	11 198	15 495	1 374
2009	222 568	12 362	14 448	1 268
2010	190 635	11 398	13 667	1 341
2011	176 031	10 763	12 848	1 162
2012	156 503	11 556	12 411	1 423
2013	155 775	12 325	12 504	1 596
2014	184 218	15 020	13 559	2 049
2015	186 575	14 409	13 868	1 784
2016	184 450	13 558	15 216	1 578
2017	177 701	15 191	16 106	1 998

Calculating emission of railway transport

In the course of our calculations, our focus essentially was on determining the emissions of the rail traction and, in particular, of the mobile sources (diesel locomotives).

In the railway sector, the sources of air pollution can be grouped as follows:

a) transport by railway or public road
- traction
- heating in trains
- dispersing, evaporation
- public road transportation

It is a typical feature that pollution occurs from mobile sources, non-stationary, along the tracks.

b) service related activities
- car cleaning

- loading
- storage of materials (cargo and fuel as well)
- construction, track maintenance
- vehicle repairs, component manufacturing
- heat supply

c) other activities

- municipal heat supply
- wastewater treatment, waste management
- wreck

As previously mentioned, in the course of calculating emissions only exhaust emissions of diesel locomotives on track were taken into account.

Railway traction vehicles

In terms of emissions from traction vehicles, only those were taken into account which are driven by heat engines. In the case of electrical traction vehicles, that is to say the power plant emissions were not taken into account. Traction with an internal combustion engine is the most polluting traction type. The emissions from coal-fired traction are very low because of its low share. The coal used for this purpose is primarily connected to the nostalgia trains, but a part of it is used for heating as well. The distribution of nostalgia trains are not uniform in space and time: takes place mainly during the summer season and on touristically more popular lines. The amount of sulfur dioxide and solid pollutants emitted locally is significant compared to other traction types, while the other components are negligible. From the amount of diesel consumption used for traction, the emissions of pollutants were calculated based on the specific emission values of the relevant instructions and measurements. It should be noted that the emission of diesel locomotives, apart from fuel quality, is highly dependent on the type, condition and operating conditions of the engine. Petrol-powered vehicles are primarily used by the construction specialist. In fact, a conventional car engine is running in the railway work machine. During the calculation of the air pollution, these machines were also ignored. The reason for this is, firstly, that its emissions are negligible (magnitudes) lower than those of diesel traction. It can be also stated that this source of emission includes diesel locomotives at stations or railway stations, or shunting locomotives for a short distance.

Road vehicles

The railway has a significant road fleet. On the one hand, it is used to complement the basic service activity to ensure its own operation. This corresponds in the case of the composition of the vehicle fleet with the domestic vehicles (both diesel and petrol are included). At the same time, we also took into consideration vehicles with registration plate when calculating the emissions from road transport, so we did not calculate the emissions of the vehicle fleet of railroad separately.

The additional air pollutant effect of carriage of rail transport

The passing train causes dust dispersion/suspension. When braking, the brake block - in the case of modern vehicles the frictional brake pad and some of the iron powder formed by the wear of each the brake disc, tire and rails adheres to the train, while the rest, which are heavier than air, settles within the limit of expropriation. Replacing iron brake blocks with plastic-based material and using disc brakes reduces this pollution.

The air pollution impact of freight transport is more significant. The loading and unloading of bulk goods is usually carried out on siding tracks or on a designated loading track.

Some of the airborne contaminants are dust, and the other part is the liquid, possibly leaving the gas. Considering that the emissions of the above-mentioned origin cannot be reliably calculated, we have also omitted to define it. The recommended specific emission values were grouped into 3 categories divided by EMEP-EEA Guidebook instead of previous country-specific emission factors. Some of the airborne pollutants are dust, and the other part are those materials, which leave from carried goods made up of liquid or possibly gas. Considering that the above-mentioned emissions cannot be reliably calculated, we have also omitted to define it.

The quantities of fuel used for traction were provided by MÁV and GYSEV corporations. Due to the transition to the new calculation methodology, we have recalculated emissions since 2010.

Emission factors

The recommended specific emission values were used in 3 categories grouped by the EMEP-EEA Guidebook instead of the previous country-specific emission factors.

<table>
<tr><th colspan="5">Emission factor values for harmful components
[g / ton of fuel]</th></tr>
<tr><th>Fuel</th><th colspan="3">Diesel</th><th>Carbon</th></tr>
<tr><th>Locomotive type</th><th>line-haul locomotives</th><th>shunting locomotives</th><th>railcars</th><th></th></tr>
<tr><td>NOx</td><td>63</td><td>54,4</td><td>39,9</td><td>2 194</td></tr>
<tr><td>CO</td><td>18</td><td>10,8</td><td>10,8</td><td>27 367</td></tr>
<tr><td>NMVOC</td><td>4,8</td><td>4,6</td><td>4,7</td><td></td></tr>
<tr><td>NH_3</td><td>0,01</td><td>0,01</td><td>0,01</td><td></td></tr>
<tr><td>TSP</td><td>1,8</td><td>3,1</td><td>1,5</td><td rowspan="3">10 970</td></tr>
<tr><td>PM_{10}</td><td>1,2</td><td>2,1</td><td>1,1</td></tr>
<tr><td>$PM_{2,5}$</td><td>1,1</td><td>2</td><td>1</td></tr>
<tr><td>N_2O</td><td>0,024</td><td>0,024</td><td>0,024</td><td></td></tr>
<tr><td>CO_2</td><td>3140</td><td>3190</td><td>3140</td><td>380 000</td></tr>
<tr><td>CH_4</td><td>0,182</td><td>0,176</td><td>0,179</td><td></td></tr>
<tr><td>SO_2 *</td><td>0,2</td><td>0,2</td><td>0,2</td><td>45 497</td></tr>
<tr><td colspan="5">For diesel, Tier2 guide values (* except for SO2, where only Tier1 is present),
In the case of coal fuel, the former Institute for Transport Sciences Non Profit Ltd. (KTI) emission factors were used in the calculation</td></tr>
</table>

Uncertainties and time-series consistency

The time series is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

None

Source-specific planned improvements

None.

3.5.4 NATIONAL NAVIGATION (NFR CODE 1A3DII)

Reported Emissions: CO, CH, NOx, SO2, Particulate Matters, Heavy Metals, HCB, PCB, DIOX
Measured Emissions: None taken into account
Methods: default
Emission factors: T1
Key source: -

Methodological issues

The calculations are based on energy statistical data and default emission factors. Currently, it is not possible to distinguish between domestic and international navigation therefore all emissions are included under national.

Activity data and emission factors

Fuel consumption data were taken from the IEA annual questionnaires. Our data source of emission factors was the 2016 EMEP/EEA Guidebook.

Uncertainties and time-series consistency

The time series can be regarded as consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

-

Source-specific planned improvements

It is not planned to change the methodology.

3.5.5 PIPELINE TRANSPORT (NFR CODE 1A3EI)

Reported Emissions: Main Pollutants (except NH_3), Particulate Matters, CO, Heavy Metals, POP (except HCB, PCB)
Measured Emissions: None taken into account
Methods: T1
Emission factors: D, CS
Key source: -

Methodological issues

The calculations are based on (amended) energy statistical data and partly default, partly country specific emission factors.

Activity data

The IEA Annual Gas Questionnaire contains fuel consumption data only for the years 2010-2017. Therefore, backward extrapolation was carried out using total natural gas consumption as proxy information.

Emission factors

The same emission factors were applied as for small industrial combustion (see Ch. 3.4.3).

Uncertainties and time-series consistency

The time series is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

-

Source-specific planned improvements

It is not planned to change the methodology.

3.6 OTHER SECTOR (NFR SECTOR 1.A.4)

Reported emissions: Main Pollutants, Particulate Matter, CO, Heavy Metals, POPs
Measured Emissions: None
Methods: Tier 1/Tier 2 methodology
Emission factors: Default Tier 1/Tier 2 (Residential: coal, biomass), CS (SO_2)
Key source: NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, PCDD/F, PAH, HCB

This sector covers combustion in public institutions, by the population and in the Agriculture/Forestry/Fisheries Sector. Mostly, the general Tier 1 approach, i.e. a fuel-based methodology with default emission factors, was applied. Consequently, fuel consumption (amount and structure) determines level and trend of emissions to a large extent. Exceptions from this rule are biomass and coal fired stoves and boilers in the residential sectors for which T2 emission factors were used. Also, T2 method is applied for off-road machinery used in agriculture.

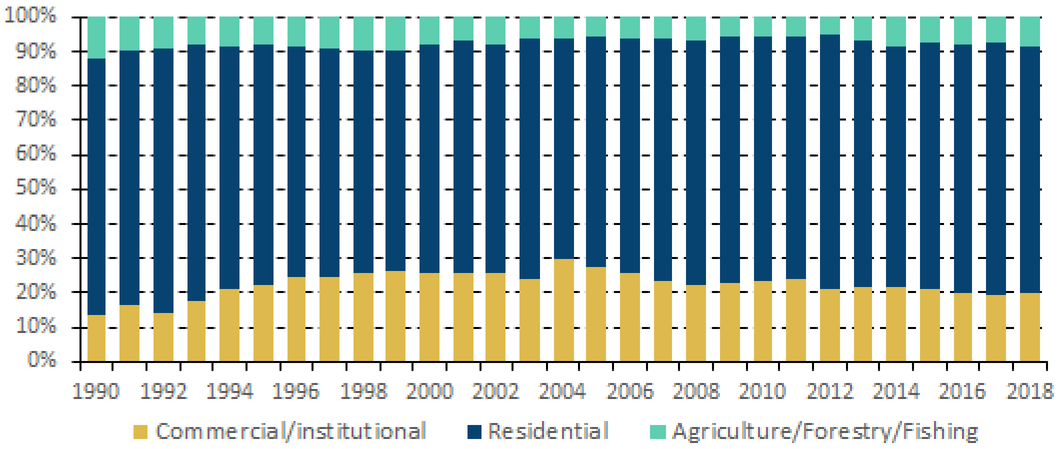


Figure 3.6.1 *Fuel combustion in the subsectors of the Other Sector (1990-2018)*

Figure 3.6.1 demonstrates the share of the three subsectors within the sector. By far, the most important is the residential sector representing around two third of all fuel use therefore in the following we will concentrate more on households. Please note that the calculation method was more or less the same, only the above-mentioned methodological distinction was applied between residential and commercial/institutional or agriculture/forestry/fishing source categories. Off-road mobile emissions in agriculture are reported separately.

Generally, in contrast with the significant reduction of coal and oil consumption, natural gas consumption has increased significantly. The population switched from coal to natural gas combustion. Household heating oil was completely replaced by LPG. During the period 1990-2018, the length of natural gas pipe-network increased from 22,549 km to 84,226 km. The number of households supplied with natural gas increased from 1.6 million in 1990 (42%) to 3.4 million in 2010 (77%) but decreased a little to 3.3 million (73%) since 2010. Residential consumption represented 34% of total inland demand in 2018. Piped gas is available in 91% of all settlements in Hungary, and this figure has not changed much since 2005 (but it was only 15% in 1990). 87% of households use natural gas for heating purpose as well. Although individual residential heating became more and more widespread, still 651 thousand dwellings (15% of all dwellings) are supplied with district heating and 601 thousand with hot water. Most of this heat (over 80%) is generated from natural gas use; however, the resulting emission was not accounted for here but under the Energy industries subsector.

The dominance of natural gas and the historical shift from liquid and solid fuels is clearly demonstrated by Figure 3.6.2 below. Steadily rising tariffs and the economic crisis were the main reasons of growing biomass use in this sector as well.

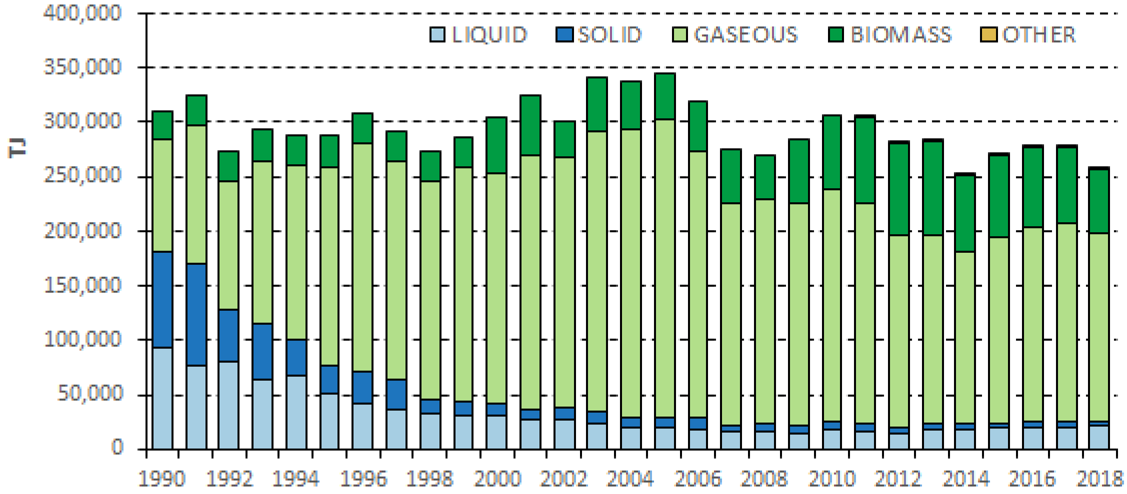


Figure 3.6.2 *Share of different combusted fuel types in the Other Sector (1990-2018)*

Natural gas consumption can be influenced by several factors. One of these factors might be the weather and the resulting heating demand. Heating degree day (HDD) is a quantitative index that reflects demand for energy to heat houses and businesses. This index is derived from daily temperature observations. The inside temperature is 18°C and base temperature (the outside temperature above which a building needs no heating) is 15°C in our calculation (following the standard European methodology). Figure 3.6.3 illustrates the relationship between residential fuel consumption and HDD. The figure demonstrates that increased fuel use can often be explained by increased HDD values and vice versa.

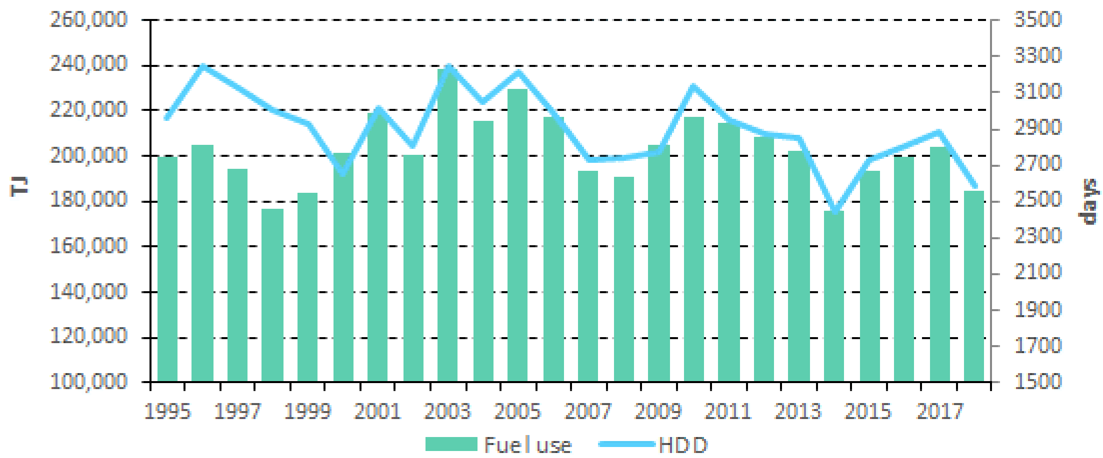


Figure 3.6.3 *Comparison of residential fuel consumption and HDD between 1995 and 2018*

Another factor is definitely the price. The (nominal) price of pipelined gas increased from 325 to 1360 Ft/10 m3 between 2000 and 2012. This price increase might have led to increased biomass use as a substitute fuel in the residential sector. However, the above-mentioned trends have changed in recent years. Gas prices have dropped by 26% since 2012 (but are still more than double as high as in 2005), and consumption started growing again.

So, it seems that the price elasticity of demand of natural gas and other fuels. We know that the price of natural gas was significantly higher in the period 2008-2013 than that of biomass, and in this very period natural gas consumption decreased and biomass consumption increased. After 2014, however, the trend changed due to decreased natural gas prices (the price advantage of biomass disappeared), so gas consumption started increasing again while biomass consumption decreased. This is demonstrated in Figure 3.6.4 below.

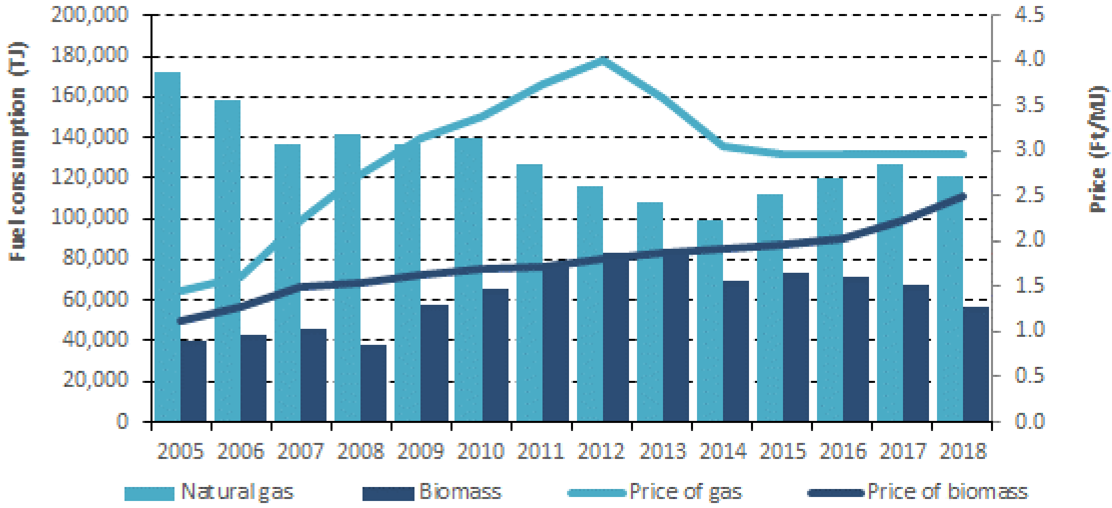


Figure 3.6.4 *Price elasticity of natural gas and fuelwood (2005-2018)*

The monthly natural gas consumption of an average household decreased from 127 m3 in 2003 to 87 m3 in 2018. In this significant decreasing trend - beside the higher energy prices – most probably also the more energy-conscious approach of the population plays a role and is definitely greatly affected by the weather. In addition, larger decrease in biomass use indicates some fuel switch from fuelwood to natural gas in the residential sector.

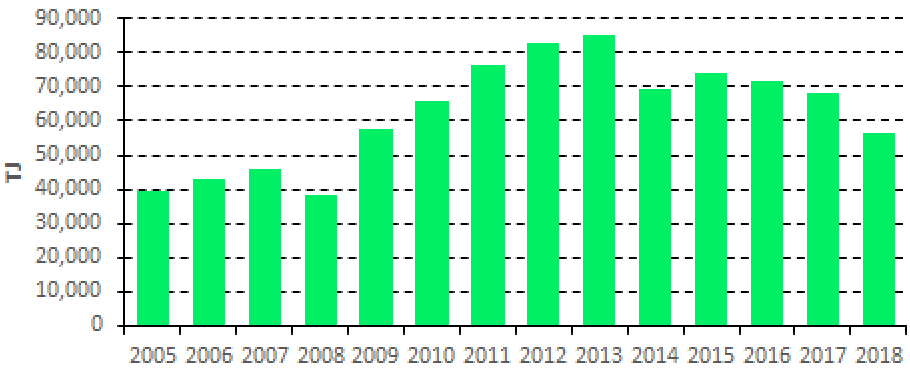


Figure 3.16 *Use of biomass (wood, wood wastes) use in the residential sector (2005-2018)*

Activity data

The joint IEA/Eurostat annual questionnaires served as activity data consistently for the whole time-series (1990-2018). It has to be repeated that about half of the losses in natural gas distribution reported in energy statistics is assumed to be fired and accounted for here in this sector.

The Tier 2 method applied for coal and wood fired stoves and boilers in the residential sector required more information on the used technologies. Based on the latest comprehensive population census conducted by the Hungarian Central Statistical Office in 2011 it was assumed that 35% of coal was used in conventional stoves and 65% in conventional boilers. As regards biomass consumption, 50% was allocated to conventional stoves and the remaining half to conventional boilers.

In order to report separate emissions for the source category "Agriculture/Forestry/Fishing: Off-road vehicles and other machinery", diesel oil consumption had to be split between stationary and mobile combustion. The Energy Statistical Yearbooks published around 1990 contained separate data for gasoil used in tractors and harvesters. Based on this information, a bit more than 60% could be allocated to mobile consumption in the early period of the time series. Considering the generally diminishing role of liquid fuels in stationary combustion, it is assumed that after 2001 all gasoil allocated to agriculture in the energy statistics has been used for mobile off-road machinery.

Emission factors

Generally, default Tier 1 emission factors were used as published in the Small combustion chapter of EMEP/EEA Guidebook, however with one minor and two major exceptions. Domestic legislation regarding maximum sulphur content of liquid fuels was taken into account similarly as described above for other source categories. As regards SO_2 emission factors for solid fuels, our calculations were based on sulphur content and calorific value of the different coals, as follows:

$$EF (SO_2) = [S] \times 20{,}000 / CVNet$$

where:

$EF (SO_2)$ is the SO_2 emission factor (g/GJ)

[S] is sulphur content of the fuel (% w/w)

CVNet is fuel CV (GJ/tonne, net basis)

Sulphur content of the domestically produced coals was received from the Hungarian Office for Mining and Geology (MBFH). Recently, domestic lignite and brown had a sulphur content of 1 to 3.3 per cent. In the 90's, coals with even higher sulphur content were mined; domestic coal had an average sulphur content of 2.9%. The resulting implied emission factor for domestic brown coal changed from 4000 kg/TJ in the 90's to 3300-3800 in recent years. For domestic coal, 20% retention is ash was assumed. The sulphur content of imported coals, based on data from distributors, varied between 0.5 and 3 per cent, therefore 1.75% sulphur content was assumed for sub-bituminous coal, and 1% for better quality hard coal. Calorific values were taken from the IEA annual coal questionnaire. In the case of imported coal, 10% retention in ash was assumed. The resulting IEF varied between 1200-2500 kg/TJ.

In case of biomass and coal fired stoves and boilers, for all other pollutants default T2 emission factors were applied representing conventional technologies.

Further methodological description

The methodology for off-road vehicles and other machinery used in agriculture and forestry is presented here. Since the previous submission, we have implemented the Tier 2 method from the 2016 EMEP/EEA Guidebook. This method classifies the used equipment into the fuel types and layers of engine technology. The engine technology layers are stratified according to the EU emission legislation stages, and three additional layers are added to cover the emissions from engines prior to the first EU legislation stages. The used layers are as follows: <1981; 1981-1990; 1991-Stage I; Stage I; Stage II; Stage IIIA; Stage IIIB; Stage IV; Stage V. The penetration of the new technology is taken into account in the form of split (%) of total fuel consumption per engine age (irrespective of inventory year) as it can be seen for diesel-fueled non-road machinery in Table 3-3 in the Guidebook. As domestic information on stock of agricultural machinery indicate a somewhat slower penetration of new technology (as in Denmark), original data in Table 3-3 have been modified as follows:

Table 3.6.1 *Used values for the split (%) of total fuel consumption per engine age (irrespective of inventory year) for diesel-fueled non-road machinery in Agriculture*

Engine age	USED	ORIGINAL in Table 3-3
0	4	8
1	4	7.6
2	4	7.2
3	4	6.79
4	6	6.39
5	6	5.99
6	6	5.59
7	6	5.18
8	6	4.78
9	6	4.38
10	6	3.98
11	4	3.57
12	3	3.17
13	3	2.77
14	3	2.37
15	3	1.97
16	3	1.9
17	3	1.83
18	3	1.76
19	3	1.69
20	3	1.62
21	2	1.55
22	1	1.48

Engine age	USED	ORIGINAL in Table 3-3
23	1	1.41
24	1	1.34
25	1	1.28
26	1	1.21
27	1	1.14
28	1	1.07
29	2	1

Emissions from household machinery in the category are reported in the category 1A4bii separately. Based on the latest survey of the Statistical Office, 56% of the households have garden or backyard on their own. There are 3.9 million households in Hungary; 56% of which is 2.2 million. It was assumed that for every garden 5 liters gasoline are used in a year. This would translate to 10.95 million liters or 8.2 kt gasoline. As part of the households use electronic devices, 6 kt of gasoline use was assumed for the whole time series. As the resulting emissions are not significant, for the calculations T1 methodology was used with default emission factors (i.e. the average factors for 2 stroke and 4 stroke engines).

Uncertainties and time-series consistency

The time series are most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

Activity data have been updated in line with the latest IEA/Eurostat Annual Questionnaires.

Source-specific planned improvements

None.

3.7 FUGITIVE EMISSIONS FROM FUELS – NFR SECTOR 1.B

This sector includes emissions from non-combustion activities during fuel production, processing, transformation, transmission and storage and also venting and flaring operations during these processes. Combustion emissions connected to these processes are to be reported in sector 1.A. Therefore, mainly NMVOC emissions are reported in sector 1.B as suggested by the 2019 EMEP/EEA Guidebook. NO_X, CO and SO_x are to be reported only in source categories where process emissions occur, i.e. in 1.B.2.a.iv Refinery, in 1.B.1.b 'Fugitive emissions from solid fuels: solid fuel transformation'and in1.B.2.c Venting and flaring. In the case of heavy metals and PAHs, coking is the significant emission source. The pollutants reported in the different subsectors are summarized in the following table together with the method used.

3.1. Table: Summary of pollutants and emissions estimation methods used within sector 1.B

	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH_3	PMs	CO	HMs	POPs
1B1a Fugitive emission from solid fuels: Coal mining and handling	NA	T3	NA	NA	T1	NA	NA	NA
1B1b Fugitive emission from solid fuels: Solid fuel transformation	T1	T1	T1	T1	T1	T1	T1	T1 – only PAHs
1B1c Other fugitive emissions from solid fuels	NA	NA	NA	NA	NA	NA	NA	NA
1B2ai Exploration, production, transport	NA	T2	NA	NA	NA	NA	NA	NA
1B2aiv Refining / storage	T3	T1	T3	T1	T1	T3	T1	T1 PCDD/F
1B2av Distribution of oil products	NA	T1, T2	NA	NA	NA	NA	NA	NE
1B2b Natural gas	NA	T2	NA	NA	NA	NA	NA	NE
1B2c Venting and flaring	T1/T2	T1	T1	NA	T1/T2	T1/T2	T1/T2	T2 – only PAHs

Default emission factors and activity data from statistics are used in every subsector, since direct measurement of fugitive emissions is not possible in general and we have no information on country specific calculations. An exception is coal mining, where country specific method is used based on research projects and another exception is 1.B.2.a.iv Refinery, where process emissions from oil refinery are reported based on plant specific data. The most important source of activity data is IEA Energy statistics of Hungary in the case of sector 1.B. The source categories of sector 1.B are very similar to the source categories of sector 1.B defined in UNFCCC reporting on greenhouse gases. While in UNFCCC reporting on greenhouse gases Natural Gas is the most important source as the main source of methane emissions, in this present LRTAP reporting Oil is of higher concern as the main source of

NMVOC. In subcategory *1.B.2.d Other fugitive emissions from energy production* no emissions are reported for most part of the time series. However thermal water extraction is present is Hungary and CH_4 emissions from extraction of thermal water is reported in UNFCCC reporting, the 2019 EMEP/EEA Guidebook suggests to report only NH_3 emissions solely where electricity is produced directly by geothermal energy in this subsector. In Hungary the general use is heat only production and electricity or CHP production from geothermal energy started only in 2017, according to HCSO and IEA Energy Statistics. The associated (quite negligible) NH3, Hg and As emissions are included in the 2020 submission for the first time.

Trend

The aggregated trend of emissions in this sector is interesting only for NMVOC since all the other pollutants are to be reported only in one or two subsectors as it is detailed above. The trend is decreasing which is mainly caused by the decline and eventual disappearance of underground mining activities in Hungary, which is in direct correlation with NMVOC emissions from this subcategory. The emissions are also slightly decreasing in *1.B.2.a – Oil operations* which is the most significant subcategory. This can be explained by the slow fall of oil refined and total gasoline sold in Hungary. The latter is caused probably by the growing fuel prices.

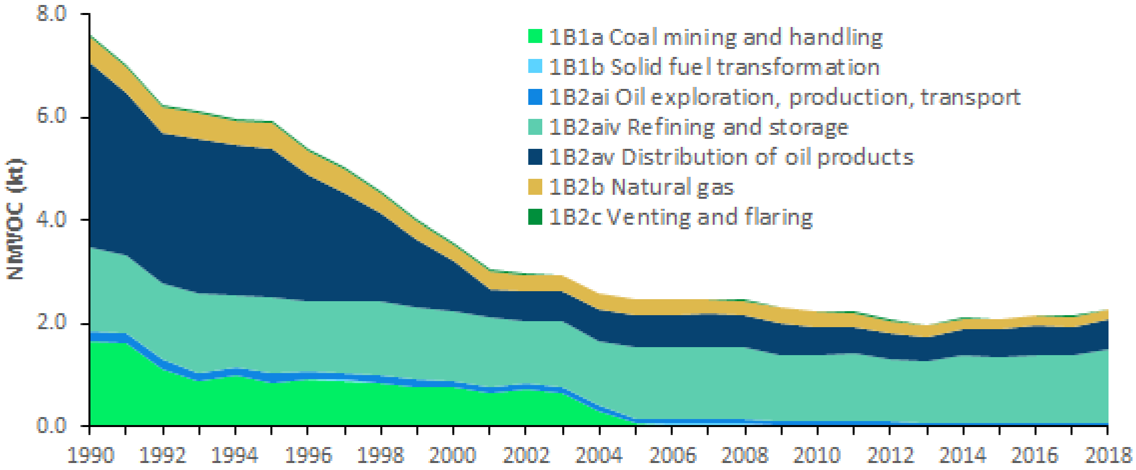


Figure 3.7.1 *Aggregated NMVOC emissions from sector 1.B*

It is worth mentioning that it is especially complicated to define realistic time series and trends of emissions in this sector, since the spread of environmentally sound technologies and improvement of abatement efficiencies has been a continuous process on diffuse or plenty of point sources. The time series presented in this chapter are mainly calculated using the default factors presented in the latest edition of the Guidebook, which usually reflects the state of the technology by the time of the preparation of the Guidebook.

Consequently, on one hand the later in time the more realistic the estimation of emissions is, on the other hand the trends of emissions reflect the change of activity rather than the change caused by application of abatement and control options. However, the application of default factors is necessary in order to fulfill the completeness and consistency criteria of inventory preparation until better data becomes available.

In the case of subsectors Refinery and Distribution of Oil products, a trend is already included in the emission factors. For details please see the relevant chapters.

3.7.1 FUGITIVE EMISSIONS FROM SOLID FUELS (NFR SECTOR 1.B.1)

Non-combustion emissions arising during coal mining and transformation into coke are reported in this sector.

3.7.1.1 FUGITIVE EMISSIONS FROM COAL MINING AND HANDLING (NFR SECTOR 1.B.1.A)

Reported Emissions: NMVOC, TSP, PM_{10}, $PM_{2.5}$
Measured Emissions: NMVOC
Methods: T1, T3
Emission factors: T1, T3

First of all, it is important to state that indigenous production of coal is not significant anymore in Hungary. The production used to be larger but a fast decline started after the change of regime especially in the case of underground mining. It is possible to see the trend of indigenous production of coal mined underground and total production of coal in *Table 3.7.3.* The 2019 EMEP/EEA Guidebook suggests reporting NMVOC and PM_{10} emissions in this sector. Emissions are reported using country specific methods. The country specific method is taken from UNFCCC reporting of CH_4 emissions originating from coal mining. NMVOC and CH_4 are both the components of in-situ gas originating from coal mines. In-situ gas content (quantity and composition) was measured in the one single underground coal working until 2017 in Hungary. The results are published in USGS, 2002. (Please see the Reference list). Methane is reported based on the results of these measurements in UNFCCC reporting. In this present LRTAP reporting NMVOC emissions are reported by proportioning the methane emissions. It is worth mentioning that the same method is used by determination of the emission factor of the 2009, 2013, 2016 and 2019 EMEP/EEA Guidebooks: "The NMVOC factor is based on an assessment of the emission factors for methane from an earlier version of the Guidebook, in combination with a species profile (Williams, 1993). This profile suggests an average NMVOC content between 0 and 12 % in the firedamp."

Surface (open-cast) mining is located in two area of the country, for the largest area no in-situ gas content is assumed, since the lignite exploited there is very young in coalification. (Net calorific value of the lignite mined there is under 10 MJ/m^3 and presented in sector 1.A.) As no methane emissions are reported from surface mining in UNFCCC reporting, no NMVOC emissions are assumed either. At the end of 2014 an old surface mine was re-opened with relatively high (20.75 m^3 CH_4/t coal) in-situ methane content, but the amount of mined coal was almost negligible. However, as CH_4 emission was reported in the UNFCCC regime, NMVOC emissions was also included here.

As far as our knowledge, Hungarian mines are not drained and there are no mine-burning or burning coal waste piles. From the older coal waste piles, the combustible part has been extracted for decades. Methane emission from abandoned mines is now calculated for the UNFCCC greenhouse gas inventory according to 2006 IPCC Guidelines, but not covered by this inventory.

To sum up, it is important to be aware that the decreasing and relatively low emissions (and implied emission factors) of NMVOC originating from coal mining presented in the figure below are due to the low in-situ gas content and NMVOC content of in-situ gases of coals of Hungary and the decreasing percentage of underground mining activity.

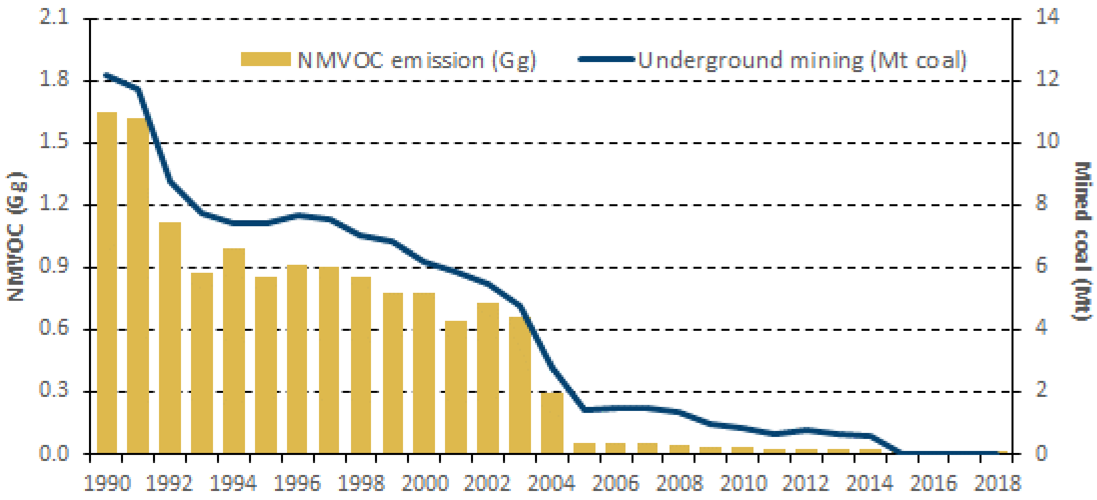


Figure 3.7.1.1 *Trend of NMVOC emissions in sector 1.B.1.a and production data of underground coal mining in Hungary*

Emission factors for particulate matter

TPS, PM_{10} and $PM_{2.5}$ emissions are reported using emission factors of 2016 EMEP/EEA Guidebook.

Emission factor for NMVOC

Methane emissions originating from coal mining are calculated in UNFCCC reporting where emission factors are based on individual measurement data. Between 2006 and 2014 the only one operating underground mine had been Márkushegy with 0.93 m^3/t coal mined in-situ methane content. The methane content of the in-situ gas (firedamp) is 95% based on the research conducted by the Hungarian Geological Service (Somos 1991, please see the Reference List for other references also), so NMVOC content of the gas is less than 5%. This is in line with the 2019 EMEP/EEA Guidebook 1.B.1.a chapter 3.2.2, where it is stated that an average NMVOC content of the firedamp is between 0 and 12 %. The methane emission from coal mining reported in NIR is the 95% of the in-situ gas (firedamp), so NMVOC emissions are calculated as the 0,05/0,95=0,05263 part of the methane emissions. In 2014 an old surface mine (in Mecsek region, where gassy mines of Hungary are located) was re-opened with relative high (20.75 m^3 CH_4/t coal) in-situ methane content, but the amount of mined coal was almost negligible in the first year, however emission was reported in UNFCCC reporting, so NMVOC emissions also presented here. In the last two years production of this mine was very low, but underground production was also marginal, so this mine represented significant proportion in emissions, therefore the implied emission factor changed significantly. Since 2015 only one minor underground mine was working after the closure of the mine of the last bituminous/sub-bituminous coal fired power plant, and in 2018 underground mining ceased eventually.

Please note that the implied emission factor calculated based on NMVOC emission and AD reported in NFR Table might be misleading, since the latter is the TOTAL indigenous production and not the amount mined underground. However, in the case of PMs and TSP, the whole amount (TOTAL indigenous production) is to be taken into account.

Activity data

Detailed data on coal mining is available from both IEA (IEA_COAL_Total indigenous production) - energy statistics and the Hungarian Mining Authority (MBFH). Data is compared and they are corresponding. Underground mining of coal decreased significantly since 1980. Nowadays the open-cast mining of a coal has become more important. One single underground mine was operating until 2017, and open cast mining is also limited almost to one area of the country and it is combusted mainly in one single power plant. At the end of 2014 an old surface mine was re-opened to produce coal for resident population. However, this coal production is very limited (falls below the threshold of reported amount in the IEA publication) according to the information of Mining and Geological Survey of Hungary (former Hungarian Office for Mining and Geology) there is some CH4 and NMVOC emissions because of relatively high in-situ methane content.

Please note that the Activity data reported in NFR Table is the data of Total indigenous production of coal including underground and surface (open-cast) mining. PMs and TSP emission factors have this data as the unit of measure of the emission factor, but NMVOC emissions are correlated to activity data of underground mining.

It is worth mentioning that total coal production in 2014 increased only by 0.3 Mt compared to 2013, so because of rounding Table 3.7.2 has same values in case of total production, PM and TSP emissions for 2013 and 2014.

***Table 3.2** Activity data and emissions in sector 1.B.1.a*

	Underground mining		Total production (underground + surface mining)			
Year	***Coal (Mt)***	**1.B.1.a NMVOC (Gg)**	***Coal (Mt)***	**1.B.1.a $PM_{2.5}$ (Gg)**	**1.B.1.a PM_{10} (Gg)**	**1.B.1.a TSP (Gg)**
1990	*12.19*	1.78	*17.66*	0.09	0.74	1.57
1991	*11.73*	1.72	*17.06*	0.09	0.72	1.52
1992	*8.76*	1.21	*15.75*	0.08	0.66	1.40
1993	*7.72*	0.98	*14.61*	0.07	0.61	1.30
1994	*7.38*	1.03	*14.11*	0.07	0.59	1.26
1995	*7.44*	0.90	*14.59*	0.07	0.61	1.30
1996	*7.65*	0.93	*15.19*	0.08	0.64	1.35
1997	*7.51*	0.91	*15.59*	0.08	0.65	1.39
1998	*7.04*	0.86	*14.65*	0.07	0.62	1.30
1999	*6.85*	0.78	*14.55*	0.07	0.61	1.29
2000	*6.16*	0.78	*14.03*	0.07	0.59	1.25
2001	*5.87*	0.64	*13.91*	0.07	0.58	1.24
2002	*5.45*	0.73	*13.03*	0.07	0.55	1.16
2003	*4.74*	0.66	*13.30*	0.07	0.56	1.18
2004	*2.77*	0.29	*11.24*	0.06	0.47	1.00
2005	*1.42*	0.05	*9.57*	0.05	0.40	0.85
2006	*1.49*	0.05	*9.95*	0.05	0.42	0.89
2007	*1.47*	0.05	*9.82*	0.05	0.41	0.87
2008	*1.36*	0.05	*9.40*	0.05	0.39	0.84
2009	*0.96*	0.03	*8.99*	0.04	0.38	0.80
2010	*0.81*	0.03	*9.11*	0.05	0.38	0.81
2011	*0.67*	0.02	*0.00*	0.05	0.40	0.85
2012	*0.76*	0.03	*9.30*	0.05	0.39	0.83
2013	*0.62*	0.02	*9.55*	0.05	0.40	0.85
2014	*0.60*	0.02	*9.55*	0.05	0.40	0.85
2015	*0.02*	0.005	*9.26*	0.05	0.39	0.82
2016	*0.01*	0.001	*9.23*	0.05	0.39	0.82
2017	*<0.01*	0.001	*7.97*	0.04	0.35	0.71
2018	*NO*	0.001	*7.90*	0.04	0.33	0.70

Recalculations, QA/QC activities and planned improvements

There was no recalculation in this category. NMVOC emission from abandoned underground coal mines will be calculated after the revision of methane emission for the UNFCCC as the NMVOC calculation is based on methane emission.

3.7.1.2 FUGITIVE EMISSION FROM SOLID FUELS: SOLID FUEL TRANSFORMATION (NFR SECTOR 1.B.1.B)

Last update: 15.03.2020
Reported Emissions: NOx, SOx, NMVOC, CO, NH3, PM10, PM2.5, TSP, HMs (Pb, Cd, Hg, As, Ni), PCDD/F, PAHs
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Trend PCDD/F

It is important to take into account the definition of the 2019 EMEP/EEA Guidebook in order to avoid double counting and separate the combustion emissions: *"This source category discusses emissions from coke ovens (only fugitive emissions including emissions from charging, door and lid leaks, off-take leaks, quenching, pushing. Emissions from combustion stacks and preheater are included in chapter 1.A.1.c 'Manufacture of solid fuels and other energy industries'. Coke production in general can be divided into coal handling and storage, coke oven charging, coal coking, extinction of coke and coke oven-gas purification. Combustion in coke oven furnaces is treated in chapter 1.A.1.c; the fugitive emissions from door leakage and extinction are covered by this chapter. Leakage and extinction lead to emissions of all major pollutants including heavy metals and POPs."* (2019 EMEP/EEA Guidebook). For fugitive emissions, the default Tier 1 approach is used. NMVOC, NH3, PMs, TSP, several HMs (Pb, Cd, Hg, As, Ni), PCDD/F and PAHs are reported here. In contrast to previous submissions, also NOx, SOx and CO emissions have been included.

Emission factor

Tier 1 default emission factors of the 2019 EMEP/EEA Guidebook are used for all emission calculation reported in 1B1b sector. However, the company producing coke in Hungary is reporting to LAIR, but not all the substances, where default EF is provided in the 2019 EMEP/EEA Guidebook (e.g. no reporting of PCDD/F, PCB, HCB, etc.). It might be the case that there is no emission at all from certain pollutants, but in the absence of detailed information, we prefer to use the default factors. In this way the results are probably a very conservative overestimation of several substances.

Activity data

Production of coke is available from IEA Energy statistics.

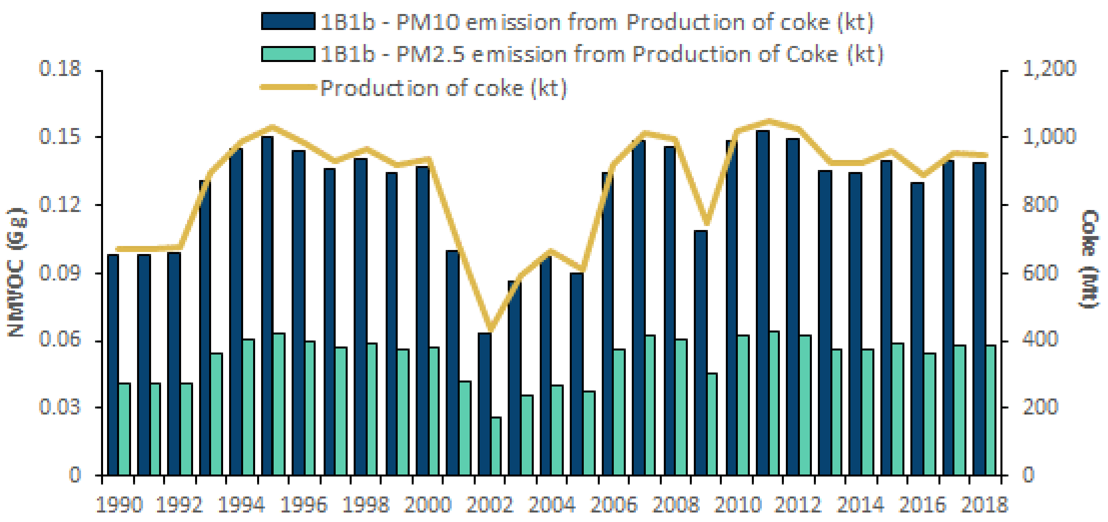


Figure 3.3 *Activity data and PM_{10} emission in 1.B.1.b sector*

Recalculations, QA/QC activities and planned improvements

For this submission, we have included fugitive NOx, CO, and SOx emissions.

3.7.2 FUGITIVE EMISSIONS FROM OIL AND GAS OPERATIONS (NFR SECTOR 1.B.2)

In this sector fugitive emission arising during exploration, production, transport, transmission, distribution, storage and processing of Natural Gas and Oil are reported including emissions from venting and flaring operations of these processes. NMVOC is the most important pollutant, but in the case of subcategory Venting and flaring also NOX, SOx and CO is reported within this sector (and not in sector 1) as it is suggested by the 2016 EMEP/EEA Guidebook.

In Hungary all the operations mentioned above are present but the processes related to indigenous production of natural gas and oil are not significant due to the relatively low volumes exploited.

In the case of natural gas, the fugitive emissions of methane are of higher concern, which is reported under UNFCCC reporting, NMVOC emissions are less important.

Also, in this sector default emission factors and activity data from statistics are used. 1.B.2.a.iv Refinery and 1.B.2.a v. Distribution of Oil products subsectors are the two exceptions. In the former case plant specific data and extrapolation is used. In the case of subsector Distribution of Oil products, the emission factor is time-dependent since the date and effect of change of technology was quite easy to define. For details please see the relevant chapters.

The most important time series of activity data and NMVOC emissions by subsector are presented in the following tables.

***Table 3.3** Activity data and NMVOC emissions in 1.B.2.a Oil operations subsector*

Year	*Crude oil indigenous prod. (kt)*	**1B2a i-iii NMVOC (Gg)**	*Refinery intake (kt)*	**1.B.2.a iv - NMVOC (Gg)**	*Total gasoline sold (kt)*	**1.B.2.a v - NMVOC (Gg)**
1990	*1915*	**0.192**	*8147*	**1.629**	*1790*	*3.580*
1991	*1841*	**0.184**	*7655*	**1.531**	*1567*	*3.134*
1992	*1769*	**0.177**	*7458*	**1.492**	*1463*	*2.926*
1993	*1654*	**0.165**	*7717*	**1.543**	*1488*	*2.976*
1994	*1575*	**0.158**	*7043*	**1.409**	*1445*	*2.890*
1995	*1668*	**0.167**	*7506*	**1.501**	*1427*	*2.854*
1996	*1477*	**0.148**	*6787*	**1.357**	*1345*	2.473
1997	*1360*	**0.136**	*7022*	**1.404**	*1353*	2.092
1998	*1260*	**0.126**	*7171*	**1.434**	*1386*	1.711
1999	*1243*	**0.124**	*6982*	**1.396**	*1402*	1.330
2000	*1136*	**0.114**	*6801*	**1.360**	*1336*	0.950
2001	*1065*	**0.107**	*6842*	**1.368**	*1391*	0.569
2002	*1050*	**0.105**	*6035*	**1.207**	*1409*	**0.576**
2003	*1134*	**0.113**	*6382*	**1.276**	*1427*	**0.583**
2004	*1077*	**0.108**	*6371*	**1.274**	*1442*	**0.590**
2005	*948*	**0.095**	*7032*	**1.406**	*1486*	**0.608**
2006	*886*	**0.089**	*6915*	**1.383**	*1527*	**0.624**
2007	*839*	**0.084**	*7087*	**1.417**	*1575*	**0.644**
2008	*811*	**0.081**	*6967*	**1.393**	*1565*	**0.640**
2009	*791*	**0.079**	*6324*	**1.265**	*1565*	**0.640**
2010	*734*	**0.073**	*6389*	**1.278**	*1372*	**0.561**
2011	*659*	**0.066**	*6594*	**1.319**	*1271*	**0.520**
2012	*649*	**0.065**	*6114*	**1.223**	*1256*	**0.513**
2013	*599*	**0.060**	*5968*	**1.194**	*1160*	**0.474**
2014	*584*	**0.058**	*6507*	**1.301**	*1278*	**0.522**
2015	*623*	**0.062**	*6477*	**1.295**	*1288*	**0.527**
2016	*712*	**0.071**	*6637*	**1.327**	*1390*	**0.568**
2017	*714*	**0.071**	*6525*	**1.305**	*1363*	**0.562**
2018	*808*	**0.081**	*7039*	**1.408**	*1428*	**0.584**

Notes regarding 1.B.2.a.v Distribution of oil products subsector:

Numbers in italics = Emissions calculated using Tier1 EF (Stage I control)

Numbers in green= linear interpolation

Numbers in bold= Emissions calculated using Tier 2 country specific EF (Stage II control)

Table 3.4: *Activity data and NMVOC emissions in 1.B.2.b Natural Gas operations subsector and 1.B.2.c Venting and flaring subsector*

Year	*Natural Gas indigenous prod. (Mm3)*	1.B.2.b.i-iii NMVOC (Gg)	1B2c i-ii NMVOC (Gg)	1B2c iii NMVOC (Gg)
1990	*4874*	**0.487**	**0.0231**	**0.019**
1991	*4976*	**0.498**	**0.0236**	**0.018**
1992	*4753*	**0.475**	**0.0225**	**0.017**
1993	*5042*	**0.504**	**0.0239**	**0.018**
1994	*4851*	**0.485**	**0.0230**	**0.016**
1995	*4886*	**0.489**	**0.0231**	**0.017**
1996	*4668*	**0.467**	**0.0221**	**0.016**
1997	*4369*	**0.437**	**0.0207**	**0.016**
1998	*3877*	**0.388**	**0.0184**	**0.016**
1999	*3401*	**0.340**	**0.0161**	**0.016**
2000	*3194*	**0.319**	**0.0151**	**0.016**
2001	*3231*	**0.323**	**0.0153**	**0.016**
2002	*3106*	**0.311**	**0.0153**	**0.014**
2003	*2945*	**0.295**	**0.0046**	**0.015**
2004	*3051*	**0.305**	**0.0031**	**0.015**
2005	*3028*	**0.303**	**0.0031**	**0.016**
2006	*3095*	**0.310**	**0.0046**	**0.016**
2007	*2615*	**0.262**	**0.0031**	**0.016**
2008	*2643*	**0.264**	**0.0092**	**0.016**
2009	*2968*	**0.297**	**0.0031**	**0.015**
2010	*2900*	**0.290**	**0.0030**	**0.015**
2011	*2766*	**0.277**	**0.0031**	**0.015**
2012	*2234*	**0.223**	**0.0023**	**0.014**
2013	*1960*	**0.196**	**0.0030**	**0.014**
2014	*1858*	**0.186**	**0.0044**	**0.015**
2015	*1772**	**0.177***	**0.0028**	**0.015**
2016	*1841*	**0.184**	**0.0027**	**0.015**
2017	*1821*	**0.182**	**0.0036**	**0.015**
2018	*1905*	**0.191**	**0.0025**	**0.016**

*Revised IEA activity data

3.7.2.1 EXPLORATION, PRODUCTION, TRANSPORT OF OIL (NFR SECTOR 1.B.2.A I-III)

Last update: 03.2020
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T2
Emission factors: T2

NMVOC emissions arising during exploration, production and transport of oil are reported using Tier 2 method from 2019 EMEP/EEA Guidebook

Oil production is not significant in Hungary and the whole production is on-shore of course, so Tier 2 method can be applied. Due to the declaration of the producer company, the exploration and production is performed with high standard equipment.

Emission factor

The emission factors used are Tier 2 default emission factors from the 2019 EMEP/EEA Guidebook for production (i.e. 0.1 kg/Mg oil).

Activity data

Production of crude oil is available from IEA Energy statistics.

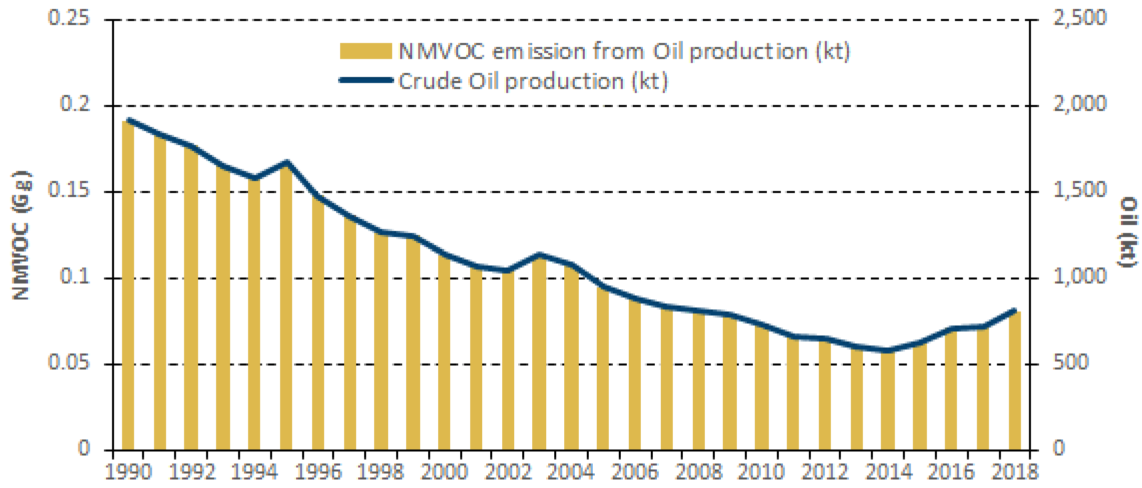


Figure 3.4 *Activity data and NMVOC emissions in 1.B.2.a i-iii subsectors*

Recalculations, QA/QC activities and planned improvements

In previous submission, emission factor from 2006 IPCC Guidelines in the case of transportation of oil was also applied. For this submission, the 2019 EMEP/EEA Guidebook was used solely.

3.7.2.2 REFINING / STORAGE (NFR SECTOR 1B2A IV)

Last update: 03.2020
Reported Emissions: NMVOC, SO_2, NO_x, NH_3, TSP, PMs, CO, HMs, PCDD/F
Measured Emissions: SO_2, NO_x, CO, TSP
Methods: T1, T3
Emission factors: T1, T3

Only emission of NMVOC, SO_2, NO_x, TSP, PMs, CO, HMs and PCDD/F arising from processes are reported in this category. All combustion emissions are reported in category *1.A.1.b.* and refinery venting and flaring emissions are reported in subcategory *1.B.2.c*.

Emission factor

NMVOC and NH3, HMs and PCDD/F are reported using Tier 1 emission factors from the 2019 EMEP/EEA Guidebook.

Plant specific data on SOx, NOx, TSP, and CO of oil refinery is available in LAIR database (see description in chapter 1.5). Thanks to the fact that in LAIR database emissions are reported by technology, it is possible to separate combustion and process emissions in this case. Therefore, process emissions (catalytic cracking and sulphur recovery (Claus-plants)) can be allocated to 1.B.2.a.iv and all other emissions and technologies are reported in 1.A.1.b.

The sectoral splits between 1.A.1.b and 1.B.2.a.iv in case of SOx and NOx are presented together on the following Figure.

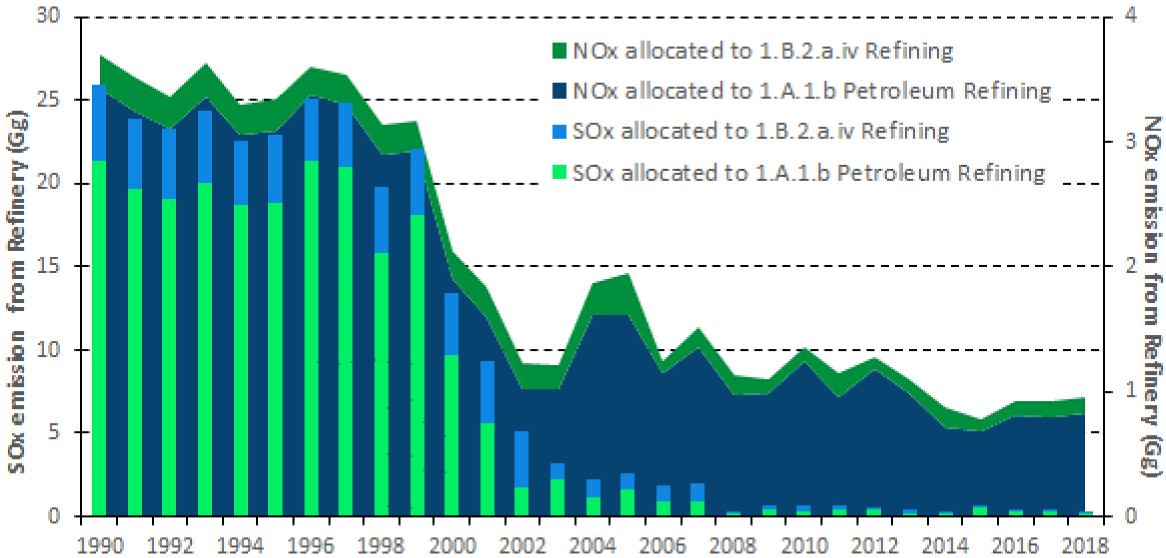


Figure 3.5 *Allocation of SO_x and NO_x emissions from Petroleum Refining between 1.A.1.b and 1.B.2.a.iv subsectors*

Reporting to LAIR database is compulsory only from 2002. So, for the years before 2002 extrapolation is applied using implied emission factor (Gg PROCESS emission/ kt Refinery intake) of year 2002. The application of IEF of year 2002 for extrapolation is better than the application of an average as the trend of IEF of the years after 2002 is decreasing.

Extrapolated process emission time series of SO2, NOx, TSP, PMs and CO are of course also subtracted from the time series of 1.A.1.b for the years before 2002 in order to apply the allocation between 1.A.1.b and 1.B.2.a.iv consistently.

Activity data

Data on refinery intake is available from IEA Energy statistics which is also used for extrapolation for the years before 2002 and for the calculation of IEF.

Recalculations, QA/QC activities and planned improvements

During the bilateral consultations with IIASA as part of the preparation for amendment of NEC Directive (see general description in chapter 1.7 of the IIR) significant differences were discovered between GAINS model and HU time series in case of emissions from Refinery.

In case of NMVOC, the difference is due to the gap between 2009 EMEP/EEA Guidebook (which is the same as in 2013 version) Tier 1 method (applied by HU in 2014 submission) and GAINS model „no control" emission factor. In addition, SOx, NOx, CO, TSP and PM process (fugitive) emissions (1.B.2.a.iv) and combustion emissions (1.A.1.b) have been separated in order to be able to compare GAINS model and HU time series. Plant specific data applied in HU time-series are lower than results of GAINS model.

Further verification of plant specific data and the extrapolation method is also planned.

3.7.2.3 DISTRIBUTION OF OIL PRODUCTS (NFR SECTOR 1.B.2.A V)

Last update: 03.2019
Reported Emissions: NMVOC
Measured Emissions: none
Methods: CS
Emission factors: T1, T2

NMVOC emissions are reported using country-specific method that combines Tier 1 and Tier 2 method included in 2016 EMEP/EEA Guidebook in order to reflect more the trend of emissions. However, only emissions originating from petrol stations are reported due to absence of other data since it is regarded anyway less significant than the emissions originating from service stations. Marine terminals are not relevant for Hungary.

"Considerable reduction of hydrocarbon emissions from gasoline distribution network is achieved. These emission controls have been mandated under the terms of Directive 94/63/EC (EU. 1994) "Stage I controls refer to a variety of techniques reducing NMVOC emissions at marketing terminals (Stage IA) and when gasoline is delivered to service stations (Stage IB)." "Stage II applies to vapour balancing systems between automobile fuel tanks during refueling and the service station tank supplying the gasoline." (2019 EMEP/EEA Guidebook)

Control options to be used by distribution of oil are regulated by 94/63/EC (Stage I) and 2009/126/EC (Stage II) directives. In Hungary the Stage II control option was mandatory from 2001 due to 9/1995

(VIII.31.) KTM Ministerial Decree. It is now withdrawn and both directives are fully implemented in Hungary by 118/2011 (XII.15.) VM Ministerial Decree.

It is very obvious in this subsector that the Tier 2 emission factor is not realistic for the whole time series. It is very probable that before the entry into force of the above-mentioned legislation the most service stations had only limited control in place. Tier 1 emission factor of the 2016 EMEP/EEA Guidebook takes into account Stage I control level and the Tier 2 emission factor is calculated taking into account Stage I and II control levels. 9/1995. (VIII.31.) KTM Ministerial Decree prescribed the compulsory implementation of Stage II control option within 6 years for service stations with gasoline throughputs higher than 100 m3/year in Hungary.

So, in the time series Tier 1 emission factor was used before 1995 and calculated Tier 2 emission factor was used after 2001. Between 1995 (the entry into force of 9/1995 (VIII.31. KTM Ministerial decree prescribing Stage II) and 2001 (6 years after the entry into force as the deadline for implementation) a linear interpolation was made.

Emission factor

Tier 2 emission factor is calculated taking into account Stage I and II control. The abatement efficiencies related to this control options provided in the 2016 EMEP/EEA Guidebook are taken into account. Two country specific properties are needed: the average mean temperature of Hungary is taken from the public website of the HMS and the maximal RVP is determined by Government decree 30/2011.

Please find below the calculation of the country specific Tier 2 emission factor incorporating abatement efficiencies as it is suggested in the 2016 EMEP/EEA Guidebook:

$TVP = RVP \times 10^{AT+B}$

Calculation of TVP in Hungary

3.2. Table 3.5 Calculation of TVP in Hungary

A=	0.000007047× RVP + 0.0132
B=	0.0002311× RVP − 0.5236
T is the temperature (in °C). Average temperature of Hungary:	10
RVP is the Reid Vapour Pressure (in kPa). Maximal RVP determined by Government decree 30/2011.	60
A	0.01362282
B	-0.509734
A*T+B	-0.3735058
10^{AT+B}	0.423149859
TVP	**25.38899151**

Table 3.6 *Calculation of Tier 2 NMVOC emission factor in category 1.B.2.a.v*

Category	Emission source	NMVOC default EF. (g/m³ throughput/ kPa TVP)	Abatement efficiency %	True Vapour Pressure (TVP). (kPa)	NMVOC EF g/m³ (EF abated*TVP)
Gasoline in service stations	Storage tank Filling with no Stage 1.B	24	95% (stage I)	25.4	30.48
	Storage tank Breathing	3		25.4	76.2
	Automobile refuelling with no emission controls in operation	37	85% (stage II)	25.4	140.97
	Automobile refuelling: drips and spills	2		25.4	50.8
				SUM:	**298.5 g/m³**

Using the assumption: *"The assumed liquid gasoline density is 730 kg/m³"* (2019 EMEP/EEA Guidebook - 1.B.2.a.v. chapter 3.3.2.3.) the 298.5 g/m³ results **0.4088 kg NMVOC /t gasoline.**

Activity data

Data on total sold gasoline is available from IEA Energy statistics.

The following statements of the 2016 EMEP/EEA Guidebook are confirming that significant part of the emissions is reported in this way:

"Due to the volatility of gasoline, the majority of NMVOC emissions in the distribution of oil products occur during its storage and handling, and thus this chapter focuses on gasoline distribution." (2019 EMEP/EEA Guidebook 1.B.2.a.v, chapter 2*)*

Time series using the methodology described above are presented in the following Figure.

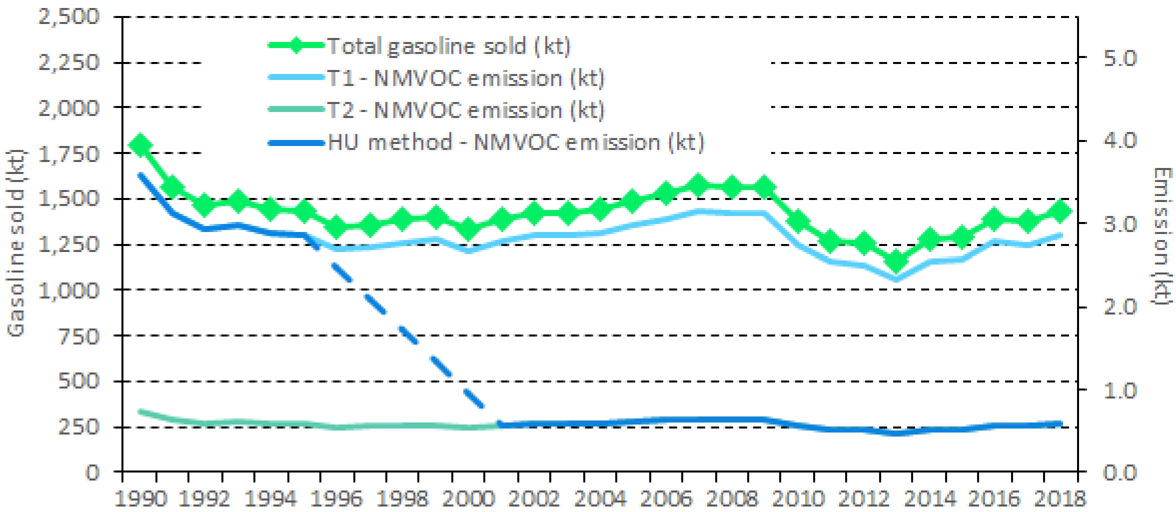


Figure 3.6 *Comparison of the time series calculated with or without adjustment*

Recalculations, QA/QC activities and planned improvements

Yearly average temperature instead of climatic average temperature is planned to applied for the next submission. Resulted changes are assumed to be lower than 10% of the actual emission of the category.

Inclusion of refinery dispatch stations is planned if data will be available.

3.7.2.4 NATURAL GAS (NFR SECTOR 1.B.2.B)

Last update: 03.2020
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T2
Emission factors: T2

In this category NMVOC emission from natural gas production, processing, transmission, distribution and storage are reported using Tier 2 methodology. Venting and flaring emissions are reported in category 1B2c.

Natural gas is not a significant natural resource of Hungary, either, although it is more important than oil. Production is declining as it is possible to see in the following figure (Figure 3.7); therefore, also emissions are decreasing.

Emission factor

Tier 2 emission factor of the 2019 EMEP/EEA Guidebook (i.e. 0.1 g NMVOC/m3 gas) is used for production of gas since it is obvious that all production occurs on-shore in Hungary.

Activity data

Activity data of natural gas production is available from IEA Energy Statistics.

Recalculations, QA/QC activities and planned improvements

All previous calculations using additional emission factors from the 2006 IPCC Guidelines have been removed.

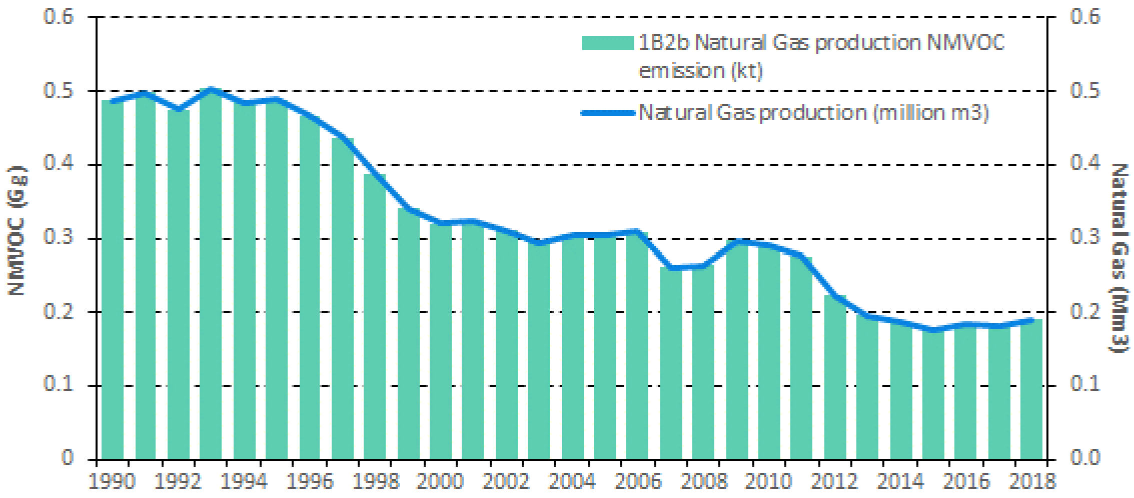


Figure3.7 *Natural gas indigenous production and NMVOC emissions*

3.7.2.5 VENTING AND FLARING (NFR SECTOR 1.B.2.C)

Last update: 03.2020
Reported Emissions: NO_X, SO_x, CO, NMVOC, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs
Measured Emissions: none
Methods: T1, T2
Emission factors: T1, T2
Key source: Trend SO_x, Cd, Hg

This section includes emissions arising from venting and flaring during gas and oil and gas extraction and refinery processes. Tier 1 methodology contains emission factor for natural gas and oil production and refinery venting and flaring. In addition to NMVOC, also NOX, SOx, and CO are reported based on the suggestion of 2016 EMEP/EEA Guidebook.

Emission factor

Tier1 emission factor is used for emissions from gas production venting and flaring provided in the 2019 EMEP/EEA Guidebook.

In case of oil refinery flaring only NMVOC and SOx emissions are calculated with Tier 1 emission factors from 2019 EMEP/EEA Guidebook, Tier 2 emission factors were used for all other pollutant.

Please note that the implied emission factor calculated simply based on NMVOC emission and AD reported in NFR Table might be misleading since gas flared in natural gas production is only one of the several activity data to be taken into account in this category.

Activity data

Activity data (Natural Gas flared, Crude Oil production, Crude Oil refined) is available from IEA Energy Statistics.

Please note that activity data reported in NFR Table Crude oil production but total emissions from subsector 1.B.2.c contain also emissions from gas production flaring and oil refinery flaring.

Activity data for Tier 2 method in case of oil refinery flaring is the annual flared amount for each refinery. Since 2006 this information can be found in EU ETS database. For years before 2006 extrapolation was applied using the ratio of measured flared amount and IEA refinery intake.

Recalculations, QA/QC activities and planned improvements

Collection of plant specific information on oil refinery venting and flaring in Hungary would allow more realistic estimation of emissions. NOX, SOx and CO emissions are reported to the LAIR database also by oil and gas production sites. It could be included instead of Tier 1 emissions, but further investigation is needed to decide whether all sites are reported to the database. In addition, data are available only for 2004 and after 2007.

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Coalbed Gas in Hungary— A Preliminary Report USGS Open File Report 01-473 Version 1.0 2002

U.S. Department of the Interior U.S. Geological Survey

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Dr. Fodor Béla: **MAGYARORSZÁG SZÉNHEZKÖTÖTT METÁNVAGYONA.** Magyar Geológiai Szolgálat

Available online at: http://bdszarhiv.atw.hu/files/metan.pdf

4 INDUSTRIAL PROCESSES AND PRODUCT USES (NFR SECTOR 2)

4.1 OVERVIEW OF SECTOR

In this chapter the methodologies of estimating emissions originating from industrial processes and product uses sector (*hereinafter: IPPU*) are described. Methodologies are based on 2016 EMEP/EEA Guidebook.

It is very important to emphasize that as it is suggested by the 2016 EMEP/EEA Guidebook and earlier versions of the Guidebook, all emissions originating from combustion during industrial processes are reported in sector 1A, as the separation of combustion emissions and process emissions are not possible in most cases. That is why NO_X, SO_x, CO are reported in sector 1.A.2., while NMVOC, PMs and other pollutants are reported in sector 2 following the recommendation of the 2016 EMEP/EEA Guidebook. In the case any NO_x, SO_x, or CO emissions are reported in sector 2, these are always process emissions separated from combustion emissions. The only exception is chemical industry where also combustion emissions are reported together with process emissions in sector 2, where process emissions occur. Combustion emissions from the section of chemical industry without process emissions are still included in 1A2c. The reason for this change is the consistency with the allocation required by 2006 IPCC Guidelines.

As it is described in the general chapter, different data sources for activity data and emission factors are taken into account to prepare NFR. The data sources for activity data include: Hungarian Central Statistical Office (HCSO), activity data reported by companies for UNFCCC reporting purposes and other international statistics (FAOStat, EUROSTAT). Emission factors used are taken from 2016 EMEP/EEA Guidebook and 2006 IPCC Guidelines.

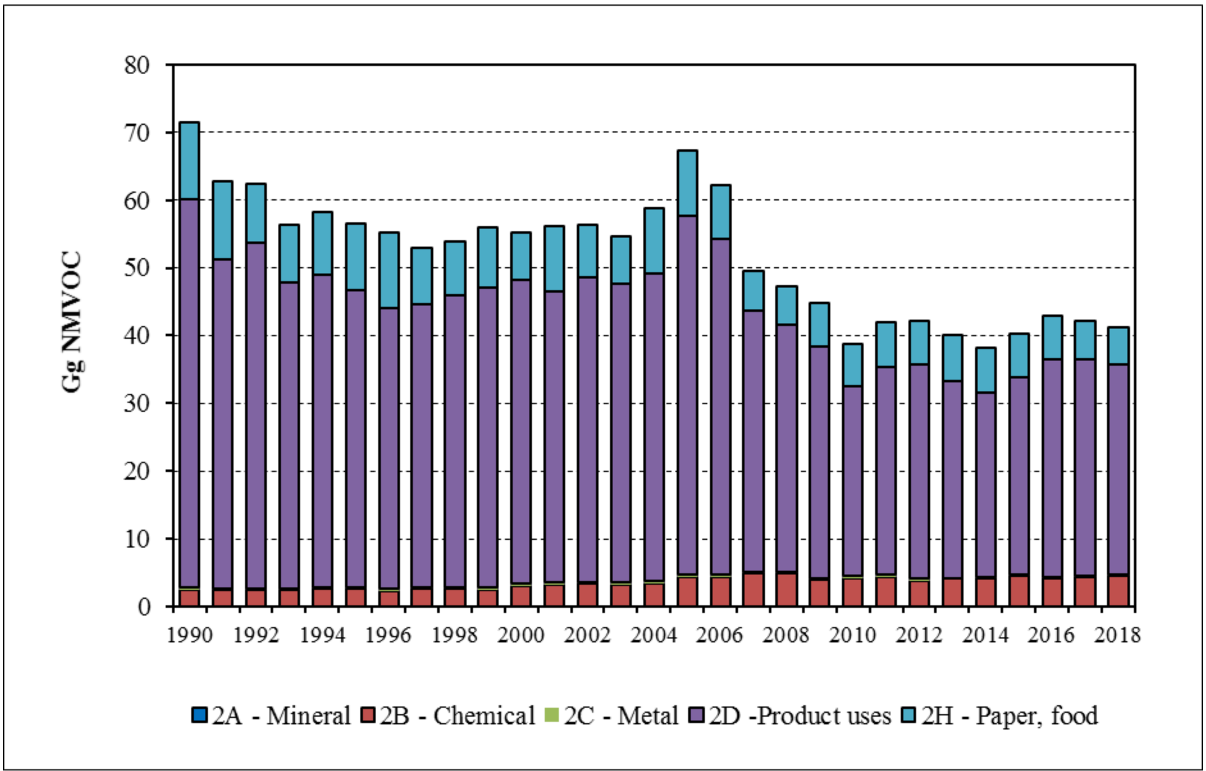
In several cases emission data reported directly by individual companies are taken into account. This data is available in the LAIR (Hungarian Air Emissions Information System) and/or in E-PRTR reporting (please see more detailed description in chapter 1.5). Where directly reported data is used, activity data is taken either from statistics or it is also reported by companies for UNFCCC (and EU ETS) purposes.

In several significant sectors of the Industrial Processes only 1-4 producing companies are present in Hungary that are also well known and they usually report in E-PRTR and EU ETS, too. This is especially true for sectors: Cement and Lime production, Ammonia, Nitric Acid production, Iron and Steel industry. This situation provides the possibility of verification of the directly reported data so in these cases the use of LAIR or direct reporting of companies result a more realistic data.

Hungary became Member State of the EU in 2004. So, the relevant environmental regulation of the EU (including Integrated Pollution Prevention and Control directive prescribing the use of BAT for the installations under its scope and E-PRTR Regulation) is implemented and enforced. Compliance and reporting of emissions are regularly checked by the Department of Environmental Protection and Nature Conservation of the regional Government Offices. So, in the cases when emission factors are differentiated for Eastern European countries/ EU countries, Hungary has to apply the latter at least from 2004.

Pollutants

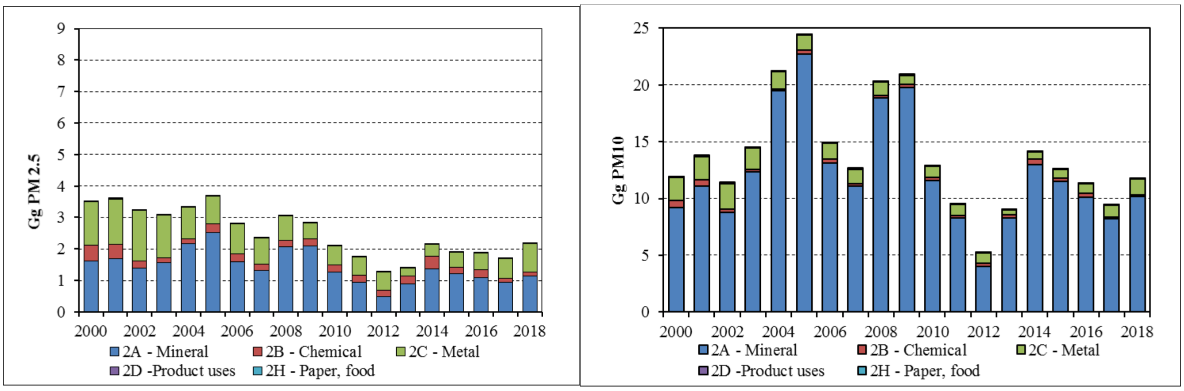
NMVOC emissions determined usually by using default emission factors provided in the 2016 EMEP/EEA Guidebook have the biggest volume in this sector. Direct reporting of NMVOC emission is usually not available because in the LAIR (see description in chapter 1.5 of the IIR) NMVOCs are usually not reported in group but several organic compounds are reported separately (depending on the content of the environmental permit of the given installation).



4.1. Figure: Trend of NMVOC emissions of subsectors within IPPU

In the case of particulate matter emissions, we adopted the approach that TSP (Total Suspended Particles) includes PM_{10}, PM_{10} includes $PM_{2.5}$, and $PM_{2.5}$ includes BC. This means that there is always TSP emission when either PM_{10} or $PM_{2.5}$ or BC emissions are present.

In LAIR the companies are reporting only TSP (Total Suspended Particles) emission and no PM_{10} and/or $PM_{2.5}$. (This is probably due to the fact that nor IPPC, neither E-PRTR regulation indicate explicitly the disaggregation of the particulate matter emissions.) In these cases, the emission data is regarded as TSP and PM emissions are calculated based on TSP/ PM_{10}/ $PM_{2.5}$ proportion of emission factors. In LAIR several companies are reporting “soot”, but it is not yet verified, what it exactly means in LAIR and whether any relationship with BC in NFR might be stated. Therefore, BC is always reported based on default EFs (percentage of $PM_{2.5}$) from the Guidebook.



4.2. Figure: Trend of $PM_{2.5}$ and PM_{10} emissions of subsectors within IPPU

Trend

The declining trend of emission is probably due to the restructuring of industrial sectors on one hand because the most emitting sectors have fallen or ceased after or around the change of regime in Hungary. On the other hand, the improvement and spread of emission control technologies play also a significant role partly introduced following the evolution of environmental regulations.

Volume indices of industrial production in general show a really instable trend therefore correlation between emissions and industrial production can only be found in subsector level.

PM emissions are determined mostly by mineral industry, especially the category of construction and demolition.

General description of sectors reported in Industry and Other Products use category

OTHER categories in 2020 submission include:

2.B.10.a Other chemical industry: Production of sulfuric acid, chlorine, carbon black, ethylene, propylene, 1,2 diclorethane and vinilcloride balanced, PE (LD and HD), PP, PVC, Polystyrene, Urea, Ammonium nitrate and other fertilizers
2D3g Other chemical products: Manufacture of shoes, manufacture of pharmaceutical products, paints and glues and processing of foams
2G Other Product use: Consumption of tobacco, use of fireworks

The sectors not described in the chapters following are not reported because they are assumed to be negligible or not occurring in Hungary. Please see the reasons in the following table.

4.1. Table: Sectors not reported in the 2020 submission

Sector	Explanation
2.A.5.c Storage, handling and transport of mineral products	"It is assumed that these emissions are accounted for in the relevant mineral chapter". (2016 EMEP/EEA Guidebook)
2. A. 6. Other mineral products	No method available.
2.B.3 Adipic acid production	Not occurring in Hungary.
2.B.5 Carbide production	Not occurring in Hungary.
2. B.6 Titanium-dioxide	Not occurring in Hungary.
2.B.10.b Storage, handling and transport of chemical products:	Emissions are not to be reported in this category in the case of application of Tier 2 methodology since they are included in the specific sectors due to the 2016 EMEP/EEA Guidebook.
2.C.2 Ferroalloys production	No data is available on occurrence.
2. C.5. Lead production	No data is available on occurrence.
2. C.6. Nickel production	No data is available on occurrence.
2.C.7.c Other metal production	No data is available on occurrence.
2.C.7.d Storage, handling and transport of metal products	"It is assumed that emissions from storage. handling and transport of metal products are included in the Tier 1 from the relevant chapter in the metal industry" (2016 EMEP/EEA Guidebook)
2.J Production of POPs	Not occurring in Hungary.
2.L Other production, consumption, storage, transportation or handling of bulk products	"The contribution of this source category is thought to be insignificant". (2016 EMEP/EEA Guidebook)

Time series consistency and recalculations in recent years

Before the 2014 May submission, no time-series were submitted. Emissions were calculated for individual years using different methods in several years. The calculation methods of old submissions were not documented in detail. Due to restructuring of the inventory compilation system, significant changes occurred since 2012. As the compilation of NFR has become the task of the same unit of HMS and the same experts as the UNFCCC reporting, the practice and QA/QC and a lot of data became available and were imported. In 2014 May submission Hungary submitted whole recalculated time series based on 2009 EMEP/EEA Guidebook and CLRTAP Reporting Guidelines (ECE/EB.AIR/97).

In 2015 submission the time-series have been recalculated based on 2013 EMEP/EEA Guidebook, the new version of CLRTAP Reporting Guidelines (EME/EB.AIR/125) and using the calculation methods described below.

These recalculated time series are now fully consistent with the time series reported in UNFCCC GHG Inventory of Hungary in the case of IPPU sector. However please note that several subsectors are aggregated in the UNFCCC GHG inventory as CRF reporter software does not always follow the allocation of NFR Table.

The 2017 submission relied mostly on 2016 EMEP/EEA Guidebook with some small exceptions. In case of category 2.A.5.b (Construction and demolition) – which is key category (for PM_{10} and TSP) for Hungary - the new methodology differs fundamentally from the previous versions, requiring significant amount of new data, therefore implementation of the new Guidebook in this category has been delayed to the 2021 submission.

In the recent submission, the following recalculations were done:

2.A.2. Reported TSP emissions from a calcium hydroxide plant and a new furnace of one of the companies were taken into account in lime production.

2.A.5.b. Road construction data were estimated (and recalculated) for 2017.

2.C.1. Recalculation of TSP, PM_{10}, $PM_{2.5}$ and BC emissions was made from the year 2009 onwards because of reported diffuse TSP emissions.

2.C.6. SO_x emissions from secondary zinc production have been calculated and provided for every year from 1990.

2.D.3.f From the 2020 submission, NMVOC emissions from dry cleaning are reported using Tier 2 approach based on technology-dependent emission factors and the quantity of material cleaned.

4.2 MINERAL PRODUCTS (NFR SECTOR 2.A)

4.2.1 CEMENT PRODUCTION (NFR SECTOR 2.A.1)

Last update: 11.03.2020.

Reported Emissions: TSP, PM_{10}, $PM_{2.5}$, BC
Measured Emissions: TSP
Methods: T3, T1
Emission factors: PS
Key source: Trend PM_{10}, $PM_{2.5}$

Cement production is a typical case where combustion emissions and process emissions are non-separable. Reporting follows the recommendation of the 2016 EMEP/EEA Guidebook, so the NO_X, SO_2, CO emissions originating from cement production are reported in sector 1.A.2. In sector 2.A.1 only TSP, PM_{10} and $PM_{2.5}$, and BC emissions are reported as it is suggested by the 2016 EMEP/EEA Guidebook.

It is important to state that the 5 cement producing plants in Hungary – which are included in the time series – are regulated based on EU requirements. In 2011 one of the 5 plants was closed down and a new one was opened. Since 2014 there are only 3 cement producing plants (2 companies) in Hungary. All have Integrated Pollution Prevention and Control permit which describes the use of BAT. Compliance is regularly checked by the regional Inspectorates for Environment and Nature.

The decreasing trend of emissions (especially the solid particles) is reflecting the improvement of abatement technologies and the very strong decline of mineral industries production in Hungary. This strong decline stopped in 2014 and a slight rise has begun since then.

There is only 3 cement producing plants and statistics are confidential, therefore activity data and implied emission factors have not been reported since 2018 submission, because one of the plants did not give permission for disclose neither the aggregate production data.

Methodological issues

Tier 3 methodology is applied using facility level data. Emissions reported to LAIR by the cement producing companies of Hungary are used. However, only TSP data is reported. PM emissions are calculated based on TSP/ PM_{10}/ $PM_{2.5}$ / BC proportion of Tier 1 emission factors (applicable for EU countries) of PMs presented in the following Table.

Emission factor

4.2. Table: Proportion of size fractions calculated from Tier 1 default emission factors

TSP	100.0%
PM10	90.0%
PM2.5	50.0%
BC	1.5%

Implied emission factors for the Hungarian cement industry derived from reported emissions and reported clinker production are summarized in the table below. In 2018, IEF is C again because of the confidential activity data. At the end of the time-series IEFs are very close to the ones described in the EU BAT Ref. document (2013).

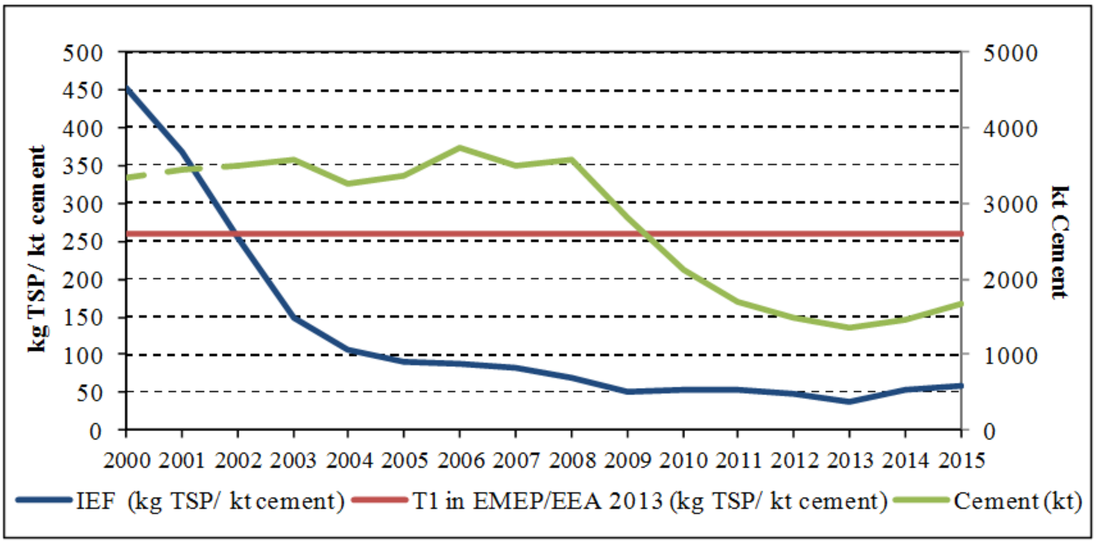
4.3. Table: Implied emission factors for cement production in Hungary, 2000-2017

	2000	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***
IEF (g TSP/t clinker)	599	504	333	198	139	129	128	111	101
	2009	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016-2018***	
IEF (g TSP/t clinker)	75	80	82	54	51	24	26	C	

As plant specific data is usually available only from 2002, extrapolation is needed for the years before 2002. Extrapolation is performed in 2014 submission and kept henceforward using data by plant (as IEF by plant are quite different).

IEF of 2002 is applied for extrapolation for 2000 and 2001 in the case:

- 2002 IEF is higher than T1 emission factor from 2009 EMEP/EEA Guidebook (it is still relevant because IEFs are also higher than EF in 2016 EMEP/EA Guidebook), or
- documented information is available on the presence of the same abatement option in 2000 than in 2002.



4.3. Figure: Activity data and implied emission factor in sector 2.A.1 Cement production (2000-2015)

Activity data

Cement production data is available both from the HCSO and from the individual companies. Also EU ETS reports of all companies are checked for production data. Latter is used in NFR table as activity data and for the calculation of IEF consistent with UNFCCC GHG Inventory reporting. Since 2018 activity data have not been reported.

Uncertainty, recalculations, QA/QC activities and planned improvements

There was no recalculation in the 2020 submission.

Further verification of plant specific data is planned: since LAIR database also contains data about the filtered TSP, use of these data to verify the efficiency of abatement technology and the plant specific emissions are possible.

4.2.2 LIME PRODUCTION (NFR SECTOR 2.A.2)

Last update: 11.03.2020.
Reported Emissions: TSP, PM_{10}, $PM_{2.5}$, BC
Measured Emissions: TSP, PM_{10} (from 2013)
Methods: T3, T2
Emission factors: T3, T2
Key source: none

Reporting follows the recommendation of the 2016 EMEP/EEA Guidebook. So, the NO_X, SO_2, and CO emissions originating from lime production are reported in sector 1.A.2. In sector 2.A.2 only TSP, PM_{10} and $PM_{2.5}$ and BC emissions are reported. Three lime producing companies of Hungary - which are included in the time-series - are also covered by IPPC directive, also application of BAT is required. Since 2013 only two companies exist.

Methodological issues

Tier 3 methodology is applied by using facility level data, Tier 2 methodology is applied in all other cases. Emissions reported to LAIR by the 3 (nowadays 2) lime producing companies of Hungary are used.

Emission factor

Only TSP data is reported directly for all plants. In 2011 reported PM_{10} emission turned up in case of one plant in the LAIR database. For the first two years (2011 and 2012) proportions of measured PM_{10} and TSP were very low (15% and 40% on the average), then this proportion stabilized around at 50% - which is the default value in the Guidebook, as well -, so only the measurements after 2012 were taken into account in the calculations. For the other lime works the original calculation was kept. Besides this PM emissions are calculated based on TSP/ PM_{10}/ $PM_{2.5}$ / BC proportion of Tier 2 emission factors of PMs presented in the following Table (Table 4.4.) that is the same in 2009, 2013 and 2016 versions of the Guidebook.

4.4. Table: Proportion of size fractions calculated from Tier 2 (controlled) default emission factors

TSP	100.0%
PM_{10}	50.0%
$PM_{2.5}$	7.5%
BC	3.45%

Please note that in this sector Tier 1 emission factors in 2016 EMEP/EEAGuidebooks do not include abatement option (uncontrolled process) therefore they are much higher than Tier 3 implied emission factor. The directly reported plant specific emissions correspond to the Tier 1 emission factor with cc. 90% abatement efficiency.

As plant specific data is usually available only from 2002 a linear extrapolation is used for the years before 2002.

Activity data

Lime production data is provided both by the HCSO (for the years until 2013) and from the individual companies. The latter is used as activity data in NFR table and for the calculation of implied emission factor consistent with UNFCCC GHG Inventory reporting. Production is declining until 2013 with the number of lime works. In recent years production fluctuates according to the demand of construction.

Despite the fact that there are only 2 factories activity data – aggregated production data - are presented with the permission of the plants in the NFR and and IIR, as well.

Uncertainty, recalculations, QA/QC activities and planned improvements

Recalculation was made for the 2003-2017 period, because TSP emissions from a calcium hydroxide plant of one of the companies were not taken into calculation, however it was reported in the LAIR. An other recalculation was made for 2017 based on reported PM10 data from a new furnace of the other company, when TSP data were calculated based on the proportion of size fractions calculated from Tier 2 (controlled) default emission factors.

4.5. Table: Recalculation in lime production

Years	Changes in TSP emission of lime production in kt	Changes in TSP emission of lime production in %
2003	0.00147	5.7
2004	0.00136	5.3
2005	0.00037	0.2
2006	0.00044	0.5
2007	0.00083	2.5
2008	0.00065	2.5
2009	0.00071	7.1
2010	0.00005	0.3
2011	0.00005	0.3
2012	0.00008	1.0
2013	0.00009	0.6
2014	0.00018	1.0
2015	0.00035	1.7
2016	0.00034	1.8
2017	0.00886	41.0

4.2.3 GLASS PRODUCTION (NFR SECTOR 2.A.3)

Last update: 11.03.2020.
Reported Emissions: NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, HMs
Measured Emissions: NMVOC, TSP
Methods: T1, T2, T3
Emission factors: T1, T2, T3
Key source: Level Pb, Cd; Trend Pb

In this sector only process emissions originating from Glass production are reported.

Flat glass, container glass, other glass (technical), glass wool and mineral wool production are all present in Hungary, although production is declining. Since disaggregated activity data is available, Tier 2 methodology can be used for estimating process emissions.

Emissions from mineral wool production are reported for the first time in 2015 submission using plant-specific data as it is available from LAIR.

Also in this subsector combustion related emissions are reported in sector 1.A.2. In sector 2A3 the following pollutants are reported: NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$,BC and HMs.

Emission factor

Tier 2 technology specific emission factors of 2013 EMEP/EEA Guidebook are used.

No further abatement efficiency is taken into account due to absence of data. Plant specific emissions from mineral wool production are available for TSP, NH_3 and organic compounds. The sum of organic compounds is reported as NMVOC while PM emissions are calculated based on TSP/ PM_{10}/ $PM_{2.5}$ / BC proportion of Tier 2 emission factors of Glass wool production. Reasons of the high implied emission factor are still under investigation, clarification will be included in the next submission.

Activity data

Technology specific, disaggregated activity data is available from HCSO and LAIR database for several years. Unfortunately more and more data from HCSO is missing from official report due to declining number of producers.

More detailed data request was sent to HCSO to verify the information from LAIR database. Also glass manufacturers were asked to declare their used technology and amount of production for the calculation of GHG inventory. The recalculation of CO_2 emission did not affected the calculation of air pollutant, because in most cases T3 - measured emissions have been reported in this inventory for several years. Activity data are different for the two inventories, because this inventory includes manufacturing of safety glass and other technical glass, which does not involve CO_2 emission.

Uncertainty, recalculations, QA/QC activities and planned improvements

There was no recalculation in the 2020 submission.

4.2.4 QUARRYING AND MINING OF MINERALS OTHER THAN COAL (NFR SECTOR 2.A.5.A)

Last update: 11.03.2020.
Reported Emissions: TSP, PM_{10} and $PM_{2.5}$
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Level and trend TSP

Emission factor

Tier1 emission factors provided in 2016 EMEP/EEA Guidebook are used.

Activity data

Activity data is collected from HCSO database and contains the following categories of mining activities:

- ores
- stones (mostly limestone and dolomite), gypsum
- gravel, sand and clay
- other minerals
- minerals for chemical industry or fertilizer.

In 2018 submission mining of peat was taken out of calculation assuming wet conditions without PM emission. Also activity data were changed in the 2003-2008 period, because mining of ore was confidential in HCSO database, however the Mining and Geological Survey of Hungary (former Hungarian Office for Mining and Geology) published these data, so these data were included in this submission.

Since there are confidential data is some categories, only aggregated activity data are reported in the following table.

4.6. Table: Mined amount in Mt of ores and minerals in Hungary (2000-2018)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AD in 2.A.5.a (Mt)	27	32	32	31	35	42	38	42	42	42	34	29	27	28	47	45	37	39	47

Further verification of activity data is planned.

4.2.5 CONSTRUCTION AND DEMOLITION (NFR SECTOR 2.A.5.B)

Last update: 11.03.2020.
Reported Emissions: TSP, PM_{10}, $PM_{2.5}$
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Level and trend PM_{10}, TSP

Methodological issues

TSP, PM_{10} and $PM_{2.5}$ are reported using Tier 1 method of 2016 EMEP/EEA Guidebook. The 2016 EMEP/Guidebook requires more detailed activity data compared the previous version in the following categories:

- residential housing, single- or two family
- residential housing, apartments
- non-residential building
- road construction.

Collection of required information was finished for the 2018 submission.

Activity data

Detailed annual statistics for residential housing is available from HCSO, but statistics about non-residential construction is very limited and road construction statistics is not available from this data source.

In case of residential housing number of completed residential buildings is reported in Yearbook of Housing Statistics (HCSO, 2000-2016) in 5 types of buildings: family house; group of buildings; multi-storey, multi-dwelling buildings; building in residenz' park; housing estate building. In all categories average useful floor area and duration of construction are also available. Average useful area is taken into account in case of the family house and group of buildings, for all other categories the affected area was calculated with default parameters for apartment on building basis (585 m^2/building). The average duration of construction in Hungary is quite long (700-800 days), especially in case of family houses, and also economic crisis has an important effect on all construction. Therefore, default duration length of Guidebook was applied, but affected area was modified with the area of those years on which the construction was started.

In case of non-residential construction number of new construction permits is available only, also the buildings' useful floor space is given in the statistics. Buildings for the following purposes: office, commercial, educational and health care, lodging and catering; were taken into consideration as apartment buildings by calculating the affected area. Affected area of all other type of buildings ("industrial", "agricultural" and "other" categories) was estimated using 0.8 m^2 footprint area per m^2 utility floor area as it was suggested in the 2016 Guidebook.

In road construction category only the total length of public road owned by the state is published, which is a small part of all national roads (state public roads, private roads and roads of local governments). Therefore, data request was sent to the National Infrastructure Developing Private Company Limited (NIF; 100% property of the Hungarian State, the ownership rights are controlled by the Ministry of Transport), which company is responsible for development of public roads and railways to calculate the total affected area of road construction in each year in the 2000-2016 period. Very detailed calculation was made by NIF for the whole time-series.

In Hungary duration of infrastructural investments could be as long as 2-3 years. In these cases only those projects were taken into account where PM might be emitted. The affected area for road construction was estimated from the length of new road constructed multiplied with the appropriate width of exposed area of each road construction. Latter depends on the type of action, the topology and the horizontal and vertical alignment of road; so, the width of road was taken into account with 20, 25, 30, 50 or 60 m. According to the regulations included in contracts of construction entrepreneurs are bound to minimalize PM emissions both during extensive earthmoving and in case of maintenance of transport roads.

Activity data for road construction for 2017 and 2018 was estimated using databases of NIF, from where total length of new roads can be calculated. However, NIF has not sent us detailed road construction data from 2016 onward. Affected area was estimated using default width of exposed area from the 2016 Guidebook.

Activity data were reduced significantly using the 2016 Guidelines instead of the 2014 Guidelines. In specific years (2000, 2006 and 2012) the originally applied and in 2017 submitted activity data were obtained from CORINE land cover database. According to the 2018 calculations affected area are much lower than in CORINE land cover databases, while emissions increased significantly. Previously used method cannot be compared to the actual calculation, where country specific parameters have been taken into account instead of global average values.

Emission factor

Default PM_{10} emission factors for uncontrolled PM emissions from all types of construction activities were applied in the calculations according to the 2016 Guidebook.

Tier 1 method has four parameters which modify the emission factors profoundly.

One of these parameters is the correction factor for soil moisture, where precipitation-evapotranspiration index should be calculated for each year based on monthly average temperature and precipitation data. Nationwide average temperature and nationwide average precipitation data are available from the Hungarian Meteorological Service.

Soil silt content is another very important factor in Tier 1 calculation for all categories. The average silt content of soils in Hungary was calculated from the Digital Kreybig Soil Information System (Pásztor et al., 2012) which is the most detailed nationwide spatial dataset which covers the whole area of Hungary, using the Hungarian classification of soil texture to keep consistency. In Hungary the particle size of silt fraction varies between 0.02 and 0.002 mm. The resulted average silt content in Hungary is 22.2%.

Default values were kept for parameter of duration of construction in all categories due to the reasons mentioned at description of activity data and also for the control efficiency factor of applied emission reduction measures.

Uncertainty, recalculations, QA/QC activities and planned improvement

Remarkable changes due to methodological changes for the years before 2017 were reported in previous submissions. As the National Infrastructure Developing Private Company Limited (NIF) has not sent any data for 2017 and 2018, road construction data were estimated (and recalculated for 2017) based on publicly available data of NIF.

4.3 CHEMICAL INDUSTRY (NFR SECTOR 2.B)

Ammonia, Hydrogen, Nitric acid production and activities classified as Other Chemical Industry are present in Hungary. Other chemical industry sector (2B10a) includes the following processes: production of sulfuric acid, chlorine, carbon black, ethylene, propylene, 1.2 diclorethane and vinilcloride balanced, PE (LD and HD), PP, PVC, Polystyrene, Urea, Ammonium nitrate and other fertilizers.

No emissions are reported in sector 2.B.10.b – Storage and handling of chemical products since it is assumed that emissions arising during storage and handling are included in emissions of the specific subsectors based on statement of the 2016 EMEP/EEA Guidebook.

Different from other subsectors, in the case of chemical industry also combustion emissions are reported together with process emissions in this sector, where process emissions occur. Combustion emissions from the section of chemical industry without process emissions are still included in 1A2c. The reason for this change is the consistency with the allocation required by 2006 IPCC Guidelines.

In this industrial sector many changes have been taking place since 1980 because older factories were closed down in the 1990's and significant emission reductions were achieved by the plants still operating.

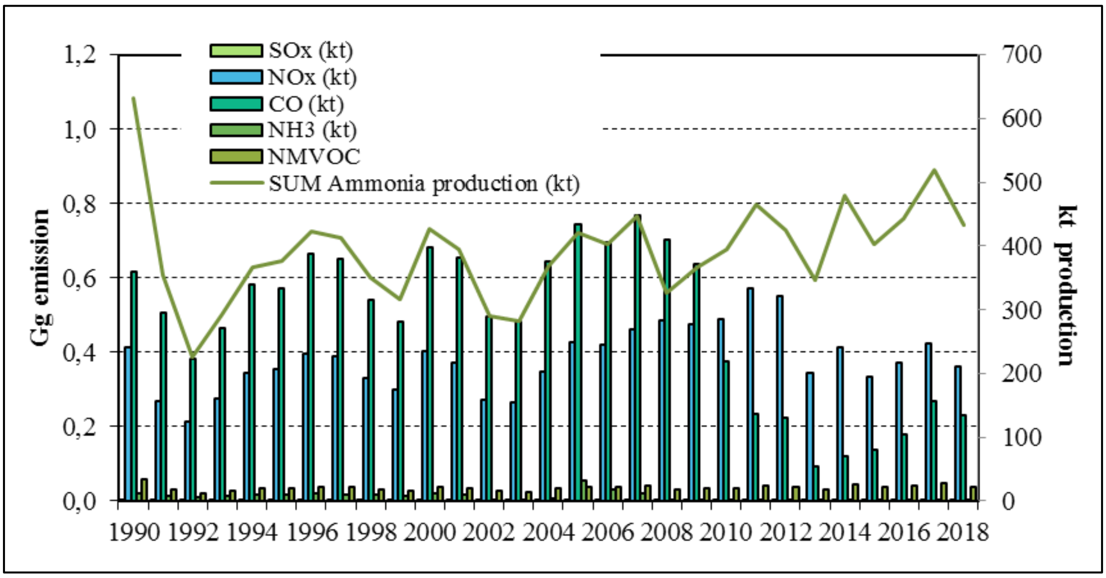
In the case of ammonia and nitric acid production directly reported emission data is used. In this case the quality of the data is verifiable since the same data is reported to E-PRTR, too. Well known company having IPPC permit (including BAT prescribed) and the abatement technology causing a significant reduction of NO_X and N_2O was implemented by the means of a well-documented (partly publicly available) JI project. Further details are described in chapter 4.3.2 – Nitric acid production.

4.3.1 AMMONIA PRODUCTION (NFR SECTOR 2.B.1)

Last update: 11.03.2020.
Reported Emissions: NMVOC, NO_x, CO, SO_x, NH_3
Measured Emissions: NO_x, CO, SO_x, NH_3
Methods: T2, T3
Emission factors: T2, T3

In 1990 three ammonia producers were operating in Hungary, at the moment two companies are working. One of them produces hydrogen (and synthesis gas) within the plant while the other one acquires hydrogen from a different company.

The strong interannual changes in the time-series of emissions are related to the changes of the production, e.g. decline in 1992 is caused by the strong decrease of the production, and in addition one of the tree production sites was also closed.



4.4. Figure: Emissions and production of ammonia

In 2015 submission time-series have been recalculated as the allocation rules of combustion and process emissions are slightly changed in 2006 IPCC Guidelines, as it is stated in chapter 1.2.1 of Vol.3.:

"Combustion emissions from fuels obtained directly or indirectly from the feedstock for an IPPU process will normally be allocated to the part of the source category in which the process occurs."

Therefore, in the case of ammonia production all emissions from Natural gas use are reported in 2B1 sector in the GHG inventory. In order to remain consistent, we follow the same allocation here. So, in this sector also combustion emissions are reported. In addition, the natural gas used for hydrogen production is also reported in the GHG inventory within this sector, so plant specific emissions reported by hydrogen producers has been included from 2016 submission.

Emission factor

NMVOC, NO_x, CO, NH_3 and SO_x are reported. The following table summarizes the used factors for each process.

4.7. Table: Used emission factors in 2.B.1 category

	Ammonia production	Hydrogen production
SO_x (kt)	T3	T3
NO_x (kt)	T2, T3	T3
CO (kt)	T2, T3	T3
NH_3 (kt)	T2, T3	-
NMVOC	T2	-

Activity data

Activity data for Tier 2 emission calculations are available from the HCSO and it is reported also by the companies for UNFCCC reporting purposes. Measured emissions are obtained from LAIR database.

Uncertainty, recalculations, QA/QC activities and planned improvements

There was no recalculation in the 2020 submission.

4.3.2 NITRIC ACID PRODUCTION (NFR SECTOR 2.B.2)

Last update: 11.03.2020.
Reported Emissions: NO_x, NH_3
Measured Emissions: NO_x, NH_3
Methods: T3
Emission factors: T3
Key source: Trend NO_x

However only NO_X emission factor is provided in the EMEP/EEA 2016 Guidebook, also NH_3 process emissions are reported besides NO_X based on direct emissions reported by company in the LAIR.

Nitric acid (HNO_3) is produced by oxidizing ammonia. The process end gas contains N_2O and NO_X. In order to control the emissions, the latter is reduced to nitrogen using natural gas and the carbon content of the natural gas is released in the form of carbon dioxide.

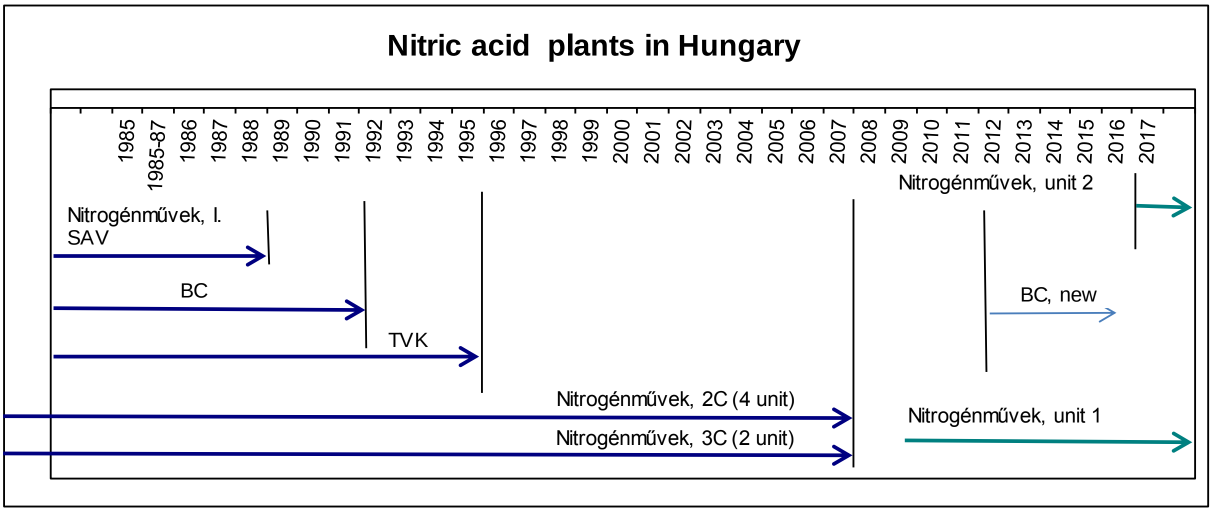
In this industrial sector many changes have been taking place since 1980. Among the old factories using obsolete technologies, one was abandoned in 1988, another in 1991, and a third in 1995.

Between 1996 and 2012 only one plant was operating. Until 2006 two production lines were operated in this plant – the older one was established in 1975 and used GIAP technology which consists of four units. These four units represented the major part (about 80%) of the production volume. Emissions from this process were measured from 2004. The other existing technology represented only 20% and had been operational since 1984 (combined acid factory producing diluted and concentrated nitric acid).

Since 1995 several abatement technologies have been introduced. Then, the implementation of a new and more advanced production technology was started in 2005 in the framework of a UNFCCC joint implementation project (further information please see below), and it was installed in September 2007. At the same time, the old production lines were closed down. Now a state-of-the-art technology is used therefore drastic emission reduction was achieved by application of the EnviNO$_X$ technology.

In 2012 another plant has been restarted using catalytic abatement technology as well based on its IPPC permit. However, the latter plant produces significantly lower volumes yet.

In 2018 the activity of nitric acid plants was similar to that of 2017.



4.5. Figure: Nitric acid plants in Hungary (1985-2018)

Emission factor

Tier 3 method is used. Directly reported plant specific data on nitric acid process emissions is applied from 2007. For earlier years, implied emission factor was extrapolated as it was presented in the previous submission.

The low implied emission factor for NO$_X$ after 2008 is reflecting the state of the art N_2O and NO$_X$ abatement technologies implemented by the main nitric acid producer company. The increase of NO$_x$ emission factor from 2011 is due to the restart of the other producer company. The sharp reduction in the last two years reported emissions from the reopened plant were investigated because the IEFs were very low. According to the information received from the plant, in August 2015 during the summer repairs the DeN$_2$O catalyst was removed and during the assembly of the reactor 50% of the catalysts were replaced by new catalysts. With the new catalysts N_2O and also NO$_x$ content of the flue gas reduced significantly. Further explanations and description of the EnviNOs technology was presented in the previous submissions.

Activity data

Activity data is available from the HCSO and it is reported also by the companies for UNFCCC GHG Inventory reporting purposes.

Uncertainty, recalculations, QA/QC activities and planned improvements

The dates of introduction of abatement technologies are published at the website of the producer operating continuously:

http://www.nitrogen.hu/index.php?option=com_content&view=category&layout=blog&id=9&Itemid=26

The significant reduction of NO_x emission in 2008 is justified by the introduction of EnviNO_x technology by the company hosting the JI project mentioned above.

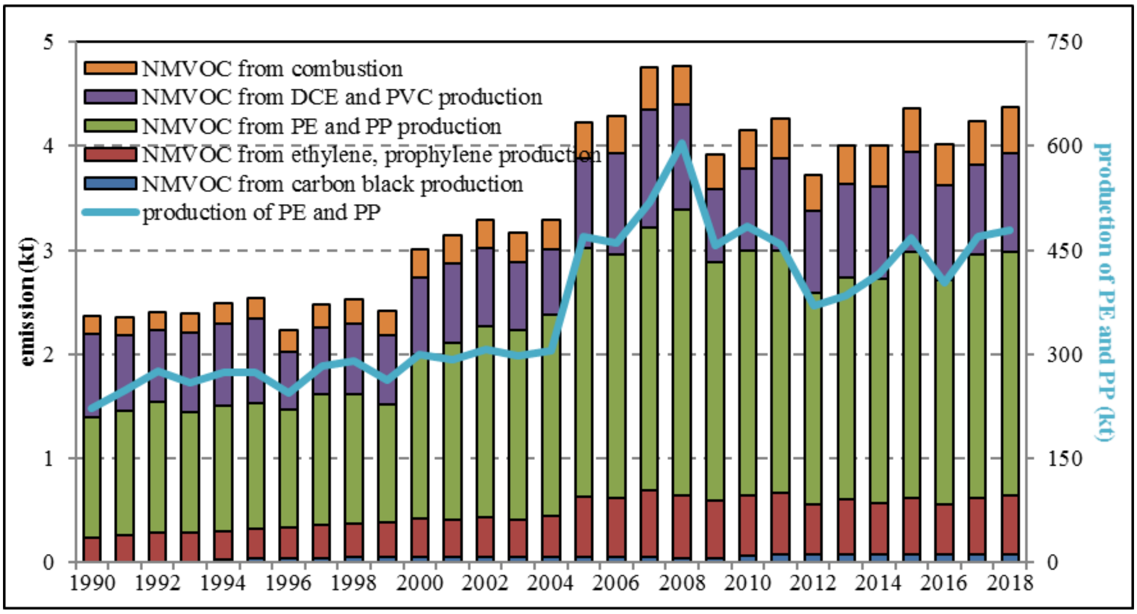
In 2016 submission it was stated that data for 2014 had been extrapolated using production volume and the implied emission factor of last year, because the reported plant specific data seemed to be outlier. Measured emissions were checked, and emissions were corrected for 2013 and 2014 according to the renewed LAIR database.

The sharp reduction in the last two years reported NOx emissions from the reopened plant were investigated because the IEFs were very low. The new catalyst has reduced N_2O and also NO_x emissions.

There was no recalculation in the 2020 submission.

4.3.3 OTHER CHEMICAL INDUSTRY (NFR SECTOR 2.B.10.A.)

Last update: 11.03.2020.
Reported Emissions: NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Hg
Measured Emissions: NO_x, SO_x, NH_3, TSP, CO, Hg
Methods: CS, T2, T3
Emission factors: CS, T2, T3
Key source: Level NMVOC, Hg; Trend NMVOC, NH_3, Hg



4.6. Figure: NMVOC emissions in 2.B.10.a sector

Emissions from several inorganic and organic chemical activities are reported in this sector. The new allocation described in chapter *4.3.1 Ammonia production* above has resulted the inclusion of combustion emissions and thus the recalculation of time-series in previous submission.

However, the inclusion of combustion emissions did not result a significant change in this sector, especially not in the case of NMVOC, in which case the category is key as it is possible to see at the Figure above.

Activities, pollutants and the emission calculation methods used are presented in table below. In addition, all the combustion emissions are plant-specific data.

4.8. Table: List of processes and pollutants and emission estimation method used within 2.B.10.a Other Chemical industry sector

SNAP code. activity	Pollutant	Emission factor used
040401 Sulphuric acid	SO_x	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR
040413 Chlorine	Hg	**2005-2017: plant specific** (www.eurochlor.org) 1990-2004: linear interpolation of the IEF between Tier 2 and 2005 plant specific data
040409 Carbon black	NMVOC	**Tier 2**
	NO_X	**2005-2017: LAIR** 1990-2004: LAIR 2005 IEF
	SO_x	**2004-2017: LAIR** 1990-2003: LAIR 2004 IEF
	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF
	$PM_{2.5}$	CS: Tier 1 proportion of TSP (for gaseous fuel in 1.A.2) as a combined factor for process and combustion emissions
	PM_{10}	CS: Tier 1 proportion of TSP (for gaseous fuel in 1.A.2) as a combined factor for process and combustion emissions
	BC	CS: Tier 1 proportion of TSP (for gaseous fuel in 1.A.2) as a combined factor for process and combustion emissions
	CO	**2005-2017: LAIR** 1990-2004: LAIR 2006-2013 average IEF
040501 Ethylene	NMVOC	**Tier 2**
040502 Propylene	NMVOC	**Tier 2**
040505 1.2 dichloroethane + vinylchloride (balanced)	NMVOC	**Tier 2**
040506 Polyethylene Low Density	NMVOC	**Tier 2 for LD**
+ 040507 Polyethylene High Density	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF

040509 Polypropylene	NMVOC	**Tier 2**
	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF
040508 Polyvinylchloride	NMVOC	**Tier 2-(E-PVC)**
	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF
	$PM_{2.5}$	CS: Tier 1 proportion of TSP (for gaseous fuel in 1.A.2) as a combined factor for process and combustion emissions
	PM_{10}	CS: Tier 1 proportion of TSP (for gaseous fuel in 1.A.2) as a combined factor for process and combustion emissions
040511 Polystyrene	NMVOC	**Tier 2 (GPPS)**
	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF
Fertilisers		
040405 Ammonium nitrate	NH_3	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR [1)]
	TSP	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR [1)]
040408 Urea	NH_3	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR [1)]
	TSP	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR [1)]
	$PM_{2.5}$	Tier 2 proportion to TSP
	PM_{10}	Tier 2 proportion to TSP
	BC	Tier 2
Other fertilizers	NH_3	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR [1)]
	TSP	**2002-2017: LAIR** 1990-2001: linear interpolation of the IEF between Tier 2 and 2002 LAIR [1)]

	$PM_{2.5}$	Tier 2 proportion to TSP
	PM_{10}	Tier 2 proportion to TSP
	BC	CS: same as for urea production

1) *Extrapolation of fertilizers are performed together as activity data is not yet detailed by fertilizer type*

Please find the detailed description of LAIR database in chapter 1.4 of the IIR.

Emission factor

Emission factors used are included in the Table above. Directly reported emission data is prioritized in every case it is available and verifiable (usually for TSP and NH_3). Default factors are used in other cases (usually for NMVOC). In LAIR only TSP data is reported, so PM emissions are calculated based on PM_{10}, $PM_{2.5}$ and BC proportion to Tier 2 emission factor of TSP, where available. This is the case by production of PVC and fertilizers.

As directly reported emissions are available usually only from 2002, extrapolation is needed in order to complete the time series. Extrapolation is performed in the following ways:

- in the case of TSP (and PMs calculated based on TSP) the earliest and/or highest available implied emission factor (usually data of year 2002) is used for the calculation of the years before 2002;

- in the case of carbon black SO_x and fertilizers NH_3, an implied emission factor calculated using a linear interpolation between the earlier available directly reported data and the Tier 2 emission factor is used.

- combustion emissions: using production volumes as surrogate data and implied factor of either 2005 or average of 2006-2013 in the case there is no trend.

Activity data

Activity data is available from the HCSO and in several cases it is reported also by the companies for UNFCCC GHG Inventory reporting purposes.

Uncertainty, recalculations, QA/QC activities and planned improvements

Since the coverage of the sector 2.B.10.a is very wide, continuous efforts are needed to explore further possible emitters in order to improve completeness. However, it should be taken into consideration that the eventually missing emissions are expected to be non-significant compared to the National Totals.

There was no recalculation in the 2020 submission.

4.4 METAL PRODUCTION (NFR SECTOR 2.C)

4.4.1 IRON AND STEEL INDUSTRY (NFR SECTOR 2.C.1.)

Last update: 11.03.2020.
Reported Emissions: TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cu, Zn, NMVOC, Cd, Hg, As, Cr, Ni, Se, PCB, PCDD/F, HCB
Measured Emissions: TSP, Pb, Cu, Zn, PCDD/F
Methods: T1, CS, T3
Emission factors: T1, CS, T3
Key source: Level Hg,; Trend PM_{10}, $PM_{2.5}$, TSP, Hg, PCDD/F

In this sector only process emissions from Iron and steel production are reported and NO_x, SO_x and CO are reported entirely in sector 1A as it is suggested by the 2016 EMEP/EEA Guidebook. Emissions from combustion during production of Iron and steel are reported in sector 1A2a. Combustion emissions from production of coke are reported in 1A2b and fugitive emissions arising during production of coke are reported in sector 1B1b.

In Hungary both pig iron and steel are produced and both basic oxygen furnace and electric arc furnace technologies are present.

Emission factor

Tier 3 method, i.e. direct emissions reported by companies are used in the case of **TSP, Pb, Cu and Zn**. PM emissions are calculated based on **PM_{10}, $PM_{2.5}$, BC** proportion to TSP of Tier 1 emission factors. As directly reported emission data in LAIR database is available only from 2002, extrapolation is applied by using IEF of year 2002 or the average of 2002-2003 or Tier 1 EF, whichever is the higher. Please find the implied emission factors in the following table.

4.9. Table: Comparison of Tier 1 and Tier 3 emission factors used for extrapolation for the years before 2002

	Tier 1 EF	**IEF applied for the years before 2002**	**source of the IEF**
	g/Mg steel		
TSP	***300***	1372	average of 2002-2003 LAIR
PM_{10}	***180***	823	
$PM_{2.5}$	***140***	640	
BC	*0,36% of $PM_{2.5}$ = 0.5*	2.3	
Pb	***4.6***	4.92	2002 LAIR
Cu	***0.07***	0.28	2002 LAIR
Zn	***4***	4.00	Tier 1

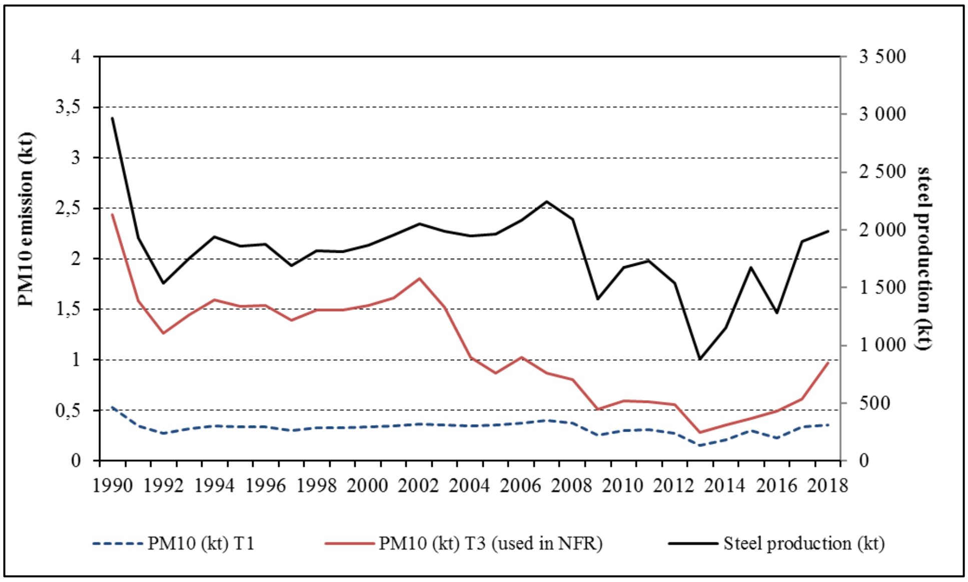
PCDD/F emissions are reported using E-PRTR data. As E-PRTR data is available usually only for year x-3, IEF of the year x-3 and activity data of year x-2 is used. Although the use of E-PRTR data results higher emission of PCDD/F than the use of Tier 1 default factor, former is applied to ensure consistency with E-PRTR reporting. It seems that emission factor from UNEP Toolkit 2005 was used to calculate PCDD/F emissions for E-PRTR reporting purposes.

All other emissions (namely **NMVOC, Cd, Hg, As, Cr, Ni, Se, and PCB**) are estimated based on Tier 1 default factor of the 2016 EMEP/EEA Guidebook. A higher Tier methodology for the calculation of Cd and Hg emissions will be developed for the next submission.

The use of default factors for Total 1-4 PAHs emissions would result an unreasonable vast value and no directly reported data is available either, therefore no emissions are reported.

Activity data

Activity data is available from the HCSO and it is reported also by the companies for UNFCCC reporting purposes.



4.7. Figure: Production of steel in Hungary and comparison of PM_{10} time series calculated with T1 and T3 method

Emission increased for almost all air pollutant (except for PCDD/F) in iron and steel industry subsector in 2017, where the favourable EU export market situation and competitiveness of Dunaferr Zrt. in this market resulted from the efficiency improvement measures taken by the company between 2014 and 2016.

Uncertainty, recalculations, QA/QC activities and planned improvements

Recalculation of TSP, PM_{10}, $PM_{2.5}$ and BC emissions was made from the year 2009 onwards because next to its point sources, one of the companies reported diffuse TSP emissions in the LAIR from 2014. Based on reported activity data of the 2014-2017 period, an extrapolation was made back to the year 2009.

4.4.2 ALUMINIUM PRODUCTION (NFR SECTOR 2.C.3.)

Last update: 11.03.2020.
Reported Emissions: TSP, PM_{10}, $PM_{2.5}$, PCDD/F, heavy metals
Measured Emissions: PCDD/F
Methods: T2, T3
Emission factors: T2, T3

Process emissions from primary and secondary metal production are reported within this sector. Since 2006 there is no primary aluminium production in Hungary. However alumina production is present in the country, these process emissions are not estimated due to absence of emission factors or directly reported emissions except for PCDD/F emissions. Combustion emissions of production of alumina are included in sector 1A.

The following pollutants are reported in this sector:

Secondary aluminium: TSP, PM_{10}, $PM_{2.5}$, PCDD/F, heavy metals.

Reasons for not reporting HCB/PCB

HCB emissions are not estimated due to the poor information available. The emissions of these pollutants are not reported directly by the companies. The use of default factors presented in the 2009 EMEP/EEA Guidebook would result incredibly high emissions. E.g. in aluminium production it would mean a 2000 time higher emission than the whole EU 27. Also the relevant chapter of the 2009 EMEP/EEA Guidebook (2.Description of sources) does not provide description of HCB, HCH and PCB sources within the process.

A deeper research after the source of the emission factors presented in the 2009 EMEP/EEA Guidebook have shown that neither the BREF on Non-ferrous Metals Industries (Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Non Ferrous Metals Industries. December 2001 - http://eippcb.jrc.es/reference/BREF/nfm_bref_1201.pdf) nor the reference mentioned in the 2009 EMEP/EEA Guidebook (Theloke et al. (2008)) does not explicitly mention this emissions factors (and emissions).

The 2009 EMEP/EEA Guidebook also states: “For secondary aluminium production, only particulate emissions are relevant for the process part.” (2.C.3 Aluminium production Chapter 3.3.2.3). So, we have decided to report these emissions as not estimated yet since these industrial activities are anyway not significant in Hungary and these pollutants are not strictly mandatory to report.

Unfortunately, these factors are not changed in the new version of the Guidebook.

Emission factor

Tier 2 default emission factors for secondary aluminium production are used for TSP. PM_{10}, $PM_{2.5}$, BC and for process NO_x, SO_x, TSP, PMs and PAH emissions from primary aluminium production E-PRTR data is used for PCDD/F.

Heavy metals reported are the directly reported data by the secondary aluminium processing facilities.

Activity data

Activity data is available from HCSO.

Uncertainty, recalculations, QA/QC activities and planned improvements

In addition, search for emission data or emission factors for the inclusion of process emissions of alumina production together with activity data before 2003 would be needed as well.

There was no recalculation in the 2020 submission.

4.4.3 COPPER PRODUCTION (NFR SECTOR 2.C.7.A.) AND ZINC PRODUCTION (NFR SECTOR 2.C.6)

Last update: 11.03.2020.
Reported Emissions: TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cd, Hg, Zn, As, Cu, Ni, PCB, PCDD/F, SO_x
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: none

Only process emissions from **secondary** metal production are reported within these sectors using default Tier 1 emission factors of the 2016 EMEP/EEA Guidebook.

Secondary copper: TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cd, As, Cu, Ni, PCDD/F.

Secondary zinc: TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cd, Hg, Zn, PCB, PCDD/F, SO_x

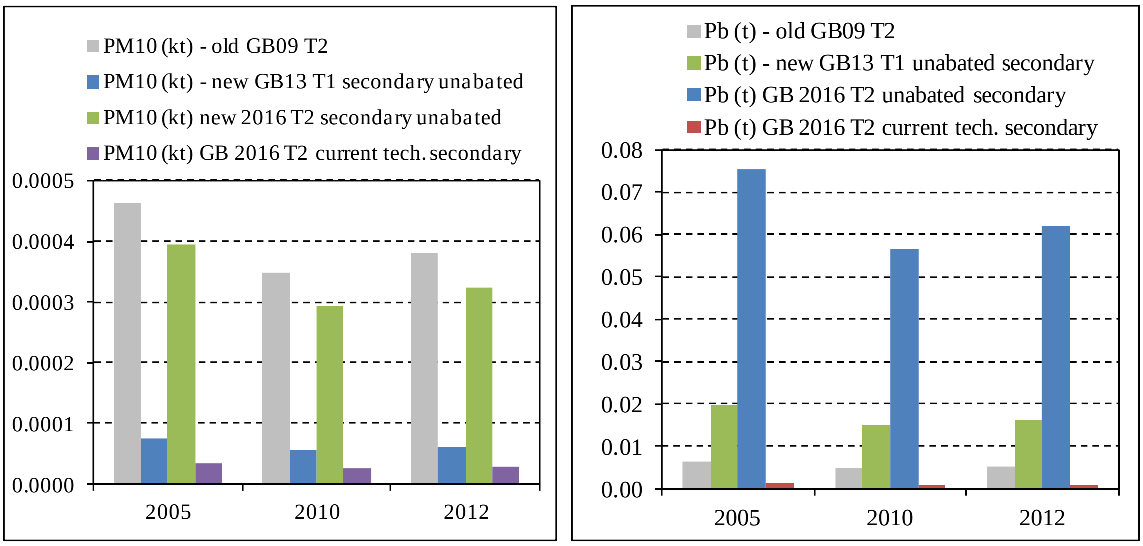
However, the companies processing non-ferrous metals (secondary production) in Hungary are reporting to LAIR but not all the substances where default EF is provided in the EMEP/EEA Guidebook (e.g. no reporting of PCDD/F, PCB, HCB, etc.). It might be the case that there is no emission at all from certain pollutants but in the absence of detailed information we have used default factors. So, the results are probably a very conservative overestimation of several substances.

SO_x emissions from secondary zinc production have been calculated from 1990 using Tier 1 methodology and default Tier 1 emission factor of the 2016 EMEP/EEA Guidebook. However, further investigation is needed concerning the overestimation of several substances mentioned in the previous paragraph.

Emission factor

In case of copper production PM10, Pb and As emission factor was changed in the guidebooks. In this submission emissions of these pollutant were recalculated according to Tier 2 (secondary production) methodology of the 2016 Guidebook. No abatement efficiency is taken into account neither of the reported pollutant due to absence of data.

There are significant changes between the EFs of 2009, 2013 and 2016 versions of the EMEP/EEA Guidebook in 2A6 Zinc production sector. As emission factors in the new guidebooks for unabated and current technology differ extremely. In this submission Tier 2 emission factors - valid for EU-28 current tech. level - from 2016 Guidebook were used. It was assumed that all installations in the EU must achieve the required standard of BAT Ref. Document. Investigating the reported abatement efficiency of selected non-ferrous metal producers in the LAIR database this assumption seems reasonable. Before 2004 the old calculation was kept, because Hungary became part of the EU in this year. In addition, uncertainty of all emissions before 2008 is very high in this category, because activity data is not available from the HCSO, for years before 2008 they were extrapolated with fuel consumption of non-ferrous metal producers as surrogate data.



4.8. Figure: *Comparison of emissions for PM_{10} and Pb calculated using EMEP/EEA 2009(old GB09), 2013 (new GB13) and 2016 versions from 2C6 Zink Production (secondary)*

Activity data

Activity data is available from HCSO. Due to confidentiality problems activity data were reported in aggregated way as secondary zinc and copper production.

Uncertainty, recalculations, QA/QC activities and planned improvements

SO_x emissions from secondary zinc production have been calculated and provided for every year from 1990.

4.4.4 OTHER METAL PRODUCTION (NFR SECTOR 2.C.7.C)

Last update: 11.03.2020.
Reported Emissions: Zn
Measured Emissions: Zn
Methods: T3
Emission factors: T3

Significant amount of zinc emissions are reported to the E-PRTR database from coating of metals and casting. However, the database is incomplete, there are years where no emissions were reported. To have complete and consistent time-series emission reports from coating (galvanizing) and casting were collected from LAIR database. Zinc emission from these sources is reported first time in the 2018 submission.

Emission factor

NMVOC emissions are reported using directly reported data from LAIR, where no activity data is reported.

Activity data

Activity data is created using the volume index of coting of metals from HCSO database.

Uncertainty, recalculations, QA/QC activities and planned improvements

Emissions of other pollutant of these sources will be included when complete time-series will be available.

There was no recalculation in the 2020 submission.

4.5 PRODUCT USES (NFR SECTOR 2D)

The main difficulty in this sector is to gather activity data, since mostly consumption data is needed of a wide range of products that is usually not directly available from statistics. This is why several assumptions and estimation are needed which increases the uncertainty of the emissions reported.

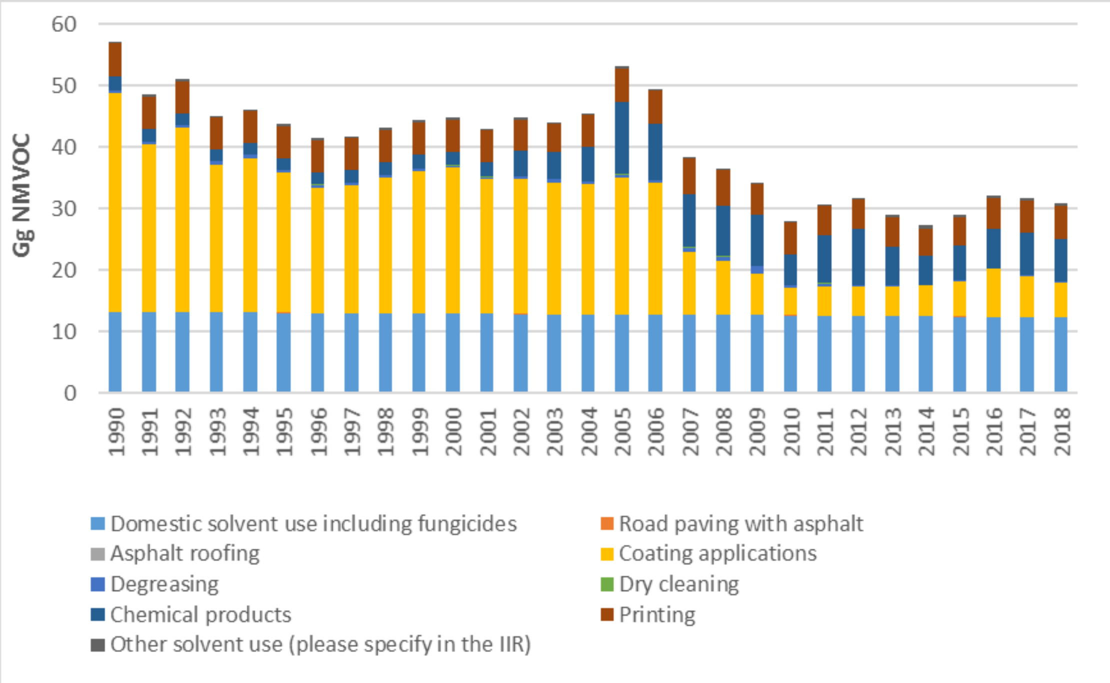


Figure 4.9 NMVOC emissions of product uses

4.5.1 DOMESTIC SOLVENT USE (NFR SECTOR 2.D.3.A)

Last update: 14.03.2020.
Reported Emissions: NMVOC, Hg
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Level and trend NMVOC

The coverage of this sector is defined in 2016 EMEP/EEA Guidebook as follows:

"NMVOCs are used in a large number of products sold for use by the public. These can be divided into a number of categories.

- Cosmetics and toiletries: Products for the maintenance or improvement of personal appearance, health or hygiene;

- Household products: Products used to maintain or improve the appearance of household durables.

- Construction/DIY: Products used to improve the appearance or the structure of buildings such as adhesives and paint remover. This sector would also normally include coatings; however these fall outside the scope of this section and will be omitted.

- Car care products: Products used for improving the appearance of vehicles to maintain vehicles or winter products such as antifreeze."

"NMVOCs are mainly present in consumer products as solvents. In aerosols, NMVOCs such as butane and propane are also used as propellants. Propellants generally act as solvents as well". …"Emissions occur due to the evaporation of NMVOCs contained in the products during their use". …" There are only limited data available on the NMVOC species present in consumer products. …."

Please note that "*this section does not include the use of decorative paints*", it is included in sector 2D3d Coating applications.

The 2016 EMEP/EEA Guidebook uses defaults calculated from inventories of western European countries with detailed data on product uses which was then extrapolated for other groups of countries. NMVOC emissions from residential use of solvents are reported using the per capita default emission factor provided in the 2016 EMEP/EEA.

The TERT noted in 2018 review that for Hg from 2D3a Domestic solvent use including fungicides Hungary reported "NA" in the NFR tables. Mercury emission from fluorescent tube or bulb is included using Tier 1 default emission factor.

Emission factor

During the 2017 review the TERT recommended to use Tier 2 method, because this category is key category for all years. The use of the original Tier 2 emission factors would require consumption data of very wide range of products as activity data, which is not available. The lowest Tier 2 EF value from the 95% confidence interval for each category from table 3.5 in 2016 EMEP/EEA Guidebook, i.e. 1.269 kg/capita is used. In the Guidebook special case of Tier 2a refers to ESIG paper where it is clear that Hungary has the lowest per capita emission (1.4 kg/kapita) among EU 27 – the factors are between 1.9 and 9.0 kg/capita for other countries.

However, the TERT in the 2018 review noted that the rationale for choosing this lower value was not included in the IIR and that no information was provided on the investigations for improvements (e.g. collecting information on consumption habits) in the IIR. The TERT asked Hungary A) to include the rationale for choosing the lower value of the 95% confidence interval of the Tier 2 EF, B) to provide information on efforts for further improvements.

Cosmetics Europe with the support of Risk & Policy Analysts Ltd published a report about a comprehensive evaluation of the socio-economic contribution made by the European cosmetics industry covering the EU-28 plus Norway and Switzerland (Socio-Economic Contribution of the European Cosmetics Industry, 2018). From this report it is clear that Hungarian consumers spend on cosmetics much less than average in EU-28 per year (*Figure 4.10*).

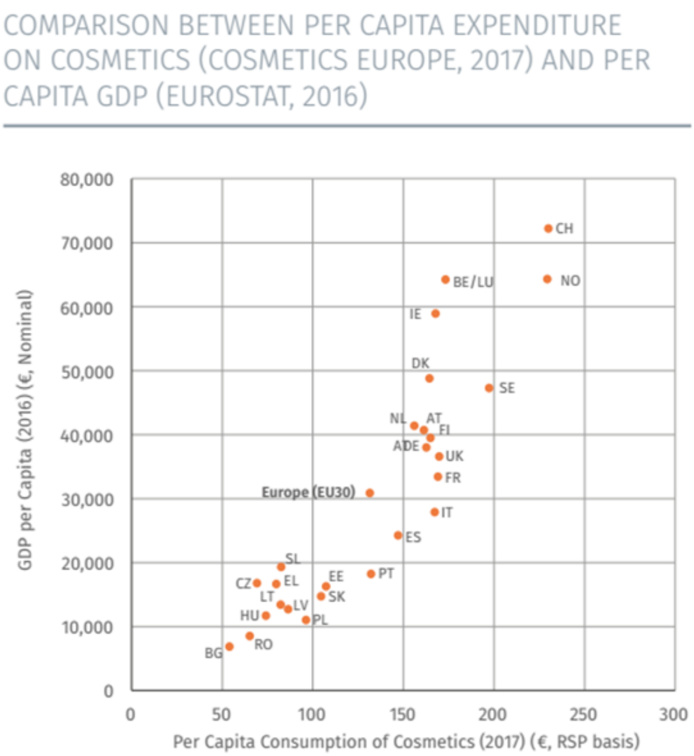


Figure 4.10 Per Capita Consumption of Cosmetics (2017) (€, RSP basis). Source: Cosmetics Europe, 2018

Mercury emission is calculated using Tier 1 default emission factor.

Activity data

Population data provided by HCSO is used.

During the 2017 review data request was sent to HCSO to provide consumption (or production, import and export) data in the appropriate source categories. There are no available data according to the statement of HSCO.

The only available dataset (production, import and export) is about hair sprays, but the time-series is very short, between 1999 and 2005. Also, there are statistics from paint thinners and removers, but these categories include residential and industrial “consumption”, as well, which cannot be separated.

Uncertainty, recalculations, QA/QC activities and planned improvements

Further investigation is planned to improve both Hg and NMVOC emissions in this category.
Development of a higher Tier methodology needs serious investigations of possible data sources.

There was no recalculation in the 2020 submission.

4.5.2 ROAD PAVING WITH ASPHALT (NFR SECTOR 2.D.3.B)

Last update: 14.03.2020
Reported Emissions: NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC
Measured Emissions: TSP
Methods: T2, T3
Emission factors: T2, T3

NMVOC is reported using Tier 1 method. In the 2015 submission, time series of TSP and PMs had been recalculated using the Tier 3 method, i.e. direct emissions reported by companies. In the LAIR system hot mix asphalt plants are reporting TSP. PM emissions are calculated based on PM_{10}, $PM_{2.5}$ and BC proportion to TSP of Tier 1 emission factors. As directly reported emission data in the LAIR database is available only from 2002, extrapolation is applied by using IEF of year 2002, as the trend of implied emission factors is decreasing over time.

Emission factor

Tier 1 EFs provided in the 2019 EMEP/EEA Guidebook are used for NMVOC, and the proportion of PM_{10}, $PM_{2.5}$and BC to TSP from the Guidebook Tier 1 factors. These are the same as in the earlier version of the Guidebook. Total TSP emission of the category is retrieved from LAIR database.

Activity data

Total Production of Hot Mix Asphalt in Hungary published by EAPA (European Asphalt Pavement Association: www.eapa.org) is used as activity data for the extrapolation before 2002 and for NMVOC calculation.

Uncertainty, recalculations, QA/QC activities and planned improvements

TSP (PMs and BC as well) emissions of the beginning of 2000s are significantly higher (also IEF is very high for 2002). Reported values were checked. These high values seem to be realistic as the emitters had to pay environmental penalty according to these reported emissions. Some of the emitters were also closed down in few years because they could not meet the environmental requirements.

There was no recalculation in the 2020 submission.

4.5.3 ASPHALT ROOFING (NFR SECTOR 2.D.3.C)

Last update: 14.03.2020
Reported Emissions: NMVOC, CO, TSP, PM_{10}, $PM_{2.5}$, BC
Measured Emissions: none
Methods: T1
Emission factors: T1

NMVOC, CO and TSP emissions are reported as it is required by the 2019 EMEP/EEA Guidebook using Tier 1 emission factors and activity data from HCSO. Emission factors haven't changed compared to the old version of the Guidebook. Emission from this sector are not significant, all of the pollutants are generally below 0.1 Gg.

Activity data

Unfortunately, there are very few data available on production asphalt roofing material. The data used in this sector is provided by HCSO, however unfortunately it is consistent only for the years 2007-2010. Therefore, extrapolation is used for other years using volume index of "other mineral products" as surrogate data for the years 2011-2014. Since 2015 activity data from HCSO has been given in m^2 instead of tons, so data should be converted which increases the uncertainty of the calculation.

Uncertainty, recalculations, QA/QC activities and planned improvements

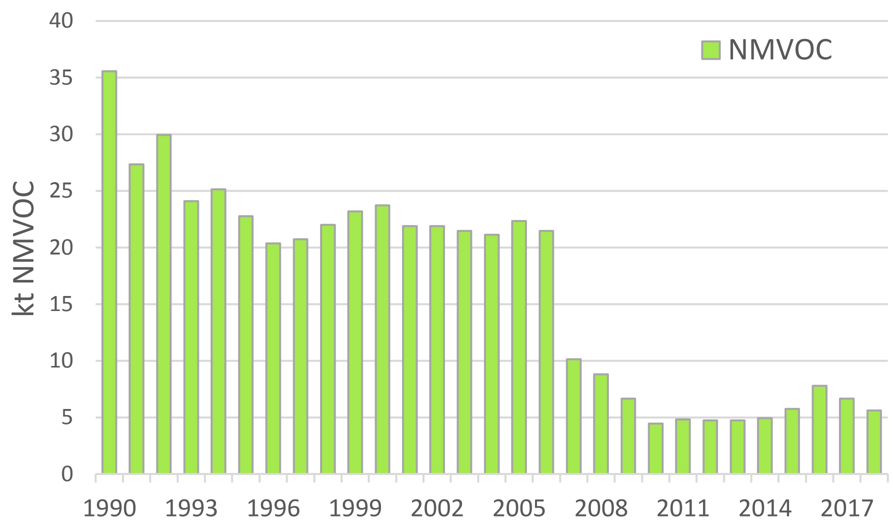
There was no recalculation in the 2020 submission.

4.5.4 COATING APPLICATION (NFR SECTOR 2.D.3.D)

Last update: 14.03.2020
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T1
Emission factors: CS
Key source: Level NMVOC

In this sector NMVOC emission from the use of several types of paints (including solvents) is reported.

In 2018 investigation was started to use higher Tier method and because Tier 1 method could not reflect changes in components of paints, especially the NMVOC contents controlled by the Directive 2004/42/CE of the European Parliament and of the Council. The effect of the above mentioned directive was significant, because the emission from coating application subcategory was reduced.



4.11. Figure: *Emission of NMVOC from 2.D.3.d between 1990 and 2018*

Calculations based on the amount of imported, exported and producted coatings. Data about content of NMVOC in paints is available for all the 3 types of paints. Between 1990 and 2006 amount of applied paint (imported-exported+producted) by types was multiplied by the values of NMVOC content by the appropriate type. After 2006, emission was taken into account as the quantity of NMVOC content of applied paints are reported by manufacturers or by first starters. The reporting is regulatory for those companies that manufacture or target more than 100 kg NMVOC content paints.

Emission factor

Hungary has used country specific values to give the emission from this activity, so Tier 2 methodology was used. According to this approache, quantity of emitted NMVOC is the same amount as the NMVOC content of the applied paints.

Activity data

Quantity of producted paints in Hungary is available for the whole time series and the exported and imported quantities are available only between 1992 and 2018. For years 1990 and 1991 the same values were used as in 1992. Production data from HCSO PRODCOM (in Hungarian: ITO) categorization and trade data from HCSO – Eurostat Combined Nomenclature categorization was used. Activity data of applied paint is calculated as apparent consumption (e.g. import-export+production) until 2006, after 2007 Hungary has exact consumption data about the amount of applied paint (and about the paint's NMVOC content) according to the commitments of 2004/42/EK.

The amount of exported, imported and producted paints have revised since last submission because of the correction of allocation of paint types (water-borne coating, solvent-borne coating, oil-colors). According to an expert judgment NMVOC content of paints are the following in Hungary:

4.10. Table: *NMVOC content of several types of paints*

Paint type	NMVOC content (%)
water-borne coating	6
solvent-borne coating	50
oil-colors	25

Uncertainty, recalculations, QA/QC activities and planned improvements

In response to the TERT's recommendation emission from Coating application was recalculated in this submission.

The following table summarizes the changes in this sector.

4.11. Table: *Changes in NMVOC emissions in 2.D.3.d sector due to the recalculation*

	Submission 2019 (kt)	Submission 2020 (kt)	difference between 2020 and 2019 submissions (kt)
1990	32,0	35,6	3,5
1991	25,2	27,3	2,1
1992	26,8	29,9	3,2
1993	25,8	24,1	-1,7
1994	27,5	25,1	-2,3
1995	26,2	22,8	-3,4
1996	26,7	20,4	-6,4
1997	26,7	20,7	-6,0
1998	26,7	22,0	-4,7
1999	25,6	23,2	-2,4
2000	26,8	23,7	-3,1
2001	25,1	21,9	-3,2
2002	24,5	21,9	-2,6
2003	24,4	21,5	-2,9
2004	24,2	21,1	-3,0
2005	14,8	22,3	7,6
2006	13,0	21,5	8,4
2007	14,5	10,1	-4,3
2008	15,8	8,8	-7,0
2009	12,1	6,6	-5,5
2010	11,3	4,4	-6,9
2011	12,1	4,8	-7,3
2012	12,8	4,7	-8,1
2013	14,8	4,7	-10,1
2014	15,5	4,9	-10,6
2015	17,1	5,7	-11,4
2016	15,7	7,8	-7,9
2017	17,3	6,7	-10,6

4.5.5 DEGREASING (NFR SECTOR 2.D.3.E)

Last update: 14.03.2020.
Reported Emissions: NMVOC
Measured Emissions: NMVOC
Methods: T3
Emission factors: T3

NMVOC emissions are reported using directly reported data from LAIR, where no activity data is reported. Therefore, no implied emission factor has been expressed.

Uncertainty, recalculations, QA/QC activities and planned improvement

There was no recalculation in the 2020 submission.

4.5.6 DRY CLEANING (NFR SECTOR 2.D.3.F)

Last update: 11.03.2020.
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T2
Emission factors: CS

From the 2020 submission, NMVOC emissions from dry cleaning are reported using Tier 2 approach based on technology-dependent emission factors and the quantity of material cleaned. Activity data are available from the year 2004, for earlier years an extrapolation was made based on an estimated factor of emission per capita using population data.

Emission factor

According to the 2019 EMEP/EEA Guidebook, a number of add-on technologies exist that are aimed at reducing the emissions of specific pollutants. The resulting emissions can be calculated by replacing the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{technologyabated} = (1-\eta_{abatement}) \times EF_{technologyunabated}$$

The unabated emission factor for NMVOC is 177 g/kg textiles cleaned (2019 EMEP/EEA Guidebook, Chapter 2.D.3.f, Table 3-2), while the abatement efficiency ($\eta_{abatement}$) was calculated based on the analysis of the available technology data in Hungary. Activity data (quantity of material cleaned) is reported by the companies to the LAIR system, while technology data are partly available. The estimated abatement efficiency for Hungary is approximately 88 % . Further investigation is needed on technology data.

Activity data

Activity data from 2004 is the quantity of material cleaned reported by the companies to the LAIR system. For earlier years an extrapolation was made based on an estimated factor of emission per capita using population data. Data on population is available from HCSO.

Uncertainty, recalculations, QA/QC activities and planned improvements

Further investigation of the country-specific emission factor is planned.

Recalculation was made for every year in the 2020 submission.

4.5.7 CHEMICAL PRODUCTS (NFR SECTOR 2.D.3.G)

Last update: 14.03.2020
Reported Emissions: NMVOC, benzo(a)pyrene
Measured Emissions: NMVOC
Methods: T2, T3
Emission factors: T2, T3
Key source: Level and trend NMVOC

In spite of the name of the sector not exclusively chemical products has been reported here, but also shoes and production of foams based on suggestion of EMEP/EEA Guidebooks.

Although there are several potential sources included in the Guidebook, the estimation of emissions in this sector contains solely where both default emission factor and required activity data is available. Unfortunately, the availability of production (or consumption) data of these special products is poor.

The activity reported at the moment is manufacture of shoes, processing of polyurethane and polystyrene foams, manufacture of paint and glues (ink is not manufactured in Hungary), manufacture of pharmaceutical products and asphalt blowing.

The 2019 EMEP/EEA Guidebook provides an emission factor for chemical products manufacture where the unit of measure is g/kg solvents used. Unfortunately, the amount of the solvents used is not known in addition it is probably confidential information specific for every manufacturer, technology and process. So, it was not possible to use the default emission factor. However, in LAIR the emissions of several organic compounds are reported by the pharmaceutical products manufacturers. Due to absence of other methodology this data was aggregated and inserted within this sector.

Emission from asphalt blowing was not accounted until recent submission because of the high value of emission factor for PAH. The emission factor for PAH was replaced in the 2019 EMEP/EEA Guidebook and it seems to be more correct than the previous in 2016 Guidebook. Emission of benzo(a)pyrene is appearing only between 1990 and 2002, because gases are treated with afterburner since 2002.

According to the expert of one of the plant where this activity takes place the efficiency of afterburner is 100%. So emission of PAH was not appeared after 2002 in this category.

Emission factor

Tier 2 default emission factor of 0.045 kg NMVOC/pair of shoes; 60 g NMVOC /kg polystyrene foam processed and 120 g/kg polyurethane foam processed; 11 g NMVOC/kg paint and glues manufactured and 2.55 g/Mg asphalt are used in addition to directly reported emission data from manufacturers of pharmaceutical products.

Activity data

Production data of shoes and of paints and glues are available from HCSO. Foam processed is calculated using import, export and production data from EUROStat Combined Nomenclature trade data. Production of asphalt (in tonne) is available directly from the manufacturer between 1990 and 2018.

Uncertainty, recalculations, QA/QC activities and planned improvements

- Activity data for manufacture paints and glues was revised.

Emission from asphalt blowing was taken into account in this submission.

4.5.8 PRINTING (NFR SECTOR 2.D.3.H)

Last update: 14.03.2020
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Level and trend NMVOC

NMVOC emissions are reported based on Tier 1 method yet.

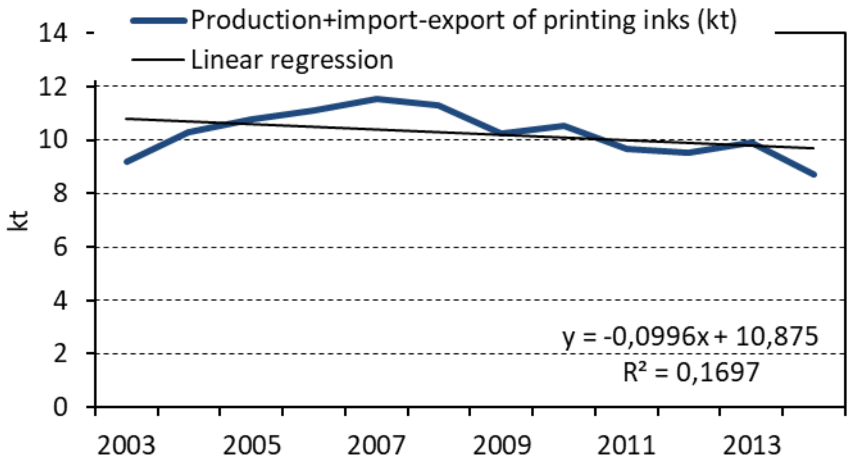
Emission factor

2019 EMEP/EEA Guidebook Tier 1 emissions factor (500 g/ kg ink applied) has been used.

Activity data

Printing ink applied was calculated as apparent consumption, e.g. import-export+production, Trade data from HCSO – EUROStat Combined Nomenclature categorization (code 3215) was used. Printing inks production data is the time-series of Prodcom Code 203 024.

Data from HCSO is available only from 2003. In order to complete the time series, linear extrapolation was used for earlier years (using 2003-2014 time-series) as the trend of the time series after 2003 seems to be quite constant as it is possible to observe on the following Figure.



4.12. Figure: Trend of apparent consumption of printing inks between 2003 and 2014

Uncertainty, recalculations, QA/QC activities and planned improvements

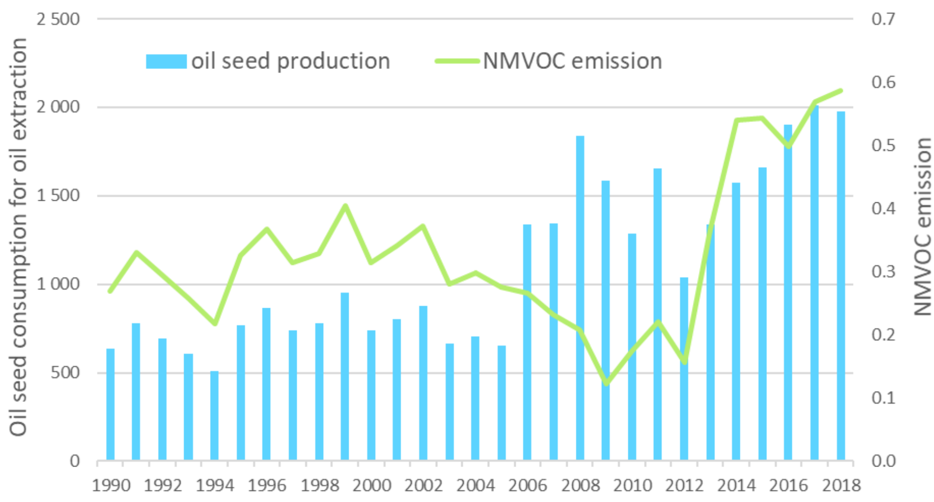
In 2018 investigation was started to use higher Tier method and because Tier 1 method could not reflect changes in technologies, however printing is a fast-developing industrial sector. LAIR database collects VOC balance data for those installation which falls within the scope of the directive 2010/75/EU of the European Parliament and of the Council. In this case only large installations are covered by this regulation, therefore data obtained from LAIR database cannot be used directly. Further investigation is planned to improve the calculation with available addition information from the LAIR database for submission 2021.

4.5.9 OTHER SOLVENT AND PRODUCT USE (NFR SECTOR 2.D.3.I)

Last update: 14.03.2020
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T3
Emission factors: T3

This was a new source category in the 2019 submission and it was created to include emissions from "fat, edible and non-edible oil extraction". Hungary was the largest sunflower oil producer in the EU in 2017 (according to statistics of FEDIOL) and it was known that the largest plant in Hungary use solvents for oil extraction. Also, oil producers fall within the scope of the directive 2010/75/EU of the European Parliament and of the Council, so VOC balance and direct emissions are reported to the LAIR database from 2002. For years before 2002 emissions were calculated using oil seed production knowing the typical industrial consumption rate and applied abatement technologies.

Figure below shows activity data and NMVOC emissions of this source category.



4.13. Figure: Oil seed processed and NMVOC emissions (1990-2018)

Emission factor

Tier 3 measured emissions were taken into account for years between 2002 and 2017. Before that period implied emission factors and information about abatement technologies were used in the calculations.

Activity data

Tier 3 measured emissions were taken into account for years between 2002 and 2017. Before that period data of oil seed production and rate of its industrial processing were used obtained from HCSO.

4.5.10 OTHER PRODUCT USE (NFR SECTOR 2.G)

Last update: 14.03.2020
Reported Emissions: NO_x, CO, SO_2, NH_3, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, Cd, Ni, Zn, Cu, As, Cr, Hg, Pb, PCDD/F, PAHs
Measured Emissions: none
Methods: T2
Emission factors: T2
Key source: Level and trend Cd

Activities are reported within this sector in Hungary are the tobacco consumption and use of fireworks.

Emission factor

Tier 2 default emission factors for all pollutants are used from 2019 EMEP/EEA Guidebook.

Activity data

Tobacco combustion:

Production, import and export data of tobacco is published by HCSO. Two assumptions are made:

- Consumption of tobacco of a given year = Production-export+import;
- 1 piece of cigarette is 1g.

Use of fireworks:

Using the quantity of manufactured, imported and exported firework for these 2 years we can provide a first estimation of emissions. For these two years, the activity data would be 535 and 679 tonne, respectively. By applying the Tier2 methodology from the 2019 EMEP/EEA Guidebook,

In response to a recommendation of TERT, submission 2020 includes the emission from use of fireworks. As database use of fireworks in Hungary is incomplete (only available for the years 2003 and 2004), to give an estimation for emission of pollutants from this category, calculation was made with the following assumptions. First of all, for those years when quantity of imported, exported and manufactured products are available, the quantity of export and production is quite the same. The quantity of exported fireworks are in the same order of magnitude as compared to the quantity of manufactured fireworks. Therefore those years, when trade of these products and also production data is available, the activity data is calculated with the equation of import-export+ production. In that case if database is incomplete, the quantity of imported product is the activity data, moreover for some years Hungary was used interpolation method for compsumption.

For 1990 and 1991 imported data is not available, so the emissions are estimated from 1992.

The following table includes the consumption of fireworks in Hungary (activity data).

4.12. Table: Consumption of fireworks in Hungary between 1990 and 2018

	Consumption (tonne)		**Consumption (tonne)**
1990	3.5	**2005**	695.0
1991	3.5	**2006**	711.3
1992	3.5	**2007**	727.7
1993	12.9	**2008**	838.0
1994	15.3	**2009**	522.5
1995	6.0	**2010**	564.4
1996	34.5	**2011**	606.4
1997	9.0	**2012**	648.3
1998	41.5	**2013**	690.3
1999	82.5	**2014**	732.2
2000	143.9	**2015**	774.2

2001	207.4	**2016**	816.1
2002	187.3	**2017**	858.1
2003	535.1	**2018**	900.0
2004	678.6		

Uncertainty, recalculations, QA/QC activities and planned improvements

During the 2019 review the TERT notes with reference to category 2G that there may be an underestimate of emissions, so Hungary was made an effort to give the emission from use of fireworks. Emission from use of fireworks is not calculated until the 2019 submission because of lack of activity data. Using the quantity of manufactured, imported and exported firework for these 2 years we can provide a first estimation of emissions by applying the emission factors of Tier2 methodology from 2019 EMEP/EEA Guidebook.

4.5.11 PULP AND PAPER (NFR SECTOR 2.H.1)

Last update: 14.03.2020
Reported Emissions: NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC
Measured Emissions: none
Methods: T2
Emission factors: T2

Process emissions of NMVOC, TSP, PM_{10} and $PM_{2.5}$ and BC from Paper and Pulp Industry are reported using Tier 2 method. NO_x, CO, SO_x emissions are reported in sector 1A2, based on the general recommendation of the Guidebook.

Due to the limited number of paper producer companies of Hungary, the use of directly reported emission data in LAIR would have also been possible. On one hand the completeness was not satisfactory neither in the number of reporting companies nor the pollutants reported; on the other hand, combustion emissions were not separable from process emission in this case. In addition, the estimation using default factors seem to be quite realistic, since Tier 2 factors provided in the 2016 EMEP/EEA Guidebook are derived from BAT-BREF document including scrubber and electrostatic precipitator abatement technology, which is probably the case by the most paper and pulp producer facilities in Hungary.

Emission factor

Tier 2 default emission factors of the 2019 EMEP/EEA Guidebook for Kraft process are used, as this is the most common technology. The emission factors are the same as for Tier 1 methodology and as in the earlier version of the Guidebook. No further abatement efficiency is taken into account due to absence of data.

Activity data

Activity data on Pulp for paper of Food and Agricultural Organization Statistics Division (FAOStat) is used. Between 2016 and 2018 activity data could be found in the E-PRTR reports and are more accurate (not rounded to 1000 tonnes as they are in the FAO statistics), so the source of activity data is now the LAIR database.

Uncertainty, recalculations, QA/QC activities and planned improvements

Due to the limited number of paper producer companies of Hungary, the use of directly reported emission data would be an improvement. The use of this data is not yet feasible because combustion emissions are not separated from process emission in LAIR in this case.

4.5.12 FOOD AND DRINK (NFR SECTOR 2.H.2)

Last update: 14.03.2020
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T2
Emission factors: T2
Key source: Level NMVOC

NMVOC emissions are reported in this category, using Tier 2 method. Combustion emissions arising during production of food and drinks are reported in category 1.A.2.e.

Emission factor

Tier 2 default emission factors from 2019 EMEP/EEA Guidebook are used for the production of bread (Europe), sugar, coffee roasting, wine, champagne, beer and spirits. No abatement efficiency is taken into account due to absence of data.

Activity data

Activity data is available from HCSO database. Prodcom codes (ITO Code in Hungarian) and detailed time series of the activity data used is presented in Table 4.5.3.

Uncertainty, recalculations, QA/QC activities and planned improvements

Further verification and eventual consolidation of time series of the activity data would be needed due to the inconsistencies and code changes in production statistics.

4.13. Table: *Activity data and NMVOC emissions in 2.H.2 Food production subsector*

PRODCOM 2012 Code	**107111 000 055**	**108110 000 055**	**108311 000 055**	**110212 000 703**	**110211 000 703**	**110510 000 703**	**110110 000 271**	
NMVOC T2 EF (kg/hl or t)	*4.5*	*10*	*0.55*	*0.08*	*0.035*	*0.035*	*15*	
	Bread	**Sugar**	**Coffee roasting**	**Wine of grape**	**Champagne white wine**	**Beer**	**Spirits**	**NMVOC emitted**
	t	t	t	hl	hl	hl	abs hl	**Gg**
1990	673000	512334	17600	1691920	284980	9917830	180182	**11.36**
1991	587000	605475	17400	1027670	178900	9569500	158236	**11.50**
1992	485000	399192	16900	1179460	300400	9161870	128513	**8.54**
1993	384000	392883	13600	1089380	358780	7877330	160994	**8.45**
1994	336000	439348	15800	1086830	324960	8081850	193474	**9.20**
1995	293000	479690	13700	992300	296150	7697440	225955	**9.87**
1996	283873	555538	25600	946520	284840	7270440	258436	**11.06**
1997	284232	487174	28300	809790	198050	6973180	121917	**8.31**
1998	285111	439421	21000	1074760	217100	7163970	122648	**7.87**
1999	381689	438277	26100	2220040	195820	6995860	156230	**8.89**
2000	334713	280466	27289	2137270	220390	7194280	153674	**7.06**
2001	356073	443447	53477	2252820	209080	7141920	204778	**9.58**
2002	346754	352201	30084	1961180	236020	7275280	149659	**7.76**
2003	344977	258600	27450	2189740	195320	7245110	161340	**7.01**
2004	367219	493440	23364	2095440	130350	6292000	177036	**9.65**
2005	351129	517049	12087	1984380	172680	6627630	153674	**9.46**
2006	327165	357282	11535	1700070	190860	7208200	170831	**8.01**
2007	295198	223092	11570	1715950	199450	7565700	125568	**5.86**
2008	334485	65874	11272	1765390	178560	7050340	206603	**5.66**
2009	326563	139873	10617	1741680	210430	6512130	202952	**6.29**
2010	332969	122723	10896	1074300	209390	6163570	217758	**6.31**
2011	352515	158585	9036	1201860	157200	6453280	202780	**6.55**
2012	358284	136902	9452	1665720	241300	6387650	202663	**6.39**
2013	476442	177152	8393	1884850	180790	5999990	157804	**6.65**
2014	495616	154123	2675	1820300	244420	5946360	161713	**6.56**
2015	465832	136637	1977	2344330	219440	5817700	170688	**6.42**
2016	326359	165003	1728	2012050	203790	6075130	193002	**6.40**
2017	316434	148275	4259	2237030	180680	6135930	162561	**5.75**
2018	319529	115880	3859	2712780	196470	5885480	162562	**5.47**

4.5.12. WOOD PROCESSING (NFR SECTOR 2.I)

Last update: 14.03.2020
Reported Emissions: TSP
Measured Emissions: none
Methods: T1
Emission factors: T1

Wood processing is only important for particulate emissions. This subcategory includes mainly the manufacture of plywood, fibreboard, chipboard, pallet and sawn timber products.

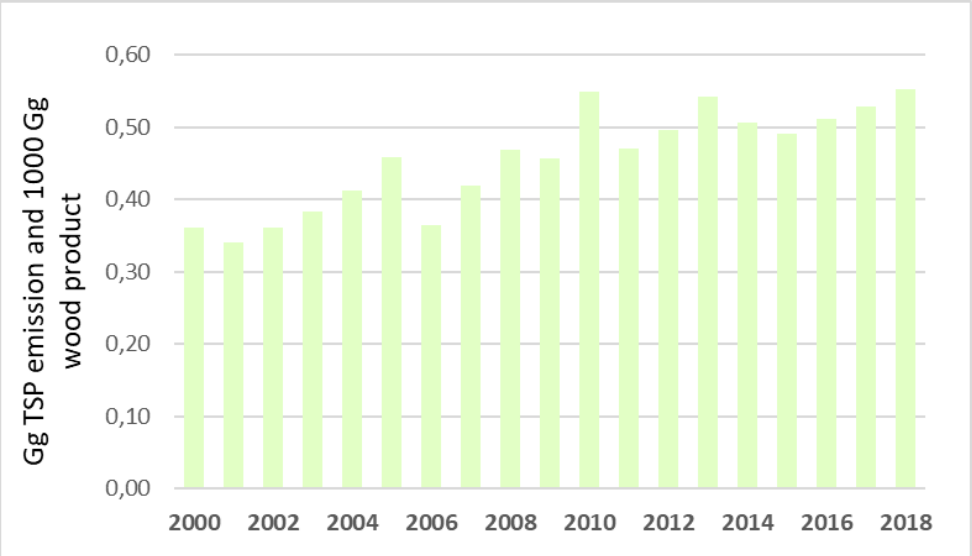
It is only a minor source of emissions and not a key category, thus Tier1 default approach suggested by EMEP/EEA air pollutant emission inventory guidebook 2019 was applied. So, the activity data is the mass of wood products processed.

Emission factor

According to the 2019 EMEP/EEA Guidebook, 1 kg TSP/Mg wood product was used as emission factor.

Activity data

Activity data for wood production have been taken from HCSO database.



4.14. ***Figure: Wood production and TSP emission from NFR 2.I categorgy***

Uncertainty, recalculations, QA/QC activities and planned improvements

None.

4.5.13. CONSUMPTION OF POPS AND HEAVY METALS (NFR SECTOR 2.K)

Last update: 14.03.2020
Reported Emissions: Hg
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Level and trend Hg

The use of PCBs in open systems was banned by OECD in 1970s. Hungary was not produced PCB and consumption of PCBs from import was stopped in 1980s. From the beginning of 1990s only insignificant (1-2 kg) amount was used. PCB contained oils have not been filled into Hungarian produced electrical equipment since 1984.

Mercury emission arise mainly from the use of batteries, electrical equipment and lighting. Tier1 method was applied to estimate the emission of this substance.

Emission factor

For calculating Hg emission from this subcategory default emission factor from EMEP/EEA air pollutant emission inventory guidebook 2019 was used, which is 0.01 g Hg per capita.

Activity data

According to the guidebook emission was calculated by using the above mentioned emission factor and the country's total population.

Uncertainty, recalculations, QA/QC activities and planned improvements

It's a planned improvement to calculate the emission of PCB from the use of transformers and capacitors for the earlier years to have more accurate emissions data (emissions are not significant due to bans (in 2010) of use of PCB contained electrical equipment).

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5 AGRICULTURE (NFR SECTOR 3.)

Last update: March 2020

Agriculture sector comprises NH_3, NO_x (as NO_2), NMVOC, SO_2, CO, particulate matter (PM), heavy metals (HM) and persistent organic pollutant (POP) emissions from the NFR sector 3. Agriculture. However, agriculture is a minor source of SO_2, CO, HM and POPs (except HCB) these emissions generate only from field burning.

In submission 2020, many significant improvements have been implemented to the estimation of emissions from agriculture sector.

Following the recommendations of the NECD Review, 2019 Hungary made the following improvements to the 2020 submissions:

1. HCB emissions from 1990 onwards for all relevant substances have been included;
2. Country-specific N-excretion rates for laying hens as well as broilers have been developped which allowed the application of Tier 2 methodology for NH_3 emissions from these sources;
3. Emissions from 3.F Field Burning of Agricultural Wastes have been reported for the first time.

In response to a recommendation from the review of air pollutant emission projections under the NECD, 2019 the retention rate for breeding boars and breeding sows was revised, along with the up-date of nitrogen intake.

For this submission some further important improvements were made which are as follows:

- NH_3 abatement (as cattle tied housing and manure spreading technologies) has been accounted for the first time.
- Piglets numbers under 20 kg was splitted into suckling piglets under 8kg and weaned piglets 8-20 kg. Emission estimates have been updated accordingly by taking into account pig numbers between 8 and 20 kg in the total number of fattening pigs, while suckling piglets under 8 kg are reported along with sows – in line with the EMEP methodologies.
- For the 2020 submission Hungary switched from the 2016 to the 2019 EMEP/EEA Emission Inventory Guidebook, thus agricultural emissions were recalculated using the most up-to-date, 2019 EMEP/EEA Emission Inventory Guidebook.

The Hungarian national system takes advantage of parallel inventory preparation and reporting of greenhouse gases (GHG) and air pollutants ensuring efficiency and consistency in the compilation of emission inventories, because a wide range of substances using common datasets and inputs. Annual greenhouse gas reporting under the UNFCCC requires the reporting of indirect N_2O emissions through volatilization of NH_3 and NO_x. Therefore, a link is established between the NH_3, NO_x 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 agricultural emission estimates.

5.1 SECTOR OVERVIEW

This chapter contains emission estimations for source categories '3B Manure management' and '3D Agricultural soils'. '3F Field burning of agricultural wastes' has been reported for the first time, while '3.I Agriculture other' sector is not used in the Hungarian inventory therefore, emission estimates from these sources are reported as 'NO' (not occurring).

Under category '3B Manure management' emissions from Dairy cattle, Non-dairy cattle, Sheep, Swine, Buffalo, Goats, Horses, Mules and Asses, Laying hens, Broilers, Turkeys, Other poultry and Rabbits as 'Other animals' are reported. In the Hungarian inventory 'Other poultry' comprises Geese, Ducks and Guinea Fowls.

In sub-sector 3D emissions from '3Da1 Inorganic N-fertilizers (includes also urea application)', 3Da2a Animal manure applied to soils, '3Da2b Sewage sludge applied to soils', 3Da2c Other organic fertilizers applied to soils (including compost), 3Da3 Urine and dung deposited by grazing animals, 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products, 3De Cultivated crops and 3Df Use of pesticides are reported.

To give an overview of Hungarian agriculture the main characteristics are as follows:

In Hungary, agricultural production practically stopped growing in the late 1980's. This was followed by a dramatic drop in the 1990s, as a result of the economic and political transition taking place in the country. The gross value of agricultural production dropped, by 20 to 40 per cent from the level of the 1980s. The drop was smaller for crop production (10-30%) than for animal husbandry. The output of the latter was only two third or less of the level of 1990 (Laczka and Soós, 2003). The volume index of gross agricultural production reached a minimum in 1993 of 69.1 per cent of the level of 1990. The crop production has fluctuated considerably since 1993. It dropped in 2002-2003 and 2007 due to drought. In contrast, the agricultural production was relatively high due to the significantly high crop production in 2004 and 2008. The animal husbandry remained at a low level between 1993 and 2004, and decreased after the European Union accession (2004) (Laczka, 2007). In recent years swine population has seemed to be stabilized, while cattle population slightly increased as a result of the state incentives to promote the recovery of livestock sector. In 2018 the gross production of agriculture increased, because the output volume of crop production and animal husbandry rose by 2.6% and 5.7% in comparison to 2017 (HCSO, 2019).

5.2 TRENDS IN EMISSIONS

5.2.1 AMMONIA (NH_3)

Agriculture is the main source of NH_3 emissions, with 92% share of the national total in 2018 (Table 5.1). Manure management accounts for the bulk of national total ammonia emissions in Hungary, it was responsible for 45.4% and 36.0 Gg share of national total in 2018. Under 3B Swine, Poultry and Cattle accounted for the majority of agricultural total NH_3 emissions. Fertilizer use at 24.2% (19.0 Gg) are the second largest contributor to the national total ammonia emissions. Distribution of main sources of ammonia from agriculture for 2018 is shown in Figure 5.1.

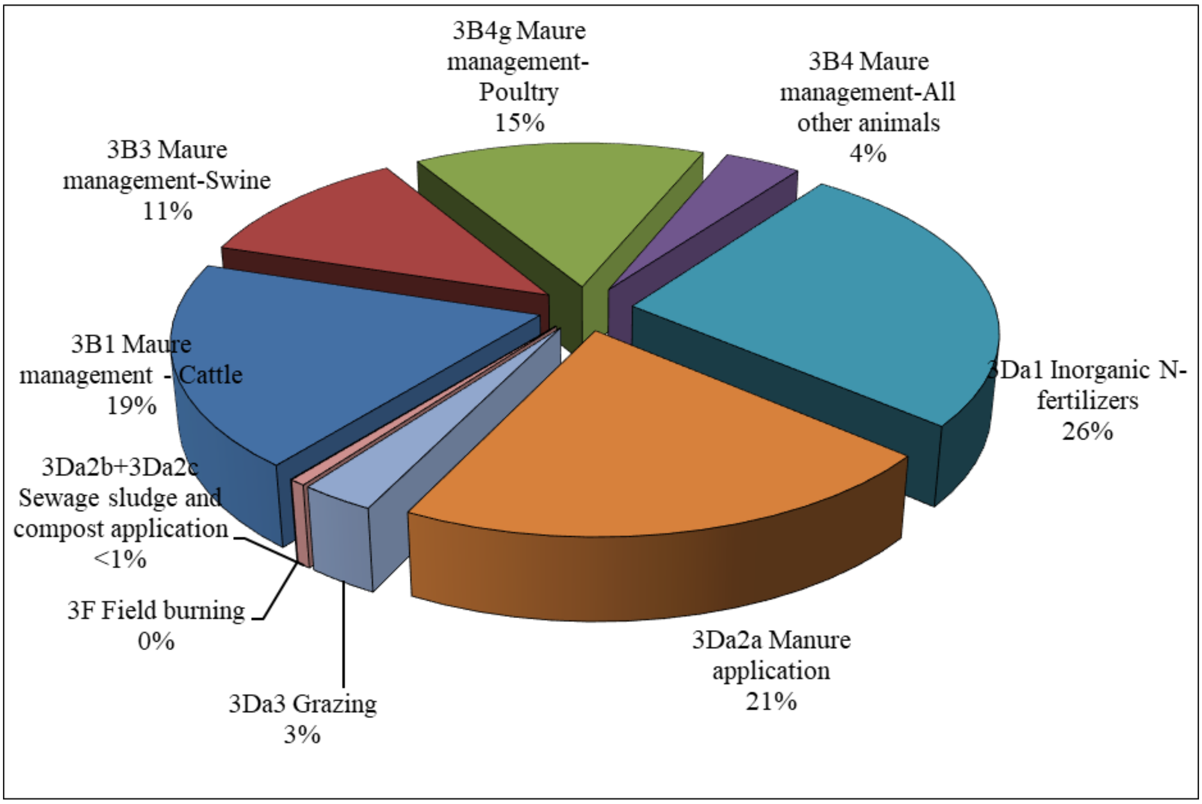


Figure 5.1 Ammonia emissions from Agriculture, 2018

Agricultural NH_3 emissions have decreased by 41.6% since 1990 (Table 5.1and Figure 5.2). The main drivers of this reduction are the significant decrease in the emissions form swine and cattle, due to the dramatic drop in livestock numbers. Focusing on the period between 2005 and 2018 NH_3 emissions from the agricultural sector have also decreased due to the further shrinking animal livestock. However, in the last years a slight increase in the emissions has been detectable due to the increasing fertilizer use.

Table 5.1 Emission trend of ammonia 1990-2018

Year	3.B	3.D	3
	Manure Management	Crop production and agricultural soils	Agriculture Total
	Gg		
1990	68.6	55.4	124.0
1991	62.1	40.9	103.0
1992	52.8	34.6	87.4
1993	45.9	30.9	76.8
1994	42.1	29.9	72.0
1995	42.5	30.9	73.4
1996	41.7	30.7	72.5
1997	40.6	30.7	71.3
1998	42.0	32.0	74.1
1999	42.6	33.2	75.8
2000	44.4	33.6	78.0
2001	43.1	33.9	77.0
2002	43.7	35.4	79.1
2003	44.2	35.5	79.7
2004	42.1	35.8	77.9
2005	39.8	33.9	73.7
2006	38.6	34.8	73.4
2007	38.3	34.7	73.0
2008	37.5	29.8	67.3
2009	35.8	28.1	63.9
2010	36.1	28.2	64.3
2011	35.4	28.9	64.4
2012	34.7	28.7	63.4
2013	34.2	30.9	65.1
2014	35.4	31.6	66.9
2015	36.3	34.5	70.8
2016	36.5	35.2	71.7
2017	35.5	37.1	72.6
2018	35.7	36.8	72.4
Share in Hungarian total in 2018	**45.4%**	**46.9%**	**92.3%**
Trend 1990-2018	**-48.0%**	**-33.6%**	**-41.6%**
Trend 2005-2018	**-10.4%**	**8.5%**	**-1.7%**

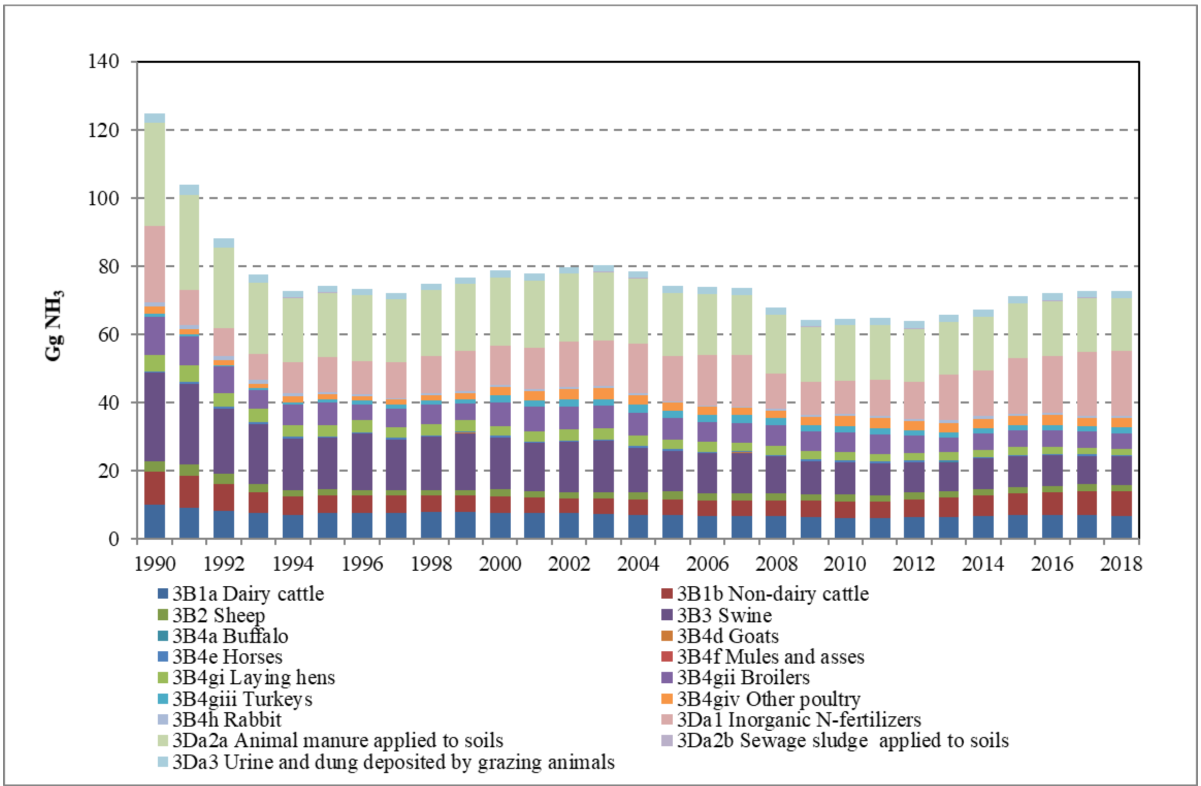


Figure 5.2. Emissions of NH_3, 1990-2018

The significantly shrinking urea use also contributed to the decreasing trends. Emissions from 3Da1 Fertilizer use have reduced by 15.9 per cent since 1990, despite the fact that the total N-content of the fertilizer applied has increased over the period 1991-2012 after a sudden fall in 1991. The decline in the emission level is due to the drop in the urea use, as a result of the rise of the urea price in 2008, in the European Union as well as in Hungary. Besides, Péti Nitrogénművek Ltd, the only fertilizer producer in Hungary, came to a halt of the production due to the uncertain market conditions, in autumn 2008.

5.2.2 PARTICULATE MATTER

In 2018 Agriculture accounted for 1.9% (0.8 Gg), 15.5% (9.6 Gg) and 15.6% (14.4 Gg) of the national total $PM_{2.5}$, PM_{10} and TSP emissions, respectively. The Agriculture sector was a significant contributor to the PM_{10} and TSP emissions in 2018, because of the high emissions from crop production. The contribution of the 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products sector was 7.0% (6.5 Gg) to the national total PM_{10} emissions. The relatively high emission level from this source is reasonable, considering the fact that 47% of the total area of the country is cropland.

$PM_{2.5}$ and TSP emissions from agriculture have decreased in the 2000-2018 period as a result of the continuously decreasing emissions from 3B Manure management. However, emissions from '3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products' have increased modestly, but this increase was offset by the decreasing livestock (Table 5.2 and Table 5.3). PM_{10} emissions have slightly increased over the inventory period; the slightly increasing emissions from 3Dc offset the decreasing emissions from 3B. TSP emissions from Agriculture are shown in Figure 5.3 and Table 5.3.

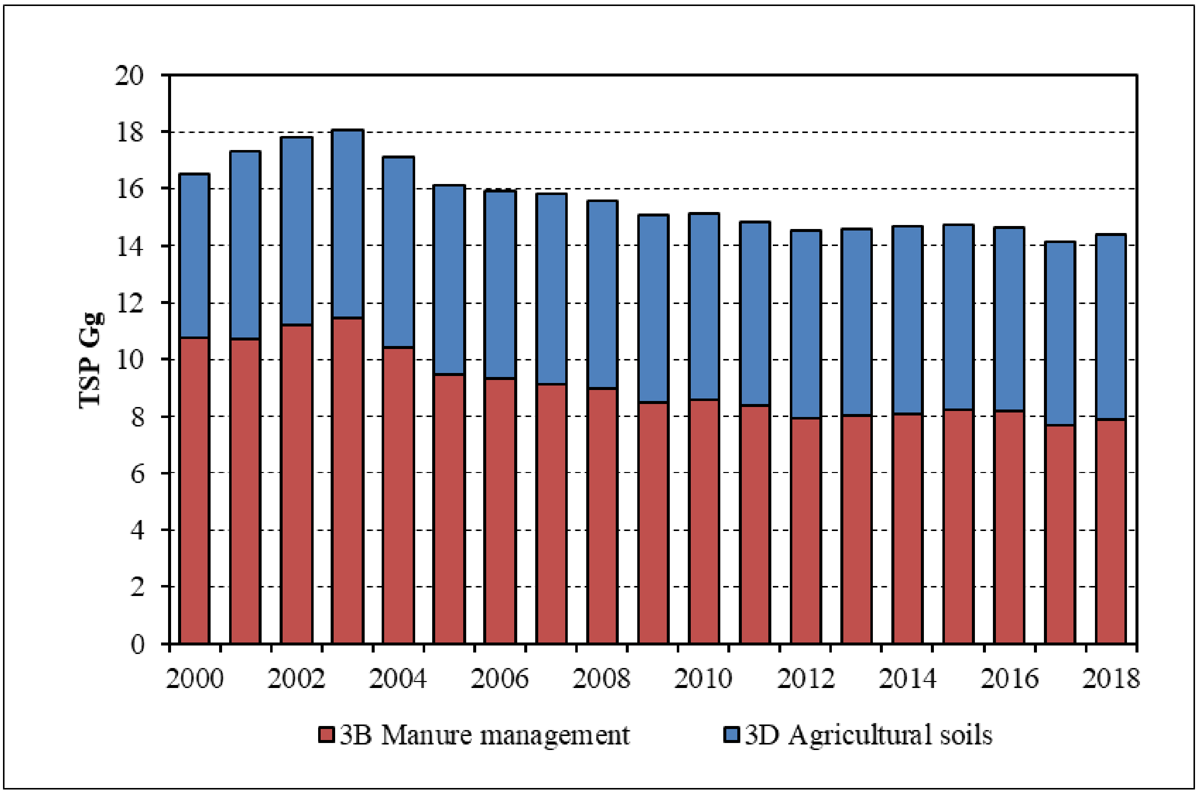


Figure 5.3 TSP emissions from Agriculture, 2000-2018

Table 5.2 Emission trend in agricultural $PM_{2.5}$ emissions, 2000-2018

Year	3.B Manure Management	3.D Crop production and agricultural soils	3.F Field burning	3 Agriculture Total
		Gg		
2000	0.57	0.22	0.02	0.81
2001	0.56	0.25	0.01	0.82
2002	0.59	0.25	0.02	0.86
2003	0.60	0.26	0.02	0.87
2004	0.57	0.26	0.02	0.84

Year	3.B Manure Management	3.D Crop production and agricultural soils	3.F Field burning	3 Agriculture Total
		Gg		
2005	0.51	0.26	0.02	0.79
2006	0.50	0.25	0.01	0.77
2007	0.49	0.26	0.02	0.77
2008	0.49	0.26	0.02	0.77
2009	0.49	0.26	0.02	0.76
2010	0.51	0.25	0.00	0.77
2011	0.51	0.25	0.02	0.78
2012	0.49	0.25	0.02	0.77
2013	0.50	0.25	0.02	0.77
2014	0.50	0.25	0.02	0.77
2015	0.50	0.25	0.02	0.77
2016	0.52	0.25	0.02	0.78
2017	0.48	0.25	0.02	0.75
2018	0.51	0.25	0.02	0.78
Share in Hungarian total in 2018	**1.2%**	**0.6%**	**0.1%**	**1.9%**
Trend 2000-2018	**-10.0%**	**11.9%**	**27.1%**	**-3.1%**
Trend 2005-2018	**-0.8%**	**-3.0%**	**42.3%**	**-0.6%**

Table 5.3 Emission trend in agricultural PM_{10} emissions, 2000-2018

Year	3.B Manure Management	3.D Crop production and agricultural soils	3.F Field burning	3 Agriculture Total
		Gg		
2000	3.66	5.78	0.02	9.46
2001	3.67	6.60	0.01	10.28
2002	3.93	6.63	0.02	10.58
2003	4.07	6.64	0.02	10.73
2004	3.75	6.69	0.02	10.47
2005	3.32	6.67	0.02	10.01
2006	3.27	6.60	0.01	9.88
2007	3.20	6.69	0.02	9.90
2008	3.22	6.64	0.02	9.87

Year	3.B Manure Management	3.D Crop production and agricultural soils	3.F Field burning	3 Agriculture Total
		Gg		
2009	3.15	6.65	0.02	9.81
2010	3.30	6.59	0.00	9.90
2011	3.31	6.48	0.02	9.80
2012	3.10	6.56	0.02	9.68
2013	3.14	6.55	0.02	9.72
2014	3.12	6.59	0.02	9.73
2015	3.13	6.49	0.02	9.64
2016	3.22	6.43	0.02	9.68
2017	2.95	6.45	0.02	9.43
2018	3.14	6.47	0.02	9.63
Share in Hungarian total in 2018	**5.0%**	**10.4%**	**0.0%**	**15.5%**
Trend 2000-2018	**-14.3%**	**11.9%**	**27.1%**	**1.8%**
Trend 2005-2018	**-5.6%**	**-3.0%**	**42.3%**	**-3.8%**

Table 5.4 Emission trend in agricultural TSP emissions, 2000-2018

Year	3.B Manure Management	3.D Crop production and agricultural soils	3.F Field burning	3 Agriculture Total
		Gg		
2000	10.75	5.78	0.02	16.55
2001	10.72	6.60	0.01	17.33
2002	11.20	6.63	0.02	17.85
2003	11.43	6.64	0.02	18.10
2004	10.41	6.69	0.02	17.13
2005	9.48	6.67	0.02	16.16
2006	9.34	6.60	0.01	15.96
2007	9.14	6.69	0.02	15.85
2008	8.95	6.64	0.02	15.61
2009	8.46	6.65	0.02	15.12
2010	8.56	6.59	0.00	15.15
2011	8.36	6.48	0.02	14.85
2012	7.95	6.56	0.02	14.54

2013	8.04	6.55	0.02	14.62
2014	8.08	6.59	0.02	14.69
2015	8.23	6.49	0.02	14.74
2016	8.19	6.43	0.02	14.65
2017	7.70	6.45	0.02	14.17
2018	7.90	6.47	0.02	14.39
Share in Hungarian total in 2018	**8.5%**	**7.0%**	**0.0%**	**15.6%**
Trend 2000-2018	**-26.5%**	**11.9%**	**27.1%**	**-13.0%**
Trend 2005-2018	**-16.7%**	**-3.0%**	**42.3%**	**-10.9%**

5.2.3 NO_X

In 2018 the NO_x emissions from agriculture amounted to 23.2 Gg (19.4% of the national total), which is 9.4% lower than the level of 1990. This decrease is the result of the reduction in livestock population and N-fertilizer use (Table 5.5). However, focusing on the period 2005-2018 a significant increase is detectable due to the increasing fertilizer use in the recent years.

Table 5.5 Trends in NO_x emissions, 1990-2018

	3.B	**3.D**	**3**
Year	**Manure Management**	**Crop production and agricultural soils**	**Agriculture Total**
		Gg	
1990	2.5	23.1	25.6
1991	2.1	13.8	16.0
1992	1.9	13.0	14.9
1993	1.6	12.6	14.2
1994	1.5	14.4	15.9
1995	1.6	13.0	14.6
1996	1.4	13.4	14.8
1997	1.4	13.3	14.7
1998	1.5	15.1	16.6
1999	1.4	15.7	17.2
2000	1.6	15.7	17.3
2001	1.6	16.2	17.9
2002	1.6	17.4	19.0
2003	1.6	16.9	18.5
2004	1.6	16.9	18.5
2005	1.5	15.5	16.9

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total
		Gg	
2006	1.4	16.5	17.9
2007	1.4	17.7	19.1
2008	1.4	16.5	17.9
2009	1.4	15.6	17.0
2010	1.4	15.8	17.3
2011	1.4	16.6	18.1
2012	1.4	17.2	18.6
2013	1.3	18.5	19.8
2014	1.3	18.5	19.9
2015	1.4	20.1	21.5
2016	1.4	21.1	22.5
2017	1.4	21.9	23.2
2018	1.4	21.8	23.2
Share in Hungarian total in 2018	1.1%	18.2%	19.3%
Trend 1990-2018	-46.0%	-5.3%	-9.4%
Trend 2005-2018	-7.1%	41.4%	37.2%

5.2.4 NMVOC

In 2018 Agricultural NMVOC emissions amounted to 31.0 Gg and 25.0% share of the national total (Table 5.6). The main agricultural source of MNVOC emissions is the 3B Manure management accounting for 22.0% of national total emission. NMVOC emissions from animal husbandry mainly originate from silage feeding and partly digested fat, carbohydrate and protein decomposition in the rumen and in the manure. Consequently, Cattle husbandry is the most important source of agricultural NMVOC emissions. While cultivated crops are an insignificant source with a share of 2.8% of national total. NMVOC emissions have decreased by 42.7% over the period 1990-2018, as a result of the decreasing animal livestock.

Table 5.6 Emission trend for NMVOC from Agriculture, 1990-2018

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total

	Gg		
1990	50.1	3.9	54.1
1991	45.4	3.9	49.3
1992	39.0	3.5	42.5
1993	33.4	3.3	36.7
1994	30.7	3.6	34.3
1995	30.5	3.7	34.2
1996	30.0	3.7	33.7
1997	29.6	3.7	33.3
1998	29.7	3.6	33.3
1999	29.7	3.2	32.9
2000	30.7	3.2	33.9
2001	29.8	3.6	33.5
2002	29.9	3.7	33.6
2003	29.6	3.7	33.3
2004	28.5	3.7	32.2
2005	27.0	3.7	30.7
2006	26.4	3.6	30.1
2007	26.3	3.7	30.0
2008	26.0	3.7	29.7
2009	25.3	3.7	29.0
2010	25.3	3.6	28.9
2011	25.0	3.6	28.6
2012	25.3	3.6	28.9
2013	25.4	3.6	29.0
2014	25.9	3.6	29.6
2015	26.6	3.6	30.2
2016	26.8	3.5	30.4
2017	26.5	3.6	30.1
2018	27.4	3.6	31.0
Share in Hungarian total in 2018	**21.9%**	**2.8%**	**24.7%**
Trend 1990-2018	**-45.2%**	**-9.4%**	**-42.7%**
Trend 2005-2018	**1.5%**	**-3.0%**	**1.0%**

5.3 NFR 3B MANURE MANAGEMENT

From category 3B Manure management emissions of NH_3, NO_x, NMVOC and PM are estimated.

5.3.1 ACTIVITY DATA

Activity data used in the agricultural air pollutant inventory are the same or consistent with those are used in the GHG-inventory as a result of streamlining effort has been made in the last five years. The common approach to the UNFCCC and UNECE reporting enables to use the same country-specific values and research results.

5.3.1.1 LIVESTOCK POPULATION

The HCSO has been producing two censuses of animal numbers per year since 2009. One survey is conducted in June and the other in December. The annual average population for a certain year was calculated by using the chronological mean of censuses. as follows:

$NoA_t = (0.5*NoA_{Dec.t-1})+NoA_{June.t}+0.5*NoA_{Dec.t})/2$

Where:

NoA_t = chronological mean of the annual population ofa livestock category in a year t [1'000 head]

$NoA_{Dec.t-1}$ = population of a livestock category in December of the year t-1 [1'000 head]

$NoA_{June.t}$ = population of a livestock category in June of the year t [1'000 head]

$NoA_{Dec.t}$ = population of a livestock category in December of the year t [1'000 head]

The method delineated above was suggested by the HCSO's expert (Tóth, 2004) to smooth out the seasonal changes in the livestock population.

Until the end of 2008 the HCSO collected data on animal livestock population three times a year. namely April. August and December. For the calculation of the annual average population for the years before 2009 the chronological mean was used similarly. based on the three surveys data.

In the case of swine the HCSO uses a livestock category 'piglets<20 kg', while the EMEP methodology provides emission factors for 'sows and pigs<8 kg' and 'finishing pigs 8-110 kg'. Until the 2019 submission there was no data available regarding the share of piglets<8 kg. For this submission improvements were made concerning breeding sows, hence the required data has become available (as litter weight and daily weight gain). Thus, for the 2020 submission piglet numbers under 20 kg has been splitted into piglets<8 kg and piglets between 8 and 20 kg. The share of piglets<8 kg was calculated on the basis of daily weight gain by Zs, Benedek, 2019.

The annual average livestock populations used to the calculations are provided in Table 5.7-Table 5.10.

Table 5.7 Animal populations and their trends for 1990-2018

Year	Livestock numbers (1'000 head)									
	3B1a	3B1b	3B2	3B3	4B4a	3B4d	3B4e	3B4f	3B4g	3B4h
	Dairy cattle	Non-dairy cattle	Sheep	Swine	Buffalo	Goats	Horses	Mules and Asses	Poultry	Other (Rabbit)
1990	563.6	1053.0	1958.3	8708.5	0.1	35.1	79.8	4.5	70325.6	2587.2
1991	526.6	1017.8	2008.7	7809.1	0.1	39.3	84.0	4.3	58827.4	2629.5
1992	479.5	833.9	1867.3	6237.4	0.1	50.0	78.8	4.3	52168.4	2389.5
1993	436.3	648.5	1457.7	5805.4	0.1	60.6	74.6	4.3	43429.1	2149.5
1994	408.5	554.4	1089.0	5006.9	0.1	71.3	85.1	4.3	44477.4	1909.4
1995	394.5	548.8	997.7	5023.0	0.2	76.1	74.6	4.3	44874.5	1669.4
1996	389.4	545.9	930.0	5493.5	0.3	80.9	73.5	4.3	38537.7	1148.9
1997	387.8	520.8	900.9	5012.7	0.4	85.7	75.6	4.3	40416.6	1071.3
1998	381.3	493.8	954.5	5246.7	0.5	90.5	76.7	4.3	42707.6	1051.8
1999	385.0	488.5	980.7	5609.0	0.6	95.3	77.7	4.3	40260.3	1040.4
2000	362.8	479.2	1192.2	5146.2	0.7	96.6	77.8	3.6	48562.1	942.5
2001	353.0	443.3	1162.8	4823.3	0.8	107.2	67.5	3.5	51074.0	1087.2
2002	344.5	433.7	1138.2	5050.0	0.9	96.7	63.2	3.4	51333.7	1179.7
2003	330.0	433.2	1226.5	5077.5	1.0	94.5	62.5	3.3	52486.2	1088.8
2004	309.3	424.3	1380.2	4385.0	1.1	84.5	64.5	3.2	50492.0	1181.7
2005	299.8	419.7	1446.7	4021.7	1.2	77.8	67.0	3.0	46404.7	1002.7
2006	275.2	428.2	1358.2	3943.7	1.3	81.2	64.8	2.3	44653.3	1084.3
2007	267.5	442.3	1300.7	4039.0	1.4	71.5	59.0	2.1	43159.7	1055.0
2008	263.8	436.2	1269.7	3664.7	1.4	72.8	58.3	2.0	45032.7	903.5
2009	257.5	444.3	1260.8	3248.0	1.5	65.0	59.8	1.9	44789.3	871.3
2010	244.5	454.0	1203.0	3208.0	2.5	79.3	65.5	3.1	46587.0	916.3
2011	250.6	440.2	1159.1	3131.3	3.7	83.8	73.0	3.5	46283.8	949.1
2012	256.0	474.8	1179.3	2981.5	3.4	86.0	76.2	3.5	43063.7	1367.1
2013	248.5	518.7	1204.9	2943.9	3.7	85.2	66.1	2.7	41674.3	1560.1
2014	252.0	538.5	1222.6	3064.9	3.7	76.7	63.0	2.1	42683.1	1643.2
2015	252.1	562.8	1193.9	3127.0	3.7	79.5	61.3	2.5	44459.1	1610.4
2016	247.0	592.2	1189.3	3020.8	5.4	84.0	56.5	3.2	44907.6	1300.4
2017	244.8	617.7	1160.3	2847.6	6.1	85.0	53.7	4.1	42711.1	1149.9
2018	242.7	635.8	1145.6	2865.1	6.6	75.3	51.9	4.6	43136.9	1204.6
Trend 1990-2018	**-57%**	**-40%**	**-41%**	**-67%**	**6475%**	**115%**	**-35%**	**3%**	**-39%**	**-53%**
Trend 2005-2018	**-19%**	**52%**	**-21%**	**-29%**	**448%**	**-3%**	**-23%**	**56%**	**-7%**	**20%**

Table 5.8 Non-Dairy Cattle populations and their trends for 1990-2018

Year	Livestock numbers (1'000 head)							
	<1 year		1-2 year		>2 year			
	Bovines for slaughter and other calves (male)	Bovines for slaughter and other calves (female)	Bovines (male)	Heifers for slaughter and other heifers	First calf heifers	Mature Non-Dairy (male)	Heifers for slaughter	Beef Cow
1990	212.6	241.2	169.6	256.9	65.6	17.1	15.7	74.4
1991	204.7	237.8	162.2	251.9	61.8	16.4	14.9	67.9
1992	164.1	206.5	110.7	219.5	55.1	13.1	11.0	54.0
1993	128.7	162.9	86.2	170.9	44.7	9.7	7.0	38.5
1994	109.1	143.9	68.3	151.2	41.2	8.0	5.0	27.8
1995	107.4	143.4	65.9	149.1	42.7	7.9	4.9	27.5
1996	105.5	139.3	70.1	144.3	43.8	7.8	4.8	30.3
1997	99.5	133.0	63.5	138.8	47.3	7.4	4.3	27.0
1998	98.7	131.8	41.5	137.5	49.5	6.9	3.7	24.3
1999	97.4	130.1	47.8	135.7	44.3	6.8	3.6	23.0
2000	96.0	132.6	36.2	136.7	41.9	5.8	2.7	27.4
2001	88.0	125.9	29.4	131.4	37.1	4.8	2.7	24.0
2002	85.0	124.7	27.0	130.0	37.2	4.7	2.2	22.9
2003	87.8	121.4	26.6	124.4	36.0	4.5	2.3	30.1
2004	81.5	113.7	25.3	122.4	34.2	6.0	2.7	38.5
2005	84.7	109.2	22.6	119.1	32.8	5.8	2.0	43.4
2006	84.6	106.5	30.3	116.9	30.6	5.5	2.5	51.3
2007	86.6	106.2	37.0	116.4	33.0	6.2	2.2	54.7
2008	78.9	109.5	32.1	114.7	32.0	6.0	2.3	60.6
2009	81.5	108.2	31.7	120.2	32.5	6.5	2.0	61.7
2010	75.7	108.2	35.0	120.7	35.5	7.2	3.2	68.5
2011	74.5	105.6	26.4	115.7	35.6	7.0	2.6	72.8
2012	86.9	113.5	31.8	117.5	35.6	7.0	4.2	78.3
2013	89.1	119.6	41.5	130.1	35.3	8.2	4.3	90.5
2014	90.2	122.9	44.2	131.2	37.0	8.4	2.7	101.9
2015	90.3	129.9	43.2	135.7	38.3	9.2	3.7	112.5
2016	98.6	133.3	38.3	138.1	39.1	10.1	4.7	129.9
2017	104.0	138.9	37.8	137.4	37.8	10.5	5.2	146.2
2018	107.8	140.7	43.0	140.4	34.0	11.3	3.3	155.3
Trend 1990-2018	**-49%**	**-42%**	**-75%**	**-45%**	**-48%**	**-34%**	**-79%**	**109%**
Trend 2005-2018	**27%**	**29%**	**90%**	**18%**	**4%**	**94%**	**68%**	**258%**

Table 5.9 Swine populations and their trends for 1990-2018

Year	Animal Population 1,000 head							
	Pigs<8 kg	Pigs 8-20 kg	Young pigs, 20-50 kg	Pigs for fattening over 50 kg	Breeding sows	Breeding boars	Guilts not yet mated	Sows mated for the first time
1990	1008.0	945.0	2,626.3	3,239.6	27.2	657.5	116.3	88.5
1991	832.1	780.1	2,349.7	3,090.6	25.1	563.0	104.0	64.4
1992	676.2	633.9	1,844.5	2,436.3	20.4	486.7	81.7	57.8
1993	631.1	591.6	1,744.1	2,245.4	18.0	446.0	77.2	52.0
1994	541.9	508.0	1,499.5	1,958.4	15.4	372.5	66.4	44.8
1995	571.5	535.7	1,458.5	1,921.6	15.3	404.7	64.6	51.1
1996	648.7	608.1	1,523.9	2,146.8	15.7	429.8	67.5	53.0
1997	612.9	574.6	1,302.1	2,039.4	14.3	356.3	56.7	56.3
1998	643.8	603.6	1,407.0	2,073.5	14.0	364.0	65.0	75.8
1999	661.3	620.0	1,503.1	2,299.8	14.8	396.9	56.3	56.8
2000	623.5	584.5	1,302.8	2,143.5	14.2	359.8	56.7	61.2
2001	650.6	609.9	1,108.0	1,984.5	12.5	342.2	54.7	61.0
2002	702.6	658.6	1,136.7	2,043.0	12.8	368.0	60.3	68.0
2003	661.6	620.2	1,157.8	2,150.9	12.0	362.3	56.0	56.7
2004	549.3	515.0	1,015.0	1,885.3	9.8	309.2	50.0	51.3
2005	515.4	483.2	916.5	1,701.9	10.0	291.5	50.7	52.5
2006	503.7	472.2	933.1	1,635.4	8.7	282.2	54.8	53.5
2007	524.0	491.3	934.2	1,700.3	7.8	279.0	52.0	50.3
2008	452.9	424.6	848.3	1,595.3	6.8	249.7	46.3	40.7
2009	390.9	366.5	795.4	1,374.1	6.0	226.5	45.0	43.5
2010	394.0	369.4	751.7	1,374.1	6.5	225.2	42.2	44.7
2011	387.9	363.6	748.6	1,326.9	5.7	217.6	43.4	37.8
2012	365.0	342.1	726.7	1,256.8	5.0	205.8	42.0	38.1
2013	373.7	350.3	683.6	1,250.4	4.8	194.2	44.1	42.8
2014	392.9	368.4	725.0	1,288.5	4.9	198.5	43.5	43.2
2015	404.8	379.5	741.4	1,308.3	4.7	201.1	44.8	42.5
2016	366.9	344.0	665.9	1,370.3	4.2	184.9	43.7	40.9
2017	352.5	330.5	636.8	1,271.5	3.4	175.0	43.7	36.9
2018	359.2	336.7	633.9	1,275.1	3.0	176.6	43.7	36.4
Trend 1990-2018	**-64%**	**-64%**	**-76%**	**-61%**	**-89%**	**-73%**	**-62%**	**-59%**
Trend 2005-2018	**-30%**	**-30%**	**-31%**	**-25%**	**-69%**	**-39%**	**-14%**	**-31%**

Table 5.10 Poultry populations and their trends for 1990-2018

Year	Livestock numbers (1'000 head)						
	3B4gi	3B4gii	3B4giii	3B4giv	3B4giv	3B4giv	3B4giv
	Laying hens	Broilers	Turkeys	Other poultry*	Ducks	Geese	Guinea Fowls
1990	22,735.0	40,178.1	1,772.6	5,639.9	2,463.6	2,926.5	249.8
1991	23,460.1	29,487.6	1,252.7	4,626.9	2,216.7	2,167.5	242.6
1992	20,187.3	27,392.8	916.7	3,671.7	1,969.9	1,459.2	242.6
1993	19,314.4	19,289.5	1,080.1	3,745.1	2,008.4	1,494.1	242.6
1994	17,092.6	21,666.5	1,288.8	4,429.4	2,339.1	1,854.9	235.5
1995	15,732.5	23,349.4	1,599.1	4,193.5	2,144.6	1,833.9	215.0
1996	16,368.0	16,430.5	1,979.1	3,760.1	1,955.3	1,616.4	188.3
1997	15,491.1	18,816.0	2,156.9	3,952.5	2,139.8	1,634.8	178.0
1998	15,824.0	20,158.3	2,156.9	4,568.4	2,725.7	1,623.8	219.0
1999	15,255.0	17,749.4	2,084.3	5,171.6	3,222.1	1,689.9	259.6
2000	13,744.3	24,223.7	4,029.8	6,564.3	3,249.5	3,080.3	234.4
2001	15,396.5	25,290.0	3,449.3	6,938.2	3,790.2	2,915.5	232.5
2002	16,051.5	23,327.7	3,789.8	8,164.7	4,490.0	3,474.3	200.3
2003	16,384.8	23,645.2	3,495.8	8,960.3	4,770.7	3,986.3	203.3
2004	15,398.8	23,187.2	4,637.3	7,268.7	3,898.0	3,177.3	193.3
2005	14,232.3	22,058.3	4,036.5	6,077.5	3,704.0	2,183.2	190.3
2006	14,424.7	20,268.5	4,270.3	5,689.8	3,117.3	2,387.3	185.2
2007	13,063.8	20,359.0	4,430.8	5,306.0	2,780.5	2,374.5	151.0
2008	13,376.3	21,865.8	4,071.2	5,719.3	3,070.0	2,487.8	161.5
2009	12,732.3	22,364.5	3,422.3	6,270.3	3,736.3	2,384.8	149.3
2010	12,544.5	23,163.5	3,365.0	7,514.0	5,155.0	2,211.3	147.8
2011	11,453.4	23,878.3	3,152.8	7,799.4	5,208.1	2,455.5	135.9
2012	11,088.8	22,003.7	3,023.6	6,947.6	4,489.2	2,311.0	147.4
2013	11,839.9	19,959.2	2,432.8	7,442.4	4,533.1	2,774.7	134.6
2014	11,291.9	21,505.5	2,692.7	7,193.1	4,781.3	2,280.7	131.1
2015	11,722.5	22,963.7	2,928.3	6,844.7	4,687.6	2,027.5	129.6
2016	11,246.6	23,307.9	3,022.3	7,330.8	4,854.5	2,354.1	122.3
2017	10,748.7	22,990.4	2,888.4	6,083.6	3,952.7	2,016.1	114.8
2018	10,891.7	22,118.3	2,834.1	7,292.9	4,898.8	2,290.3	103.8
Trend 1990-2018	**-52%**	**-45%**	**60%**	**29%**	**99%**	**-22%**	**-58%**
Trend 2005-2018	**-23%**	**0%**	**-30%**	**20%**	**32%**	**5%**	**-45%**

**Ducks, Geese and Guinea Fowls are reported here*

Animal livestock populations, which have significant influence on the air pollutant inventory, have decreased considerably over the period 1990-2018. The Swine population have decreased by 67 per cent, whereas the Cattle population dropped by 46 per cent over the period 1990-2018. However, animal livestock has started to increase in the recent years, thus Non-Dairy Cattle livestock has shown a 52% increase over the period 2005-2018.

5.3.1.2 ANIMAL HOUSING AND WASTE MANAGEMENT SYSTEMS (AWMS)

Activity data on allocation of manure to animal waste management systems is based on processing and synthesizing of statistics from the HCSO's General Agricultural Censuses conducted in 2000 and 2010, Farm Structure Surveys, conducted in 2003, 2005, 2007, 2013 and 2016 annual data for the period 2004-2018 from the Nitrogen Database, reports on agricultural waste such as manure.

In Hungary the first comprehensive study on animal waste management system distribution for emission inventory purposes was carried out by Ráky in 2003 based on the HCSO's General Agricultural Census 2000. This study focused on product producer farms and provides data by farm-size structure. The results of the HCSO's General Agricultural Census 2010 provided comprehensive information on the manure management distribution again. The census provide data on housing practices for cattle, swine and laying hens, and in addition on grazing for all animal species for the year 2010. The surveyed housing systems are as follows:

Cattle

Tied systems, solid and liquid slurry system

Tied systems, liquid slurry system

Loose houses, solid and liquid slurry system

Loose houses, liquid slurry system

Other

Swine

Partial grid floor

Grid floor

Deep litter

Other

Farm Structure Survey data was applied to get representative activity data from the different datasets published by farm size structure and it was applied as surrogate data to the interpolation of the 2000-2010 time-series. Farm structure survey conducted in 2013 and 2016 contained a more detailed data collection on grazing than former surveys. These data on proportion of grazing animals as well as grazing period was also taken into account in the inventory preparation.

Agricultural census is taken every 10 years, thus for the recent years statistics from the Nitrogen Database provide the most reliable data on animal waste management system distribution. Annual statistics from the Nitrogen Database are supplied by the National Food Chain Safety Office (NFCSO) to the inventory compilation. Data collection for the Nitrogen Database is based on the Decree of the

Ministry of Agriculture and Rural Development No. 59/2008 (IV. 29). The Annex 6 of the Decree contains a questionnaire. Data supply obligation is prescribed for farmers, whose animal production exceeds the household requirements. The first version of this Decree (Government Decree No. 49/2001 (IV. 3)) entered into force in 2001. The collected data have been stored in a database since 2003. This database contains data on cattle and swine by sub-categories, poultry (laying hens, cocks and broilers, ducks, geese, turkey), sheep and goats, horse. Six different management systems were distinguished: liquid, solid, deep litter, grazing, farmyard/paddock and other. Amendments of this decree in 2008 resulted in a minor change in the structure of the data collection. Until 2007 only the livestock numbers for six housing systems were collected, while since 2008 the amount of the manure has also been surveyed. In 2009 a more detailed livestock characterization was introduced for cattle and swine. At the same time sheep and goats were separated into two different categories. The former paper questionnaires were replaced by on-line forms in 2014. This measure contributed to the improvement of the compliance with data provision obligations. In 2013 Hungary revised the area of the so-called ‘Nitrogen Vulnerable Zones’ (hereafter NVZs). Thus, the areas designated as NVZs increased to approximately 68-69% of the country from the former 47%, further increasing the number of farms under the data provision obligations.

In 2016 the data provision obligations of farmers were amended. The new regulations were developed in line with the data needs of emission inventories. The former six categories of management systems were improved by more detailed categories.

The number of the received questionnaire has been increasing since 2003, although the representativeness of this sample varies between different years and livestock categories. The dataset is most representative for cattle, swine and poultry, about 80-90 per cent of these livestock are covered. It can be considered to be reliable for sheep, too. About 60 per cent of the livestock is reported. It is least representative for goats and horse about 10 per cent coverage.

The applied data sources sometimes contain information on housing practices rather than manure management storage systems in many cases, therefore additional qualitative information was needed to define the relationship between the housing and manure management systems. Two studies (Mészáros, 2005 and Pazsiczky et. al, 2006) were applied to get additional information.

Despite the abovementioned methodological differences between the applied databases, the trend in the animal waste management systems distribution can be tracked.

Trends in manure management of Cattle and Swine

For cattle and swine, a slight increase of the liquid manure and the extensive housing technology i.e. grazing in the case of beef cattle can be identified. The former may be explained by the increasing proportions of the farms holding at least 100 animals. Increasing proportion of grazing probably is the results of the high fodder prices and increasing proportion of beef cattle.

Activity data for 1990 and 2018 are presented in Table 5.11 and, Table 5.12 respectively. In case of cattle and swine interpolation and surrogate data were used to complete the time-series.

Table 5.11 Animal waste management distribution for Cattle and Swine for the year 1990

1990	Building		Outside the building	
	Proportion of livestock housed on slurry-based system (%)	Proportion of livestock housed on FYM-based system (%)	Excreta on yards	Excreta on pasture
Dairy Cows	4.2%	95.8%	3.2%	8.0%
Non-dairy Cattle (Calves)	3.2%	96.8%	3.4%	14.9%
Non-dairy Cattle (all other cattle)	2.5%	97.5%	3.6%	15.4%
Breeding sows	39.3%	60.7%	1.3%	0.0%
Fattening pigs	40.7%	59.3%	1.5%	0.0%

Table 5.12 Animal waste management distribution for Cattle and Swine for the year 2018

2018	Building		Outside the building	
	Proportion of livestock housed on slurry-based system (%)	Proportion of livestock housed on FYM-based system (%)	Excreta on yards	Excreta on pasture
Dairy Cows	16.4%	83.6%	4.8%	7.7%
Non-dairy Cattle (Calves)	5.5%	94.5%	7.0%	11.5%
Non-dairy Cattle (all other cattle)	3.0%	97.0%	7.9%	17.7%
Breeding sows	72.0%	28.0%	9.4%	10.2%
Fattening pigs	62.7%	37.3%	8.4%	20.0%

The N-flow tool provided to the 2019 EMEP/EEA Guidebook differentiates between tied and loose housing systems regarding N_2O emission factors for Dairy Cattle. As mentioned previously, the HCSO censuses provide data on tied and loose housing systems. Gaps in the time series were filled by interpolation and extrapolation.

Manure storage - cattle and swine

To ensure consistency with the GHG-inventory liquid/slurry with and without natural crust was distinguished. According to the expert judgment from the NARIC Institute of Agricultural Engineering (Mészáros, 2015), 80% of cattle liquid manure is covered with natural crust in Hungary and 20% is not. In the case of swine manure 73% of sows' and 52% of fattening pigs' liquid manure are covered by natural crust and the remainder is not, which equates to 54% of total swine liquid manure on average. Therefore, cattle and swine liquid/slurry were further stratified between ‘with natural crust cover’ and without.

According to the Hungarian rules and regulations, farms with deep litter barns do not have to build a manure storage, because the manure is composted in the barn and can be applied to the soil directly. Therefore, all deep litter was assumed to be not stored, but applied to the soils directly. Considering this fact, the resulted proportions of solid manure stored before application (x_{store_solid}) are shown in Table 5.13.

Table 5.13 Proportions of solid manure stored before application

	1990	2005	2010	2015	2016	2017	2018
Dairy cattle	48%	47%	47%	48%	48%	48%	48%
Non-dairy cattle	42%	43%	43%	30%	25%	24%	24%
Non-dairy cattle (calves)	65%	61%	49%	40%	40%	40%	40%
Swine (finishing pigs)	100%	76%	71%	73%	75%	75%	75%
Swine (sows)	100%	88%	79%	71%	70%	70%	70%

Due to lack of data on proportions of liquid/slurry stored before application all manure was assumed to be stored (x_{store_slurry}=1 was assumed).

Data on anaerobic digestion to estimate the proportion of anaerobic digested manure has not been available yet. However, data collection, compilation and quality check of the required data are in progress. According to the provisional data proportion of the digested manure seems to be low, and probably has no significant effect on the reported emissions.

N-input from straw

In line with the EMEP/EEA Guidebook (EEA, 2019) N input from straw use in manure management systems was taken into account. Due to lack of reliable data, annual straw use in litter-based manure management systems and the N added in straw were estimated using the default values provided in Table 3.7 of the 2019 EMEP/EEA Guidebook.

5.3.1.3 ANNUAL AVERAGE NITROGEN EXCRETION RATES

For values of annual average nitrogen excretion rates country specific (Tier 2) coefficients derived based on the Equation 10.31 of the 2006 IPCC Guidelines were used for Dairy Cattle, Non-dairy Cattle, Swine, Laying hens and Broilers.

In calculation for breeding sows three different stages as gestation, lactation and the period ‘between weaning and mating’ were distinguished. The daily nitrogen intake/retention was determined for each period and annual values were calculated as the weighted mean using the length of periods as weighting factors. According to the Hungarian practices the length of gestation and lactation are 114 and 21 days, respectively. While the period between two successive farrowing decreased gradually across the timeseries. Annual values are provided in Table 5.17.

For broilers four-phase feeding was assumed for the period 2005-2018 and three phases from 2004 backwards. Timeseries consistency was ensured based on the timeseries overlap approach of the 2006 IPCC Guidelines (Volume 1, Chapter 5). Therefore, for the years 2005-2007 the three- and four-phase feeding systems were assumed, parallelly.

There was no need to distinguish between different stages in case of laying hens.

Nitrogen intake

To the above equation Nitrogen intakes were determined from the crude protein content of the dietary components for all subcategories of these animals. The crude protein intakes were multiplied by 0.16, which is the fraction of nitrogen in protein, to convert the protein content into nitrogen. In the case of cattle and swine subcategories (breeding sows and breeding boars excepted) crude protein content in the diet was calculated from the feed ingredients. Data on crude protein contents of each components were taken from the so-called 'feed database' containing the laboratory measurements of all kind of feed used for animal nutrition in Hungary. The feed database is available in the Hungarian Nutrition Codex, 2004.

In respect of breeding swine, laying hens and broilers data on crude protein content of the feed (CP%) in proportion of dry matter intake (DMI) was provided from the animal feed monitoring system operated by the AERI. Therefore, the nitrogen intake for a certain animal subcategory and stage was calculated using the following equation:

$$N_{intake(T,i)} = DMI_{T,i} \cdot \frac{\frac{CP\%_{T,i}}{100}}{6.25}$$

Equation 5.1

Where:

$N_{intake(T,i)}$= daily N consumed per animal of category (T) and stage (i), kg N animal^{-1} day^{-1}
$DMI_{T,i}$ = dry matter intake per animal in a certain stage (kg DMI animal day^{-1})
$CP\%_{T,i}$= per cent crude protein in dry matter
6.25 = conversion from kg of dietary protein to kg of dietary N, kg feed protein (kg N)$^{-1}$

In Hungary a feed monitoring system started to operate in 2016, with a retrospective data collection for the year 2005. For the year 1990 standards of the DMI and CP% intakes taken from the Hungarian Nutrition Codex, 1990 were applied and interpolation was used to complete the timeseries. According to the expert opinions and the depth interviews of the AERI, the Hungarian Nutrition Codex provided the most appropriate values of DMI and CP% for swine. While for broiler and laying hens the breeder's guides seemed to be the most reliable sources before 2005. However, as the research of the AERI revealed, in the years between 2005-2007, the crude protein content of the laying hen and broiler diet could be slightly lower than as it is provided in the breeder's guides. Therefore, timeseries overlapping was applied to avoid timeseries inconsistency arising from the use of data from two different sources.

Table 5.14 shows the trends in the crude protein content in the diet of breeding sows and breeding boars. These trends in the CP% for sows are the result of two opposite effects. The rising productivity resulted in an increase in the protein demand and the nitrogen intake. This rising trend was maintained to 2010 after which the amino acid supplements lead to decreasing trends in the crude protein content in the breeding sow diet. Trends in the CP% for breeding boar shows a slight increase over the inventory period.

Table 5.14 Crude protein content in the diet of breeding sow and breeding boar in proportion of DMI BY, 1990-2018

Year	gestating sow	lactating sow	weighted average for breeding sow	breeding boar
	CP(%)			
BY	13.8	16.1	14.1	15.0
1990	13.8	16.1	14.1	15.0
1991	13.8	16.2	14.1	15.1
1992	13.9	16.2	14.2	15.1
1993	13.9	16.3	14.2	15.2
1994	13.9	16.4	14.2	15.2
1995	14.0	16.5	14.3	15.3
1996	14.0	16.5	14.3	15.3
1997	14.0	16.6	14.3	15.4
1998	14.1	16.7	14.4	15.4
1999	14.1	16.8	14.4	15.5
2000	14.1	16.8	14.5	15.5
2001	14.2	16.9	14.5	15.6
2002	14.2	17.0	14.5	15.6
2003	14.2	17.1	14.6	15.7
2004	14.3	17.1	14.6	15.7
2005	14.3	17.2	14.7	15.8
2006	14.3	17.2	14.7	15.8
2007	14.3	17.2	14.7	15.9
2008	14.3	17.2	14.7	15.9
2009	14.3	17.2	14.7	16.0
2010	14.3	17.2	14.7	16.0
2011	14.3	17.0	14.6	16.1
2012	14.0	17.1	14.4	16.1
2013	13.9	17.2	14.3	16.2
2014	13.7	16.9	14.1	16.2
2015	13.6	16.7	14.0	16.3
2016	13.4	16.7	13.8	16.3
2017	13.3	16.9	13.8	16.4
2018	13.4	16.9	13.9	16.4

The trend in the N-intake of broiler (Table 5.15) is also driven by the abovementioned two contrary effects. The growing living weight result in an increase in the protein demand and the nitrogen intake. In 2007 the N-intake reached a peak. After that N-intake decreased gradually, due to the amino acid supplements and the. Finally, the N-intake started to increase slightly again in the last two years.

The overall slightly decreasing trend in the N-intake of laying hens reflects the improvement of the feeding practices and the importance of the amino acid supplements (Table 5.16).

Table 5.15 Crude protein content in the diet of broilers in proportion of DMI BY, 1990-2018

Year	CP% (breeder's recommendation)			Year	CP% (AERI's data collection)			
	starter	grower I.	finisher		starter	grower I.	grower II.	finisher
BY	23.0	20.0	18.5	**2005**	22.1	20.3	20.2	19.4
1990	23.0	20.0	18.5	**2006**	22.0	20.3	20.0	19.2
1991	23.0	20.0	18.5	**2007**	22.0	20.3	19.9	19.1
1992	23.0	20.0	18.5	**2008**	22.0	20.3	19.7	19.0
1993	23.0	20.0	18.5	**2009**	21.9	20.3	19.6	18.9
1994	23.0	20.0	18.5	**2010**	21.9	20.3	19.5	18.7
1995	22.9	20.0	18.6	**2011**	21.9	20.2	19.2	18.6
1996	22.9	20.1	18.6	**2012**	21.6	20.1	19.0	18.4
1997	22.8	20.1	18.7	**2013**	21.4	19.9	19.1	18.3
1998	22.8	20.2	18.8	**2014**	21.3	19.8	19.0	18.5
1999	22.7	20.2	18.8	**2015**	21.1	19.9	18.9	18.3
2000	22.7	20.3	18.9	**2016**	21.2	19.8	19.0	18.2
2001	22.6	20.3	19.0	**2017**	21.4	20.0	19.3	18.3
2002	22.6	20.4	19.1	**2018**	21.5	20.1	19.4	18.5
2003	22.5	20.4	19.1					
2004	22.5	20.5	19.2					
2005	*22.4*	*20.5*	*19.3*					
2006	*22.4*	*20.6*	*19.3*					
2007	*22.3*	*20.6*	*19.4*					

Table 5.16 Crude protein content in the diet of laying hens in proportion of DMI BY, 1990-2018

Year	CP% (breeder's recommendation)	Year	CP% (AERI's data collection)
BY	17.4	**2005**	17.2
1990	17.4	**2006**	17.2
1991	17.5	**2007**	17.2
1992	17.6	**2008**	17.1
1993	17.6	**2009**	17.1
1994	17.7	**2010**	17.1
1995	17.8	**2011**	17.4
1996	17.6	**2012**	17.5
1997	17.5	**2013**	16.8
1998	17.4	**2014**	16.7

Year	CP% (breeder's recommendation)	Year	CP% (AERI's data collection)
1999	17.4	**2015**	16.7
2000	17.4	**2016**	16.7
2001	17.4	**2017**	16.6
2002	17.4	**2018**	16.4
2003	17.4		
2004	17.4		
2005	*17.4*		
2006	*17.3*		
2007	*17.2*		

N retention

N retained by gestating sows and lactating sows were calculated using the following equation:

$$N_{retention,i} = N_{gain,i} + N_{piglets,i}$$

Equation 5.2

Where:

$N_{retention,i}$= *amount of N retained by the sow in the stage i (head · day^{-1})*

$N_{gain,i}$= *amount of N retained in the sow in the stage i (head · day^{-1})*

$N_{piglets,i}$ = *amount of N in piglets in the stage i (heads · day-1)*

i=stage (i=1 gestation, i=2 lactation, i=3 period 'between weaning and mating')

$$N_{piglets,i} = 0.0256 \cdot LITSIZE_i \cdot WG_{piglets,i}$$

Equation 5.3

Where:
$LITSIZE_i$ = *litter size, in the stage i, heads;*
$WG_{piglets,i}$ = *weigh gain of piglets, in the stage i, head·day-1;*
0.0256 = N-content of weight gain (kg/kg) Lfl, 2013

For sows in the period between two successive farrowing and breading boars the nitrogen retention was calculated based on the daily weight gain.

Background data as litter size, weaning weight and days between two successive farrowing are provided in Table 5.17. Data was compiled by the HMS, based on the annual yearbooks of 'Results of Pig Breeding' 1985-2018, published by the NFCSO. Piglets weight at birth was assumed to be 1.3 kg.

Table 5.17 Background data to the calculation of nitrogen retention rate of breeding sows

Year	piglet weight at weaning	number of piglets at birth	number of piglets at weaning	period between two successive farrowing
	kg	heads	heads	days
BY	5.9	9.8	8.9	178.4
1990	6.3	10.1	8.8	178.1
1991	6.2	10.1	8.9	178.8
1992	6.2	10.2	8.8	181.2
1993	6.2	9.8	8.5	181.2
1994	6.2	9.8	8.4	182.2
1995	6.4	10.0	8.4	181.3
1996	6.5	10.1	8.5	181.0
1997	6.5	10.1	8.5	182.9
1998	6.2	10.2	9.1	181.6
1999	6.2	10.3	9.3	178.6
2000	6.3	10.4	9.3	180.2
2001	6.4	10.3	9.2	173.4
2002	6.5	10.2	9.1	173.3
2003	6.3	10.2	9.2	172.1
2004	6.4	10.2	9.2	170.7
2005	6.6	10.2	9.2	170.6
2006	6.7	10.3	9.2	170.4
2007	6.8	10.3	9.4	169.1
2008	7.0	10.4	9.4	168.9
2009	7.3	10.4	9.5	167.5
2010	7.6	10.5	9.5	166.6
2011	7.7	10.6	9.6	166.0
2012	7.7	10.7	9.8	162.6
2013	7.7	10.9	9.9	162.2
2014	7.7	11.1	10.0	162.0
2015	7.8	11.2	10.1	161.9
2016	7.8	11.3	10.2	161.8
2017	7.8	11.5	10.3	161.4
2018	7.9	11.4	10.2	161.8

Source: NFCSO

N retention for laying hens was calculated from the production data using the following equation:

$$N_{retention} = \left[N_{LW} \cdot DWG + \left(\frac{N_{egg} \cdot EGG}{1000}\right)\right]$$

Equation 5.4

Where:

$N_{retention}$ = daily nitrogen retention of laying hens, kg N·head^{-1}·day^{-1};

N_{LW} = average content of nitrogen in live weight, kg N·kg head^{-1}. Default value of 0.028 provided in the 2019 Refinement was applied;

DWG = average daily weight gain, kg·head^{-1}·day^{-1};

N_{EGG} = average content of nitrogen in eggs, kg N·kg egg^{-1}. Default value of 0.0185 provided in the 2019 Refinement was used;

EGG = egg mass production, g egg·head^{-1}·day^{-1}.

Data on egg production was obtained from the HCSO (Table 5.18). Average daily weight gain (DWG) was calculated from the daily weight gain of the typical laying hen breeds, as Tetra, Lohman and Hy-Line. Data on the distribution of typical breeds in Hungary were provided by the Hungarian Poultry Board. The average egg weight was calculated similarly, based on the egg weight of the typical laying hen breeds.

Table 5.18 Background data to the calculation of nitrogen retention rate of laying hens

Year	Egg production [egg· head^{-1}·year^{-1}]
BY	206
1990	206
1991	189
1992	206
1993	218
1994	227
1995	220
1996	200
1997	212
1998	207
1999	202
2000	208
2001	213
2002	212
2003	210
2004	212
2005	208
2006	205
2007	218
2008	215
2009	215
2010	218
2011	214
2012	217
2013	208
2014	214
2015	218
2016	225
2017	227
2018	233

Source: HCSO, 2019

Nitrogen retention for broilers was calculated using the following equation:

$$N_{retention} = \frac{(BW_{Final} - BW_{Initial}) \cdot N_{gain}}{production\_period}$$

Equation 5.5

Where:

N retention= amount of N retained in animal (head) day^{-1}

BW_{Final} = Live weight of the animal at the end of the stage (kg)

$BW_{Initial}$ = Live weight of the animal at the beginning of the stage (kg)

N_{gain} = the fraction of N (kg) retained per kg BW gain (kg $^{kg-1}$)

Production period = length of time from chick to slaughter (fattening duration)

N_{gain} was assumed to be 0.0304 kg kg^{-1} based on Haenel et al., 2018 and Haenel és Dämmgen, 2009. This value relates to the 40 days fattening duration, but in order to ensure the time-series consistency this value was applied for the whole inventory period. Data on BW_{Final} was obtained from the slaughter house statistics of the AERI. This statistic provides data on living weight before slaughtering. The value of $BW_{initial}$ was estimated to be 0.042 kg based on expert judgement. Fattening duration was estimated to be 49, 42 and 40 days for the years 1994, 2007 and 2018 based on the Breeders Management Manuals of Arbor Acres and Aviagen, respectively; and interpolation was used to complete the timeseries. Background data to calculate nitrogen retention rate for broilers are shown in Table 5.19.

Table 5.19 Background data to the calculation of the nitrogen retention rate in broilers

Year	BW_{final}	Production period (fattening duration)
	kg	day
BY	1.9	49.0
1990	1.9	49.0
1991	1.9	49.0
1992	1.9	49.0
1993	1.9	49.0
1994	1.9	49.0
1995	1.9	48.5
1996	1.9	47.9
1997	1.9	47.4
1998	1.9	46.8
1999	2.0	46.3
2000	2.0	45.8
2001	2.0	45.2
2002	2.0	44.7

Year	BW_{final} kg	Production period (fattening duration) day
2003	2.1	44.2
2004	2.0	43.6
2005	2.0	43.1
2006	2.1	42.5
2007	2.1	42.0
2008	2.1	41.8
2009	2.2	41.6
2010	2.2	41.3
2011	2.3	41.1
2012	2.3	40.9
2013	2.3	40.7
2014	2.4	40.4
2015	2.4	40.2
2016	2.4	40.0
2017	2.5	40.0
2018	2.5	40.0

Values of fraction of annual N-intakes that is retained by animals ($N_{retention}$) and their sources are summarized in Table 5.20. The resulted values of N-excretion for Dairy Cattle and Non-dairy Cattle are provided in Table 5.24 and Table 5.25, respectively. While values of N excretion for Swine are presented in Table 5.21.

Table 5.20 $N_{retention}$ rates and their sources

Animal species	$N_{retention}$	Source
Dairy Cattle	0.20	2006 IPCC GLs
Non-Dairy Cattle	0.07	2006 IPCC GLs
Swine		
Piglets under 20 kg	0.48	Fébel and Gundel, 2007
Young pigs, 20-50 kg	0.34	Fébel and Gundel, 2007
Pigs for fattening over 50 kg	0.34	Fébel and Gundel, 2007
Breeding sows, weighted mean (2018)	0.34	country-specific (calculated based on the Hungarian production data, annually)
Gestating Sows	*0.30*	country-specific
Lactating Sows	*0.42*	country-specific
Sows between weaning and mating	*0.26*	country-specific
Breeding boars (2018)	*0.08*	country-specific (calculated based on the Hungarian production data)
Guilts not yet mated	0.34	Fébel and Gundel, 2007

Sows mated for the first time	0.34	Fébel and Gundel, 2007
Laying hens	0.27	country-specific (calculated based on the Hungarian production data, annually)
Broilers	0.55	country-specific (calculated based on the Hungarian production data, annually)

Table 5.21 Annual average Nitrogen excretion rates (N_{ex}) for Swine

Sub-categories	**N_{ex} [kg head^{-1} year^{-1}]**
Piglets under 20 kg	3.0
Young pigs, 20-50 kg	8.6
Pigs for fattening over 50 kg	12.3
Breeding sows (weighted average, 1990)	**15.9**
Gestating Sows	*13.3*
Lactating Sows	*33.7*
Sows between weaning and mating	*13.4*
Breeding sows (weighted average, 2018)	**15.8**
Gestating Sows	*12.6*
Lactating Sows	*38.1*
Sows between weaning and mating	*12.9*
Breeding boars (1990)	24.4
Breeding boars (2018)	22.1
Guilts not yet mated	9.9
Sows mated for the first time	13.8
Swine, weighted average (1990)	**9.9**
Swine, weighted average (2018)	**9.4**

For other livestock categories the default values of nitrogen excretion provided in Table 10.19 of the 2006 IPCC Guidelines were used except Buffalo for which the EMEP/EEA Guidebook (EEA, 2019) were applied (Table 3.9). Nitrogen excretion rates for 'Other animals' and the related body weights are shown in Table 5.22.

Table 5.22 Annual average Nitrogen excretion rates (Nex) for 'Other livestock'

Animal Category	**N_{ex} [kg head^{-1} year^{-1}]**	**Source**
Buffalo	82	2019 EMEP/EEA GB / 2006 IPCC GLs
Sheep	16	2006 IPCC GLs, Eastern Europe
Goats	18	2006 IPCC GLs, Eastern Europe
Horses	41	2006 IPCC GLs, Eastern Europe
Asses & Mules	14	2006 IPCC GLs, Eastern Europe
Poultry (2018)	0.72	Weighted average for 2018
Laying hens (2018)	*0.76*	*Country-specific, calculated annually*

Broilers (2018)	*0.56*	*Country-specific, calculated annually*
Turkey	*1.84*	*2006 IPCC GLs, Eastern Europe*
Ducks	*0.82*	*2006 IPCC GLs, Eastern Europe*
Geese	*0.55**	*2019 EMEP/EEA GB*
Guinea Fowls	*0.36*	*as default for Broilers provided in the 2006 IPCC Guidelines*
Rabbit	8.1	2006 IPCC GLs

**There is no value provided in the 2006 IPCC GLs*

Typical animal weights to calculate the annual N-excretion per head are provided in Table 5.23.

Table 5.23 Typical animal weight for other livestock

Livestock	Weight [kg]	Source/Note
Buffalo	380	Table 10A-6 of 2006 IPCC GLs
Sheep	48.5	Table 10A-9 of 2006 IPCC GLs
Goats	38.5	Table 10A-9 of 2006 IPCC GLs
Horses	377	Table 10A-9, Developed, 2006 IPCC GLs
Asses and Mules	130	Table 10A-9, Developed, 2006 IPCC GLs
Poultry	2.2	Weighted average for 2018
Laying hens (2018)	*2.0**	Country-specific
Broiler (2018)	*1.5**	Country-specific
Turkey	*6.8*	Table 10A-9 of 2006 IPCC GLs
Ducks	*2.7*	Table 10A-9 of 2006 IPCC GLs
Geese	*3.5*	*2019 EMEP/EEA Guidebook*
Guinea fowls	*0.9*	*Default for Broiler due to lack of information*
Rabbit	1.6	Table 10A-9 of 2006 IPCC GLs

**Please note that Tier 2 is applied, therefore TAM is not used in the calculation. These values are reported for information.*

Table 5.24 Country-specific NH_3 emission factors for 3B1a Dairy Cattle and background data for the period 1990–2018

Year	Body Mass, Average	Milk Yield	N-excretion	Emission Factor for 3B1a
	kg/head	kg/head/year	kg N / head*year	kg NH_3/ head*year
1990	633	13.78	83	16.8
1991	636	12.91	81	16.4
1992	639	13.10	82	16.5
1993	641	13.03	82	16.5
1994	641	12.92	82	16.4
1995	641	13.67	88	18.0

Year	Body Mass, Average	Milk Yield	N-excretion	Emission Factor for 3B1a
	kg/head	kg/head/year	kg N / head*year	kg NH_3/ head*year
1996	640	13.87	89	18.3
1997	640	14.01	90	18.5
1998	641	15.10	94	19.5
1999	639	14.94	94	19.4
2000	641	16.13	97	20.2
2001	641	16.58	99	20.6
2002	641	16.86	100	20.9
2003	642	16.86	100	21.0
2004	642	16.80	103	21.8
2005	642	17.61	106	22.5
2006	642	18.37	109	23.3
2007	643	18.83	111	23.7
2008	643	19.10	112	24.1
2009	642	18.67	110	23.6
2010	642	18.84	110	23.7
2011	640	18.73	109	23.5
2012	639	19.46	112	24.2
2013	641	19.55	112	24.3
2014	641	20.39	115	25.3
2015	642	21.10	119	26.3
2016	643	21.28	120	26.8
2017	643	22.02	123	27.7
2018	643	22.00	119	26.5

Table 5.25 Country-specific NH_3 emission factors and background data for 3B1b Non-dairy Cattle, 1990, 2005 and 2018

1990	Live weight	N excretion	NH_3 Emission Factor for 3B1b
	kg	kg N · head^{-1}·year^{-1}	kg NH_3 · head^{-1} · year^{-1}
Calves	182	42	8.42
All other cattle	437	46	9.43

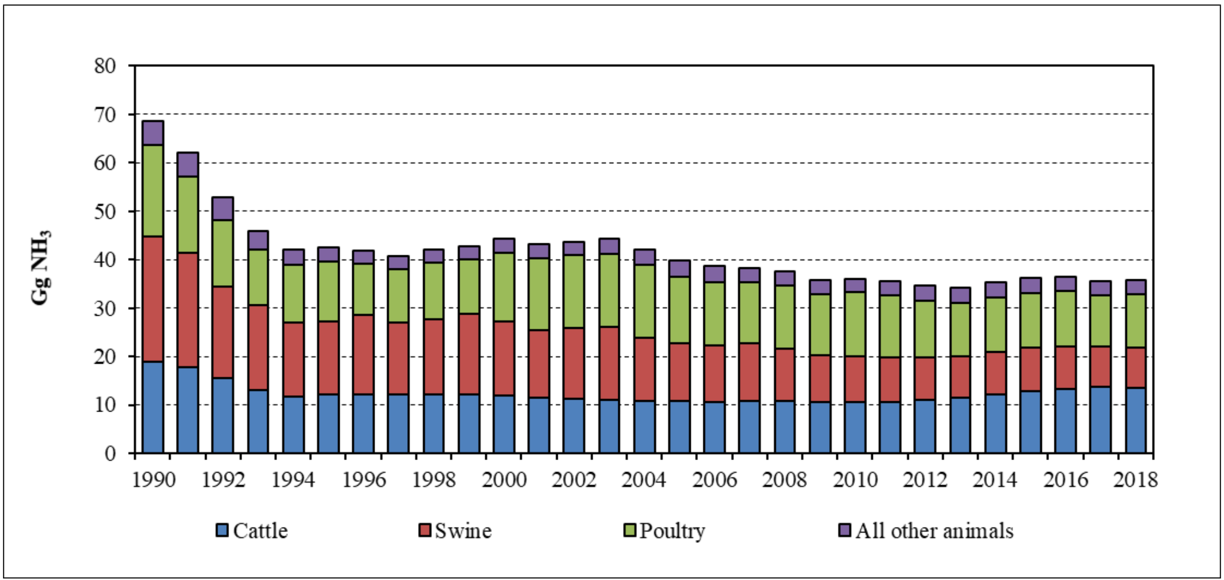
2005	Live weight	N excretion	NH_3 Emission Factor for 3B1b
	kg	kg N · head^{-1}·year^{-1}	kg NH_3 · head^{-1} · year^{-1}
Calves	181	43	8.73
All other cattle	446	51	10.81

2018	Live weight	N excretion	Emission Factor for 3B1b
	kg	kg N · head^{-1}·year^{-1}	kg NH_3 · head^{-1} · year^{-1}
Calves	181	43	8.42
All other cattle	487	58	12.91

5.3.2 NH_3

The main source of NH_3 emissions is manure management. 45% of the national total NH_3 emissions related to the animal production in 2018. The main part of this emission is connected with Cattle, Poultry and Swine housing, corresponding to 38%, 24% and 31% of the emissions from 3B (Figure 5.4). The decrease in the emissions over the period 1990-2012 is the effect of the fall in the animal livestock. Although, in the case of Dairy Cattle the increasing milk production per cow partly offset the impact of decreasing animal livestock. As a result of the implementation of the 'Pig Farming Strategy' accepted in 2012 in Hungary the swine livestock and the emissions seem to be stabilized at the end of the time-series.

Figure 5.4 NH_3 emissions from manure management 1990-2018



5.3.2.1 METHODOLOGICAL ISSUES

Emissions from 3B1 Cattle, 3B2 Sheep, 3B3 Swine, 3B4gi Laying hens and 3B4gii Broilers are calculated using the Tier 2 method of the EMEP/EEA Guidebook (EEA, 2019) and country-specific values whenever possible. For the other livestock the emission calculation is based on the Tier 1 methodology provided in the EMEP/EEA Guidebook (EEA, 2019).

5.3.2.2 ACTIVITY DATA

See Chapter 5.3.1

5.3.2.3 EMISSION FACTORS

Cattle, Swine, Laying hens and Broilers

Emission factors were calculated by the Manure Management N-flow tool provided to the EMEP/EEA Guidebook (EEA, 2019). 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 each animal sub-category. The input data on N-excretion and proportion of liquid, solid and yard manure are presented in Section 5.3.2. The housed period was estimated based on the proportion of manure excreted in the house, yard and during grazing. The resulted time period for housing is significantly higher than the EMEP/EEA default values. In 2018, in case of Dairy Cattle 319 days were estimated whereas for Non-Dairy Cattle calves and all other cattle 297 and 271 days were assumed, respectively. The reason for the higher values is the low proportion of grazing in Hungary. For the remaining input data as well as for the emission factors, standards and default values provided in the EMEP/EEA Guidebook (EEA, 2019) were applied. In the calculation all liquid/slurry was assumed to be stored as a conservative approach. In the Hungarian inventory 'solid' manure covers solid manure and deep litter in line with the definitions of these manure management systems in the 2006 IPCC Guidelines. According to the regulation of nitrate pollution prevention in Hungary, construction of a manure storage is not necessary in case of deep litter barn, because the manure is composted in the barn and it is applied to the soils, directly. Therefore, in the case of deep litter no storage was assumed.

The 2019 EMEP/EEA Guidebook differentiate between tied and loose housing for Dairy Cattle which were taken into account in the emission estimate as well.

Further abatement of emissions was not taken into account due to lack of data. However, abatement measures are required for IPPC (Integrated Pollution Prevention and Control) Farms in Hungary. The EU's IPPC directive came into force in 2001 in Hungary.

The resulted emission factors are shown in Table 5.26 and Table 5.27.

Table 5.26 NH_3 emission factors for Cattle, 2018

Subcategories	Emission Factors for NH_3 from Cattle		
	3B Manure Management	3Da2a Animal manure applied to soils/	3Da3 Grazing animals
	EF_{NH3} (kg NH_3*a^{-1}·AAP^{-1})		
Dairy Cattle	26.49	14.34	2.59
Non-Dairy Cattle, Calves	8.42	4.16	2.53
Non-Dairy Cattle, all other cattle	12.91	6.51	1.62

Table 5.27 NH_3 emission factors for Sheep, Swine, Laying hens and Broilers 2018

Subcategories	Emission Factors for NH_3 from Swine		
	3B3 Manure Management	3Da2a Animal manure applied to soils	3Da3 Urine and dung deposited by grazing animals
	EF_{NH3} (kg NH_3*a^{-1}*AAP^{-1})		
Sheep	1.63	0.83	0.55
Swine (finishing pigs)	3.19	0.90	0.00
Swine (sows)	5.32	1.25	0.00
Laying hens	0.17	0.14	0.00
Broilers	0.21	0.05	0.00

Sheep

The Tier 1 emission factor for Sheep assumes a 30-day long housing period according to the Table 3.7 of the 2019 EMEP/EEA Emission Inventory Guidebook. In Hungary the length of the housing period is significantly longer, 135 days in a year. Thus, an adjustment was made to the Tier 1 emission factor, using the Manure Management N-flow tool. In the Excel spreadsheet, the housing period was replaced by the country-specific value, and the default values were used for the other parameters. This correction resulted in a value of 1.63 kg NH_3 a^{-1} AAP^{-1} for the emission factor for 3B, Housing, Storage and Yard.

Other livestock (Laying hens and Broilers excluded)

This section covers the 3B4a Buffalo, 3B4d Goats, 3B4e Horses, 3B4f Mules and asses, 3B4giii Turkeys, 3B4giv Other poultry and 3B4h Other animals (Rabbits) NFR categories. Emission factors were taken from Table 3.2 of the EMEP/EEA Guidebook (EEA, 2019), using a Tier 1 methodology. The EMEP/EEA Guidebook (EEA, 2019) does not provide emission factor for Rabbits; therefore, the emission factor published in Italy's IIR, 2014 was applied.

5.3.3 NO_X

Manure management is an insignificant source of NO_x emissions. In 2018, about 1% of the national total NO_x emissions generated in the Manure management. The main determinant of the downward trend in NO_x emissions is the decreasing animal livestock.

5.3.3.1 METHODOLOGICAL ISSUES

Emissions were calculated using the Tier 1 methodology provided in the EMEP/EEA Guidebook (EEA, 2019).

5.3.3.2 ACTIVITY DATA

See chapter 5.3.1.

5.3.3.3 EMISSION FACTORS

Emission factors were taken from the Table 3.3 of the EMEP/EEA Guidebook (EEA, 2019), using a Tier 1 methodology in line with the manure type. Two housing types was distinguished for Cattle liquid (slurry-based) and solid-manure-based housing. For swine three housing types were taken into account, namely liquid (slurry-based), solid-manure-based housing and outdoor (yard). The characteristic manure type for each animal livestock was determined according to the Hungarian manure management system usage data, as it is outlined in Section 5.3.2.1.

5.3.4 NMVOC

The main source of agricultural NMVOC emissions is the Cattle husbandry. In 2018, 21.9% of the national total NMVOC emissions related to the manure management and 66% of the emission from manure management generated in the Cattle husbandry.

5.3.4.1 METHODOLOGICAL ISSUES

Following the recommendation from the previous NECD Review, 2017 Tier 2 technology-specific approaches in EMEP/EEA Guidebook (EEA, 2019), were used for NFR categories 3B1a Dairy Cattle, 3B1a Non-dairy Cattle and 3B4giv Other poultry, and the Tier 1 methodology was applied for the 'remaining' livestock categories.

5.3.4.2 ACTIVITY DATA

See chapter 5.3.1.

5.3.4.1 EMISSION FACTORS

Cattle

NMVOC emissions from Cattle (3B1) are estimated using Tier 2 emission factors, calculated in accordance with the Equations 48-54 of the 2019 EMEP/EEA Guidebook. Estimates are made for silage stores, silage feeding, livestock housing, manure storage and application. The EMEP methodology for Cattle is based on feed intake, for which country-specific values taken from Hungary's GHG emission inventory was applied. Data used for UNFCCC reporting was multiplied by 365 to obtain feed intake in MJ per year.

Proportions of time cattle spend in the animal house in a year (x_{house}) are the same as those used to estimate the Tier 2 emission factors for NH_3 emissions.

$Frac_{silage}$ was calculated from the fraction of silage in the dry matter during housing divided by the maximum proportion of silage possible in the feed composition. Data on silage content in feed rations by sub-categories were taken from the GHG inventory. The maximum proportions of silage in feed rations are also used in the GHG-inventory for quality check. These values were calculated using the following assumptions: according to the Hungarian animal feeding practices, the maximum proportion of silage in feed rations of cattle depends on the quality, dry matter and acidic acid content of the silage. Based on the acidic acid content of silage used in Hungary for cattle feeding and the acidic acid tolerance of the Hungarian cattle species the maximum amount of the silage was assumed to be about 55g good quality (maze) silage per body weight per day for Dairy cattle. In the case of Non-dairy Cattle, an average of 35g silage per body weight per day was assumed as the maximum.

For $Frac_{silage\_store}$ the default value of 0.25 from the 2019 EMEP/EEA Guidebook was used for all sub-categories.

Emission factors ($EF_{NMVOC\_silage\_feeding}$, $EF_{NMVOC\_building}$, EF_{NMVOC_graz}) were based on the defaults provided in the Table 3.11 of the 2019 EMEP/EEA Guidebook.

Parameters used to estimate NMVOC emissions from Dairy cattle and Non-dairy cattle are shown in Table 5.28 and Table 5.29, respectively.

Table 5.28 Parameters used to estimate NMVOC emissions from manure management of Dairy Cattle

Year	Feed intake	X_{house}	$Frac_{silage}$	$E_{NMVOC, sillage\_store}$	$E_{NMVOC, sillage\_feeding}$	$E_{NMVOC, house}$	$E_{NMVOC, manure\_store}$	$E_{NMVOC, appl}$	$E_{NMVOC, graz}$
	MJ yr^{-1} $head^{-1}$	%	%	kg yr^{-1} $head^{-1}$					
1990	92998	0.89	0.64	2.64	10.55	2.92	7.53	6.07	0.07
1991	89748	0.89	0.62	2.46	9.83	2.81	7.21	5.82	0.07
1992	89647	0.88	0.61	2.44	9.74	2.80	7.21	5.84	0.07
1993	89088	0.88	0.61	2.41	9.63	2.78	7.17	5.80	0.07
1994	88685	0.88	0.61	2.38	9.53	2.76	7.13	5.78	0.07
1995	90300	0.88	0.59	2.35	9.39	2.80	7.44	6.03	0.07
1996	90937	0.88	0.59	2.36	9.42	2.82	7.51	6.09	0.08

Year	Feed intake	X_{house}	$Frac_{silage}$	$E_{NMVOC, sillage\_store}$	$E_{NMVOC, sillage\_feeding}$	$E_{NMVOC, house}$	$E_{NMVOC, manure\_store}$	$E_{NMVOC, appl}$	$E_{NMVOC, graz}$
	$MJ\ yr^{-1}\ head^{-1}$	%	%			$kg\ yr^{-1}\ head^{-1}$			
1997	91294	0.88	0.59	2.35	9.40	2.83	7.55	6.13	0.08
1998	93931	0.88	0.58	2.40	9.60	2.91	7.87	6.38	0.08
1999	93980	0.88	0.58	2.40	9.59	2.91	7.86	6.39	0.08
2000	96271	0.88	0.58	2.45	9.81	2.98	8.13	6.60	0.08
2001	97536	0.88	0.58	2.48	9.94	3.01	8.19	6.69	0.08
2002	98665	0.87	0.58	2.51	10.04	3.05	8.23	6.74	0.09
2003	98749	0.87	0.58	2.51	10.03	3.04	8.18	6.71	0.09
2004	98847	0.87	0.57	2.47	9.90	3.05	8.17	6.71	0.09
2005	100151	0.87	0.57	2.50	9.99	3.09	8.26	6.79	0.09
2006	102653	0.87	0.57	2.55	10.21	3.16	8.45	6.94	0.09
2007	104255	0.87	0.57	2.58	10.32	3.21	8.53	7.01	0.09
2008	105370	0.87	0.56	2.59	10.37	3.25	8.56	7.04	0.09
2009	104794	0.87	0.56	2.55	10.21	3.23	8.41	6.91	0.09
2010	105063	0.87	0.55	2.54	10.16	3.24	8.36	6.86	0.09
2011	105342	0.87	0.55	2.53	10.12	3.25	8.29	6.80	0.09
2012	107652	0.87	0.55	2.58	10.30	3.32	8.43	6.90	0.09
2013	107812	0.87	0.54	2.57	10.27	3.32	8.37	6.84	0.09
2014	109476	0.87	0.54	2.60	10.40	3.38	8.33	6.84	0.10
2015	111902	0.87	0.54	2.65	10.61	3.45	8.35	6.88	0.10
2016	112986	0.87	0.54	2.67	10.67	3.49	8.23	6.85	0.10
2017	114625	0.87	0.53	2.66	10.63	3.54	8.38	6.87	0.10
2018	115600	0.87	0.62	3.13	12.50	3.57	8.38	6.78	0.10

Table 5.29 Parameters used to estimate NMVOC emissions from manure management of Non-Dairy cattle, 2018

Parameters	Unit	Cattle <1 year		Cattle 1-2 year		Cattle> 2 year			
		male	female	male	female	male	heifer for slaughter	other heifers	Cows, beef
Feed intake	$MJ\ yr^{-1}\ head^{-1}$	34369	34296	58795	59443	72531	69584	70156	58984
X_{house}	%	0.81	0.81	0.80	0.79	0.72	0.72	0.72	0.58
$Frac_{silage}$	%	0.80	0.83	0.73	0.70	0.70	0.77	0.75	0.69
$E_{NMVOC, sillage\_store}$	$kg\ yr^{-1}\ head^{-1}$	1.12	1.16	1.72	1.64	1.81	1.91	1.89	1.18
$E_{NMVOC, sillage\_feeding}$	$kg\ yr^{-1}\ head^{-1}$	4.49	4.62	6.87	6.57	7.22	7.64	7.56	4.70
$E_{NMVOC, house}$	$kg\ yr^{-1}\ head^{-1}$	0.99	0.99	1.67	1.65	1.83	1.76	1.77	1.21
$E_{NMVOC, manure\_store}$	$kg\ yr^{-1}\ head^{-1}$	2.73	2.73	5.21	5.15	5.72	5.49	5.53	3.78
$E_{NMVOC, appl}$	$kg\ yr^{-1}\ head^{-1}$	2.17	2.16	4.07	4.02	4.47	4.29	4.32	2.95

$E_{NMVOC, graz}$	kg yr^{-1} head^{-1}	0.04	0.04	0.08	0.09	0.14	0.14	0.14	0.17

Other poultry

Tier 2 approach for other animals slightly differs from the methodology for cattle. It is based on the volatile solid excretion rate (VS) instead of gross energy intake. Equations of Tier 2 approach require preferably country-specific values of VS. NFR category 3B4giv Other poultry covers geese, ducks and guinea fowls, in Hungary. These livestock species share of agricultural total emissions is rather low in the air pollutant- as well as the GHG-inventory, therefore country-specific values are not available. Therefore, default values of VS from Table 10A-9 of the 2006 IPCC Guidelines were used to calculate the tier 2 emission factors. VS and NMVOC Tier 2 EFs for Geese and Guinea Fowls, since IPCC default values are not available, were taken as values provided for Ducks and Broilers, respectively. IPCC default values of VS were multiplied by 365 to get kg per year values.

Table 5.30 summarizes parameters used in the equations 55-60 of the EMEP/EEA Guidebook (EEA, 2019) to calculate NMVOC emissions from Other poultry.

Table 5.30 Parameters used to estimate NMVOC emissions from 3B4giv Manure management of Other poultry

Parameters	Unit	Ducks	Geese	Guinea Fowls	Source
X_{house}		1	1	1	Based on defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
VS	kg yr^{-1} head^{-1}	7.3	7.3	3.65	Based on Table 10A-9 of the 2006 IPCC Guidelines. Geese as Ducks and Guinea Fowls as Broilers due to lack of information
$Frac_{silage}$		0	0	0	silage is not used for poultry feeding
$E_{NH3storage}$	kg NH_3-N (kg TAN)$^{-1}$	0.24	0.57	0.17	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
$E_{NH3building}$	kg NH_3-N (kg TAN)$^{-1}$	0.24	0.16	0.28	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
$E_{NH3appl}$	kg NH_3-N (kg TAN)$^{-1}$	0.54	0.45	0.66	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
$EF_{NMVOC, silage feed}$	kg NMVOC (kg VS excreted)$^{-1}$	0	0	0	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
$EF_{NMVOC, building}$	kg NMVOC (kg VS excreted)$^{-1}$	0.0057	0.0057	0.009	Defaults from Table 3.12 of 2016 EMEP/EEA Guidebook
$EF_{NMVOC, Grazing}$	kg NMVOC (kg VS excreted)$^{-1}$	0	0	0	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook

Other animals (Swine, Buffalo, Goats, Horses, Laying hens, Broilers, Turkeys, Rabbit)

NMVOC emissions from 3B Manure management of other animals than Cattle and Other poultry were calculated using the Tier 1 approach and default emission factors outlined in the EMEP/EEA Guidebook (EEA, 2019). The EMEP methodology distinguishes emission factors 'with silage feeding' from values 'without silage feeding'. To get the most reliable emission estimate, emission factors used in the Hungarian inventory were calculated from default values weighted by the length of the 'silage feeding' and 'without silage feeding'. The assumed length of 'with' and 'without silage feeding' for sheep and goats were estimated as 145 and 220 day, for the remaining livestock species silage feeding was not assumed. The resulted emission factors are shown in Table 5.31.

Table 5.31 *Implied Tier 1 emission factors for NMVOC emissions from 3B Manure management*

NFR category	Livestock	Emission Factor [kg NMVOC/ head]
3B3	Fattening pigs	0.55
3B3	Sows	1.70
3B2	Sheep	0.21
3B4e	Horses	5.67
3B4gi	Laying hens	0.17
3B4gii	Broilers	0.11
3B4giii	Turkeys	0.49
3B4h	Rabbit	0.06
3B4d	Goats	0.57
3B4f	Mules and asses	2.08
3B4a	Buffalo	6.24

5.3.5 PARTICULATE MATTER ($PM_{2.5}$, PM_{10}, TSP)

In 2018 manure management contributed 8.5% to the national total PM emissions given as TSP. 57.0% of the sectorial emissions relates to the poultry production. The second largest contributors are pigs with its 34.2% share of PM emissions from 3B.

5.3.5.1 METHODOLOGICAL ISSUES

Emission estimation is based on the Tier 1 methodology of the EMEP/EEA Guidebook (EEA, 2019).

5.3.5.2 ACTIVITY DATA

See chapter 5.3.1

5.3.5.3 EMISSION FACTORS

$PM_{2.5}$, PM_{10} and TSP emission factors were taken from the Table 3.5 of the EMEP/EEA Guidebook (EEA, 2019), using the default emission factors of the Tier 1 methodology. Particulate matter emissions from rabbit are not reported, because there no emission factor provided in the EMEP/EEA Guidebook (EEA, 2019).

5.4 NFR 3D AGRICULTURAL SOILS

NFR sector 3D contains NH_3 and NO_x 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 Farm-level agricultural operations including storage, handling and transport of agricultural products (3Dc) and Crop production (3De). Following a recommendation from the NECD Review 2019, HCB emissions from 3Df Use of pesticide have been reported for the first time in this submission.

5.4.1 METHODOLOGY

Emissions for 3D are estimated in accordance with the EMEP/EEA Guidebook (EEA, 2019). NH_3 emissions from 3Da1 Inorganic N-fertilizer, Cattle, Swine, Laying hens, Broiler and Sheep manure applied to soils for NFR category 3Da2a and Cattle and Sheep urine and dung deposited during grazing for NFR category 3Da3 are estimated using Tier 2 methodology, whereas Tier 1 methodologies are applied for the remaining emissions, where data limitations dictate the use of the simpler methodologies.

NMVOC emissions from 3Da2a Animal manure applied to soils and 3Da3 Urine and dung deposited during grazing for Cattle are estimated using Tier 2 approach, but these emissions are reported under subcategories 3B1a, 3B1b similarly to the other livestock categories, for which Tier 1 approach is applied.

5.4.2 ACTIVITY DATA

Activity data required for the estimations are available from the HCSO's and the Research Institute of Agricultural Economics annual statistics. While activity data on use of pesticide are provided by the Directorate of Plant Protection, Soil Conservation and Agri-environment of the NFCSO (hereafter Directorate).

5.4.3 EMISSION FACTORS

Technology specific emission factors are used for the NH_3 emissions, while default emission factors for the other sources and air pollutants.

5.4.4 NFR 3DA1 INORGANIC N-FERTILIZERS

NH_3 and NO_x emissions are estimated from this source. Ammonia emissions from synthetic fertilizer use are a key source in Hungary, about 24.2% of the national total ammonia emissions derive from inorganic fertilizers. Emissions of NO_x from 3Da1 are a main source of agricultural NO_x emissions, contributing to 73.0% of agricultural NO_x emissions.

NH_3 emissions have decreased since 1990, because of the significant drop in N-fertilizer, in particular urea use in 1991. Proportion of urea in fertilizer N decreased from about 30% at the beginning of the timeseries to the current level of 8%. NO_x emissions after the significant drop in the early 90's started to increase, and due to the continuous increase in the N-content of the synthetic fertilizer applied in the recent years, NO_x emissions have exceeded the level seen in 1990 (Figure 5.5).

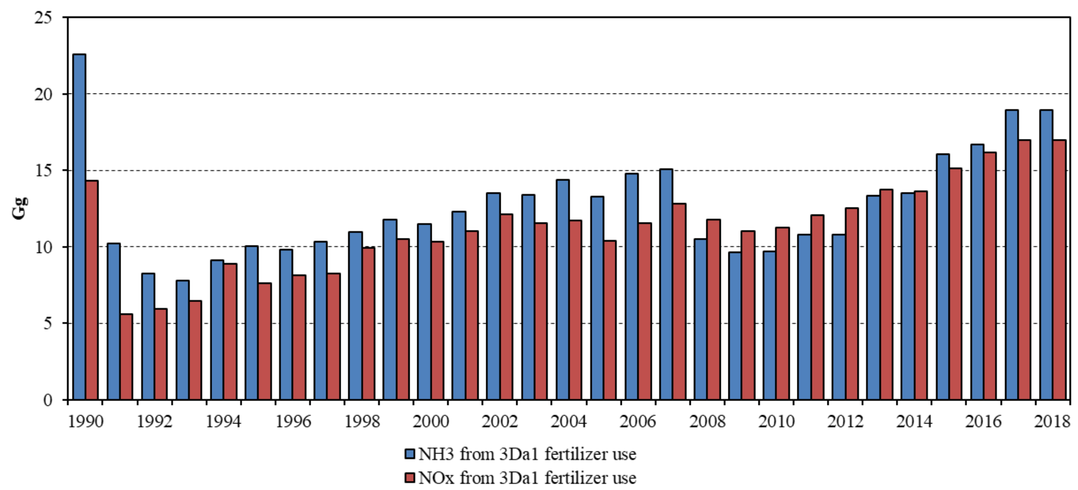


Figure 5.5 NH_3 and NO_x emissions from inorganic N-fertilizers, 1990-2018

5.4.4.1 METHODOLOGICAL ISSUES

The Tier 2 methodology provided in the EMEP/EEA Guidebook (EEA, 2019) is applied to estimate NH_3 emissions from inorganic fertilizers. Thus, emissions were estimated based on the N content of fertilizers by main types, climate zones and soil pH, whereas calculation of NO_x emissions is based on the total amount of N in synthetic fertilizers consumption, according to the Tier 1 methodology.

5.4.4.2 ACTIVITY DATA

Data on mass of fertilizer type consumed nationally was derived from sales statistics by product lines. Annual synthetic fertilizer consumption data by so detailed manner as it is required to the emission estimate is not available for Hungary. Amounts of sold fertilizer are reported quarterly, and annually by the Research Institute of Agricultural Economics. The data collection is executed in the frame of the National Statistical Data Collection Program (OSAP). The HCSO publishes only the total amount of inorganic N-fertilizers, based on this data collection.

Mass of fertilizer type *i* consumed nationally, which is required to the emission estimate, was determined from the amount and the N-content of sold fertilizer products. In the case of mixed fertilizers, the N-content was taken into account according to the proportion of the individual fertilizer components. (E.g. 'DASA' is a mixture of ammonium sulphate and ammonium nitrate; hence, the total N-content of this fertilizer was disaggregated into ammonium sulphate and ammonium nitrate according to the proportion of the two compounds.)

The 2019 EMEP/EEA Guidebook requires data on mass of fertilizer by type as well as by region. In Hungary further disaggregation of mass of fertilizer type is not applicable.

Table 5.32 shows the amount of Urea N and 'Other fertilizer-N' applied for the period 1990-2018. Although, fertilizer N data are available disaggregated by fertilizer types for the emission estimate, here is published aggregated, because of data confidentiality. (According to the Hungarian Statistical Law (Act No. CLV of 2016) data is considered to be confidential if it was derived from data of less than three data suppliers. This is the case of Anhydrous ammonia; therefore, all non-Urea fertilizers are published aggregated here.)

Table 5.32 Trends in nitrogen fertilizer application 1990-2018

Year	1'000 t N		
	Urea N	Other Fertilizer N	Total N-content
1990	103	255	358
1991	48	92	140
1992	34	114	148
1993	29	132	161
1994	28	194	222
1995	28	163	191
1996	27	176	203
1997	28	178	206
1998	30	218	248
1999	31	231	262
2000	30	273	303
2001	32	243	275
2002	35	268	303
2003	40	249	289
2004	48	245	293
2005	47	213	260
2006	52	237	289
2007	48	272	320
2008	14	280	294
2009	14	261	275
2010	20	261	281
2011	24	277	302
2012	20	293	313
2013	31	312	343

Year	1'000 t N		
	Urea N	Other Fertilizer N	Total N-content
2014	25	316	341
2015	35	343	378
2016	35	369	404
2017	42	383	424
2018	36	389	424
Trend 1990-2018	**-65%**	**52%**	**19%**
Trend 2005-2018	**-24%**	**82%**	**63%**

Both the total amount of fertilizer N and the types of the fertilizer applied has changed significantly over the period 1990-2018 affecting a considerable fall in the NH_3 emissions. The most marked change is the sudden drop of Urea use in 1991 and 2008 (Table 5.32). At the same time, the use of the Calcium ammonium nitrate (CAN) and the Nitrogen solution fertilizer has increased gradually over the time-series, but the CAN fertilizers are not a significant source of ammonium emissions having the lowest emission factor among the fertilizers, while the amount of Nitrogen solution fertilizer remained at a low level despite the increase.

5.4.4.3 EMISSION FACTORS

NH_3

For the calculation of NH_3 emissions from synthetic fertilizers country-specific emission factors were applied. Method provided in the 2019 EMEP/EEA Inventory Guidebook gives specific NH_3 emission factors for different types of synthetic fertilizers depending on the climate and soil acidity. To summarize, NH_3 emissions can be calculated by means of the following equation:

$$E_{fert_{NH3}} = \sum_{i=1} \sum_{j=1} m_{fert_{i,j}} \circ EF_{i,j}$$

Where:

$E_{fertNH3}$= NH_3 emission from fertilization (kg a^{-1} NH_3)

m_{fert_i}= mass of fertilizer type i consumed nationally (kg a^{-1} N)

$EF_{i=EF}$ for fertilizer type i in region j (kg NH_3 (kg N)$^{-1}$)

Definitions of climate zones of the 2019 EMEP/EEA Guidebook are the same as those of 2006 IPCC Guidelines. According to the Guidebook, cool climate zone has an annual mean temperature below 15°C. The annual mean temperature in most parts of Hungary is between 10 and 11 °C, therefore, the emission factors given for cool climate zone were applied for the whole country.

Proportion of soil with normal pH and high pH was determined based on the most up-to-date high resolution (250 m) soils map (Tóth, G. et al., 2015), shown in Figure 5.6. 41% of the areas as identified from the soil map was allocated to the normal soil pH (pH≤7), and 59% to the high pH (pH >7).

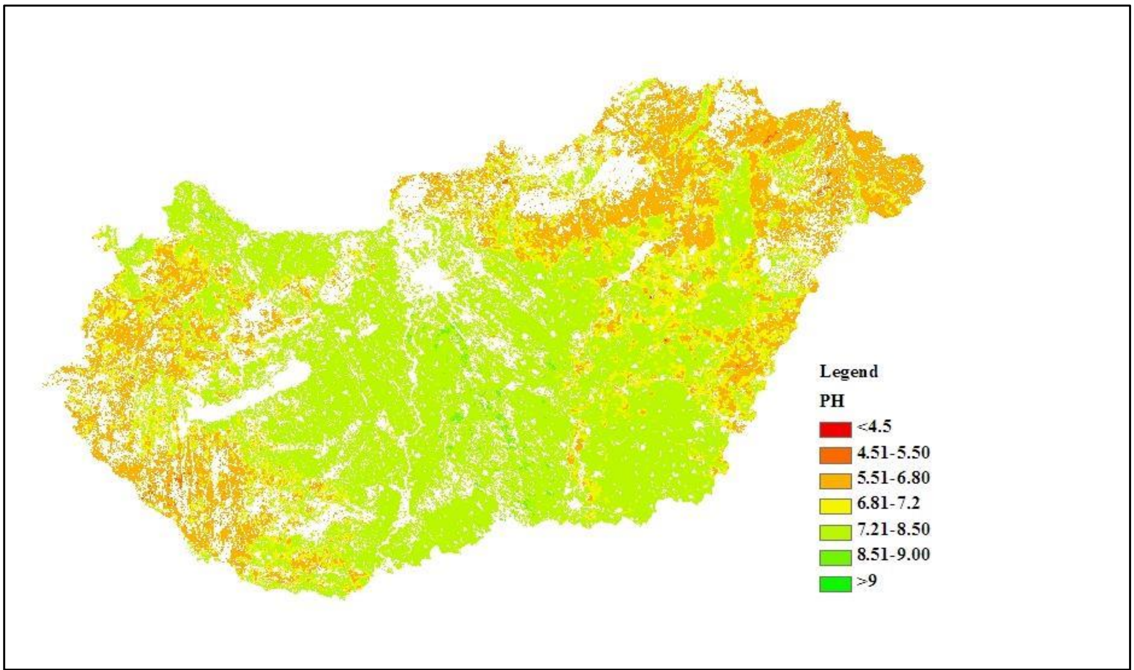


Figure 5.6 Soil acidity in Hungary

Emission factors provided by soil pH in the 2019 EMEP/EEA Guidebook were weighted by the resulted proportions and weighted national average emission factors, given in Table 5.33, were calculated for each fertilizer types.

Table 5.33 Emission factors for NH_3 emissions from 3Da1

Fertilizers	IEFs by soil pH [kg NH_3 kg^{-1} N]
Ammonium nitrate	0.025
Anhydrous ammonia	0.028
Ammonium phosphate, NP	0.074
Ammonium sulphate	0.134
Calcium ammonium nitrate	0.013
Other straight N compounds (Calcium nitrate)	0.015

Nitrogen solutions	0.096
Urea	0.160
NK mixtures	0.025
NPK mixtures	0.074
Implied EF (2018)	**0.045**

NO_x

The Tier 1 methodology of the EMEP/EEA Guidebook (EEA, 2019) and the default emission factors provided in Table 3.1 of the Guidebook was applied.

5.4.5 NFR 3Da2a ANIMAL MANURE APPLIED TO SOILS

NH_3

Default NH_3 emission factors of the 2019 EMEP/EEA Guidebook for spreading of slurry and solid manure were applied in proportion of total ammoniacal nitrogen (TAN) as shown in Table 5.34.

Table 5.34 Emission factors for NH_3 emissions from animal manure application

Livestock	Manure type	proportion of TAN	EF spreading [kg NH3-N (kg TAN)$^{-1}$]
Cattle	slurry	0.6	0.55
	solid		0.68
Fattening pigs	slurry	0.7	0.4
	solid		0.45
Sows	slurry	0.7	0.29
	solid		0.45
Sheep	solid	0.5	0.9
Horses, Mules and Asses	solid	0.6	0.9
Laying hens	solid/ slurry	0.7	0.69
Broilers	solid	0.7	0.38
Turkey	solid	0.7	0.54
Ducks	solid	0.7	0.54
Geese	solid	0.7	0.45

Cattle, Swine, Sheep, Laying hens and Broiler

NH_3 emissions were calculated using the Manure Management N-flow tool provided to the EMEP/EEA Guidebook (EEA, 2019), similarly, to the calculation of emissions from housing, storage and yards. For more details and the resulted emission factors see Section 5.3.2.

Application technologies – cattle and swine

Effects of different liquid manure spreading technologies have been reported for the first time in the agricultural inventory. Hungary started a regular data collection on liquid manure spreading technologies in 2016. Spread of the different liquid manure spreading technologies for the year 2018 are shown in Table 5.35 based on the servey data.

Table 5.35 Spread of manure application technologies, Cattle and Swine liquid manure, 2018

Application technology	Cattle	Swine
Band spreading with trailing hose	24%	15%
Broadcast application, with no incorporation (reference)	21%	13%
Incorporation of surface applied slurry, immediately	15%	13%
Incorporation of surface applied slurry, within 24 hours	22%	27%
Injection, deep	10%	15%
Injection, shallow	6%	16%
Band spreading with trailing shoe	2%	2%

The first regulation on fertilizer application was issued in 2001. Therefore, for the period 1990-2001 the broadcast application not followed by incorporation was assumed, exclusively; while for the period 2001-2015 interpolation was applied for gap filling. Data on the abatement efficiency was taken from the Ammonia Guidance Document, 2014. Timeseries of capacities controlled and abatement efficiency for application of cattle and swine liquid manure are shown in Table 5.36.

Table 5.36 Capacities controlled and abatement efficiency for Cattle and Swine liquid manure spreading technologies

Year	Spread of NH_3 abatement technologies		Efficiency (weighted average)	
	Swine	Cattle	Swine	Cattle
2001	0%	0%	43%	35%
2002	6%	5%	43%	35%
2003	11%	10%	43%	35%
2004	17%	15%	43%	35%
2005	23%	20%	43%	35%
2006	29%	25%	43%	35%
2007	34%	30%	43%	35%
2008	40%	36%	43%	35%
2009	46%	41%	43%	35%
2010	51%	46%	43%	35%

Year	Spread of NH_3 abatement technologies		Efficiency (weighted average)	
	Swine	Cattle	Swine	Cattle
2011	57%	51%	43%	35%
2012	63%	56%	43%	35%
2013	69%	61%	43%	35%
2014	74%	66%	43%	35%
2015	80%	71%	43%	35%
2016	80%	71%	43%	35%
2017	83%	73%	43%	40%
2018	87%	79%	50%	41%

Other animals (Buffalo, Goats, Horses, Turkey, Other Poultry, Rabbit)

Tier 1 method, and default emission factors given in Table 3.2 were applied to calculate NH_3 emissions from 3Da2a Animal manure application.

The EMEP/EEA Guidebook (EEA, 2019) does not provide emission factor for Rabbits; hence, the emission factor (0.54 kg $NH_3 \cdot a^{-1} \cdot AAP^{-1}$) published in Italy's IIR, 2014 was applied.

NO_x

As the Tier 1 default emission factors for NO_x emissions contain the emissions from manure application, all of the NO_x emissions are reported under the 3B Manure Management sector. The Tier 1 EFs assume that all manure is stored before application according to the Guidebook.

Activity data applied for animal manure application are available under Chapter 5.3.

5.4.6 NFR 3DA2B SEWAGE SLUDGE APPLIED TO SOILS

Under sector 3Da2b NH_3 and NO_x emissions from sewage sludge application are estimated. Emissions of NH_3 and NO_x from sewage sludge applied to soils contributed less than 1% to the emissions from agricultural soils in 2018 (Figure 5.1).

5.4.6.1 METHODOLOGY

The N content of sewage sludge was multiplied with the value of 0.13 kg NH_3 (kg N applied)$^{-1}$ given on Table 3.1 of the 2019 EMEP/EEA Guidebook to calculate the NH_3 emissions. While a value of 0.04 kg NO_2 (kg N applied)$^{-1}$ provided in Table 3.1 of the 2019 EMEP/EEA Guidebook was applied to calculate NO_2 emissions.

5.4.6.2 ACTIVITY DATA

Data on annual amount of total sewage N that is applied to agricultural soils has been available in the Urban Wastewater Information System (UWIS) since 2011. For the period 1994-2010 data were taken from the EUROSTAT statistics. The EUROSTAT provides data on sewage sludge disposal for agricultural use, but these statistics also contains the sewage sludge disposal for recultivation. 40% of the reported disposed sewage sludge based on expert judgment was assumed to be applied on agricultural lands and the remaining 60% for recultivation. Activity data was extrapolated for the period 1990-1994. The N-content of sewage sludge was assumed to be 4.2% in line with the measured data provided by the NFCSO. The resulted activity data for the period 1990-2018 are shown in Table 5.37.

Table 5.37 Activity data to estimate emissions from 3Da2d Sewage sludge applied to soils

Year	Sewage	
	sludge [1’000 t]	N [1’000 t]
1990	4.71	0.20
1991	5.59	0.23
1992	6.47	0.27
1993	7.35	0.31
1994	10.00	0.42
1995	13.36	0.56
1996	12.44	0.52
1997	10.32	0.43
1998	12.52	0.53
1999	9.84	0.41
2000	10.84	0.46
2001	10.56	0.44
2002	11.80	0.50
2003	11.52	0.48
2004	13.28	0.56
2005	22.40	0.94
2006	21.20	0.89
2007	20.16	0.85
2008	24.72	1.04
2009	25.36	1.07
2010	22.72	0.95
2011	20.27	0.85
2012	18.50	0.78
2013	13.55	0.57
2014	15.07	0.63
2015	14.24	0.60
2016	17.69	0.74
2017	15.69	0.66
2018	16.35	0.69

5.4.6.3 EMISSION FACTORS

The value of 0.13 kg NH_3 (kg N applied)$^{-1}$ given in Table 3.1 of the 2019 EMEP/EEA Guidebook was applied to calculate the NH_3 emissions. While a value of 0.04 kg NO_2 (kg N applied)$^{-1}$ provided in Table 3.1 of the 2019 EMEP/EEA Guidebook was used to calculate NO_x emissions.

5.4.7 NFR 3Da2c OTHER ORGANIC FERTILIZERS APPLIED TO SOILS (INCLUDING COMPOST)

Under sector 3Da2c NH_3 and NO_x emissions from compost application are estimated. Emissions of NH_3 and NO_x from compost applied to soils contributed about 1% to the emissions from agricultural soils in 2018 (Figure 5.1).

5.4.7.1 METHODOLOGY

The Tier 1 methodology of the 2019 EMEP/EEA Guidebook was applied. The N content of compost was multiplied with the default emission factors.

5.4.7.2 ACTIVITY DATA

In this category N content of the composted waste is reported because of the lack of published data on compost applied to agricultural soils (i.e. all compost is assumed to be applied on soils). Activity data was taken from the 5B sector. N content of the composted municipal waste and composted sewage sludge was calculated, using the IPCC default parameters on moisture content and N in dry matter given in Table 4.1 of the 2006 IPCC Guidelines.

The resulted activity data for the period 1985-2018 are provided in Table 5.38.

Table 5.38 Activity data to estimate emissions from 3.D.a.2.c Other organic fertilizers applied to soils (including compost)

Year	Compost		N 1'000t
	municipal waste [1'000t d.m.]	sewage sludge [1'000t d.m.]	
1990	NO	20.00	0.40
1991	NO	20.00	0.40
1992	NO	20.00	0.40
1993	NO	20.00	0.40
1994	NO	20.00	0.40
1995	NO	28.00	0.56
1996	7.20	29.00	0.72
1997	7.60	26.00	0.67
1998	7.20	23.00	0.60
1999	7.20	32.00	0.78

Year	Compost		
	municipal waste [1'000t d.m.]	sewage sludge [1'000t d.m.]	N 1'000t
2000	6.80	30.00	0.74
2001	6.80	27.00	0.68
2002	18.80	37.00	1.12
2003	18.80	56.00	1.50
2004	15.60	23.95	0.79
2005	16.40	52.62	1.38
2006	23.20	42.95	1.32
2007	25.60	51.14	1.53
2008	34.00	61.79	1.92
2009	36.00	89.97	2.52
2010	59.20	82.23	2.83
2011	73.20	81.37	3.09
2012	73.15	90.18	3.27
2013	74.93	93.26	3.36
2014	94.43	97.25	3.83
2015	92.24	99.32	3.83
2016	117.59	101.81	4.39
2017	123.65	102.59	4.52
2018	124.18	98.57	4.46

5.4.7.3 EMISSION FACTORS

The emission factors for NH_3 and NO_x emission from compost applied to soil was taken from the Table 3.1 of the EMEP/EEA Guidebook (EEA, 2019).

5.4.8 NFR 3Da3 URINE AND DUNG DEPOSITED BY GRAZING ANIMALS

For the sector, urine and dung deposited by grazing animals the emissions of NH_3 and NO_x are estimated. In accordance with the recommendation from the 2018 review under NECD emissions of NO_x have been reported separately for 3Da2a and 3Da3a categories.

Emissions of NH_3 from urine and dung deposited by grazing animals contributed in 2018 with 2.7% of the NH_3 emissions from the agriculture sector. Emissions of NO_x from urine and dung deposited by grazing animals contributed in 2018 with 3.2% of the NO_x emissions from the agriculture sector.

5.4.8.1 METHODOLOGY

Emission of urine and dung deposited by grazing animals is based on N excreted by animals, length of grazing period and the emission factor.

NH_3 emission factors from Cattle and Sheep

Default emission factors of the 2019 EMEP/EEA Guidebook for emissions from grazed pastures were applied in proportion of total ammoniacal nitrogen (TAN) to calculate NH_3 emissions, as shown in Table 5.29. N-excretion values and the length of housing period, which is the basis to calculate the share of N excreted on pastures, are available in Chapter 5.3.

Table 5.39 Emission factors for NH_3 emissions from animal manure application

Livestock	proportion of TAN	EF [kg NH3-N kg TAN)$^{-1}$]
Cattle	0.6	0.14
Sheep	0.5	0.09

NH_3 emission factors for other animals than Cattle and Sheep

The emission factors for NH_3 are based on default values provided in the Table 3.2 of the 2019 EMEP/EEA Guidebook.

NO_x emission factors

The emission factor for NO_x is based on the 2019 EMEP/EEA Guidebook, 0.04 kg NO_2 per N applied.

5.4.8.2 Activity Data

The activity data are number of animals (see section 5.3.1.1), N excreted by animals and the length of grazing period, which combined gives the amount of N deposited on pastures.

5.4.9 NFR 3Dc FARM-LEVEL AGRICULTURAL OPERATIONS INCLUDING STORAGE, HANDLING AND TRANSPORT OF AGRICULTURAL PRODUCTS

PM emissions from field operations during the usage of machines on agricultural soils are reported here.

Emissions from field operations contributed to national total PM10 emissions with 10.4% share of national total in 2018. While PM2.5, TSP is lesser determinant of national total emissions with contributions of 0.6% and 7.0%, respectively.

PM emissions given in TSP have increased by 11.9% from 2000 to 2018, due to the increase in the area of cultivated crops *(Figure 5.2).*

5.4.9.1 ACTIVITY DATA

Area covered by crops, derives from the HCSO's annual statistics for 'sown area of main crops'. Data on 'sown area of main crops' contains temporary grasslands, areas of greenhouses and plastic tunnels, nursery gardens, fallow lands and areas of extinct plants. Therefore, this data cannot be used directly as activity data in the air pollutant inventory. Areas listed above were subtracted from the total 'sown area of main crops' to get the required activity data. Table 5.40 shows the estimation of the activity data from the HCSO's statistics for 2018.

Table 5.40 Estimation of area covered by crops for 2018

Sown areas	***Areas [ha]***
Total sown area of main crops	4,317,689
Greenhouse and plastic tunnels	2,080
Nursery gardens	8,047
Fallow lands	160,696
Area covered by crops (calculated)	**4,146,866**

Based on HCSO, 2019

5.4.9.2 EMISSION FACTORS

Particulate Matter ($PM_{2.5}$, PM_{10}, TSP)

For each pollutant the Tier 1 method and default emission factors provided in the EMEP/EEA Guidebook (EEA, 2019) were used.

5.4.10 NFR 3De CULTIVATED CROPS

NMVOC emissions from crop production are reported under 3De Cultivated crops.

NMVOC emissions from cultivated crops contributed to the national total NMVOC emissions with 2.8 % share in 2018. NMVOC emissions from crops cultivation have reduced by 9.4% over the period 1990-2018.

5.4.10.1 ACTIVITY DATA

Area covered by crops, derives from the HCSO's annual statistics for 'sown area of main crops'. Derivation of activity are same as those outlined above in Section 5.4.9.1. Emission factors

Emissions were estimated using the default Tier 1 emission factor given in the EMEP/EEA Guidebook (EEA, 2019), Table 3.1.

5.4.11 NFR 3Df USE OF PESTICIDES

The use of the most dangerous pesticides has been prohibited by international agreement, therefore only emissions related to pesticide use that shall be reported are the HCB emissions from the HCB contamination of the used pesticides (EMEP/EEA Guidebook, 2019).

HCB emissions from use of pesticides contributed to the national total HCB emissions with 55% share in 2018. HCB emissions from the use of pesticide reduced by 73% over the period 1990-2018, but the emissions increased by 84% over the period 2005-2018, due to the increase in the use of pesticides containing higher proportion of HCB impurities.

5.4.11.1 METHODOLOGY

A Tier 1 methodology provided in the 2019 EMEP/EEA Guidebook is used for calculating emissions from 3Df Use of pesticides.

5.4.11.2 ACTIVITY DATA

Data on the amount of active substances (as Atrazine, Clopyralid, Chlorotalonil, Endosulfan, Lindane and Picloram) in the used pesticides was given by the Department of Plant Protection Product and Yield Enhancing Substance Authorisation of the Directorate of NFCSO, which is the licensing authority for pesticides. In accordance with the information provided by the Plant Protection Authority, DCPA, Dachtal, Chlothaldimethyl, Pentachloronitrobenzene, Propazine, Simazine and Penthaclorophenol were not in use in Hungary over the period 1990 and 2018.

In accordance with the Hungarian Statistical Law (Act No. CLV of 2016) the quantities of the sold Picloram for the years 2017 and 2018 are confidential, therefore the aggregated activity data on the total amount of the active substances are provided in the NFR Table as well as in

Table 5.41. As the Table above reveals the total amount of active ingredients has decreased by across the timeseries, however the active substances have used since 2005 contains higher proportion of impurities, leading to increase in the emissions.

Table 5.41 Estimation of area covered by crops for 2018

Year	Total amount of active substances (kg)	Total HCB emissions
1990	993,937	4.63
1991	966,920	6.61
1992	696,706	4.19
1993	876,142	2.46
1994	559,205	2.52
1995	380,487	2.68
1996	292,945	2.36
1997	301,900	2.33
1998	479,230	2.04
1999	660,530	2.51
2000	841,830	2.81
2001	937,671	2.55
2002	626,252	2.81
2003	623,426	1.82
2004	620,601	1.10
2005	540,384	0.67
2006	460,168	0.67
2007	346,252	0.52
2008	39,636	0.29
2009	43,647	0.32
2010	77,178	0.66
2011	95,072	0.84
2012	116,171	1.02
2013	123,380	1.14
2014	161,190	1.58
2015	151,307	1.43
2016	153,143	1.49
2017	156,229	1.56
2018	122,853	1.24
Trend 1990-2018	**-88%**	**-73%**
Trend 2005-2018	**-77%**	**84%**

5.4.11.3 EMISSION (IMPURITY) FACTORS

Impurity factors for different ingridients were taken from the Table 4 of the 2019 EMEP/EEA Guidebook, except the impurity factor of Chlorotalonil for the period 2010 and 2018, for which the Department of Plant Protection Product and Yield Enhancing Substance Evaluation of the Directorate of the NFCSO provided data based on the information given from the pesticide producer. Impurity factors used in the emission estimate are provided in Table 5.42

Table 5.42 Impurity factors to calculate HCB emissions from 3Df Use of Pesticides

Active sutstance	1990	1995	2000	2005	2010	2015	2016	2017	2018
Atrazine	2.50	1.00	1.00	1.00	use stopped	use stopped	use stopped	use stopped	use stopped
Clopyralid	not used	not used	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Chlorotalonil	300.00	300.00	155.00	10.00	*10.00*	*10.00*	*10.00*	*10.00*	*10.00*
Endosulfan	0.10	0.10	0.10	0.10	use stopped	use stopped	use stopped	use stopped	use stopped
Lindane	100.00	50.00	50.00	50.00	use stopped	use stopped	use stopped	use stopped	use stopped
Picloram	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00

Impurity factors in italics are country-specific values.

5.5 NFR 3F FIELD BURNING OF AGRICULTURAL RESIDUES

This category comprises the field burning due to plant protection reasons. In Hungary open burning of standing crops and crops residues is legally banned, the plant protection reason could be the only exception when the authority can issues a permits for an exemption from the ban of field burning.

In Hungary, the first legislation in order to control field burning of agricultural residues entered into force in 1986. According to the regulation No. 21/1986. (VI. 2.) of the Council of Ministers a burning permit was required from the local authority for crop residue burning. This legislation had been in force until 2001, when the Government Decree No. 21/2001. (II. 14.) was issued. The new decree bannned the field burning of agricultural crop residues, unless otherwise provided by law. Plant health emergency was the special exception, when burning of crop residues had been allowded. This Government Decree was amended at the end of 2010. The Government Decree No. 306/2010. (XII.23.) is currently in force, which explicitly ban the field burning of crop residues. According to this, field burning of standing crops and crop residues are prohibited unless otherwise provided by law. The only exception is if there is a plant deseases on the agricultural field that can only be eliminated by field burning. In this case the plant protection authority – the county government office – in principle may issue a burn permit. In practice such permits are issued rarely. According to the information and data provided by the plant protection authority burn permits have been issued for only rice lands due to infection of Pyricularia oryzae or Helminthosporium oryzae.

Following a recommendation from the NECD Review, 2019 Hungary reports the emissions from field burning due to plant protection reasons for the first time.

5.5.1.1 METHODOLOGY

Emissions from 3.F Field burning was estimated using the Tier 1 methodology from the EMEP/EEA Guidebook (EEA, 2019).

5.5.1.2 ACTIVITY DATA

To estimate the emissions from rice field burning the Directorate of the NFCSO, which is the plant protection authority provided data on the areas for which burn permits were issued for the period 2010-2016. Due to unavailability of data for other years the time series from the 1990 to 2009 was gap-filled by calculating an average proportion of the rice cropping area affected by plant deseas from the available data. The burnt areas for the years 2017 and 2018 was estimated similarly.

In 2018, 971 ha was burnt in Hungary, which equates to 0.02% of the areas covered by crops in 2018. Activity data to the calculation of emissions from 3F Field burning are shown in Table 5.43.

Table 5.43 Activity data to the calculation of emissions from 3F Field burning

Year	Rice field area burnt (ha)
BY	3985
1990	3,974

1991	2,980
1992	1,656
1993	1,656
1994	1,656
1995	1,325
1996	1,031
1997	726
1998	937
1999	748
2000	1,067
2001	775
2002	696
2003	848
2004	932
2005	882
2006	799
2007	867
2008	839
2009	898
2010	257
2011	882
2012	1,037
2013	1,089
2014	993
2015	932
2016	1,034
2017	916
2018	971

Data on average yield on rice (kg ha^{-1} fresh weight) was taken from the HCSO's statistics. For the ratio between the mass of crop residues and the crop yield (Y), the dry matter content of the yield (d) and the combustion factor (C_f) the IPCC default values of 1.4, 0.85 kg dm·kg fresh $weight^{-1}$ and 0.8 were taken, respectively. Proportion of those residues thar are burned (p_b) was assumed to be 1 due to the plant protection reasons.

5.5.1.3 EMISSION FACTORS

Tier 1 default emission factors provided for rice from the Table 3-1 of the 2019 EMEP/EEA Guidebook was used.

5.6 QA/QC AND VERIFICATION

General QA/QC procedures of emission inventories for Agriculture sector are described in Chapter 5 of the Hungarian National Inventory Report, 2020-submitted under the UNFCCC.

For all activity data, as livestock populations, fertilizer use, AWMS system usage etc. consistency is maintained with data application for GHG inventory.

As a standard QA/QC procedure Tier 2 emission factors were compared with the default emission factors and reasons for differences were justified. The following sections discuss the verification of Tier 2 emission factors used to estimate NH_3 emissions.

5.6.1 VERIFICATION OF TIER2 NH_3 EMISSION FACTORS FOR CATTLE AND SWINE

Tier 2 emission factors were compared with the default values given in the 2019 EMEP/EEA Guidebook. As the NH_3 emissions are calculated following the N-flow, the total emission factors, calculated for the whole life-cycle of manure were compared.

Dairy Cattle

The country-specific value of NH_3 emission factor for Dairy Cattle is increasing over the inventory period and is out of the range of default values provided in the 2019 EMEP/EEA Guidebook for some years, at the end of the inventory period (Figure 5.6). This trend is a direct result of the increase in N excretion, reflecting the rising milk production per Cow. In the Hungarian inventory the N excretion ranged from 81 to 123 kg N head^{-1} year^{-1} between 1990 and 2018. While a significantly lower value of 105 kg N head^{-1} year^{-1} was applied in the calculation of the default emission factors in the 2019EMEP/EEA Guidebook. The higher country-specific value of N excretion partially justifies the higher emission factors at the end of the inventory period. The other key underlying data of the NH_3 emission factors is the length of housing period. The EMEP/EEA Guidebook assume 180 days a^{-1} as a default, which is significantly lower than the country-specific average value of 320 days a^{-1}. The significantly longer housing period is the main reason for the higher NH_3 emissions from Dairy Cattle.

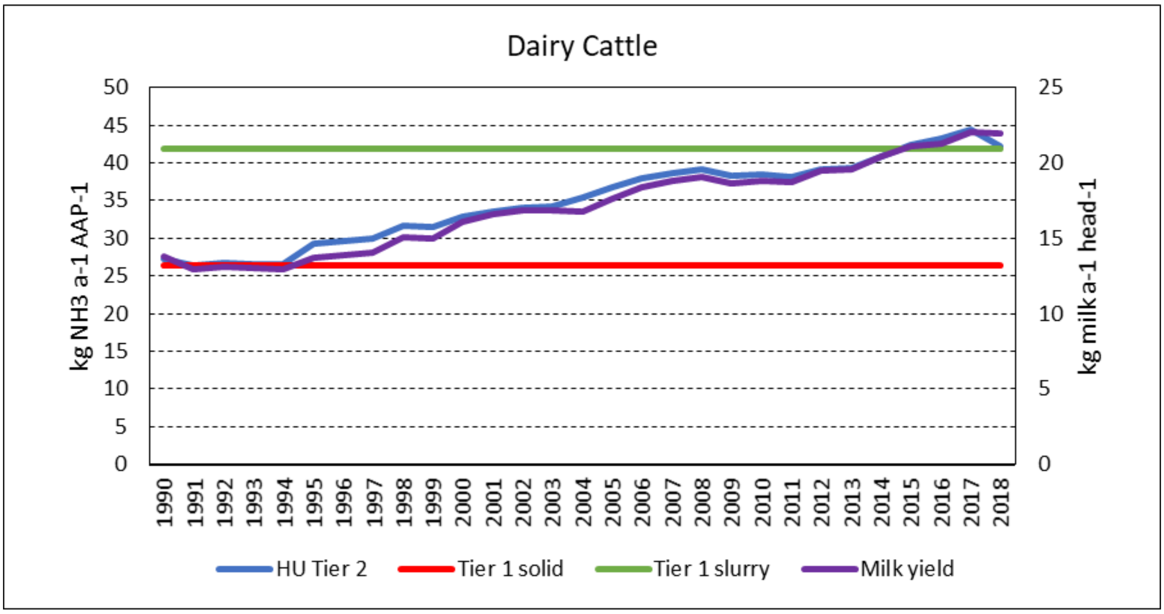


Figure 5.7 Comparison of NH_3 emission factors for Dairy Cattle

Non-dairy Cattle

The country-specific values of IEFs for total NH_3 emissions from Non-dairy Cattle slightly increasing. At the beginning of the timeseries the country-specific values are approximately equal with the default value for liquid/slurry, while in the second half of the timeseries the country-specific emission factors are higher than the EMEP default tier 1 values given in the in the Table 3.2 of the 2019 EMEP/EEA Guidebook(Figure 5.8). The reasons for the higher EFs in Hungary are, similarly to the Dairy Cattle, the higher N-excretion rates and the longer housed periods. Country-specific N excretion rates ranged from 44 to 52 kg N a^{-1} $head^{-1}$ between 1990 and 2018. In contrast, the default value is 41 kg N a^{-1} $head^{-1}$ in the 2019 EMEP/EEA Guidebook. It is worth noting that the IPCC default value is 50 kg N a^{-1} $head^{-1}$ for the Eastern-European Non-dairy Cattle according to the 2006 IPCC Guidelines. Therefore, the EMEP/EEA default value seems to be extremely low, for the Hungarian Non-dairy Cattle livestock. The contrast between the lengths of housing period is similarly striking. The EMEP/EEA default is 180 day a^{-1}, in contrast with 231-324 days Hungarian country-specific values depending on Non-dairy Cattle subcategories. Significantly higher N-excretion values, the longer housing period result in significantly higher NH_3 emission factors than the default values. The country-specific total NH_3 emission factors are in the range of 14.7 to 17.8 kg NH_3 a^{-1} $head^{-1}$ over the inventory period, whereas the default values are 10 and 15 kg NH_3 a^{-1} $head^{-1}$ for solid and slurry, respectively. Considering the differences between the background parameters, the difference seems to be reasonable.

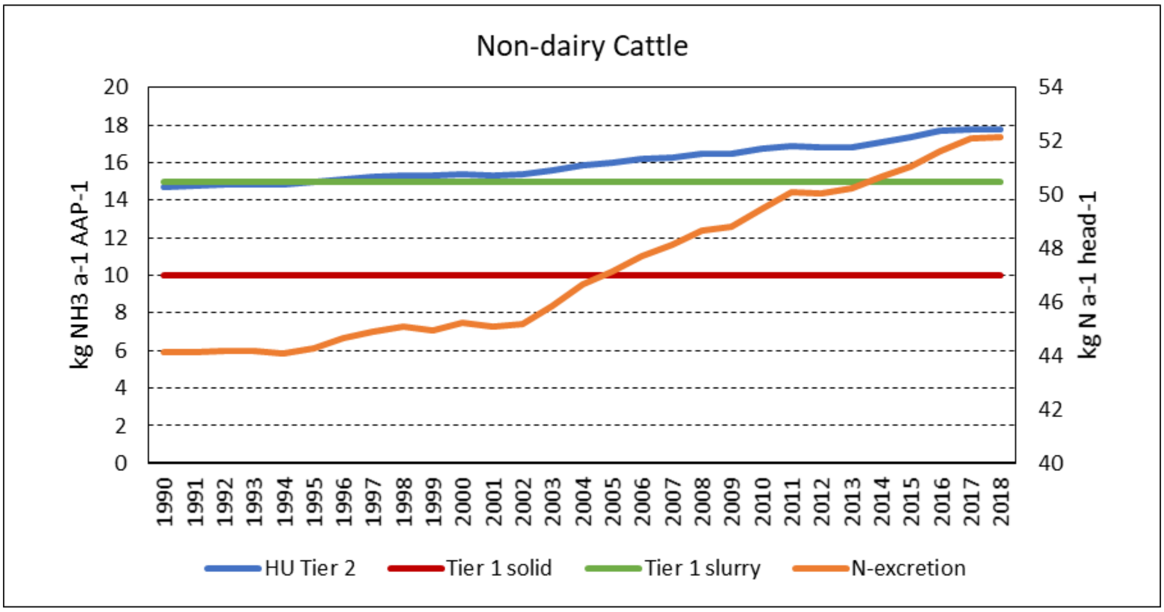


Figure 5.8 Comparison of NH_3 emission factors for Non-dairy Cattle

Swine

The 2019 EMEP/EEA Guidebook provides NH_3 emission factors for sows and fattening pigs separately, from which weighted averages was derived for solid and slurry, using the livestock data on sows and fattening pigs as weighting factors. (Figure 5.9). The implied value of default N excretion rates are in the range of 13.7 to 14.0 kg N a^{-1} $head^{-1}$for the period 1990-2018. In contrast, the Hungarian country-specific value ranged from 9.4 to 9.5 kg N a^{-1} $head^{-1}$ over the inventory period. The slightly decreasing trend reflects the slightly decreasing trend in final weights of fattening pigs and the decrease in the crude protein intake due to the amino-acid supplements. The lower N excretion rates in the Hungarian inventory lead to significantly lower NH_3 emission factors for Swine than the 2019 EMEP/EAA default. The reported emission abatement techniques during the manure application also contribute to the lower emissions.

Though the default N excretion rates were sourced from the 2006 IPCC Guidelines according to the foot note of the 2019 EMEP/EEA Guidebook, neither our calculation nor the FAO GHG database justify the EMEP/EEA defaults. Default values on N-excretion rates and weights provided in the 2006 IPCC Guidelines result in 7.7 and 9.3 for Market Swine and 17.3 and 27.6 kg N a^{-1} $head^{-1}$ for Breeding Swine for Western- and Eastern-Europe, respectively. Consequently, the NH_3 emission factors for Swine, in particular for Sows in the 2019 EMEP/EEA Guidebook seem to be overestimated for the Hungarian swine livestock.

The recent results of the examination of Hungarian pig feeds also strengthen that the N intake of pigs is relatively low in Hungary.

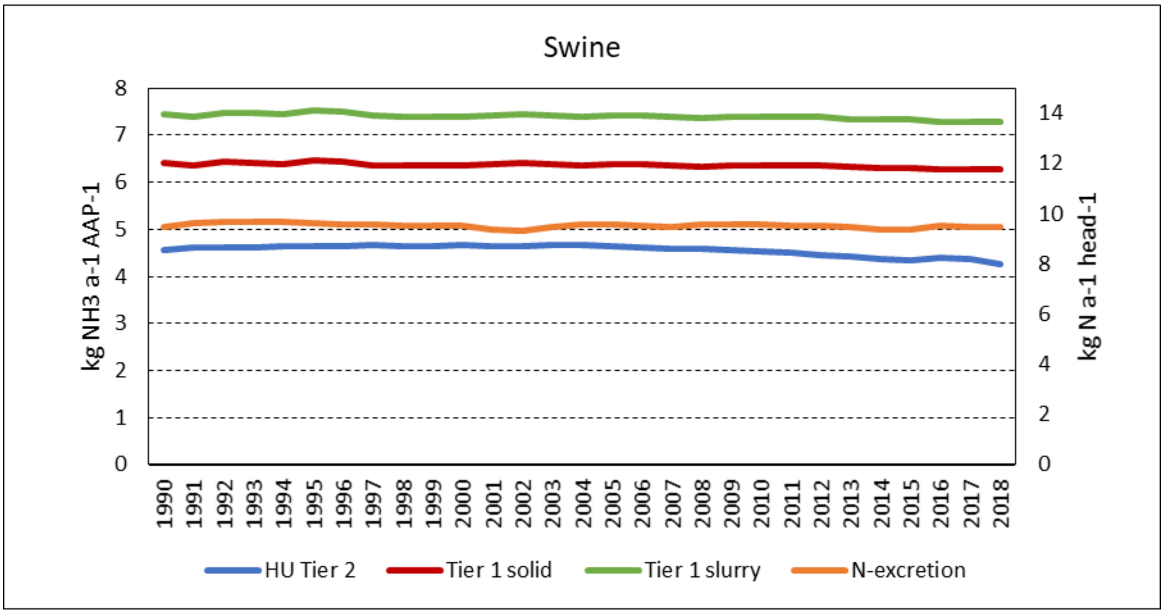


Figure 5.9 Comparison of NH_3 emission factors for Swine

5.6.2 VERIFICATION OF TIER2 EFS FOR NH_3 EMISSIONS FROM 3DA1

The use of default emission factor indicates lower emissions than the country-specific value at the beginning of the inventory period, when the proportion of urea N was about 30% in the total fertilizer N. The difference is negligible in the period between 1993 and 2007, during which period proportion of urea-N was on average 14% in the total fertilizer N. According to the Table A1.2 of the 2019 EMEP/EEA Guidebook, the default emission factor was developed based on IFA sales data for the year 2014, and the Urea N was 38%, on average, of the total fertilizer N in the applied statistics. The same proportion for Urea N justifies the quasi-equal emission factors for the beginning of the timeseries.

At the end of the inventory period the country-specific value resulted in lower emissions, because the Urea-N decreased to 8% of the total fertilizer N, which is significantly lower than the values assumed for the default emission factor. Comparison of NH_3 emissions from 3Da1 Inorganic fertilizers, calculated with Tier 1 and Tier 2 emission factors are presented in Figure 5.10.

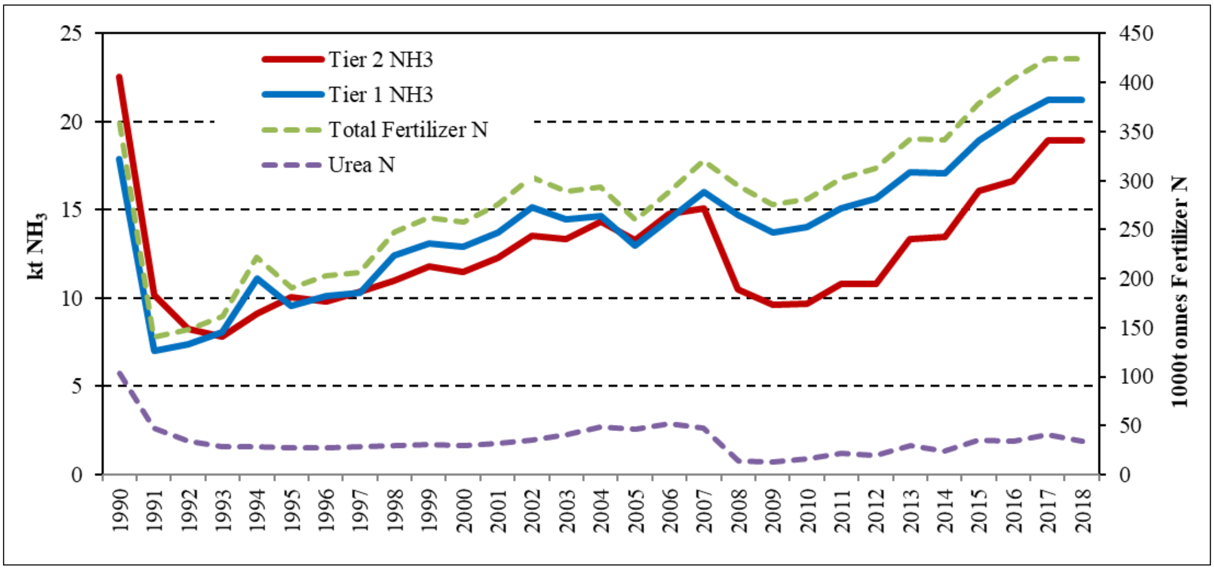


Figure 5.10 Comparison of NH_3 emissions from 3Da1 Inorganic fertilizers, calculated with Tier 1 and Tier 2 emission factors

5.7 RECALCULATIONS

The main focus of this year's improvements was the implementation of all recommendations of the NECD Review, 2019 and the switching to the 2019 EMEP/EEA Guidebook.

5.7.1 CHANGES IN METHODOLOGIES AND EMISSION FACTORS

NH_3 emissions from 3B Manure management

Updated emission factors for NH_3 emissions from housing and storage in the 2019 EMEP/EEA Guidebook resulted in recalculations of NH_3 emissions from 3B Manure management of Dairy Cattle, Non-dairy Cattle, Sheep, Swine, Laying hens, Broilers and Other poultry.

In the case of Dairy Cattle, the EMEP methodology differentiates the $EF_{housing}$ for tied and loose housing. In the previous submission the emission factor for loose housing was applied, therefore distinguishing the tied and loose housing resulted in a significant decrease in the emissions from 3B Manure management - Dairy Cattle.

In response to a recommendation from the NECD Review, 2019 country-specific nitrogen excretion rates were developed for Broiler and Laying hens. The new, country-specific N-excretion rates allowed the application of Tier 2 methodologies, leading to recalculated emissions. The use of Tier 2 methodology resulted in an increase in the NH_3 emission from Broilers due to the higher N-excretion rates than the default ones, while in the case of Laying hens the NH_3 emissions decreased.

Following a recommendation from the NECD Review of projection, 2019 country-specific nitrogen retention rates for breeding sows and breeding boars were revised, leading to revised emission estimates from 3B3 Manure management – Swine. Switch to the new EMEP methodology also contributed to the recalculated emissions.

NO_x emissions from 3B Manure management

Revised Tier 1 emission factors for NO_x from 3B in the 2019 EMEP/EEA Guidebook resulted in recalculations from NO_x emissions from 3B Manure management for all livestock categories.

NMVOC emissions from 3B Manure management

Updated emission factors for NH_3 emissions from 3B resulted in recalculation in the NMVOC emissions from those categories where Tier 2 methodology is applied (3B1a Dairy Cattle, 3B1b Non-dairy Cattle and 3B4giv Other poultry).

NH_3 emissions from 3D Agricultural soils

Updated emission factors for NH_3 emissions from 3D in the 2019 EMEP/EEA Guidebook resulted in recalculations of NH_3 emissions from 3Da2a Animal manure applied to soils.

Emission abatement due to the different manure application technologies have been reported for the first time, leading to decreased NH_3 emissions from Cattle and Swine slurry applied to soils.

3Df Use of pesticides

Fallowing a recommendation from the NECD Review, 2019 HCB emissions from 3Df use of pesticides have been reported for the first time. Resulting in a significant increase in the national total HCB emissions.

5.7.2 REVISION OF ACTIVITY DATA

3B3 Manure management - Swine

As the emission factors for Swine are provided for sows and finishing pigs of 8 kg until slaughter weights livestock numbers for 'piglets under 20 kg' was split into suckling piglets under 8kg and weaned piglets 8-20 kg. Emission estimates have been updated accordingly by taking into account pig numbers between 8 and 20 kg in the total number of fattening pigs, while suckling piglets under 8 kg are reported along with sows This revision resulted in decrease in the emissions for all pollutants, because in the former inventory submissions all piglets under 20 kg was taken into account in the category of finishing pigs.

3B4a Manure management - Buffalo and 3B34gii Broilers

Livestock numbers for the year 2017 were corrected due to a calculation error of the average annual livestock numbers. These revisions resulted in an insignificant change in the emissions.

3Da1 Inorganic N-fertilizers

Activity data for 3Da1 for the years 2014-2017 were revised by the AERI, resulting in an increase in the NH_3 and NO_x emissions from 3Da1. Due to this revision of NH_3 emissions increased between 0.9 and 1.8 Gg and NOx emissions increased by 0.4 to 1.5 Gg. While a correction was made to the activity data for the year 2013, to correct a rounding error and to ensure the consistency with the GHG-inventory. This correction resulted in a 0.1 Gg decrease in the NH_3 emissions from 3Da1 Inorganic N-fertilizers.

3Da2a Animal manure applied to soils

Due to the interlinking between the 3B and 3Da2a, revisions to the emissions from 3B led to the recalculated emissions in 3Da2a.

3Da2b Sewage sludge applied to soils

Due to the N-flow approach used in the calculation of nitrogen emissions and to ensure consistency between the reporting to the UNFCCC and the UNECE review recommendations affecting the N-budget in the GHG-inventories are taken into account in the air pollutant inventory as well. Therefore, following a recommendation from the UNFCCC review 2019, country-specific value on the N-content of the sewage sludge based on the measured data provided by the NFCSO were used in the estimation of NH_3 emissions from 3Da2b Sewage sludge applied to soils. This revision resulted in a slight increase in the emissions.

3Da3 Urine and dung deposited by grazing animals

Due to the updated NH_3 emission factors in the 2019 EMEP/EEA Guidebook resulted in recalculation in the NH_3 emissions from 3Da3 Urine and dung deposited by grazing animals.

3F Field burning of agricultural residues

Following a recommendation from the NECD review, 2019 activity data and the notation keys used in the NFR Tables for 3F Field burning of agricultural residues were revised. Emissions from field burning due to plant protection reasons have been reported for the first time.

Table 5.44summarizes the changes in the emissions of NH_3, NO_x, NMVOC and PM between the 2019 and 2020 submissions.

Table 5.44 Change in the emissions between the 2019 and 2020 submissions due to recalculations

NH_3	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
2019 Submission	139.12	82.44	86.31	80.23	70.62	70.78	70.23	72.79	73.98	78.26	78.44	79.62
2020 Submission	124.05	73.41	78.02	73.72	64.25	64.36	63.36	65.13	66.93	70.77	71.70	72.62
Difference %	-10.8%	-11.0%	-9.6%	-8.1%	-9.0%	-9.1%	-9.8%	-10.5%	-9.5%	-9.6%	-8.6%	-8.8%

NO_x	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
2019 Submission	21.91	12.30	15.01	14.87	15.38	16.20	16.78	18.03	17.56	18.92	19.25	21.15
2020 Submission	25.66	14.65	17.34	16.96	17.31	18.11	18.61	19.80	19.94	21.56	22.56	23.25
Difference %	17.1%	19.1%	15.5%	14.1%	12.5%	11.8%	10.9%	9.8%	13.6%	14.0%	17.2%	10.0%

NMVOC	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
2019 Submission	45.65	29.02	29.02	26.61	25.21	24.93	25.03	25.05	25.63	26.25	26.46	26.19
2020 Submission	54.07	34.22	33.93	30.70	28.93	28.63	28.92	29.01	29.58	30.20	30.37	30.11
Difference %	18.4%	17.9%	16.9%	15.4%	14.8%	14.8%	15.6%	15.8%	15.4%	15.0%	14.8%	15.0%

PM2.5	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
2019 Submission	0.79	0.77	0.76	0.76	0.75	0.75	0.75	0.75	0.76	0.74
2020 Submission	0.81	0.79	0.77	0.78	0.77	0.77	0.77	0.77	0.78	0.75

Difference %	2.0%	1.9%	0.3%	1.8%	2.6%	2.3%	2.1%	2.0%	2.4%	2.3%

PM10	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
2019 Submission	9.46	10.00	9.90	9.79	9.67	9.71	9.73	9.64	9.67	9.48
2020 Submission	9.46	10.01	9.90	9.80	9.68	9.72	9.73	9.64	9.68	9.43
Difference %	0.0%	0.0%	-0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	-0.6%

TSP	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
2019 Submission	16.28	15.94	14.99	14.67	14.37	14.45	14.51	14.56	14.48	14.08
2020 Submission	16.55	16.16	15.15	14.85	14.54	14.62	14.69	14.74	14.65	14.17
Difference %	1.7%	1.4%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	0.6%

5.8 PLANNED IMPROVEMENTS

Participation in the EU review mechanisms, provides an opportunity for examination of individual NFR sectors and particular issues relating to methodologies, country-specific emission factors and coefficients. Issues of planned improvements will be assigned largely in accordance with the outcome of the NECD review.

Additionally, as new data relevant to develop emission estimation for key categories in Agriculture becomes available through national research and development programs the required improvements will be implemented

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6 WASTE

Emissions relating to MSW deposition and composting, wastewater handling, incineration of different waste categories are presented in this chapter. It has to be noted that although emissions from waste incineration for energy recovery are allocated to the energy sector as required by the guidebook, the methodological description and background data of all incineration is discussed here.

6.1 BIOLOGICAL TREATMENT OF WASTE - SOLID WASTE DISPOSAL ON LAND (NFR CODE 5A)

Reported Emissions: NMVOC, Particulate Matter
Measured Emissions: None
Methods: CS, Tier 1
Emission factors: D
Key source: -

A major but decreasing part of municipal solid wastes (MSW) is treated by managed disposal and a smaller part by reuse, incineration or other means. The average specific municipal household waste generation rate decreased from 1.3 to 1.0 kg/capita/day in the last few years. The total amount of MSW was 3,746 Gg in 2018. Out of this, 1,394 Gg (37%) was recovered by recycling and composting, 501 Gg (13%) was incinerated for energy purposes, and 1,851 Gg (49%) went to landfills.

In case of managed disposal, the waste is disposed in landfills where it is compacted and covered. Under these circumstances *anaerobic* degradation occurs during which mostly methane and carbon dioxide is emitted. Degradation requires several decades and occurs at varying rates.

Methodological issues

Considering NMVOC emissions, the following assumptions were made. The EMEP/EEA Guidebook states, based on the evaluation of the US Environmental Protection Agency, that 98.7 % of the landfill gas is methane and 1.3 % are other VOCs such as perchlorethylene, pentane, butane, etc. Thus, our NMVOC emission estimates were based on methane emission calculations in line with the UNFCCC requirements. Once we had the results for methane emissions, the above-mentioned share of NMVOC (1.3% of all VOCs) was used.

Methane emissions were calculated using a first order decay (FOD) methodology applied by the IPCC Waste Model from the 2006 IPCC Guidelines. The FOD method produces a time dependent emission profile which may better reflect the true pattern of the degradation process.

For particulate matter emissions, Tier 1 method from the EMEP/EEA Guidebook was applied.

Activity data

The calculation method requires total amount of disposed waste. For the NMVOC emission calculation, disposed amount of municipal solid waste was used with some additional industrial waste with high degradable organic content (agriculture, food processing, wood products etc.). The IPCC Waste model was used emission calculation and the resulting methane emissions served as input for NMVOC emissions estimates.

For particulate matter emissions, total amount of disposed waste was taken into account, including relatively large amounts of non-degradable industrial waste. In 2018, altogether 4159 kt waste was disposed.

Emission factors

In case of PM emissions, default T1 emission factors were applied from the relevant chapter of the 2019 Guidebook.

Uncertainties and time-series consistency

The time series is most probably consistent. As regards NMVOC emissions, a consistent time series is presented in *Figure 6.1.*

Source-specific QA/QC and verification

None.

Source-specific recalculations

No change in methodology.

Source-specific planned improvements

None.

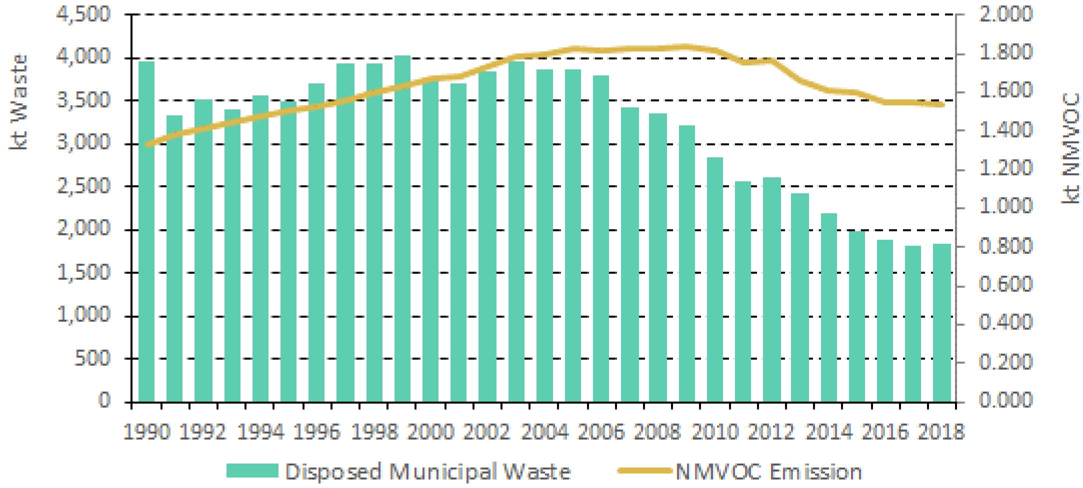


***Figure 6.6.1** Time series of NMVOC emissions from solid waste disposal*

6.2 BIOLOGICAL TREATMENT OF WASTE - COMPOSTING (NFR CODE 5B1)

Reported Emissions: NH_3
Measured Emissions: None
Methods: Tier 1
Emission factors: D
Key source: -

Methodological issues

Tier 1 method was used with the default emission factor.

Activity data

The amount of composted municipal waste was received from the Hungarian Central Statistical Office. In 2018, 310.45 kt waste was composted which represented 8% of all generated MSW.

Emission factors

The default value i.e. 0.24 kg/Mg organic waste was used from the Guidebook.

Uncertainties and time-series consistency

The time series is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

None.

Source-specific planned improvements

None.

6.3 BIOLOGICAL TREATMENT OF WASTE - ANAEROBIC DIGESTION AT BIOGAS FACILITIES (NFR CODE 5B2)

Reported Emissions: NH_3
Measured Emissions: None
Methods: Tier 1
Emission factors: D
Key source: -

Methodological issues

For the period 2015-2018, a very detailed database on various feedstock used for anaerobic digestion was analyzed. This database contained information on more than 40 types of feedstock, including fresh weight and dry matter content. Nitrogen content was then calculated by using default values from Table 3.7 of the EMEP/EEA Guidebook ("N content for various feedstock categories"). With the resulting total N amount, NH3 emission was directly calculated using the default emission factor. Based on the resulting emission, an implied emission factor (t NH3/TJ biogas) was derived and used for earlier years. (Unfortunately, we found some data problems for 2015-17 therefore for this submission only data from 2018 was used.)

Activity data

For the latest year (2018), detailed data on feedstock was used (kt dm). For the remaining part of the time series, data on produced biogas (TJ) taken from the IEA/Eurostat Annual Questionnaire served as activity data in the calculations. (However, energy data were converted to dry matter using a conversion factor of 7.3 TJ/kt dm to present a consistent time series of AD in the NFR tables.)

Emission factors

The default value (0.0275 kg NH_3-N/kg N in feedstock) was used from the Guidebook. For the period 2000-2017, an implied emission factor was applied, i.e. 0.122 t NH3 per produced biogas in TJ.

Uncertainties and time-series consistency

The time series is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

Due to data quality problems, previously used database (2015-17) on various feedstock used for anaerobic digestion had to be replaced by calculated data derived from information for 2018. In addition, the default emission factor has been updated in the 2019 version of the Guidebook.

Source-specific planned improvements

None.

6.4 WASTE INCINERATION (NFR CODE 5C1)

Reported Emissions: Main Pollutants except NH_3, Particulate Matter, CO, Heavy Metals, POPs
Measured/Plant-level Emissions: NO_X, SO_X, TSP, CO, (Pb, Cd, Hg, As, Cu, Ni, PCDD/F)
Methods: Tier 1 / Tier 3
Emission factors: D, CS
Key source: Hg, HCB.

Methodological issues

In accordance with the Guidebook, if there is heat recovery in the incineration process it is good practice to report the emission in the relevant combustion sector in the combustion section (1A). If no heat recovery occurs, it is good practice to report the emission in the waste incineration sector (5C1). Following the above recommendation, the categories under 5C1 cover only emissions from thermal waste treatment without energy recovery. However, the used method was more or less the same for waste incinerated both in the energy and waste sectors. Similarly, to other parts of the inventory, a mixture of the default Tier 1 methodology was used together with Tier 3 facility level measured data.

Activity data

For our calculations, five main data sources were used. First of all, the Hungarian Waste Management Information System (HIR) that comprises facility level data on mass and composition of waste in line with the European Waste Catalogue (EWC codes) and with European Waste Classification (EWC-Stat) but also on waste management methods in accordance with the Waste Framework Directive which made it possible to distinguish between waste incineration on land (D10) and use of waste principally as a fuel or other means to generate energy (R1). Our second data source was the Waste Incineration Works (FKF) of Budapest which is the biggest (and for long time the only one) municipal waste incinerator in Hungary. (The MSW incinerator in Budapest was reconstructed between 2002 and 2005.) Thirdly, also ETS data were taken into account, e.g. data reported by Mátra Power Plant, the biggest co-incinerator plant or by the four large cement factories in the country. Our fourth data source was the often-referred Hungarian Air Emissions Information System (LAIR). Input data for cremation (number of bodies) were received from the Hungarian Central Statistical Office.

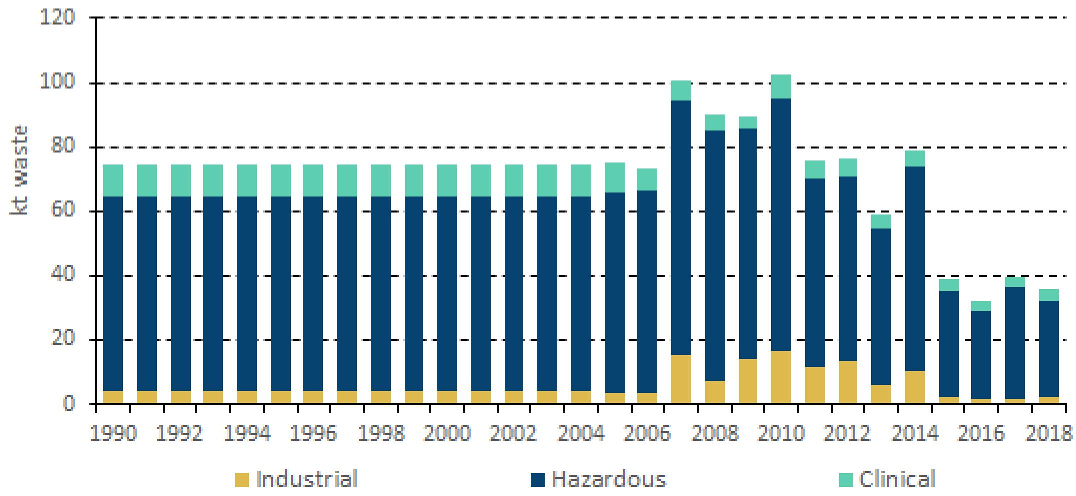


Figure 6.2 *Activity data used for emission calculations (1990-2018)*

As emissions are to be reported separately for different waste categories, the classification system of wastes in HIR according to EWC-Stat was used. In the NFR tables, the following waste categories are reported:

- Industrial waste incineration: all non-hazardous waste;
- Hazardous waste incineration: defined as all hazardous waste except clinical.
- Clinical waste incineration: defined as EWC-Stat code W05 (Health care and biological wastes);
- Cremation

It might be an interesting fact that 82 to 97 per cent of all incinerated waste in this source category was hazardous waste of which most part was liquid. Incinerating sewage sludge is not a common practice in Hungary. The above categories might however include some industrial sludges. Emissions from municipal waste incineration are reported under the source category 1A1a.

Based on information from the Hungarian Central Statistical Office, on average 1250 kt waste was treated either with energy recovery or incinerated without energy recovery between 2004 and 2018 out of which only 8% was burned without energy recovery.

Emission factors

As a general rule, default Tier 1 emission factors were applied with quite a few exceptions as summarized in the following.

In Hungary, waste incineration is regulated by law. For example, all incinerators burning hazardous waste need to operate with an afterburner with temperatures at least 1100°C for at least two seconds. The current legislation (Decree 29 of 2014 (XI.28.) FM of the Ministry of Agriculture concerning technical requirements, operational conditions and technological emission limit valued of waste incineration) contains the following emission limit values: 0.1 ng/m3 for PCDD/F, 0.05 mg/m3 for both Cd and Hg, and 0.5 mg/m3 for Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V altogether. These ELVs are valid since the second half of 2005. Assuming a calorific value of 10 GJ/t, these emission limit values could be converted to emission factors as follows: 0.546 µg/t for PCDD/F, 0.273 g/t for Cd and Hg, and 2.73 g/t for the remaining heavy metals. Especially for dioxins and furans generally and heavy metals in case of clinical waste, these values are lower than the default T1 emission factors. Consequently, the following approach was applied.

For *industrial and hazardous* waste, default T1 emission factors from Table 3-1 of the Guidebook are used for the main pollutants (NOx, CO, NMVOC, SOx). For particulate matter, somewhat higher than the default are applied (i.e. 0.04 kg/t for TSP). Default emission factors were kept for heavy metals, PAHs and HCB. For PCDD/F, an EF of 0.55 µg/t (coming from the emission limit value) is applied from 2006 on. When measured emissions were available (this was mostly the case for incinerators with energy recovery reported in the energy sector), these were used to the extent possible.

As regards *clinical waste,* different emission factors were used for the periods before and after 2005. In the early period of the time series, the default emission factors from Table 3-1 of the Guidebook were applied with the exception of PCDD/F for which a country-specific value of 30 µg/t was used. From 2006 on, the following non-default EFs are applied derived from the average IEF of a clinical waste incinerator from the years 2010-16: 1.3 kg/t for NOx, 0.2 kg/t for CO, 0.335 kg/t for SO2, and 0.045 kg/t for TSP. As for heavy metals, the used EFs are as follows: 1.031 g/t for Pb, 0.003 g/t for As, 0.033 g/t for Cr, 1.629 g/t for Cu and 0.033 g/t for Ni. All these values were derived from the emission limit value from the ministerial decree for Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V altogether (i.e. 2.73 g/t). For Hg, an EF of 0.029 g/t was used derived from measured emissions. For Cd, Tier 2 EF was applied assuming an abatement efficiency of 98% [3 g/t x (1-98%) = 0.06 g/t]. Our PCDD/F emission factor is again based on measurements (0.22 µg/t), and for HCB an abatement efficiency of 99.9% was assumed (0.1 mg/t).

Coming to *municipal waste* incineration, as almost all municipal waste is incinerated by one plant, the Waste Incineration Works in Budapest, its measured emission data were used extensively (either directly or for deriving country specific emission factors) for the following pollutants: NOx, SOx, CO, TSP, Pb, Cd, Hg, As, and PCDD/F. Due to more stringent legislation and reconstruction of the plant, the implied emission factors show mostly significantly decreasing values, for example:

- NOx: from 1.8 kg/t before 1992 to 1.3 kg/t between 1992 and 2002 to around 0.7 kg/t in recent years;
- SOx: from 1.8 kg/t before 1992 to 0.5-0.8 kg/t between 1992 and 2002 to less than 0.2 kg/t in recent years;
- CO: from 0.7 kg/t up to 1991 to less than 0.1 kg/t in recent years;
- Particulate matter: from 0.3 kg/t to close to 0.001 kg/t

As for heavy metals, the following country-specific emission factors could be derived from measurements: 0.141 g/t for Pb, 0.025 g/t for Cd, 0.026 g/t for Hg, 0.03 g/t for As, 0.034 g/t for Cr and Cu, and 0.046 g/t for Ni. For the remaining heavy metals, the default T1 emission factors were applied. The above values are valid only for the period after reconstruction of the incineration plant (i.e. after 2005). For previous years, as we assume abatement efficiencies of 90%, the applied EFs are an order of magnitude higher, (or T1 emission factors from a previous guidebook were used).

For dioxins and furans, measure data indicate an IEF of 0.023 µg/t after 2005, and an IEF of 30 µg/t before 2005.

Although emissions are allocated to the energy sector, it is worth mentioning that co-incineration occur both in power sector and in cement plants. As regards industrial waste, 95% of all incinerated waste came from the biggest co-incinerator plant (Mátra Power Plant) whose measured NOx, SOx, CO, and TSP emissions were anyhow included under 1A1a regardless of the burned fuel. In source category 1A2f, 64% of the incinerated wastes allocated here were from cement factories. All the rest was wood waste. Measured NOx, SOx, CO, TSP, and Hg emissions from cement factories were taken into consideration.

For the source category 5C1bv *Cremation*, the default methodology with default EFs were applied. Only emissions from incineration of human bodies in a crematorium is included. It is assumed that one quarter of deaths are subject of cremation.

Uncertainties and time-series consistency

The time series are most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

The used emission factors have been extensively revised on the basis of plant-specific measurements. In addition, some minor changes occurred due to updated activity data.

Source-specific planned improvements

The issue of completeness has to be addressed in case of co-firing.

6.5 OPEN BURNING OF WASTE (NFR CODE 5C2)

Reported Emissions: NOx, SOx, NMVOC, Particulate Matter, CO, Heavy Metals, POPs
Measured/Plant-level Emissions: NA
Methods: Tier 2
Emission factors: D
Key source: -
Currently, only emissions from burning of forest residues were taken into account here.

Methodological issues

Tier 2 method was used with the default emission factors.

Activity data

Amount of slash was received directly from the Forestry Directorate of the Hungarian National Land Centre.

Emission factors

The default emission factors valid for forest residues were used from the Guidebook.

Uncertainties and time-series consistency

The time series is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

Activity data have been revised by the data provider.

Source-specific planned improvements

None.

6.6 WASTEWATER HANDLING (NFR CODE 5D)

Reported Emissions: NMVOC, NH_3
Measured Emissions: None
Methods: Tier 1. Tier 2
Emission factors: D
Key source: -

Following the latest EMEP/EEA Guidebook, NMVOC emissions are calculated from wastewater handling. In addition, NH3 emission from latrines is taken into account. The resulting emissions are almost negligible.

Methodological issues

Tier 1 (NMVOC) and Tier 2 (NH_3) methods were used with default emission factors.

Activity data

For the calculation of NMVOC emission, treated wastewater in m^3 collected and published by the Hungarian Central Statistical Office was used as activity data. Only at least biologically treated wastewater was taken into account (which meant basically all wastewater in the last three years). On average, around 500 million m^3 wastewater was treated (including also mechanical only) in the last 10 years. It is worth mentioning that the share of only mechanically treated wastewater dropped from 23% in 2009 to 3% in 2010 and further to 0.1-0.2% in 2012.
(http://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_uw005.html).

Activity data for NH_3 emission estimation is the number of people using latrines (see Table 3-2 of the Guidebook). For our recent calculation, it was assumed that tenants of urban flats and country houses with either no connection to the public sewerage system or no domestic sewerage system have to use latrines outside the house. It was assumed that 86.1% of all dwellings were connected to the public sewerage network in 2018 whereas 11.4% used some domestic sewerage. Thus, we assumed that 2.5% of the total population use latrines.

Emission factors

The default values, i.e. 15 mg/m^3 (NMVOC) and 1.6 kg/person/year (NH3 from latrines) were used from the Guidebook.

Uncertainties and time-series consistency

A consistent time series of NMVOC emissions is presented in *Figure 6.4*.

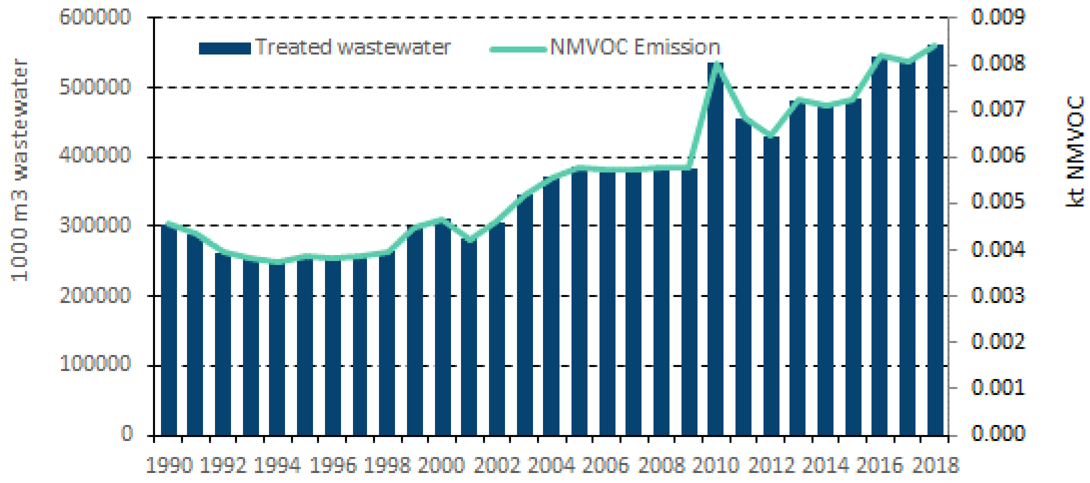


***Figure 6.4** Time series of NMVOC emissions from wastewater handling*

Source-specific QA/QC and verification

None.

Source-specific recalculations

No methodological change has been made. However, recent surveys indicated that the share of dwellings connected to the public sewerage system is higher for occupied dwellings than for all dwellings (including unoccupied) by about 5%. At the same time, shares of people using septic systems/latrines have been revised.

Source-specific planned improvements

We'll check the possibility to report emissions from industrial wastewater treatment separately.

6.7 OTHER WASTE (NFR CODE 5E)

Reported Emissions: PM, heavy metals, PCDD/F
Measured Emissions: None
Methods: Tier 2
Emission factors: D
Key source: DIOX.

In this source category, emissions from car and house fires are reported.

Methodological issues

The Tier 2 approach was applied as suggested by the EMEP/EEA Guidebook. Activity data were stratified basically into three categories: house fires, industrial building fires, and car fires.

Activity data

Two sources have been used for activity data: (1) Hungarian Central Statistical Office (for total number of fires, 1990-2018, and fires in dwellings, 2000, 2005, 2010-2018), and (2) National Directorate General for Disaster Management, Ministry of the Interior (for car fires and other building fires, from 2013). Due to incomplete information, the time series, as shown in Fig. 6.5, contains also intra- and extrapolated data.

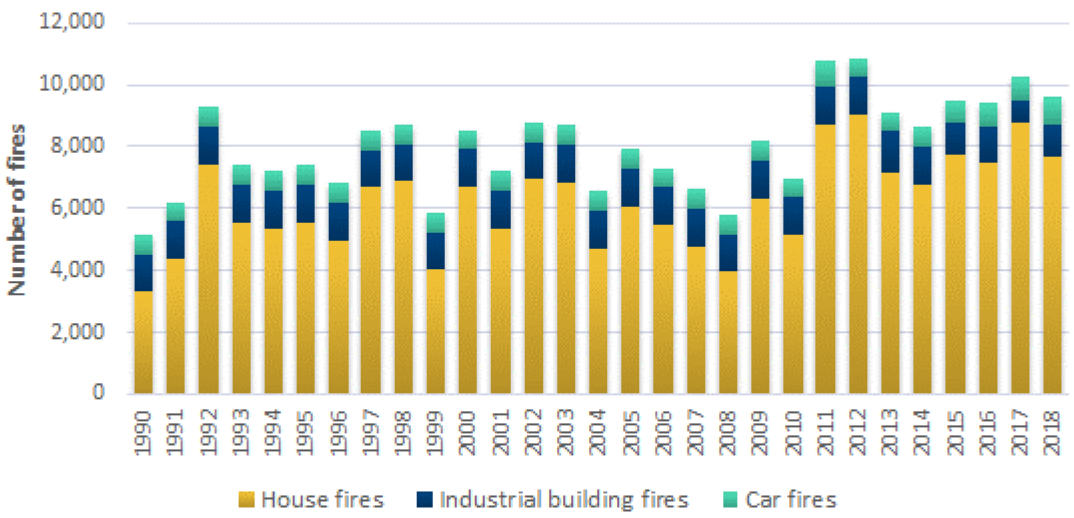


Figure 6.5 *Number of fires (1990-2018)*

Emission factors

The used default emission factors were taken from Tables 3-2, 3-3, 3-5, and 3-6. It was assumed that 60% of house fires were from detached houses, and the remaining 40% from apartment buildings.

Uncertainties and time-series consistency

The time series can be regarded as consistent

Source-specific QA/QC and verification

None.

Source-specific recalculations

No methodological change has been made.

Source-specific planned improvements

None.

7 OTHER AND NATURAL EMISSIONS

Emissions from NFR 7. Other Natural emissions are not estimated for Hungary.

8 RECALCULATIONS AND IMPROVEMENTS

8.1 RECALCULATIONS

Information is provided in the sectoral chapter above.

8.2 PLANNED IMPROVEMENTS

- Further improvement of the coordination with E-PRTR reporting and within LAIR reporting process
- quantitative uncertainty analysis
- improvement of QA/QC actions. application of the same processes as by the UNFCCC annual emission inventory reporting

9 PROJECTIONS

In this section, a short summary will be given on the most important assumptions regarding the main trends, data sources used and methodologies applied for the calculation of projected emissions. Emphasis will be placed on the WEM (with existing measures) scenario, as - at the time of writing this chapter – Hungary has not yet finalized its first National Air Pollution Control Programme.

As for the more general trends, the GDP is expected to continue growing and it most probably will exceed the value for 2015 by 76% in 2030. Growth is expected in industry, the construction sector and services, while added value from the agricultural sector will be stagnant. Hungary's population has been decreasing for years, and forecasts suggest that the trend will continue up to 2030.

9.1 ENERGY

Projections in the energy sector were harmonized with the ones in Hungary's National Energy and Climate Plan. This meant in practice that the underlying activity data, i.e. energy consumption, were the same in the emission calculations. (See sections 4. and 5. of the Plan.) The following main trends were expected as regards energy production and consumption:

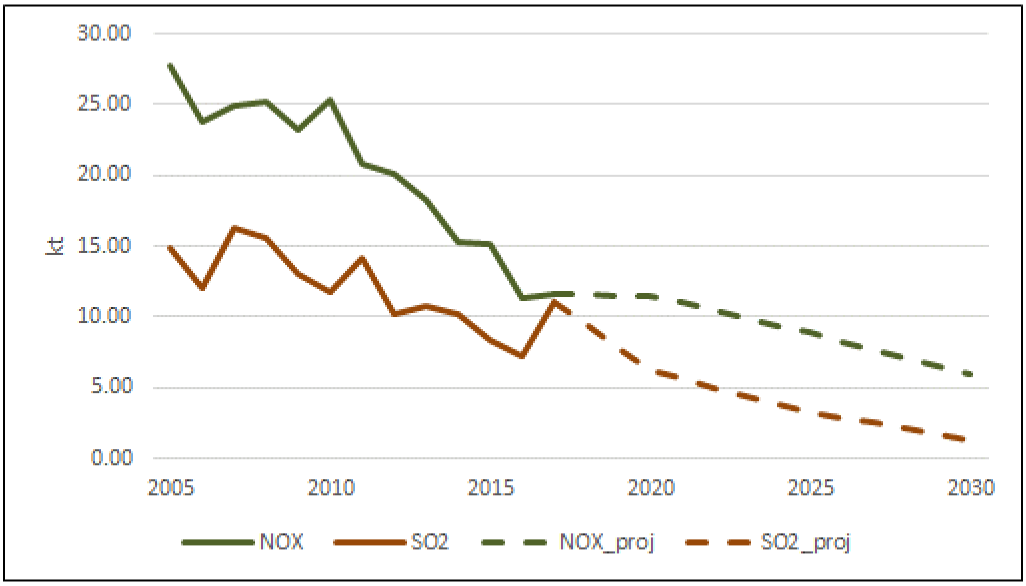
Based on the national objective of Hungary, energy consumption in 2030 should not exceed the value for 2005. With the existing policies and measures, final energy consumption may increase by 14% between 2015 and 2030 based on the forecast. The increase is attributable to the rise in industrial production and higher fuel consumption resulting from increasing income, while household energy consumption is expected to decrease. The weight of electricity and petroleum products is expected to increase within the end consumer energy mix, while the share of other energy sources will decline.

Based on the forecast, primary energy consumption may exceed the value for 2015 by 25% in 2030, Approximately one half of the increase is attributable to the generation of the new nuclear power plant units, which will replace the substantial electricity imports measured in 2015. If electricity generated by the new nuclear power plant units would be imported, primary energy consumption in 2030 would exceed the value for 2015 only by 14% (similarly to final energy consumption)

Energy industries:

Pursuant to the intergovernmental agreement between Hungary and the Russian Federation, two new nuclear power plant units will be built in Hungary by 2030, each with a capacity of 1200MW (Paks 2). The new nuclear power plant units will allow the phasing out of coal-based power generation in Hungary. In parallel with the existing policy measures, by 2030 coal-based power generation will be limited to power plants supplying lower capacity industrial heat and district heating.

According to forecasts, as a result of the existing policy measures, the installed capacity of electricity generating units generating from renewable sources will exceed 4600MW by 2030, with more than 4000MW attributable to photovoltaic panels. In 2030, the quantity of electricity from renewable resources is expected to exceed 6500 GWh, with approximately 70% of such quantity attributable to photovoltaic panels. According to the forecast, the share of renewable energy use will amount to 12.8% of gross final electricity consumption in 2030.



Projected NOx and SO2 emissions of power and heat generation

Buildings (households and the tertiary sector):

Household energy consumption declined in Hungary by roughly 15% between 2005 and 2015. As a result of the existing policy measures, household energy consumption is expected to decrease by 10% between 2015and 2030. The decline is attributable to lower heating demand; other energy consumption may be close to stagnant in the reviewed period. Energy consumption in the tertiary sector declined by 37% between 2005 and 2015, primarily affecting natural gas consumption. Similar to households, energy is mainly consumed for heating purposes in the tertiary sector, accounting for two thirds of energy consumption in the sector. Energy consumption will be close to stagnant in the tertiary sector in consideration of existing policy measures. It is expected that energy consumption will increase in the market services sector as a result of growing added value and physical infrastructure, while implemented investments will lead to declining energy demand in public services.

Industry

The energy quantity used in the industrial sector was close to stagnant in the years preceding the economic crisis, then decreased by more than one fifth during the crisis as a result of the downturn in the economic cycle. Thereafter Hungarian industrial production rebounded at a rapid pace, followed by dynamic growth from 2013, attributable to the launch of new capacities in the manufacturing industry. In 2015, energy consumption in the industrial sector exceeded the value measured in 2005 by 25%. The rise in energy consumption is predominantly attributable to electricity consumption, which significantly increased within the industrial energy mix. According to the forecast, in 2030 energy consumption in the industrial sector will be one third higher than the value for 2015, under existing policy measures.

Transport

Fuel consumption in the transport sector dynamically increased in the years preceding the economic crisis, then significantly declined during the crisis. After2013, energy consumption in the transport sector sharply increased as a result of rapidly growing household income and rising investment, and again exceeded the value for 2005 in 2015. Under the existing policy measures, in 2030 energy consumption in the transport sector will be one and a half times higher than in 2015 as a result of the dynamically growing GDP and incomes, becoming the sector with the highest energy demand. Traditional petrol and diesel fuel will continue to account for more than 90% of consumed energy quantities despite the promotion of alternative propulsion and other efforts aimed at reducing vehicle use.

According to the vehicle stock, mileage and fuel consumption data, a linear and exponential trend series were created up to 2030 considering changes of previous years. In the case of vehicle stock and mileage, the COPERT categorization of all vehicle classes, types and Euro classifications were taken into account. Regarding the fuel consumption, the national total consumed fuel of gasoline, diesel, LPG, CNG, biodiesel and bioethanol data were determined up to 2030. Finally, maximal and minimal mean temperature and humidity of previous years were considered and data were created up to 2030 as well. However, in the case of weather data climate change and any other weather modifying factors were not taken into consideration.

By looking at the vehicle stock data we can conclude a trend from the previous year's data. Vehicles with Euro 0, 1, and 2 showed a decreasing trend without a doubt. Vehicles with Euro 3 and 4 showed a slight reduction and some case stagnation, and Euro 4 vehicles pointed a slight increase in some cases. This is probably because of the import used diesel vehicles from the western countries of EU. Vehicles with Euro 5 and 6 showed an increasing trend.

All the input data were transferred to the COPERT program and emissions were calculated for 2020, 2025 and 2030.

It is also worth to mention that vehicle stock data were modified without taking into account the new "Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011".

(The new CO2 regulation will require a huge step towards electric / hybrid vehicles and alternative fuel vehicles will be less widespread in order for manufacturers to meet the CO2 targets set by the regulation. In the light of the strict limits, it is estimated that by 2025, about one third of new passenger cars will have to be electric and hybrid in order to meet the targets set by the regulation. As a result, the regulation will have a significant influence on the development of passenger cars as

electric vehicles, leaving little room for other alternative propulsion systems. Although the regulation states a neutral technology, in practice it can only be accomplished with an electric / hybrid vehicles.)

9.2 INDUSTRIAL PROCESSES AND PRODUCT USE

Key driver in IPPU sector in Hungary is rather the compliance with air quality standards (BAT Ref. Documents), therefore GHG and air pollutant projection was harmonized, which means same activity data and same projection pathways. Activity data used for projection of IPPU emissions was based on projection results from relevant studies or models executed at EU level (e.g. Potencia Model), also exsisting production capacity and planned investments of new capacities were taken into account. Technological developments influence the emission factors therefore emission factors were selected carefully for the projection: in most categories plant specfic emission factors were used. Emissions from all categories were calculated on the same level as in case of inventory. In case of 2C6 and 2C7 constant emissions from the 2017 inventory year were kept for the projected years.

Key categories (for the 2017 inventory year) in the IPPU sector occurs only in case of NMVOC. Most of them belong to the 2D subsector, where the currently applied methods in the inventory cannot capture the technological development (of implied emission factors) expected in the future.

2A1: using the results of an EU model designed for the GHG projection for activity data - only taking into account the trends; in case of PM emission the ongoing TSP reduction investment at one of the companies (that will probably be in the inventory around 2018/2019) has been taken into account; we calculated with company-specific emission factors (where there were no new investments, the average of the previous four years was taken into account because the values were much higher earlier)

2A2: There is a strong relationship with cement production, so we expect similar trends in activity data, taking into account the current built-in capacities, but we don't count on a new factory, the specific emissions are decreasing, so we used factory-specific TSP data in the last year of inventory (using default ratios for PMs and TSP)

2A3: As no capacity increase is known at this time and companies are practically maximizing performance, we used the maximum production volumes of previous years for each category (in addition, there will be more flat glass for the construction works, and also the strengthening of the container glass is questionable), one of the furnaces at the largest container glass company was shut down in 2018 due to refurbishment, but this also means that it is not planned within 5-7 years build a new one; we do not expect any improvement in emission factors in the short term (at least until 2025) unless the BAT requirements are tightened

2A5a: basically, construction, road construction (cement, lime, glass, brick) generates consumption and production in this category, as this is rather complex, so rate of change in activity data was calculated using the trends in value added of the construction industry (same data as used for the GHG projection); default T1 emission factor was used like in the inventory

2A5b: Changes in road construction based on strategy made by the ministry responsible for transport; in case of buildings different assumption were taken into account: VAT regulations for housing construction, other types of building show good correlation with cement production therefore trends of cement activity data were taken into account in tha latter case

2B1 and 2B2: the strategy of the two most important companies and the current and planned capacities were taken into account for the activity data; at 2B1, we calculated with the last year's IEF because there have been a lot of improvements in the past period, which appeared in 2017 in the inventory; at 2B2 we calculated the average IEF of the last 3 years (values were much higher before)

2B10: Production ceilings from 2008-2017 years of the inventory were assumed for petrochemical companies; 2B1 and 2B2 strategies were taken into account in fertilizer production; we kept the default T1 factors like in the inventory, and we were using T3 factors as well - taking into account the developments of recent years

2C1: Considering the capacity constraint, we do not expect any significant increase in activity data due to the completion of a comprehensive renovation / modernization (over a period of years) in the largest company in 2018, so there will be no new investment in the short term; unfortunately, the 2018 emission reports were not available before the deadline of the projection submission, so the IEF for the last inventory year was taken into account in case of PMs, and the default factor T1 for NMVOC was used like in the inventory

2C6 and 2C7: they are small emission sources where trends are not known therefore constant values of the last reported inventory year were applied in both cases

2D3a and 2D3f: Since both are estimated by population in the inventory, we also estimated it based on the projected population used for the GHG projection as well, with a T1 factor

2D3b: the trend of road construction was taken into account (same as in the 2A5a); NMVOC emission was estimated with T1 default factor as in ithe nventory; projected PM and BC emissions are based on the average factor of the last 5 years of the inventory (these are T3 factors)

2D3c and 2D3e: small emitters, we kept production and emissions constant

2D3d: Consumption data were estimated by using the trends of the value added of the construction industry (mentioned at 2A5a); since EF has been the average of the default factors in the inventory for the time being, so we continued to use it, unfortunately the effect of the EU VOC regulation does not appear – there is an ongoing research to solve this promlem in the inventory, as well

2D3g: we expected the PU production to grow from 2021 onwards, the new factory will in principle be operational; emission factors of the inventory were kept for the projection

2D3h: with increasing production, we expect declining emissions: this sector represents usually 3-5% of GDP (same GDP data were used as for the GHG projection); while technological improvement in this industrial sector is very fast and companies should keep up, we expect a 50% reduction compared to default EF by 2030 (like in the GAINS model)

2D3i: emission of the last year of inventory was kept for the projected years because the largest company is already working at maximum utilization and it is uncertain whether there will be more demand; emissions can only be reduced by new investments (because using leading technologies already), but there is no planned investment for the time being

2G: decreasing population and decreasing consumption observed as a result of measures were taken into account using default with T1 factors like in the inventory

2H: we took the average emissions from food and beverages for the period 2007-2017 (no correlation with population; between 2007 and 2008 there was a leap in alcohol and another big fluctuation in sugars, so we used quite long time-series until 2007), we do not expect a trend in the paper industry, it is not a key category, so we estimated the activity data from values of recent years; we calculated with default emission factors at all sources like in the inventory

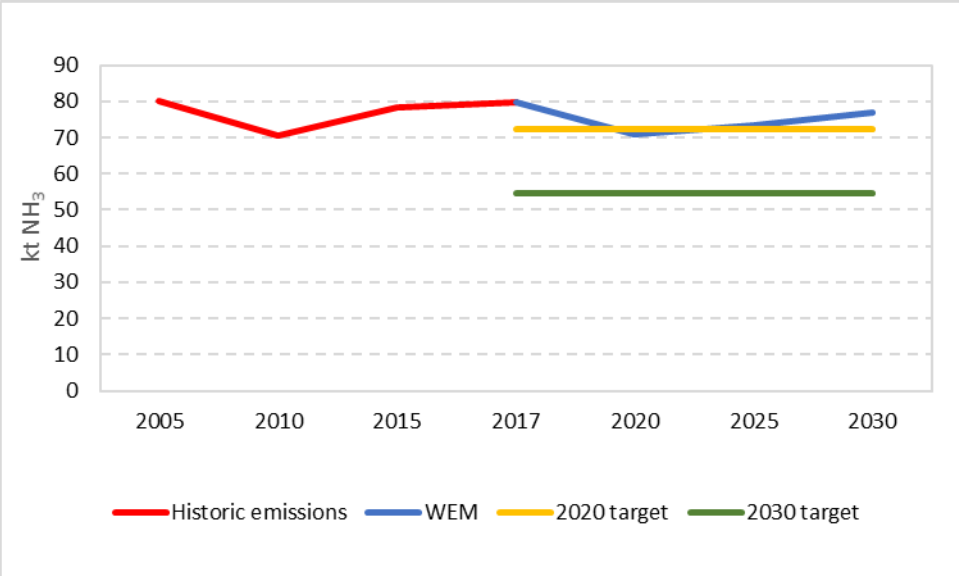
2K: There was no pollutant that should have been projecting.

9.3 AGRICULTURE

Activity data used for projection of agricultural emissions was based on data provided by the Research Institute of Agricultural Economics (RIAE). Number of cattle, swine, layers, broilers and other poultries (as geese and ducks) was projected by the model of the RIAE, while the number of sheep, goats, buffaloes, mules, asses and rabbits were assumed to be the same as 2017.

Data on the amounts of synthetic fertilizer sold were also provided by the RIAE. This data collection is executed in the frame of the National Statistical Data Collection Program. Based on these data the N-content of the synthetic fertilizers used has increased significantly over the period 2005-2017. According to the preliminary data for 2018 the nitrogen fertilizer use has been decreased by 11 per cent which shows major decline compared to previous period. International forecasts such as Fertilizers Europe or GAINS show moderate increase on long run for Hungary which is not supported by fact. For this reason, nitrogen fertilizer application is expected to be kept at a constant level from 2017 onwards.

In 2017 agriculture contributed with 91% of NH3 emissions, 17.6%, of the NO_x, 18.5% of the NMVOC and 1.5% to the PM2.5 emissions under the WEM scenario.



NH_3 emission projections for the With Existing Measures and the emission reduction targets

The total emissions of NH3 from agriculture is expected to decrease by 12% from 2005 to 2020 under the WEM scenario, which is below the 2020 target for that year. Emissions from manure management contributes with around 50% of the total NH3 emissions from the agriculture sector and is expected to increase from 2015 to 2030, despite the emission abatement measures. This is mainly due to the increase in the number of livestock, especially the number of other cattle.

Emissions from synthetic fertiliser use is expected to stagnate over the period 2017 to 2030. The dynamic increase experienced over the period 2005 to 2017 seems to be stopped. Thus, the overall trend shows a 32% increase over the period 2005-2030.

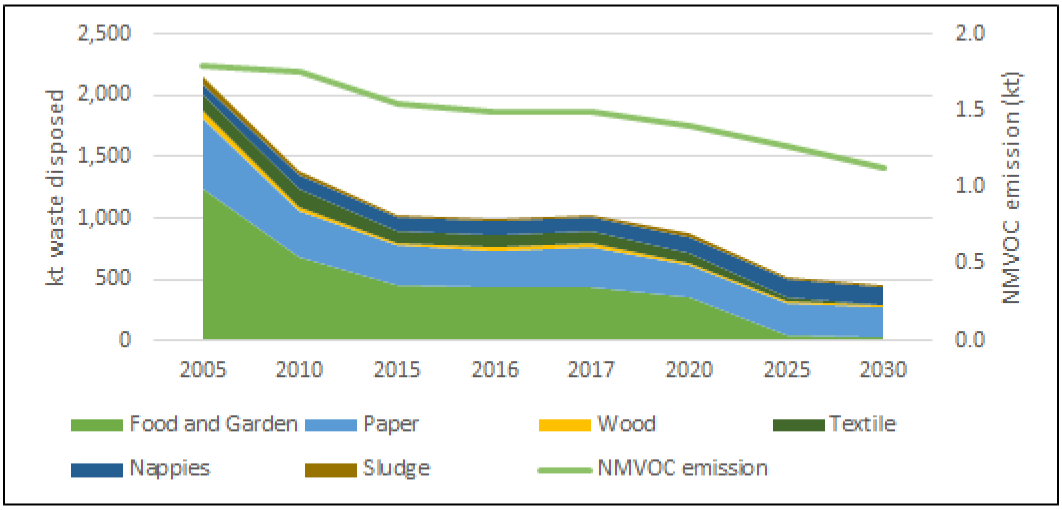
The total emission of NMVOC is expected to increase from 2017 to 2030. 86% of the MNVOC emissions comes from the 3.B Manure management. So, the reason for the growing emission levels is the increasing number of Non-dairy Cattle. The emission of NMVOC from cultivated crops is seems to be quasi-stable.

The total emission of NOx is expected to increase with 48% from 2005 to 2030, this is mainly due to increase in emissions of NOx from synthetic fertilizer use. Emission of NOx from animal manure applied to soil will also contribute to the increasing NOx emissions due to the rising animal livestock and the amount of N applied.

The total emission of PM2.5 is expected to increase slightly from 2005 to 2030 due to increase in the emission from manure management. The increase in PM2.5 emission from manure management is mainly due to increase in emission from non-dairy cattle because of increase in number of animals. The emission of PM2.5 from field operations is expected to decrease due to the minor decrease in agricultural area.

9.4 WASTE

For the projections, basically the same methodologies were used as for the inventory. More specifically, NMVOC emissions from *solid waste disposal* (5A) were calculated from estimated methane emissions assuming that 98.7 % of the landfill gas is methane and 1.3 % are other VOCs such as perchlorethylene, pentane, butane, etc. Methane emissins, in turn, were estimated using the IPCC Waste Model. This approach ensures the consistency with projections reported under Regulation (EU) No 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions. As for activity data (i.e. amount of disposed waste), information received from the ministry responsible for waste management was taken into account. The main underlying assumption was that disposal of degradable organic waste (e.g. food and garden waste) would cease after 2023, and also textile waste would not be disposed in 2030. As a consequence, methane (and consequently NMVOC) generation potential will decrease and so will the amount of recovered biogas. Projected amount of the main degradable waste types disposed together with the resulting NMVOC emission is summarized in the figure below.



In the source categories *biological treatment of waste*, ammonia emissions from both composting of municipal solid waste and anaerobic digestion at biogas facilities were considered (5B1, 5B2). As Tier 1 method with default emission factors was applied, the trend was determined by changes in activity data. It was assumed that growth in composting will continue: we calculated with a 8.5-fold increase between 2005 and 2030 as regards composted MSW. (Source of projected activity data was the ministry responsible for waste management.) Projection of biogas production seems to be quite uncertain for the moment. In this submission a 10% increase up to 2020 was assumed with slight decreases afterwards.

As a general practice, *waste incineration* in Hungary occurs with energy recovery. Consequently, waste incineration without energy recovery (5C1) contributes only with a small fraction to total emissions. As we did not expect any significant changes in this field, we did not introduce any trend and kept the average values of the last three years (2015-2017) from the inventory up to 2030. The same approach was applied to open burning of slash (5C2), too.

As for ammonia emission from latrines, it was assumed that parallel to the increasing share of dwellings connected to the public sewerage network, the use of latrines will diminish to 0.1 per cent in 2030. (In this submission, no projection was provided for NMVOC emission from wastewater treatment that is considered to be negligible.)

No trend was excepted for PM2.5 emissions from building and car fires, the average value of the last three year (2015-17) served as projection here.

10 REPORTING OF GRIDDED EMISSIONS AND LPS

The Hungarian Meteorological Service, in collaboration with the Institute for Transport Sciences and the Hungarian Central Statistical Office, has compiled a database of gridded emissions in a resolution of 0.1 x 0.1 degrees for the year 2015 as required by the reporting guidelines. The latest EMEP/EEA air pollutant emission inventory guidebook served as methodological background for the gridding of emissions. The spatial distribution of the total emission of some important air pollutants is demonstrated by the figures below.

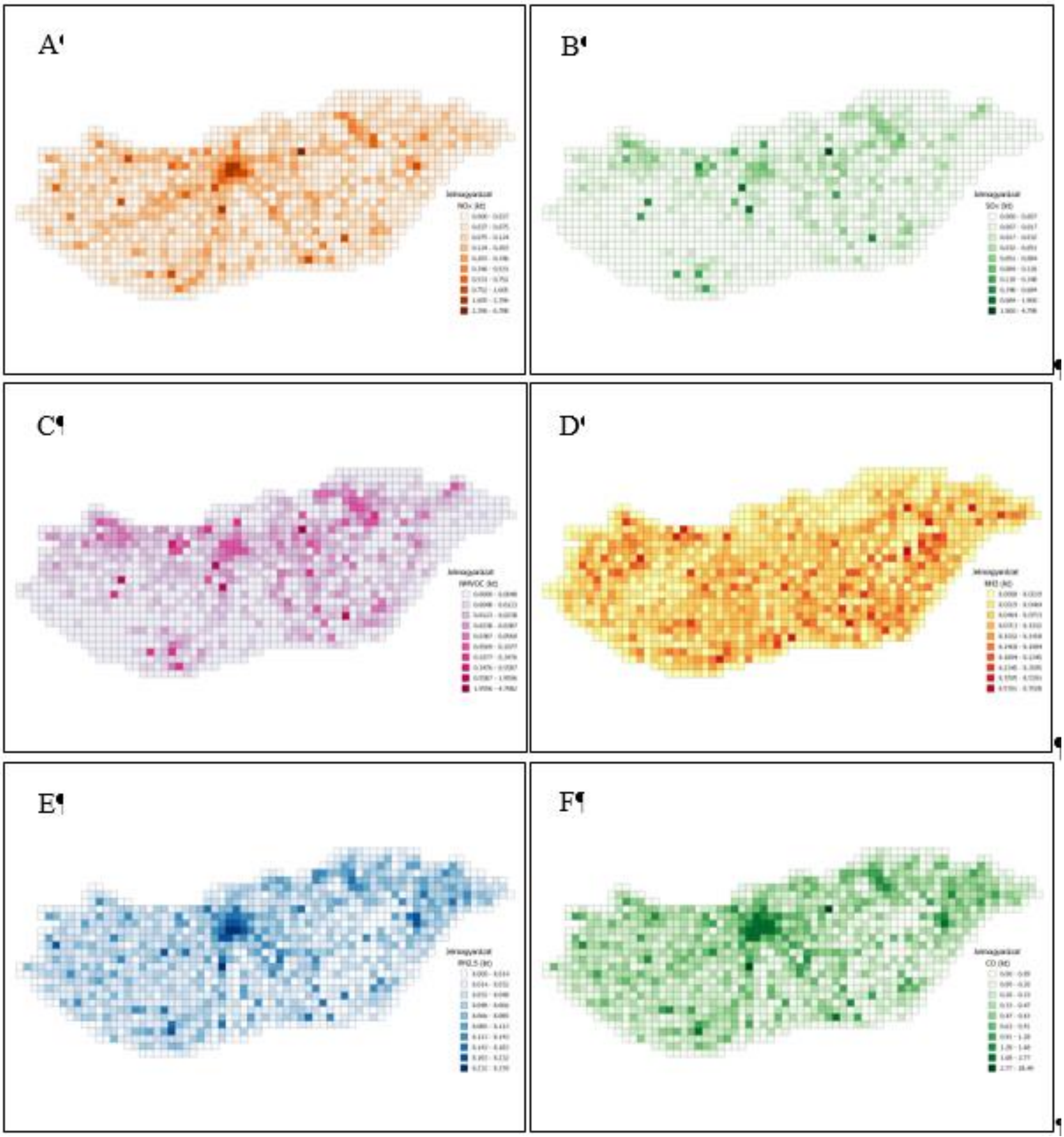


Figure 10.1 Total gridded emissions for Hungary in a 0.1 x 0.1 degrees resolution for the year 2015. A: NOx emissions, B: SOx emissions, C: NMVOC emissions, D: NH3 emissions, E: PM2.5 emissions, F: CO emissions

In the following, the used data and applied methodologies are summarized sector by sector.

Energy Industries (GNFR: A_PublicPower)

As mostly large point sources belong to this category, emissions data of about 84 facilities (with known coordinated) reported to the National Environmental Information System (OKIR) were analyzed. The remaining (diffuse) emissions were distributed to grid cells with population higher than 50,000. As regards heavy metals and POPs, measured data were usually not available (except for the large Municipal Waste Incineration Plant in Budapest). However, as these pollutants are mostly emitted by combustion of solid fuels, the emissions were distributed among coal and biomass fired power plants as follows.

NOX: Reported emissions from large point sources + diffuse emissions in grid cells with population over 50,000;

NMVOC Total emissions were distributed with the proxy of NOx emissions;

SOX Only LPSs were taken into account;

NH3 All emissions were allocated to Municipal Waste Incineration Plant in Budapest (HUHA)

PM TSP: the same method was used as for NOx. All other PM fractions followed the same pattern taking into account the differences in the national total;

CO The same method was used as for NOx

Pb Emissions were distributed among coal and biomass fired plants with a share of 66% and 34%, respectively. Emission of HUHA was also considered;

Cd Emissions were distributed among coal and biomass fired plants with a share of 73% and 27%, respectively. In addition, point source emissions from HuHa and a blast furnace and coke oven gas fired plant were taken into account;

Hg Emissions were distributed among coal and biomass fired plants with a share of 82% and 18%, respectively; Emission of HUHA was also considered;

PCDD/F Emissions were distributed among coal and biomass fired plants with a share of 35% and 65%, respectively. In addition, point source emissions from HuHa and a blast furnace and coke oven gas fired plant were taken into account;

PAH4 Emissions were distributed among coal and biomass fired plants with a share of 13% and 87%, respectively.

HCB Emissions were distributed among coal and biomass fired plants with a share of 78% and 22%, respectively. Emission of HUHA was also considered;

PCB Was allocated solely to biomass fired plants.

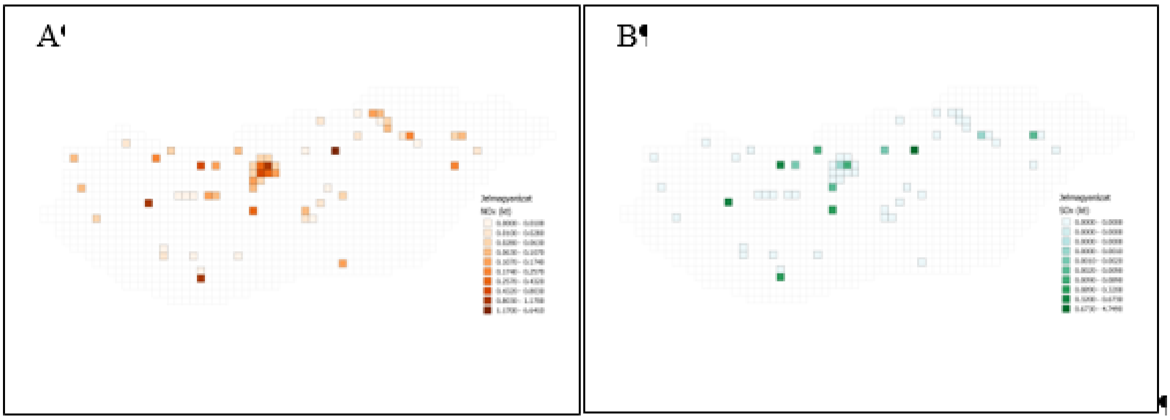


Figure 10.2 NOx (A) and SOx (B) emissions from public electricity and heat production

GNFR: B_Industry

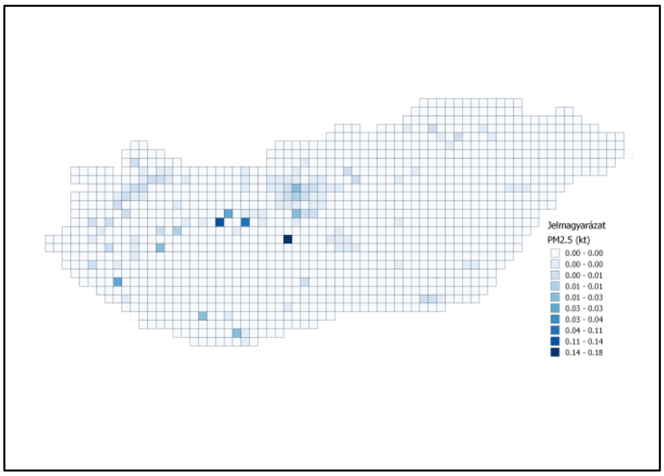


Figure 10.3 PM2.5 emissions from B_Industry in Hungary, 2015

Whenever the location of the source and the corresponding emissions were known, these data were used directly. Otherwise, employment data (in other manufacturing) served as main proxy for emissions from energy use in industry. Emissions from industrial processes were allocated to grid cells by different methods according to different source categories as follows:

2A1 TSP emissions by installation and geographical coordinates were obtained from LAIR database, other emissions were allocated to the appropriate grid cells according to proportion mentioned at methodological issues

2A2 same methodology as 2A1

2A3 geographical coordinates of installations were obtained from LAIR database; emissions were usually divided by production volumes, in some cases emissions were also known from LAIR database;

2A5a emissions are allocated to operational mines other than coal and hydrocarbon obtained from the database of Mining and Geological Survey of Hungary divided by the appropriate area

2A5b emission calculation was based in the previous submission only on the affected area; place of source was determined according to the spatial distribution (known for each township in Hungary) of ongoing construction projects and each motorway construction completed in 2015

2B1 emissions by installation and geographical coordinates were obtained from LAIR database, only NMVOC emission was allocated to the sites in proportion of production volume

2B2 emissions by installation and geographical coordinates were obtained from LAIR database

2B10a NOx, SOx, NH3, CO and TSP emissions by installation and geographical coordinates were obtained from LAIR database; PM and BC emissions were allocated to the appropriate installation according to proportion mentioned at methodological issues; place of NMVOC emission from technology were well known from LAIR database, combustion related NMVOC emission was divided according to the technological NMVOC emissions of companies

2C1 TSP emissions by installation and geographical coordinates was obtained from LAIR database, PMs and BC emissions were allocated to the appropriate grid cells according to proportion mentioned at methodological issues; emissions of other pollutant were divided by production volumes, PCDD/F emissions are well known from LAIR database

2C3 geographical coordinates of supposed producers, where recycling exist, were obtained from LAIR database, emissions were divided according to production volumes reported to the LAIR database

2C6 geographical coordinates of supposed producers, where recycling exist, were obtained from LAIR database, emissions were divided equally

2C7a geographical coordinates of supposed producers, where recycling exist, were obtained from LAIR database, emissions were divided according to production volumes reported to the LAIR database

2H1 geographical coordinates were obtained from LAIR database, emission was allocated to the sites in proportion of production volume

2H2 geographical location of producers having annual income more than a special limit (HUF 20 million) were obtained from LAIR database (originate from HCSO), emissions were divided according to annual income reported to the LAIR database

2K emission was divided by population statistics

Emissions from buildings (GNFR: C_OtherStationaryComb)

Air pollution of the commercial and public sector was distributed by the number of employees. Agricultural (stationary) emissions were also allocated based on employment data expressed in annual labor force. The distribution of domestic emissions was more complicated. Here we had to consider several factors. On the one hand, the heating mode (e.g. individual or central), on the other the different fuel types were taken into account. The number of inhabitants in each cell was also divided according to the above parameters, and the calculations were performed by fuel, weighted by the number of the population.

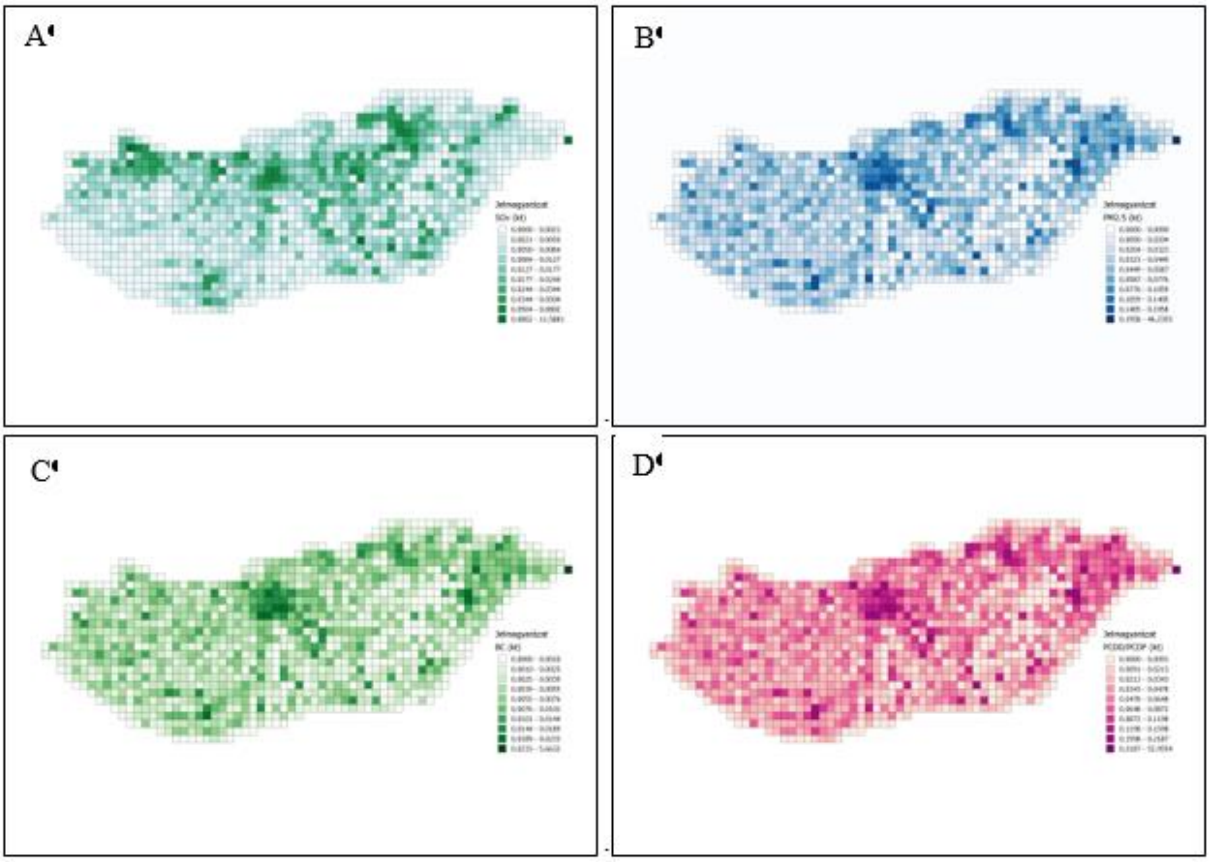


Figure 10.4 Emissions from buildings (GNFR:C_OtherStationaryComb) A: SOx emissions, B: PM2.5 emissions, C: BC (black carbon) emissions, D: PCDD/F (dioxins and furans) emissions

GNFR: D_Fugitive

Emissions from fossil fuel production, transportation and processing were allocated to grid cells by different methods according to different source categories.

In case of coal mining the place of emissions and the amount of extracted coal of each mine were well known, therefore emissions were split to the grid points (and further to grid cells) in proportion to the amount of extracted coal.

Only one production site existed in 2015 in case of solid fuel transformation, so all emissions (which were reported in 1B sector) were allocated to this point source.

In case of emissions from oil and gas pipelines only the place of line source was known, total emissions were distributed among those grid cells which contain segment from pipelines.

Emissions from other transportation (rail, truck) of oil were allocated to the oil storage units taking into account the storage capacity.

Production sites of both oil and natural gas was obtained from the database of Mining and Geological Survey of Hungary, but the production volume of each well was not available, so the total emissions were distributed among the operational wells in equal proportion. Since Hungary has now only one refinery, the gridding did not cause any difficulty neither in case of fugitive emissions nor in case of flaring.

Emissions from distribution of oil product, which were calculated from gasoline consumption, were allocated to gas stations. Hungarian Petroleum Association publishes information about members' market share in the total consumption and also the individual market share of each company. Various sources were taken into account to determine the place of all filling station in Hungary (Hungarian Petroleum Association, publication of companies). Unfortunately, the real gasoline sale of each gas station was not available, therefore it was assumed that all filling station have equal shares within the company.

In case of emissions from storage of natural gas, geographical coordinates of each site were obtained from LAIR database. Emissions of each storage facility were weighted with the volume of injection and withdrawal.

Hungarian Statistical Office provided database on grid cells containing the share of residential gas heating. This information was the base of the calculation of gridded emissions from natural gas distribution.

Place of emissions from flaring at natural gas production sites were also well known from LAIR database.

GNFR: E_Solvents

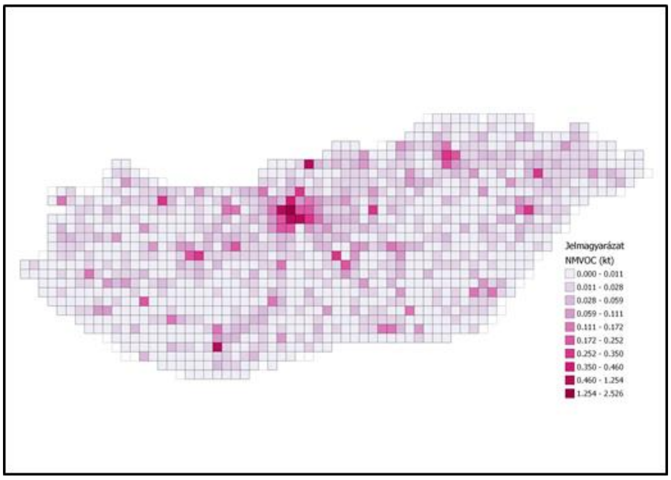


Figure 10.5 NMVOC emissions from E_Solvents in Hungary, 2015

2D3a emission was divided by population statistics

2D3b emissions by installation and geographical coordinates were obtained from LAIR database

2D3c geographical coordinates were obtained from LAIR database

2D3d emission was divided by population statistics

2D3e emissions by installation and geographical coordinates were obtained from LAIR database

2D3f geographical location of producers having annual income more than a special limit (HUF 20 million) were obtained from LAIR database (originate from HCSO), emissions were divided according to annual income reported to the LAIR database

2D3g geographical location of producers were obtained from LAIR database, emission was divided by annual operating hours to the appropriate location

2D3h geographical location of producers having annual income more than a special limit (HUF 20 million) were obtained from LAIR database (originate from HCSO), emissions were divided according to annual income reported to the LAIR database

2D3i emission was divided by population statistics

GNFR: F_RoadTransport

This part of the work was done by the Institute for Transport Sciences. Their work had largely been based on the JRC EDGAR web tool.

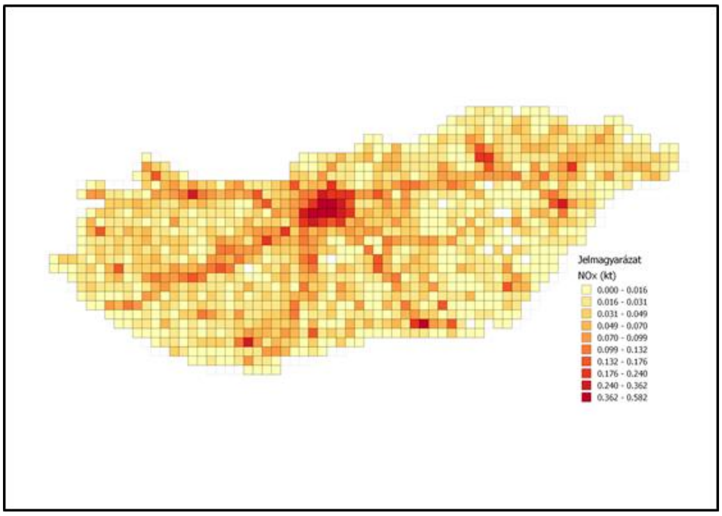


Figure 10.6 NOx emissions from road transport in Hungary, 2015

GNFR: G_Shipping

Emissions were allocated to coordinates of the most important harbors and main routes both in the largest lake (Balaton) and river (Danube).

GNFR: H_Aviation

International aviation emissions were distributed on the basis of the passenger traffic of major international airports, which practically meant that 98.2% of the emissions were allocated to Liszt Ferenc International Airport, 1.6% to Debrecen and 0.2% to Sármellék airports. The almost negligible emissions from domestic aviation were distributed among six airports based on data of other aircraft movements collected by the ministry.

Other mobile sources (GNFR: I_Offroad)

In this aggregate category there are several sources of different characteristics from railway to garden grass mowers which naturally require different approaches. Emissions from agricultural mobile machinery was distributed according to the size of the sowing areas. For industrial machines, number employees in the manufacturing industry was used as proxy. In the case of households, the (typically not too significant) emissions, mostly related to gardening, were distributed following the same pattern as PM emissions from heating in households, assuming that wherever solid fuel combustion occur there is most probably also a garden. Pipeline transport emissions were mostly allocated to compressor stations. The total emissions of military aviation were assigned to MH 59. Szentgyörgyi Dezső Air Force Base. The distribution of rail emissions was provided by the Institute for Transport Sciences.

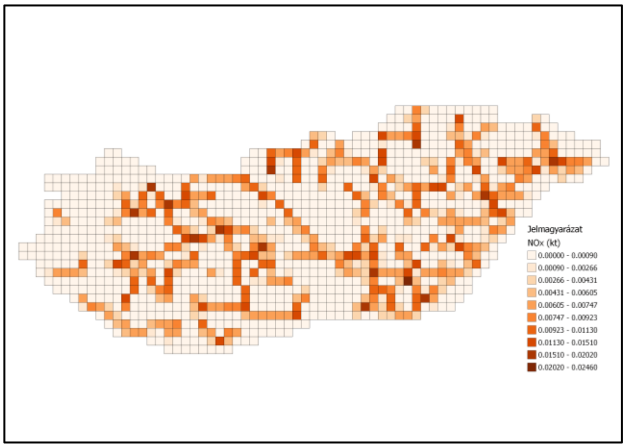


Figure 10.7 NOx emissions from railways in Hungary, 2015

GNFR: K_AgriLivestock

Emissions reported for the year 2015 in 2017 submission were spatially distributed. Emissions were spatially allocated to the grid cells based on the livestock data from the General Agricultural Census 2010, which provide detailed spatial farm livestock survey statistics. The spatial farm livestock data for cattle, swine and poultry, which are the main sources of the agricultural emissions from livestock, were processed and allocated to the grid cells by the HCSO. The NH3, NOx and PM2.5 emissions calculated for the grid each grid cell as the sum of the emissions from the different livestock species, weighted by its share to the total emissions. The use of so detailed livestock data meets the requirement of the Tier 3 spatial mapping approach for emissions from GNFR code K_AgriLivestock.

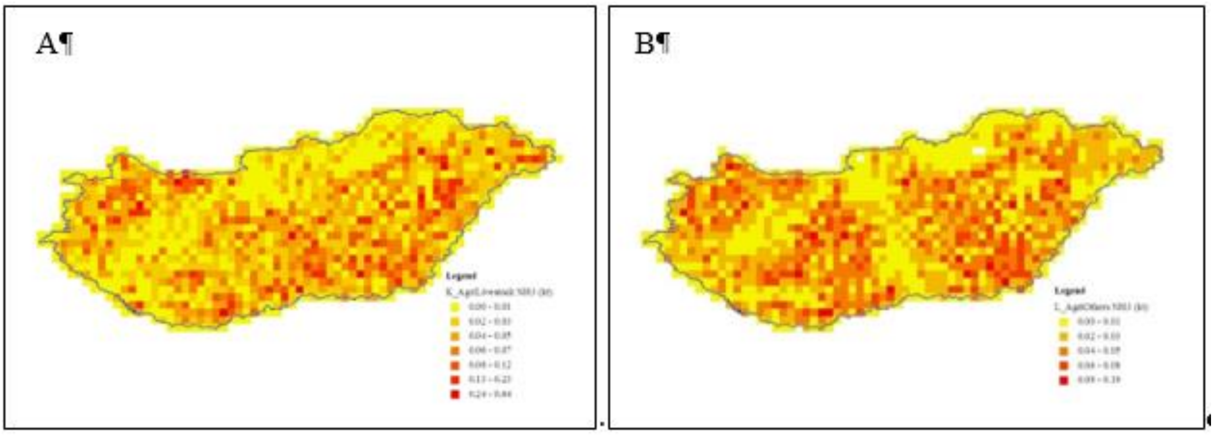


Figure 10.8 A: NH_3 emissions from GNFR code: K_AgriLivestock. B: NH3 emissions from GNFR code: L_AgriOther.

GNFR: L_AgriOther

To the spatial mapping of NH_3, NO_x and $PM_{2.5}$ emissions from 3.D the sowing areas of farms was used as proxy data. The HCSO calculated the sum of sowing areas of farms within the grid cells from the data of the General Agricultural Census 2010.

GNFR: J_Waste

In this category, too, several sources of different nature and different spatial distribution had to be taken into account. NMVOC and PM emissions from landfills were allocated to the location of landfill sites on the basis of amount of landfilled waste. For this, data of 76 municipal waste disposal sites were taken into account. Similarly, NH_3 emission from composting was allocated to composting facilities (about 90) on the basis of the amount composted. In cases of waste incineration, almost all air pollutants should be accounted for. These emissions were distributed among the seven largest incinerators weighted by the amount of waste incinerated. In the case of fires, the number of inhabitants, while in the case of slash burning, the forest area was the basis of the distribution. Emissions from cremation were allocated according to the location of the known crematoriums weighted by the number of population of the associated grid cell. NMVOC emissions of wastewater plants were allocated to the grid cells of their location taking into account the amount of wastewater treated. NH_3 emission from latrines was allocated to those homes that were neither connected to the public sewerage network nor domestic septic system was available.

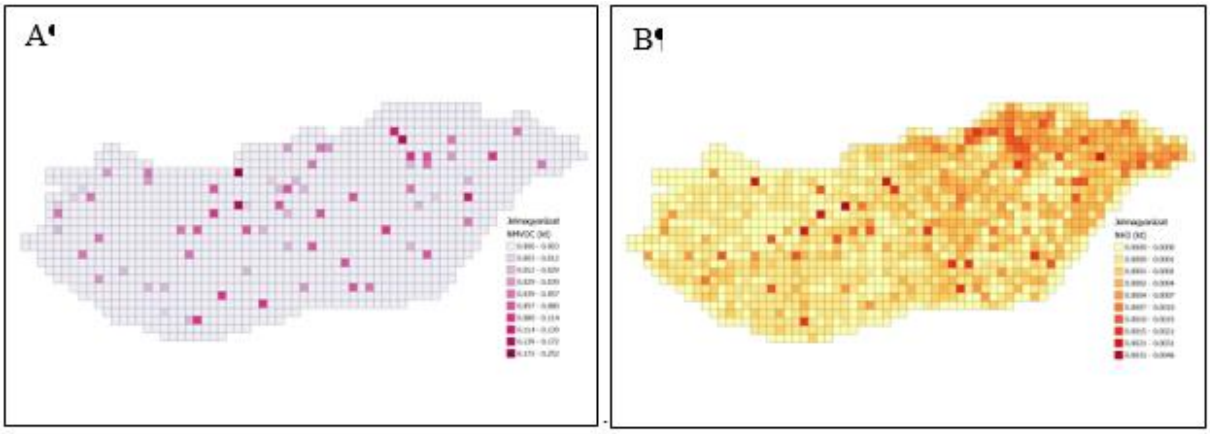


Figure 10.9 NMVOC (A) and NH_3 (B) emission from the waste sector.

11 ADJUSTMENTS

11.1 INTRODUCTION

In accordance with the EMEP Executive Body decision 2012/3 (hereafter: Decision 2012/3) Parties may apply to adjust their national emission inventory data under specific circumstances for the purpose of comparing total national emission with the emission reduction commitments.

Article 21(2) of the 'revised NEC Directive' (Directive (EU) 2016/2284) indicates that Member States may apply Article 5(1) of the Directive in relation to the ceilings in Annex I to Directive 2001/81/EC. Article 5(1) allows Member States to establish adjusted annual national emission inventories where non-compliance with emission ceilings or reduction commitments occur due to applying improved emission inventory methods in accordance with best science.

The information provided in this chapter follows the reporting requirements of the adjustment process presented in EMEP Executive Body decisions 2012/12 (hereafter Decision 2012/12) and in Article 5 and Part 4 of Annex IV of the Directive (EU) 2016/2284, which are summarized here:

The extraordinary circumstances under which Parties/MS may apply an adjustment are as follows:

a) Emission source categories are identified that were not accounted for at the time when emission reduction commitments were set;
b) Emission factors used to determine emissions levels for particular source categories for the year in which emissions reduction commitments are to be attained are significantly different than the emission factors applied to these categories when emission reduction commitments were set;
c) The methodologies used for determining emissions from specific source categories have undergone significant changes between the time when emission reduction commitments were set and the year they are to be attained.

The supporting documentation required by Parties/MS applying for an adjustment is set out in EMEP Executive Body decisions 2012/12 A Party's/MS's supporting documentation for an adjustment to its emission inventory or emission reduction commitments shall include:

a) Evidence that the Party/MS exceeds its emission reduction commitments;
b) Evidence of to what extent the adjustment to the emission inventory reduces the exceedance and possibly brings the Party/MS in compliance;
c) An estimation of whether and when the reduction commitment is expected to be met based on emission projections without the adjustment, thereby using best available science;
d) A full demonstration that the adjustment is consistent with one or more of the three broad categories above. Reference can be made, as appropriate, to relevant previous adjustments:

i. For new emission source categories:
   - Evidence that the new emission source category is acknowledged in scientific literature and/or the EMEP/EEA air pollutant emission inventory guidebook;
   - Evidence that this source category was not included in the relevant historic national emission inventory at the time when the emission reduction commitment was set;
   - Evidence that emissions from a new source category contribute to a Party/MS being unable to meet its reduction commitments, supported by a detailed description of the methodology, data and emission factors used to arrive at this conclusion;

ii. For significantly different emission factors used for determining emissions from specific source categories:
   - A description of the original emission factors, including a detailed description of the scientific basis upon which the emission factor was derived;
   - Evidence that the original emission factors were used for determining the emission reductions at the time when they were set;
   - A description of the updated emission factors, including detailed information on the scientific basis upon which the emission factor was derived;
   - A comparison of emission estimates made using the original and the updated emission factors, demonstrating that the change in emission factors contributes to a Party/MS being unable to meet its reduction commitments; and
   - The rationale for deciding whether the changes in emission factors are significant;

iii. For significantly different methodologies used for determining emissions from specific source categories:
   - A description of the original methodology used, including detailed information on the scientific basis upon which the methodology was based;
   - Evidence that the original methodology was used for determining the emission reductions at the time when they were set;
   - A description of the updated methodology used, including a detailed description of the scientific basis or reference upon which it has been derived;
   - A comparison of emission estimates made using the original and updated methodologies demonstrating that the change in methodology contributes to a Party/MS being unable to meet its reduction commitment; and
   - The rationale for deciding whether the change in methodology is significant;

11.2 ACCEPTED ADJUSTMENTS

In 2018 Hungary applied for two adjustments related to the emissions of NMVOC, due to exceedance of the emissions ceiling. The adjustments were related to NMVOC emissions from 3B Manure management and 3De Cultivated crops, which are new emission sources compared to when the emission reduction commitments were agreed. The two adjustments were accepted during the technical review and approved by the EMEP Steering Body.

The details on adjustments are provided in detail in the following sections and it is also summarized in the excel spreadsheet 'Annex_VII_Adjustments_summary_template.xlsx' that was submitted with the national emission inventory.

11.2.1 NFR 3B MANURE MANAGEMENT (NMVOC)

Emissions were calculated using the methodology provided in the 2019 EMEP/EEA Guidebook. Tier 2 approach was applied for the NFR 3B1a Manure Management- Dairy Cattle, NFR 3B1b Manure Management- Non-dairy Cattle and 3B4giv Manure Management- Other Poultry, and the Tier 1 approach was used for the remaining livestock species. Estimates were undertaken for each livestock categories. Animal population data were combined with the Tier 1 or Tier 2 emission factors to get NMVOC emission estimates from housing, storage and application for each livestock species. (For more details on the calculation see Section 5.3.4.)

The NMVOC emission from animal husbandry and manure management (NFR category 3B) is shown in Table 11.1 below.

Table 11.1 Overview of the adjusted and unadjusted NMVOC emission from NFR 3B Manure Management, kt

	2010	**2011**	**2012**	**2013**	**2014**
NMVOC from 3B Manure management	25.30	25.04	25.28	25.38	25.92
Adjustment	**-25.30**	**-25.04**	**-25.28**	**-25.38**	**-25.92**

11.2.2 NFR 3DE CULTIVATED CROPS (NMVOC)

Emissions were calculated using the Tier 1 methodology presented in the 2019 EMEP/EEA Emission Inventory Guidebook.

The NMVOC emission from cultivated crops (NFR category 3B) is shown in Table 11.2 below.

Table 11.2 Overview of the adjusted and unadjusted NMVOC emissions from NFR 3Dc Cultivated crops, kt

	2010	**2011**	**2012**	**2013**	**2014**
NMVOC emissions from Cultivated crops	3.63	3.57	3.62	3.61	3.64
Adjustment	**-3.63**	**-3.57**	**-3.62**	**-3.61**	**-3.64**

12 ANNEX-1 KEY CATEGORY ANALYSIS

Table A1.2 Final key category ranking of LEVEL assessment across main pollutants

Rank	NFR code	NFR category	% contributions to pollutant totals for key							Sum of KC % contributions
			NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	CO	
1	1A4bi	Residential: Stationary	10%	25%	41%	6%	83%	61%	69%	**295%**
2	1A1a	Public electricity and heat production	10%		40%					**50%**
3	3Da1	Inorganic N-fertilizers (includes also urea application)	14%			24%				**38%**
4	1A3bi	Road transport: Passenger cars	11%	4%					14%	**29%**
5	3Da2a	Animal manure applied to soils	3%			20%				**23%**
6	3B1b	Manure management - Non-dairy cattle		7%		9%				**16%**
7	1A3biii	Road transport: Heavy duty vehicles and buses	16%							**16%**
8	3B1a	Manure management - Dairy cattle		6%		8%				**14%**
9	3B3	Manure management - Swine				10%				**10%**
10	1A3bii	Road transport: Light duty vehicles	10%							**10%**
11	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products						10%		**10%**
12	2D3a	Domestic solvent use including fungicides		9%						**9%**
13	2A5b	Construction and demolition						9%		**9%**
14	3B4gii	Manure mangement - Broilers				6%				**6%**
15	1A4cii	Agriculture/Forestry /Fishing: Off-road	6%							**6%**

Rank	NFR code	NFR category	% contributions to pollutant totals for key							Sum of KC % contributions
			NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	CO	
		vehicles and other machinery								
16	2D3g	Chemical products		5%						**5%**
17	2D3d	Coating applications		5%						**5%**
18	2H2	Food and beverages industry		4%						**4%**
19	2D3h	Printing		4%						**4%**
20	1A4ai	Commercial/institutional: Stationary	3%							**3%**
21	1A3bv	Road transport: Gasoline evaporation		3%						**3%**
22	2B10a	Chemical industry: Other (please specify in the IIR)		3%						**3%**
23	2A5a	Quarrying and mining of minerals other than coal						3%		**3%**
24	3De	Cultivated crops		3%						**3%**
25	1A3biv	Road transport: Mopeds & motorcycles		2%						**2%**
			82%	81%	81%	83%	83%	83%	83%	

Table A1.4 *Final key category ranking of TREND assessment across main pollutants*

Rank	NFR code	Category	% contributions to pollutant totals for key							Sum of KC % contributions
			NO_x	NMVOC	SO_x	NH3	$PM_{2.5}$	PM_{10}	CO	
1	1A4bi	Residential: Stationary	4%	15%	25 %	11%	46%	39%	45%	186%
2	1A3bi	Road transport: Passenger cars	8%	33%					42%	83%
3	1A1a	Public electricity and heat production	9%		23 %		21%	28%		82%
4	3Da1	Inorganic N-fertilizers (includes also urea application)	16%			17%				34%
5	3B3	Manure management - Swine				22%				22%

Rank	NFR code	Category	% contributions to pollutant totals for key						Sum of KC % contributions
6	1A3biii	Road transport: Heavy duty vehicles and buses	9%				5%	3%	18%
7	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	8%		10 %				17%
8	2B10a	Chemical industry: Other (please specify in the IIR)		3%	5%	9%			16%
9	1A3bii	Road transport: Light duty vehicles	14%						14%
10	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	4%		6%				10%
11	2D3d	Coating applications		8%					8%
12	2A1	Cement production					4%	4%	8%
13	2D3a	Domestic solvent use including fungicides		7%					7%
14	3Da2a	Animal manure applied to soils				6%			6%
15	2C1	Iron and steel production					4%	3%	6%
16	3B4gii	Manure management - Broilers				6%			6%
17	3B1b	Manure management - Non-dairy cattle		2%		4%			6%
18	2B2	Nitric acid production	6%						6%
19	1A3c	Railways	6%						6%
20	2D3g	Chemical products		6%					6%
21	1A3dii	National navigation (shipping)		4%					4%
22	1B2c	Venting and flaring (oil, gas, combined oil and gas)			4%				4%
23	5D1	Domestic wastewater handling				4%			4%
24	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products						4%	4%
25	3B4giv	Manure management - Other poultry				4%			4%
26	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel			4%				4%
27	1A2e	Stationary combustion in manufacturing industries and construction: Food			4%				4%

Rank	NFR code	Category	% contributions to pollutant totals for key							Sum of KC % contributions
		processing, beverages and tobacco								
28	1A1b	Petroleum refining			3%					3%
29	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery					3%			3%
30	2D3h	Printing		3%						3%
			84%	81%	83 %	82%	83%	81%	88%	

13 ANNEX-2 VERIFICATION

Table A2.1 ***Comparison of NFR, LAIR and E-PRTR emission data (kt). PRTR data for 2017 are preliminary***

NO_x	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
LAIR	55,99	56,02	38,44	41,45	41,37	35,61	69,09	38,44	39,75	31,04	26,54	26,88	22,91	23,76
EPER-EPRTR				32,64	35,49	28,23	29,46	27,79	26,87	25,80	26,06	26,04	21,04	23,47
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	57,35	53,67	47,11	47,52	45,02	40,25	43,15	37,94	36,15	32,88	29,48	29,34	25,40	25,62
NFR2017 National Total	179,04	176,28	168,56	164,63	158,99	147,93	144,82	135,03	127,09	124,65	122,51	124,37	116,88	119,28
NMVOC														
LAIR	0,04	0,02	0,01	0,02	0,01	0,01	0,00	0,00	0,02	0,01		0,00		
EPER-EPRTR				1,53	1,64	3,09	4,83	7,69	6,04	3,91	2,71	1,66	0,22	
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1)	19,13	20,03	19,15	16,91	16,75	16,37	16,91	16,76	15,11	15,82	15,44	16,02	15,92	15,70
NFR2017 National Total	181,70	171,50	158,80	155,21	149,63	149,96	146,04	150,24	151,94	151,16	141,29	144,13	142,02	141,52
SO_x														
LAIR	126,46	23,90	18,85	19,69	19,36	13,06	15,08	18,05	13,39	13,70	12,56	10,27	10,24	13,30
EPER-EPRTR				18,98	20,06	19,82	19,23	22,77	16,21	15,58	15,36	12,36	12,66	15,39
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1)	130,14	22,95	19,46	23,55	20,84	17,08	16,71	19,17	15,39	14,97	14,29	12,83	11,26	15,25
NFR2017 National Total	151,50	43,01	39,23	36,31	35,90	29,79	30,50	34,33	30,57	29,41	26,04	24,32	23,01	27,72

NH_3														
LAIR	0,38	0,54	0,76	0,55	0,41	0,48	0,44	0,54	0,41	0,46	0,75	0,36	0,47	0,54
EPER-EPRTR				15,32	15,25	15,20	15,40	15,84	15,62	15,16	16,48	16,13	15,70	16,65
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1)	0,49	0,65	0,70	0,59	0,43	0,47	0,38	0,48	0,47	0,53	0,59	0,43	0,54	0,59
NFR SUM 3B3Swine + 3B4g Poultry	30,84	28,02	27,33	27,10	26,09	24,26	24,69	24,04	22,59	22,12	22,66	23,20	23,13	21,68
NFR2017 National Total	90,54	86,04	85,97	86,00	79,22	76,93	78,01	79,29	79,17	82,20	82,36	86,81	86,94	87,70
$PM_{2.5}$														
LAIR	missing, not regulated													
EPER-EPRTR	NA													
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	7,08	5,59	4,46	3,88	4,45	4,33	3,17	3,21	2,71	2,84	3,56	3,34	3,29	3,44
NFR2017 National Total	42,63	40,08	40,22	40,13	36,11	46,73	49,43	55,23	57,85	58,59	49,46	51,68	49,87	47,99
PM_{10}														
LAIR	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,04	0,04	0,05	0,04
EPER-EPRTR				2,62	2,31	0,52	1,15	2,76	1,04	0,90	1,43	1,43	5,35	
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	27,55	26,67	16,82	14,38	21,89	22,53	14,00	11,03	6,73	10,55	15,55	14,02	12,75	13,33
NFR2017 National Total	74,65	72,28	63,74	61,82	64,62	76,17	71,63	74,47	73,22	77,65	72,64	73,58	70,52	68,87
TSP														
LAIR	17,60	7,75	7,42	6,29	4,88	2,84	3,84	3,41	4,34	2,99	3,69	3,41	3,19	3,17

NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	73,58	77,84	45,69	38,10	63,56	66,46	39,23	28,91	14,81	28,45	43,12	38,49	34,29	35,83
NFR2017 National Total	130,60	132,86	102,07	94,90	115,34	129,19	106,17	101,69	90,59	104,88	109,13	107,25	101,12	100,15
CO														
LAIR	134,16	66,06	69,33	68,13	56,32	26,19	42,94	44,55	53,51	38,98	36,53	38,20	32,13	40,88
EPER-EPRTR				136,09	122,58	80,98	114,88	98,65	94,48	72,61	76,12	87,37	67,97	88,47
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	124,75	92,55	63,13	61,11	47,69	37,48	37,90	37,74	36,21	32,30	31,21	34,07	30,72	37,33
NFR2017 National Total	750,11	682,04	581,97	539,50	480,64	521,43	523,37	530,30	545,72	538,01	460,32	445,13	436,66	422,64

14 ANNEX-3 RESPONSES TO THE NECD REVIEW OF THE 2018 INVENTORY SUBMISSION

EMRT-NECD Observation	Improvement made/planned	Reference into IIR
HU-2D3a-2017-0001	The recommendation will be implemented in a future inventory submission	/
HU-2G-2017-0001	According to the recommendation Hungary was completed the NFR and the IIR with the revised estimation for several pollutants (use of fireworks). Moreover, Hungary corrected the emission factors for PM2.5, PM10 and TSP in this category.	NFR tables, IIR Chapter 4.5.10 (Other product use (NFR Sector 2.G))
HU-2C6-2017-0001	Emission estimates have been included and a methodological description has been added in the IIR 2020.	NFR tables, IIR Chapter 4.4.3
HU-2D3d-2019-0001	Emission estimates have been included and a methodological description has been added in the IIR 2020.	NFR tables, IIR Chapter 4.5.4 (Coating application (NFR Sector 2.D.3.d))
HU-1A1c-2019-0001	The error has been corrected	/
HU-1B2aiv-2019-0001	EFs from the latest 2019 EMEP/EEA Guidebook was used.	/
HU-2D3f-2019-0001	Emission estimates have been included and a methodological description has been added in the IIR 2020.	NFR tables, IIR Chapter 4.5.6
HU-2D3g-2019-0001	Emissions from pharmaceutical production is still under investigation.	/
HU-2D3h-2019-0001	The recommendation will be implemented in a future inventory submission	/
HU-3B4gi-2019-0001	Country-specific N-excretion rates have been developed for 3B4gi Laying hens and 3B4gii Broilers. NH_3 emissions have been calculated from both animal categories using Tier 2 methodology provided in the 2019 EMEP/EEA Guidebook.	Section 5.3.1.3 of HU's IIR, 2019
HU-5D1-2019-0001	Based on recent surveys, shares of people using septic systems/latrines have been revised.	See Ch. 6.6.
HU-1A3b-2018-0001	COPERT model (5.3.0) was used to calculate emissions from lubricant use. The corresponding emissions are partly reported under 1A3b and partly under 2D3i.	/
HU-1A4ciii-2018-0001	The recommendation has not yet been addressed.	/
HU-2C3-2018-0001	The recommendation will be implemented in a future inventory submission	/

EMRT-NECD Observation	Improvement made/planned	Reference into IIR
HU-2C3-2018-0002	The recommendation will be implemented in a future inventory submission	/
HU-2D3g-2018-0001	Emission estimates have been included and a methodological description has been added in the IIR 2020.	NFR tables, IIR Chapter 4.5.7 (Chemical products (NFR Sector 2.D.3.g))
HU-5E-2018-0001	The missing methodological description has been added to the IIR	IIR Chapter 6.7
HU-1B2d-2019-0002	NH3, Hg, and As emissions have been added for 2017-18, the used NKs have been revised.	/
HU-0A-2019-0001	QC procedures have been improved, e.g. compilation files detect ‘0’ values.	/
HU-1A1a-2019-0001	We have not yet implemented a proper T2 methodology, it is planned improved. We noted, however, that for solid fuels T1 and T2 EFs are the same for the technologies used in Hungary (DBB and FBB)	/
HU-1A2d-2019-0001	We changed the previously used EF specific for small combustion to EF for power plants. For Pb, T1=T2.	/
HU-1A3ai(i)-2019-0001	HMs and PCDD/F emissions have been added.	/
HU-1A3di(ii)-2019-0001	The recommendation has not yet been addressed.	
HU-1B2d-2019-0001	The notation keys have been amended accordingly.	
HU-2A3-2019-0001	The recommendation will be implemented in the 2021 inventory submission	/
HU-2C1-2019-0001	The recommendation will be implemented in the 2021 inventory submission	/
HU-3Df-2019-0001	HCB emissions from 3Df Use of pesticides have been reported for the whole inventory period.	Chapter 5.4.11 of HU’s IIR, 2020.
HU-3F-2019-0001	Notation keys in the NFR Tables have been corrected according to revisions made due to HU-3F-2019-0002.	NFR Tables
HU-3F-2019-0002	Activity data for 3.F has been revised and emissions have been reported under 3.F.	Chapter 5.5 of HU’s IIR, 2020.
HU-5C1bi-2019-0001	Background information on the used EFs has been added to the IIR	IIR Chapter 6.4
HU-5C1bii-2019-0001	Background information on the used EFs has been added to the IIR	IIR Chapter 6.4
HU-5C1biii-2019-0001	EFs for clinical waste incineration have been revised.	IIR Chapter 6.4
HU-5C1biv-2019-0001	IIR has been amended accordingly.	IIR Chapter 6.4

EMRT-NECD Observation	Improvement made/planned	Reference into IIR
HU-5C1bv-2019-0001	Short information on cremation has been added to the IIR.	IIR Chapter 6.4

15 ABBREVIATIONS

EF - emission factor
IEF- implied emission factor (emission/activity data)
AD – activity data
GHG- Greenhouse gas
GDP - gross domestic product
NCV - net calorific value
QA - quality assurance
QC - quality control
LAIR = Air pollution segment of the National Environmental Information System (partly available for the public at: http://okir.kvvm.hu/lair/)
HMS = Hungarian Meteorological Service
HCSO = Hungarian Central Statistical Office
Guidebook - EMEP/EEA 2009 = EMEP/EEA air pollutant emission inventory guidebook (European Environmental Agency Technical Report No 9/2009)
http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009
NFR - Nomenclature for Reporting (Required table format of reporting under CLRTAP and NEC) (NFR tables are available at: http://www.ceip.at/submissions-under-clrtap/2012-submissions/)
CLRTAP - UNECE Convention on Long-range Transboundary Air Pollution
NEC – National Emission Ceiling Directive (Directive 2001/81/EC of The European Parliament And Of The Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants – NEC Directive)
EMEP - Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
EEA - European Environment Agency (www.eea.eu)
IIASA – International Institute for Applied Systems Analysis (http://www.iiasa.ac.at/)
SNAP - Selected Nomenclature for reporting of Air Pollutants
UNFCCC reporting = reporting required by the United Nations Framework Convention on Climate Change (GHG inventories are available at:
http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php)

CRF - Common Reporting Format ((Required table format of reporting under UNFCCC)
NIR - National Inventory Report (Submission under the United Nations Framework Convention on Climate Change)
IPCC - Intergovernmental Panel on Climate Change
IPPC - Integrated pollution prevention and control Regulation based on Council Directive 2008/1/EC of 15 January 2008 replaced by Directive on industrial emissions 2010/75/EU (IED)
BAT - Best Available Techniques
BREF - Best Available Techniques Reference documents available at: http://eippcb.jrc.es/reference/
E-PRTR - The European Pollutant Release and Transfer Register (Data is available at: http://prtr.ec.europa.eu/)
EU ETS – European Union Emission Trading Scheme

CORINE: CORINE Land Cover Inventory (CLC2000 project with 26 participating countries in Europe)
IEA - International Energy Agency
FAO – Food and Agricultural Organization

Chemical formulas

Definitions of pollutants to report are provided in Guidelines for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/97 - available at: http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf)

C carbon
CH_4 methane
CO carbon monoxide
CO_2 carbon dioxide
HFCs hydrofluorocarbons
NMVOC non-methane volatile organic compound
N_2O nitrous oxide
NO_X nitrogen oxide
NH_3 ammonia
PFCs perfluorocarbons
SO_2 sulphur dioxide

HM – heavy metals (Pb. Cd. Hg. *As. Cr. Cu. Ni. Se. Zn*)
PM_{10} – particulate matter
$PM_{2.5}$ – particulate matter
TSP – Total Suspended Particles
POP – Persistent Organic Pollutants
PAH – Polycyclic aromatic hydrocarbons
HCB - Hexachlorobenzene
PCBs - polychlorinated biphenyls
HCH- hexachlorocyclohexane
PCDD/F - dioxins/furans

$CaCO_3$ calcium carbonate. limestone
$MgCO_3$ magnesium carbonate
CaO calcium oxide. quicklime
$Ca(OH)_2$ slack lime
HNO_3 nitric acid

Units
PJ petajoule (10^{15} J)
TJ terajoule (10^{12} J)
Gg gigagram (10^9 g)
kt kilotonnes (1000 t)
g I-Teq – gramm toxic equivalent

Notation key of NFR Table recommended by ECE/EB.AIR/97. Guidelines

(NE) Not estimated: Emissions occur. but have not been estimated or reported.
(IE) Included elsewhere: Emissions for this source are estimated and included in the inventory but not presented separately for this source. The source where these emissions are included should be indicated.
(C) Confidential information: Emissions are aggregated and included elsewhere in the inventory because reporting at a disaggregated level could lead to the disclosure of confidential information.
(NA) Not applicable: The source exists but relevant emissions are considered never to occur.
(NO) Not occurring: An source or process does not exist within a country.
(NR) Not relevant: According to paragraph 9 in the Emission Reporting Guidelines. emission inventory reporting should cover all years from 1980 onwards if data are available. However. “NR” (not relevant) is introduced to ease the reporting where emissions are not strictly required by the different protocols. e.g. for some Parties emissions of NMVOCs prior to 1988.