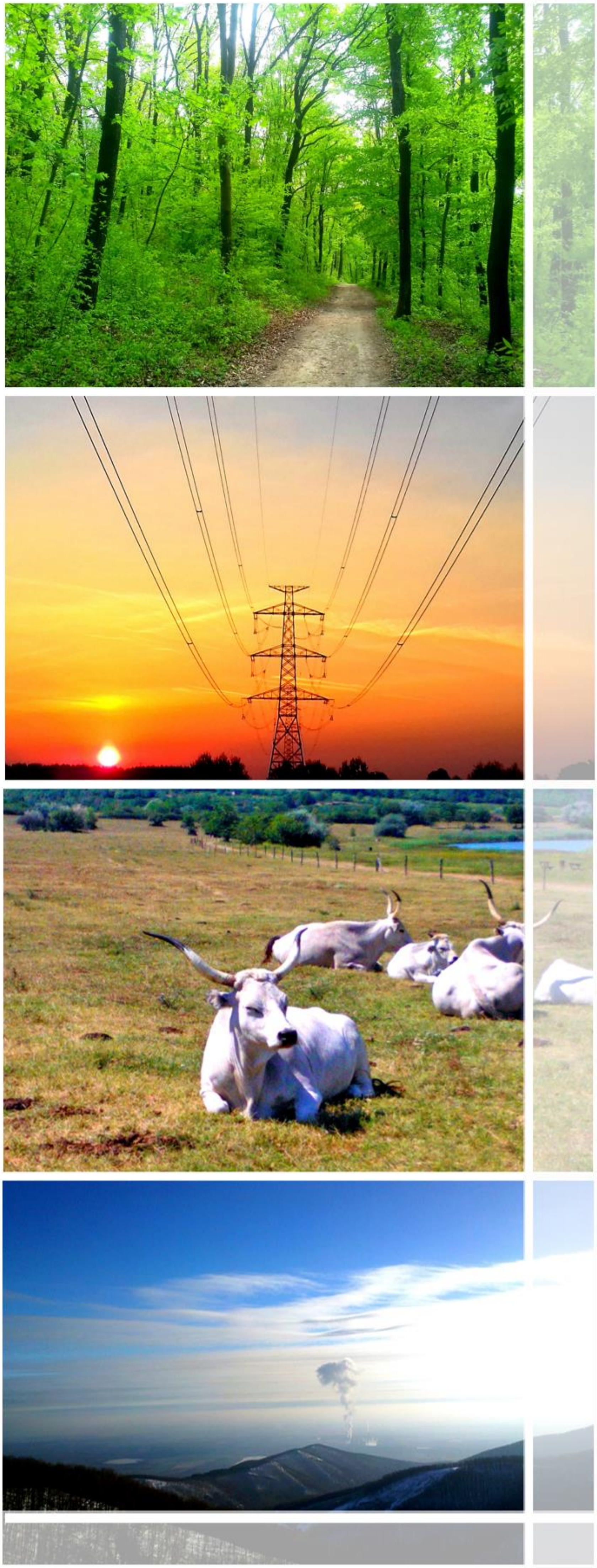

Informative Inventory Report

2017

Hungary

Compiled by the ***Hungarian Meteorological Service***

Unit of National Emissions Inventories

2019

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CONTENT

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 2018 submission contains (partly recalculated) time-series for all years between 1990-2016 (2000-2016 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 2016 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
NOx (kt)	**241,7**	**188,2**	**185,3**	**176,3**	**159,0**	**144,8**	**127,1**	**124,7**	**122,5**	**124,4**	**116,9**	**119,3**
NMVOC (kt)	**301,7**	**212,2**	**197,1**	**171,5**	**149,6**	**146,0**	**151,9**	**151,2**	**141,3**	**144,1**	**142,0**	**141,5**
SOx (kt)	**829,5**	**613,7**	**427,2**	**43,0**	**35,9**	**30,5**	**30,6**	**29,4**	**26,0**	**24,3**	**23,0**	**27,7**
NH3(kt)	**149,3**	**88,5**	**93,2**	**86,0**	**79,2**	**78,0**	**79,2**	**82,2**	**82,4**	**86,8**	**86,9**	**87,7**
PM2.5(kt)	**NR**	**NR**	**48,2**	**40,1**	**36,1**	**49,4**	**57,8**	**58,6**	**49,5**	**51,7**	**49,9**	**48,0**
PM10(kt)	0,0	0,0	72,4	72,3	64,6	71,6	73,2	77,6	72,6	73,6	70,5	68,9
TSP(kt)	0,0	0,0	105,0	132,9	115,3	106,2	90,6	104,9	109,1	107,3	101,1	100,1
CO(kt)	1413,0	963,9	829,7	682,0	480,6	523,4	545,7	538,0	460,3	445,1	436,7	422,6
Pb (t)	839,2	305,4	20,6	9,9	10,7	8,2	8,9	8,3	7,8	8,2	8,8	8,6
Cd (t)	1,7	1,5	1,7	1,2	1,2	1,5	1,6	1,7	1,5	1,5	1,5	1,5
Hg (t)	3,3	2,6	2,3	1,7	1,5	1,5	1,2	1,1	1,1	1,1	1,2	1,3
PCDD/F (g I-Teq)	104,7	66,6	72,4	59,6	52,4	76,5	86,5	80,7	70,7	78,9	77,4	66,7
PAHs (t)	79,1	30,3	25,4	23,8	20,5	28,7	34,5	34,8	28,3	29,5	30,1	29,6

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 *Substances for which parties are encouraged to report emission data*

Carbon monoxide	
Particulate matter (PM_{10} and $PM_{2.5}$ and TSP (total suspended particulate matter)).	
$PM_{2.5}$**: The mass of particulate matter that is measured after passing through a size-selective inlet with a 50 per cent efficiency cut-off at 2.5 µm aerodynamic diameter;**	
PM_{10}: **The mass of particulate matter that is measured after passing through a size-selective inlet with a 50 per cent efficiency cut-off at 10 µm aerodynamic diameter;**	
(TSP **the mass of particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analyzed, and which remain upstream of the filter and on the filter after drying under specified conditions.**	**Total suspended particulate matter (TSP)**;
	Black carbon (BC) , which means carbonaceous particulate matter that absorbs light
Heavy metals **(arsenic, chromium, copper, nickel, selenium, zinc) and their compounds.**	Arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se) and zinc (Zn) and their compounds
Persistent organic pollutants (lindane, dichloro-diphenyl-trichloroethane (DDT),	
polychlorinated biphenyl (PCBs)**, pentabromodiphenyl ether (PeBDE), perfluorooctane sulfonate (PFOS), hexachlorobutadeine (HCBD), octabromodiphenyl ether (OctaBDE), polychlorinated naphthalenes (PCNs), pentachlorobenzene (PeCB) and short-chained chlorinated paraffins (SCCP).**	

No GHGs are to be reported in this case. Reports of GHG emissions are available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php

However, NMVOC, NO_x, SO_x, CO are also indirect GHGs, and these should be reported in certain cases but not included in national TOTAL in UNFCCC.

"As emissions of oxides of nitrogen (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), and sulphur dioxide (SO_2) are reported both to the UNFCCC and UNECE CLRTAP it is important to ensure consistent methodologies and reporting between these two Conventions. (UNECE, 2003)" (IPCC 2006 Volume 1 chapter 7.2.1 box 7.1)

The consistency between the Hungarian GHG inventory and the present Air pollutants emission inventory is continuously improving.

1.2 HU COMMITMENTS

Both Gothenburg Protocol and 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) includes emission ceilings for the Parties/ Member States. Emission ceilings have to be met by 2010 and should not be exceeded after. In Table 1.2 the commitments of Hungary are presented in addition to 2010 emissions. As it is possible to see the commitments are met for all pollutants (in case of NMVOC only with adjustment).

Table 1.4 *HU commitments of NEC Directive and Gothenburg Protocol*

	Fixed emission level for 1990	HU commitment for 2010 (and until 2020)		Hungarian emission in 2019 inventory submission							
		NEC	Gothenburg Protocol	2010	2011	2012	2013	2014	2015	2016	2017
SOx(kt)	1010	500	550	**30**	**34**	**31**	**29**	**26**	**24**	**23**	**28**
NOx (kt)	238	198	198	**145**	**135**	**127**	**125**	**123**	**124**	**117**	**119**
NH3 (kt)	124	90	90	**78**	**79**	**79**	**82**	**82**	**87**	**87**	**88**
NMVOC (kt)	205	137	137	**146**	**150**	**152**	**151**	**141**	**144**	**142**	**142**

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 1.5 *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 2017**	**% reduction compared to 2005 level**	***% change compared to 2005 level in 2017***	***% distance from 2020 commitment in 2017***
NO_x(kt)	176	119	-34%	*-32%*	*-2%*
VOC (kt)	172	142	-30%	*-17%*	*-13%*
SO_2 (kt)	43	28	-46%	*-36%*	*-10%*
NH_3 (kt)	86	88	-10%	*2%*	*-12%*
PM2.5 (kt)	40	48	-13%	*20%*	*-33%*

Note: Red = at present commitment not achieved

1.3 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.

1.4 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.

1.5 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 2013 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.

1.6 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 = $\left| \textit{source category estimate} \right|$ */ 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 1.6 *Summary of Approach 1 level key category analysis*

Key Category Analysis 1990

Component	Key categories (Sorted from high to low from left to right)											Total (%)
SOx	1A1a (50.4%)	1A4bi (30.0%)										80.5
NOx	1A3bi (14.6%)	1A1a (14.5%)	1A3biii (11.1%)	1A4bi (8.0%)	3Da1 (5.9%)	1A4cii (5.9%)	1A2gviii (5.6%)	1A3c (4.8%)	1A2f (4.8%)	1A3bii (3.0%)	2B2 (3.0%)	81.3
NH3	3B3 (24.4%)	3Da2a (22.6%)	3Da1 (15.1%)	3B1b (7.9%)	3B1a (7.4%)	3B4gi (4.9%)						82.3
NMVOC	1A3bi (31.9%)	1A4bi (12.8%)	2D3d (10.6%)	2D3a (4.4%)	3B1b (4.2%)	3B1a (4.0%)	2H2 (3.8%)	1A3dii (3.7%)	1A3bv (2.3%)	3B3 (1.8%)	2D3h (1.7%)	81.2
CO	1A3bi (45.1%)	1A4bi (35.8%)										80.9
Pb	1A3bi (84.7%)											84.7
Hg	2B10a (20.1%)	1A4bi (16.8%)	1A1a (16.7%)	5C1biii (13.6%)	2C1 (9.1%)	1A2f (5.9%)						82.2
Cd	1A4bi (30.0%)	1A1a (17.1%)	1B2c (15.0%)	2G (8.5%)	2C7a (7.3%)	5C1biii (4.8%)						82.7
DIOX	1A4bi (69.7%)	2C1 (12.1%)										81.8
PAH	1A4bi (92.8%)											92.8
HCB	1A1a (44.3%)	5C1biii (40.0%)										84.3

Key Category Analysis 2005

Component	Key categories (Sorted from high to low from left to right)														Total (%)
SOx	1A4bi (37.9%)	1A1a (34.6%)	1A2f (5.4%)	1A1b (3.7%)											81.5
NOx	1A3biii (22.8%)	1A1a (15.7%)	1A3bi (13.9%)	1A4bi (7.5%)	1A3bii (5.9%)	3Da1 (5.9%)	1A2f (5.3%)	1A4cii (4.7%)							81.7
NH3	3Da2a (24.2%)	3B3 (18.1%)	3Da1 (15.5%)	3B1a (9.1%)	3B1b (6.0%)	3B4gi (5.3%)	3B4gii (3.8%)								81.9
NMVOC	1A3bi (16.4%)	1A4bi (13.0%)	2D3d (8.6%)	2D3a (7.5%)	2D3g (7.3%)	2H2 (5.5%)	3B1a (3.8%)	1A3biv (3.6%)	2D3h (3.1%)	3B1b (2.9%)	1A3bv (2.9%)	2B10a (2.5%)	3De (2.1%)	2D3f (1.8%)	81.0
CO	1A3bi (47.2%)	1A4bi (31.0%)	1A2a (9.5%)												87.7
TSP	2A5b (50.8%)	1A4bi (22.1%)	3Dc (5.0%)	2A5a (3.3%)											81.2
PM10	1A4bi (38.5%)	2A5b (27.9%)	3Dc (9.2%)	2A5a (2.9%)	1A3bii (1.9%)										80.4
PM2.5	1A4bi (67.5%)	2A5b (5.0%)	1A3bii (3.5%)	1A3biii (3.4%)	1A3bi (2.8%)										82.2
Pb	1A4bi (27.7%)	1A1a (16.7%)	2C1 (14.5%)	1A3bvi (13.8%)	2A3 (11.1%)										83.7
Hg	5C1biii (24.0%)	1A1a (16.5%)	1A4bi (11.9%)	2C1 (11.6%)	1A2f (8.3%)	2K (6.0%)	2B10a (4.5%)								82.8
Cd	1A4bi (45.8%)	1A1a (16.4%)	2G (7.1%)	5C1biii (6.4%)	2A3 (3.8%)	2C1 (3.3%)									82.9
DIOX	1A4bi (56.7%)	2C1 (17.9%)	5E (11.2%)												85.7
PAH	1A4bi (90.6%)														90.6
HCB	5C1biii (47.3%)	1A1a (33.8%)													81.0

Key Category Analysis 2017

Component	Key categories (Sorted from high to low from left to right)														Total (%)
SOx	1A4bi (41.5%)	1A1a (40.1%)													81.6
NOx	1A3biii (15.1%)	3Da1 (13.9%)	1A3bi (11.3%)	1A3bii (10.9%)	1A4bi (10.1%)	1A1a (9.7%)	1A4cii (5.7%)	1A4ai (3.6%)							80.3
NH3	3Da2a (22.7%)	3Da1 (20.0%)	3B3 (12.2%)	3B1b (9.2%)	3B1a (8.6%)	1A4bi (5.3%)	3B4gii (4.0%)								82.1
NMVOC	1A4bi (22.8%)	2D3d (12.2%)	2D3a (8.8%)	3B1b (5.0%)	2D3g (4.9%)	3B1a (4.2%)	2H2 (4.1%)	2D3h (3.7%)	1A3bi (3.6%)	1A3bv (3.1%)	2B10a (3.0%)	3De (2.5%)	2D3f (2.1%)	1A3biv (1.8%)	81.7
CO	1A4bi (69.2%)	1A3bi (14.3%)													83.5
TSP	1A4bi (42.8%)	2A5b (28.4%)	3Dc (6.5%)	2A5a (4.0%)											81.7
PM10	1A4bi (59.2%)	2A5b (12.4%)	3Dc (9.5%)												81.0
PM2.5	1A4bi (82.8%)														82.8
Pb	1A4bi (32.9%)	1A3bvi (18.9%)	1A1a (14.9%)	2A3 (9.9%)	1A2d (5.8%)										82.3
Hg	1A1a (15.0%)	2C1 (14.2%)	2B10a (12.0%)	1A4bi (11.9%)	5C1biii (10.5%)	2K (7.3%)	1A2f (6.9%)	2D3a (4.1%)							81.8
Cd	1A4bi (61.5%)	1A1a (9.7%)	2G (4.7%)	2A3 (4.2%)											80.0
DIOX	1A4bi (69.5%)	5E (14.1%)													83.6
PAH	1A4bi (90.2%)														90.2
HCB	1A1a (32.9%)	1A4bi (23.9%)	5C1biii (22.9%)	1A4ai (10.9%)											90.6

1.7 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

The following Table 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).

1.7. Table Comparison of NFR, LAIR and E-PRTR emission data (kt). PRTR data for 2016 are preliminary

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x													
LAIR	56,0	56,0	38,4	41,5	41,4	35,6	69,0	38,4	39,7	31,0	26,4	26,8	22,7
EPER-EPRTR	28,5			26,0	27,7	21,8	22,3	20,4	32,5	32,5	19,7	18,6	21,7
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	55,9	52,1	45,8	46,0	43,9	39,0	40,1	36,4	34,5	31,2	29,4	29,3	25,5
NFR2016 National Total	177,1	174,2	167,3	163,2	158,0	146,9	142,2	133,8	125,5	123,0	122,5	124,2	116,5
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	0,5			0,9	0,9	4,6	4,5	7,3	5,6	3,5	2,2		0,7
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1)	19,1	20,0	19,2	16,9	16,8	16,4	16,9	16,8	15,1	15,8	15,4	16,0	16,0
NFR2016 National Total	182,8	168,3	155,6	150,1	144,4	146,3	144,3	147,0	147,0	149,0	140,5	142,5	140,7
SO_x													
LAIR	126,5	23,9	18,9	19,7	19,4	13,0	15,0	18,0	13,4	13,7	12,5	10,1	9,6
EPER-EPRTR	101,3			16,2	16,1	13,2	12,2	15,9	11,1	11,4	11,2	8,3	10,0
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1)	128,6	21,8	18,3	22,1	19,5	15,9	15,5	17,2	14,0	13,4	14,0	11,3	9,8

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NFR2016 National Total	150,1	41,2	39,3	35,5	35,0	30,0	30,8	34,4	31,7	31,1	27,5	23,3	23,1
NH_3													
LAIR	0,4	0,5	0,8	0,6	0,4	0,5	0,4	0,5	0,4	0,5	0,7	0,4	0,5
EPER-EPRTR	0,2			10,4	10,8	10,9	11,0	11,2	11,3	10,7	11,6	14,0	14,9
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1)	0,5	0,6	0,7	0,6	0,4	0,5	0,4	0,5	0,5	0,5	0,6	0,4	0,5
NFR SUM 3B3Swine + 3B4g Poultry	30,8	28,0	27,3	27,1	26,1	24,3	24,7	24,0	22,6	22,1	22,7	23,2	23,1
NFR2016 National Total	90,5	86,0	85,9	86,0	79,2	76,9	78,1	79,4	79,3	82,3	82,5	86,9	87,1
$PM_{2.5}$													
LAIR													
EPER-EPRTR													
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	6,7	5,1	4,5	3,9	4,6	4,1	2,8	3,6	2,8	2,7	3,5	3,5	3,2
NFR2016 National Total	42,3	39,7	40,5	40,4	36,6	47,1	50,3	57,3	59,9	60,8	51,5	54,5	53,2
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	
EPER-EPRTR	4,2			0,5	0,5	0,1	0,4	0,7	0,2	0,2	0,3		0,2
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	24,6	21,8	17,0	14,3	23,6	20,6	10,0	15,4	7,4	9,3	14,5	15,8	11,7
NFR2016 National Total	71,8	67,7	64,3	62,2	66,8	74,9	68,9	80,5	76,0	78,8	73,8	78,1	73,0
TSP													
LAIR	17,6	7,8	7,4	6,3	4,9	2,8	3,8	3,4	4,3	3,0	4,1	5,5	3,3

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	63,7	61,7	46,3	38,0	69,5	60,0	25,8	43,4	17,2	24,4	39,7	44,4	30,7
NFR2016 National Total	121,0	117,2	103,3	95,4	121,9	123,5	94,1	118,0	95,2	103,3	108,0	116,0	101,3
CO													
LAIR	134,2	66,1	69,3	68,1	56,3	26,2	42,6	44,5	53,5	38,6	36,5	37,9	31,9
EPER-EPRTR	47,4			34,4	33,4	21,6	25,3	22,7	19,7	15,4	20,1	21,0	25,7
NFR SUM (1A1+ 1A2+ 1A4ai+ 2+ 5C1	124,7	92,5	63,1	61,1	47,7	37,5	37,9	37,7	36,2	32,3	31,2	33,9	30,8
NFR2016 National Total	750,5	678,5	585,2	543,4	484,4	527,0	531,4	540,7	557,0	549,6	470,9	457,8	449,9

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.

1.8 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))

1.9 GENERAL ASSESSMENT OF COMPLETENESS

Sources Not Estimated (NE)

1.8. Table: *Explanation to the Notation key NE*

NFR14 code	Substance(s)	Reason for not estimated
1A3a	heavy metals, POP	Not included in the EUROCONTROL model
2K	POPs	No methodology
All other NE		**Notation of the Guidebook default Tables for the given pollutant(s)**

Sources Included Elsewhere (IE)

1.9. 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

1.10. 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

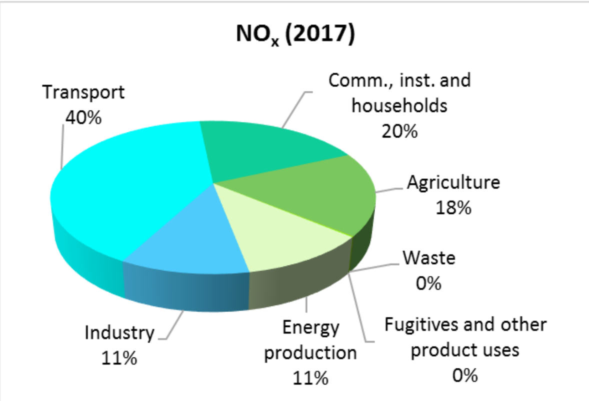
2.1 KEY TRENDS

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**
NOx (kt)	**241,7**	**188,2**	**185,3**	**176,3**	**159,0**	**144,8**	**127,1**	**124,7**	**122,5**	**124,4**	**116,9**	**119,3**
NMVOC (kt)	**301,7**	**212,2**	**197,1**	**171,5**	**149,6**	**146,0**	**151,9**	**151,2**	**141,3**	**144,1**	**142,0**	**141,5**
SOx (kt)	**829,5**	**613,7**	**427,2**	**43,0**	**35,9**	**30,5**	**30,6**	**29,4**	**26,0**	**24,3**	**23,0**	**27,7**
NH3(kt)	**149,3**	**88,5**	**93,2**	**86,0**	**79,2**	**78,0**	**79,2**	**82,2**	**82,4**	**86,8**	**86,9**	**87,7**
PM2.5(kt)	**NR**	**NR**	**48,2**	**40,1**	**36,1**	**49,4**	**57,8**	**58,6**	**49,5**	**51,7**	**49,9**	**48,0**
PM10(kt)	0,0	0,0	72,4	72,3	64,6	71,6	73,2	77,6	72,6	73,6	70,5	68,9
TSP(kt)	0,0	0,0	105,0	132,9	115,3	106,2	90,6	104,9	109,1	107,3	101,1	100,1
CO(kt)	1413,0	963,9	829,7	682,0	480,6	523,4	545,7	538,0	460,3	445,1	436,7	422,6
Pb (t)	839,2	305,4	20,6	9,9	10,7	8,2	8,9	8,3	7,8	8,2	8,8	8,6
Cd (t)	1,7	1,5	1,7	1,2	1,2	1,5	1,6	1,7	1,5	1,5	1,5	1,5
Hg (t)	3,3	2,6	2,3	1,7	1,5	1,5	1,2	1,1	1,1	1,1	1,2	1,3
PCDD/F (g I-Teq)	104,7	66,6	72,4	59,6	52,4	76,5	86,5	80,7	70,7	78,9	77,4	66,7
PAHs (t)	79,1	30,3	25,4	23,8	20,5	28,7	34,5	34,8	28,3	29,5	30,1	29,6

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



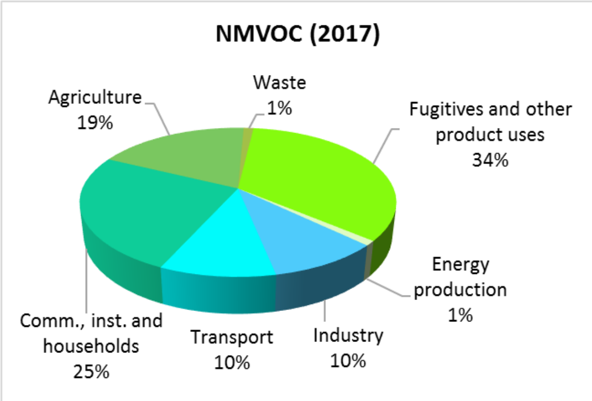


Figure 2.1 *NOx and NMVOC emissions by sectors*

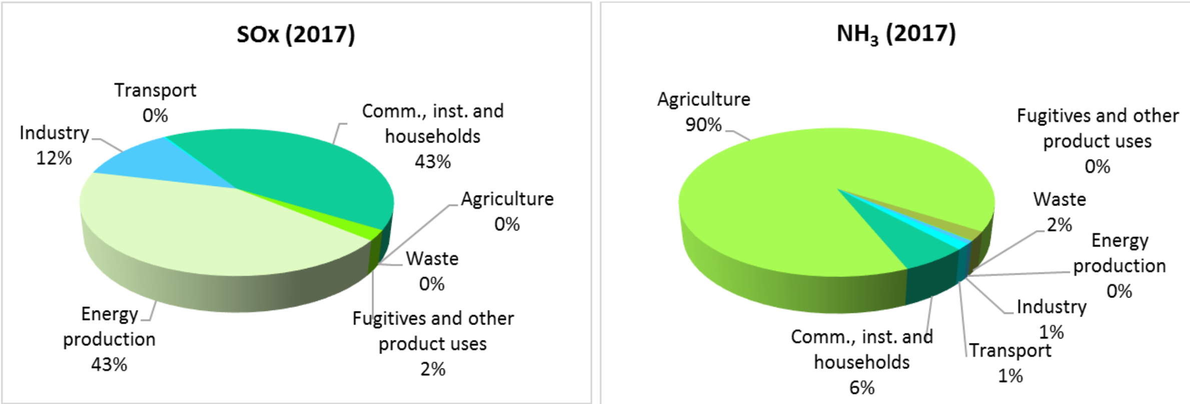


***Figure 2.2** SO_x and NH_3 emissions by sectors*

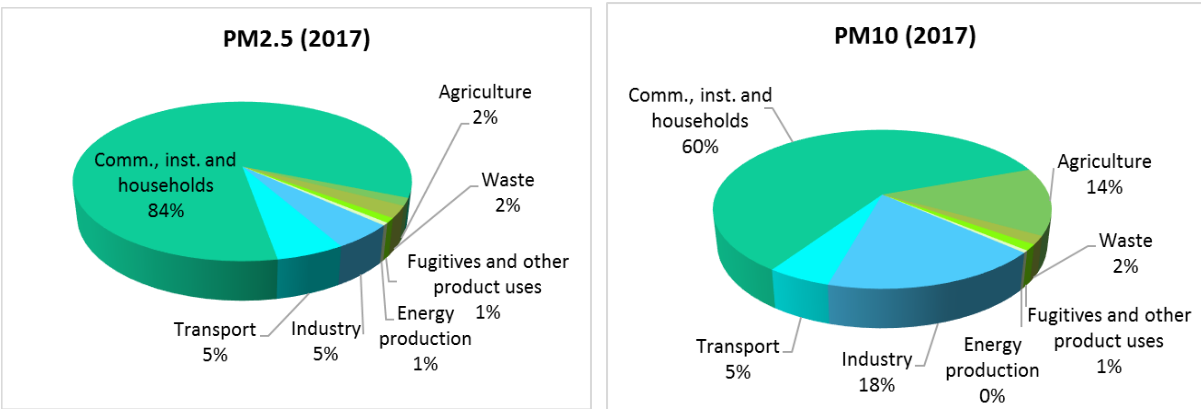


***Figure 2.3** $PM_{2.5}$ and PM_{10} emissions by sectors*

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.

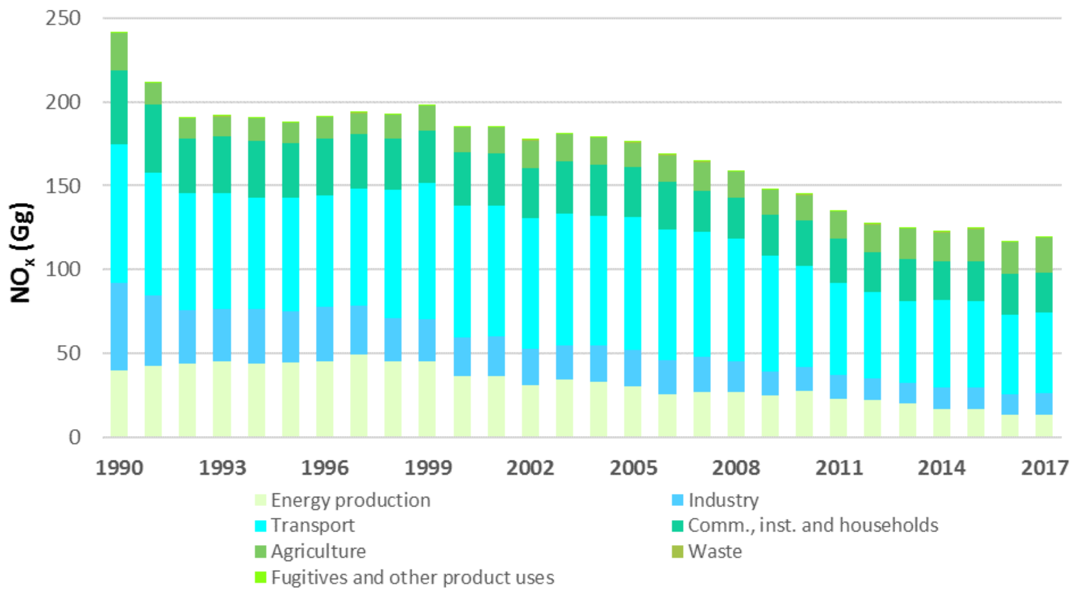


Figure 2.4 *Trend of emission of NO_x (kt)*

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	52,15	82,89	44,17	21,91	0,22	0,37	241,71
1991	42,59	42,17	72,97	40,90	12,75	0,21	0,35	**211,94**
1992	44,03	31,46	69,89	32,87	12,10	0,20	0,34	**190,89**
1993	45,13	31,19	69,09	34,02	11,80	0,18	0,35	**191,77**
1994	43,84	32,36	66,69	33,65	13,63	0,18	0,33	**190,68**
1995	44,61	30,71	67,57	32,49	12,30	0,19	0,33	**188,21**
1996	45,02	32,47	66,64	34,28	12,71	0,20	0,30	**191,62**
1997	49,50	28,65	70,10	32,38	12,66	0,19	0,31	**193,80**
1998	45,17	25,45	77,30	30,01	14,43	0,19	0,32	**192,87**
1999	45,39	24,90	81,62	30,73	15,09	0,19	0,30	**198,22**
2000	36,00	23,72	78,72	31,36	15,01	0,19	0,30	**185,30**
2001	36,17	23,94	78,35	30,79	15,56	0,18	0,30	**185,29**
2002	31,20	21,17	78,44	29,54	16,76	0,18	0,27	**177,56**
2003	34,07	20,66	78,51	31,19	16,25	0,18	0,26	**181,13**
2004	33,25	21,41	77,45	30,14	16,31	0,18	0,30	**179,04**
2005	29,92	21,76	79,77	29,42	14,86	0,17	0,38	**176,28**
2006	25,67	20,50	77,79	28,33	15,93	0,18	0,17	**168,56**
2007	27,00	20,98	74,51	24,59	17,16	0,17	0,22	**164,63**
2008	26,97	18,42	72,82	24,37	16,02	0,17	0,22	**158,99**
2009	24,80	14,46	68,72	24,48	15,13	0,16	0,18	**147,93**
2010	27,30	14,53	60,47	26,77	15,38	0,19	0,17	**144,82**
2011	22,46	14,75	54,92	26,28	16,20	0,18	0,25	**135,03**
2012	22,04	13,04	51,60	23,31	16,78	0,17	0,15	**127,09**

2013	19,95	12,44	48,45	25,44	18,03	0,16	0,16	**124,65**
2014	16,89	12,81	51,82	23,07	17,56	0,17	0,20	**122,51**
2015	16,63	12,68	51,59	24,27	18,92	0,13	0,16	**124,37**
2016	12,94	12,73	47,11	24,58	19,25	0,13	0,16	**116,88**
2017	13,08	12,99	47,98	23,80	21,15	0,13	0,15	**119,28**

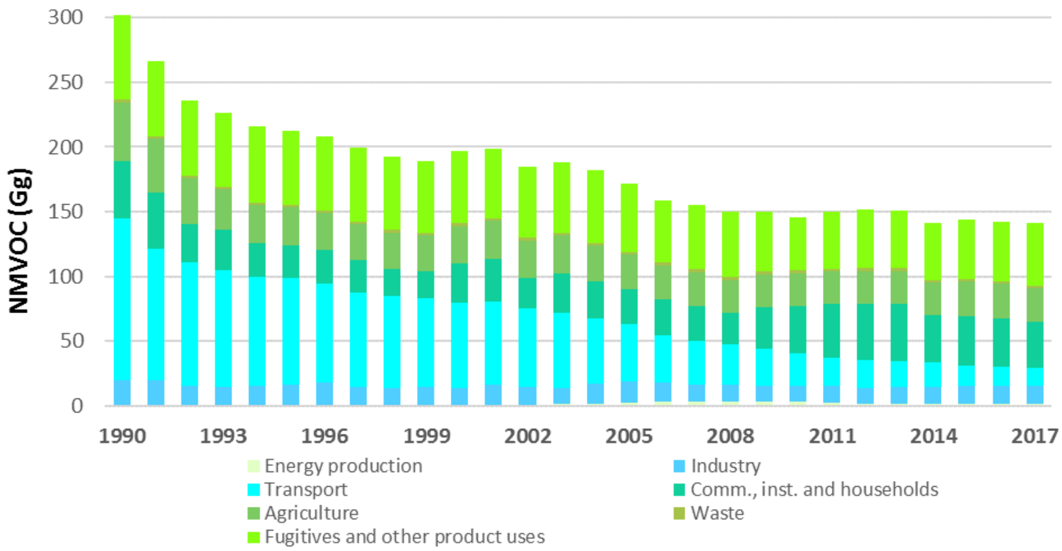


Figure 2.5 *Trend of emission of NMVOC (kt)*

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	124,64	44,16	45,65	1,86	65,26	**301,66**
1991	0,83	18,62	101,93	43,58	41,49	1,91	57,60	**265,95**
1992	0,80	14,46	95,85	29,33	35,67	1,92	58,14	**236,17**
1993	0,80	14,06	89,87	31,83	31,00	1,94	56,95	**226,45**
1994	0,75	14,62	84,28	26,47	29,14	1,97	58,49	**215,72**
1995	0,76	15,90	82,38	25,03	29,02	2,00	57,15	**212,25**
1996	0,77	16,93	76,70	25,92	28,57	2,04	57,34	**208,27**
1997	0,84	13,74	72,96	24,78	28,22	2,07	56,96	**199,56**
1998	0,84	13,18	71,07	20,46	28,27	2,10	56,86	**192,78**
1999	0,87	13,92	68,31	20,66	27,89	2,14	55,20	**188,99**
2000	0,79	12,72	65,90	30,55	29,02	2,18	55,90	**197,06**
2001	0,80	15,40	64,15	33,55	28,83	2,19	53,90	**198,82**
2002	0,69	13,80	61,01	22,91	29,12	2,24	55,00	**184,77**
2003	1,46	12,67	57,85	30,62	28,97	2,28	54,53	**188,38**
2004	1,91	15,33	50,05	28,49	27,93	2,23	55,76	**181,70**
2005	2,36	16,20	44,54	26,98	26,61	2,17	52,65	**171,50**
2006	3,10	14,90	36,76	27,88	26,14	2,32	47,69	**158,80**

2007	3,00	13,30	33,73	27,42	26,08	2,38	49,29	**155,21**
2008	3,12	12,96	31,45	23,95	25,79	2,33	50,03	**149,63**
2009	2,99	12,20	28,50	32,61	25,14	2,37	46,15	**149,96**
2010	3,10	12,45	25,18	36,56	25,21	2,43	41,11	**146,04**
2011	2,36	12,91	21,97	41,71	24,93	2,22	44,14	**150,24**
2012	1,72	12,08	21,40	43,85	25,03	2,22	45,65	**151,94**
2013	1,61	13,33	19,43	44,68	25,05	2,08	44,97	**151,16**
2014	1,41	13,44	18,45	36,47	25,63	2,08	43,82	**141,29**
2015	1,34	13,78	15,83	38,68	26,25	1,76	46,49	**144,13**
2016	1,31	13,88	14,94	37,61	26,46	1,68	46,15	**142,02**
2017	1,43	13,68	14,05	36,00	26,19	1,71	48,45	**141,52**

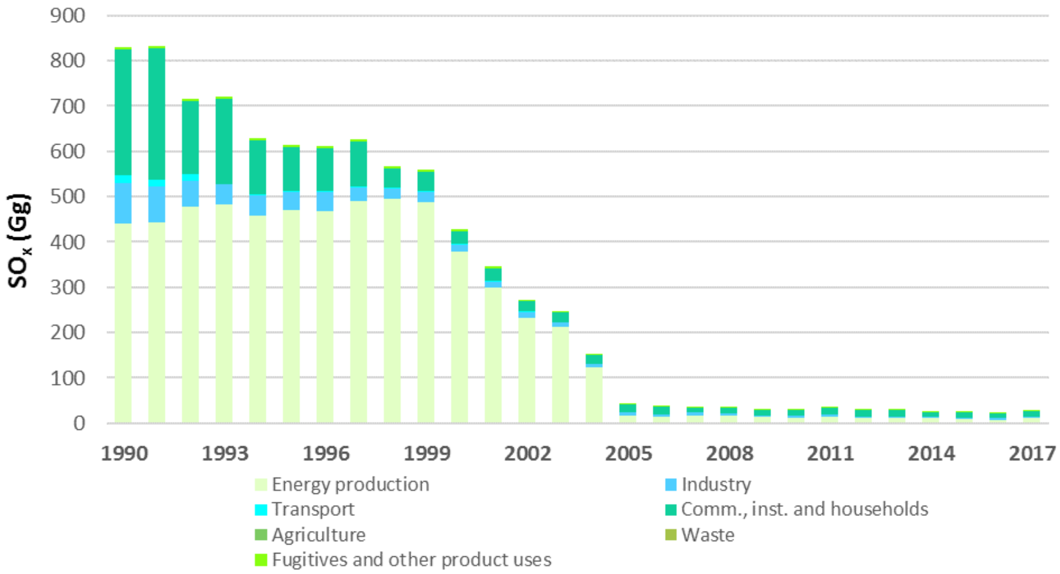


Figure 2.6 *Trend of emission of SO_x (kt)*

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	440,86	89,54	16,49	277,32	0,00	0,01	5,26	**829,47**
1991	443,97	78,81	14,44	290,04	0,00	0,01	4,94	**832,21**
1992	478,24	57,09	14,26	160,82	0,00	0,01	4,81	**715,24**
1993	482,03	44,16	2,32	186,26	0,00	0,01	4,98	**719,76**
1994	458,82	42,87	2,26	120,99	0,00	0,01	4,54	**629,50**
1995	469,69	39,54	2,30	97,31	0,00	0,01	4,84	**613,68**
1996	466,79	43,25	2,30	95,20	0,00	0,01	4,38	**611,93**
1997	489,08	30,61	2,43	98,82	0,00	0,01	4,53	**625,49**
1998	495,80	21,96	2,29	41,26	0,00	0,01	4,63	**565,94**
1999	488,05	23,11	1,53	41,27	0,00	0,01	4,50	**558,48**
2000	379,39	14,94	1,51	26,98	0,00	0,01	4,39	**427,22**

2001	300,02	12,71	1,75	27,40	0,00	0,01	4,41	**346,31**
2002	233,49	11,53	1,89	21,58	0,00	0,01	3,89	**272,39**
2003	212,53	9,09	1,89	20,89	0,00	0,01	1,63	**246,04**
2004	122,54	7,36	1,98	18,02	0,00	0,01	1,59	**151,50**
2005	16,88	6,09	1,24	17,17	0,00	0,01	1,62	**43,01**
2006	13,62	5,64	0,08	18,35	0,00	0,01	1,53	**39,23**
2007	17,82	5,43	0,08	11,30	0,00	0,01	1,67	**36,31**
2008	16,38	4,18	0,08	14,51	0,00	0,01	0,75	**35,90**
2009	13,81	3,25	0,07	11,79	0,00	0,01	0,86	**29,79**
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	**34,33**
2012	11,36	3,83	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	0,72	**29,41**
2014	10,61	3,51	0,07	11,21	0,00	0,01	0,63	**26,04**
2015	9,16	3,46	0,07	10,98	0,00	0,01	0,63	**24,32**
2016	7,88	3,12	0,08	11,30	0,00	0,01	0,63	**23,01**
2017	11,84	3,30	0,08	11,86	0,00	0,01	0,63	**27,72**

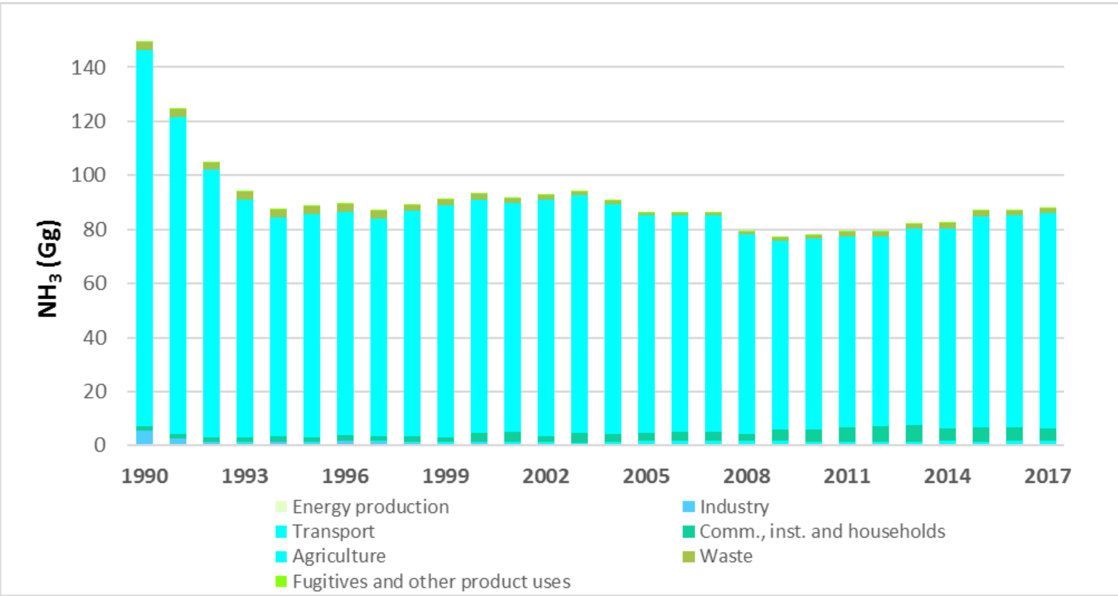


Figure 2.7 *Trend of emission of NH_3 (kt)*

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	0,04	1,85	139,12	2,69	0,12	**149,28**
1991	0,00	2,50	0,04	1,83	117,33	2,70	0,11	**124,51**
1992	0,00	1,22	0,04	1,84	99,06	2,69	0,12	**104,97**
1993	0,00	1,09	0,09	1,92	88,13	2,73	0,13	**94,09**

1994	0,00	1,30	0,15	1,93	81,07	2,76	0,12	**87,33**
1995	0,00	1,08	0,19	1,95	82,44	2,72	0,09	**88,47**
1996	0,00	1,67	0,23	1,89	82,87	2,69	0,08	**89,44**
1997	0,00	1,39	0,29	1,82	80,69	2,60	0,08	**86,87**
1998	0,00	1,02	0,38	1,84	83,49	2,42	0,09	**89,25**
1999	0,00	0,72	0,49	1,88	85,85	2,26	0,08	**91,29**
2000	0,00	0,85	0,41	3,49	86,31	2,04	0,08	**93,18**
2001	0,00	0,64	0,56	3,98	84,61	1,74	0,09	**91,62**
2002	0,00	0,51	0,71	2,31	87,38	1,58	0,09	**92,58**
2003	0,00	0,39	0,74	3,45	87,90	1,34	0,10	**93,92**
2004	0,00	0,44	0,83	3,12	84,97	1,11	0,06	**90,54**
2005	0,00	0,64	1,26	2,91	80,23	0,93	0,07	**86,04**
2006	0,00	0,70	1,14	3,12	80,12	0,79	0,10	**85,97**
2007	0,00	0,61	1,18	3,34	80,08	0,70	0,10	**86,00**
2008	0,00	0,44	1,18	2,77	73,89	0,84	0,10	**79,22**
2009	0,00	0,44	1,18	4,13	70,08	1,01	0,11	**76,93**
2010	0,00	0,34	1,04	4,64	70,62	1,28	0,08	**78,01**
2011	0,00	0,44	1,00	5,37	70,78	1,61	0,09	**79,29**
2012	0,00	0,44	1,01	5,85	70,23	1,55	0,09	**79,17**
2013	0,00	0,54	0,89	6,01	72,79	1,90	0,07	**82,20**
2014	0,00	0,62	0,96	4,87	73,98	1,86	0,07	**82,36**
2015	0,00	0,46	1,12	5,20	78,26	1,71	0,08	**86,81**
2016	0,00	0,57	1,16	5,01	78,44	1,69	0,07	**86,94**
2017	0,00	0,64	1,09	4,74	79,62	1,55	0,06	**87,70**

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.

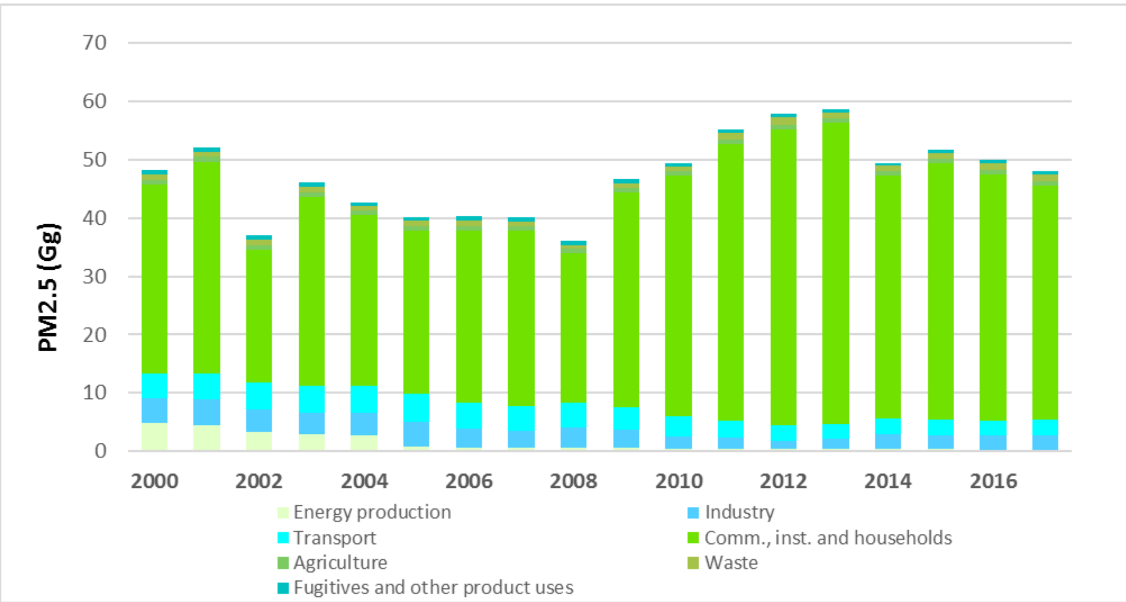


***Figure 2.8** Trend of emission of $PM_{2.5}$ (kt)*

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	4,75	4,35	4,15	32,51	0,79	0,99	0,67	**48,21**
2001	4,46	4,40	4,39	36,42	0,81	0,84	0,70	**52,02**
2002	3,36	3,88	4,47	22,75	0,85	1,00	0,70	**37,00**
2003	2,93	3,66	4,61	32,36	0,86	0,98	0,76	**46,16**
2004	2,63	3,87	4,61	29,43	0,83	0,75	0,51	**42,63**
2005	0,77	4,24	4,92	27,92	0,77	0,89	0,57	**40,08**
2006	0,58	3,38	4,36	29,56	0,76	0,83	0,77	**40,22**
2007	0,57	2,93	4,22	30,15	0,75	0,74	0,76	**40,13**
2008	0,54	3,56	4,14	25,70	0,75	0,66	0,77	**36,11**
2009	0,51	3,11	3,89	36,82	0,75	0,88	0,77	**46,73**
2010	0,43	2,13	3,50	41,18	0,76	0,79	0,63	**49,43**
2011	0,34	1,91	3,02	47,36	0,76	1,19	0,65	**55,23**
2012	0,32	1,38	2,77	50,76	0,75	1,21	0,66	**57,85**
2013	0,31	1,84	2,47	51,65	0,75	1,03	0,54	**58,59**
2014	0,37	2,60	2,63	41,58	0,75	0,97	0,54	**49,46**
2015	0,34	2,31	2,74	43,92	0,75	1,06	0,55	**51,68**
2016	0,24	2,42	2,58	42,30	0,76	1,03	0,53	**49,87**
2017	0,26	2,43	2,64	40,29	0,74	1,17	0,46	**47,99**

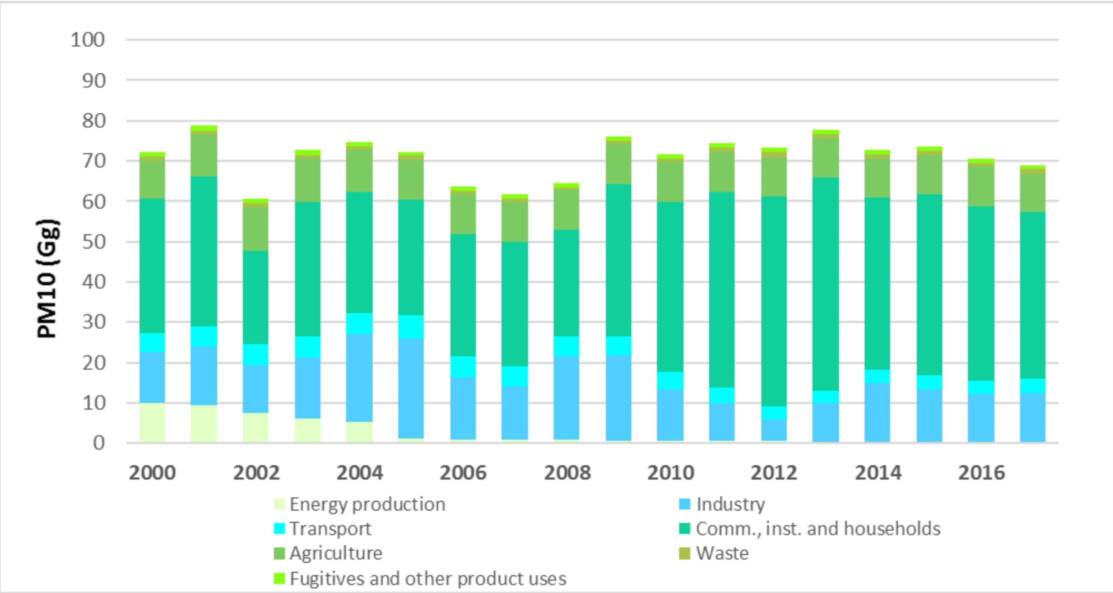


Figure 2.9 *Trend of emission of PM_{10} (kt)*

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	4,62	33,37	9,46	1,02	1,30	**72,35**
2001	9,44	14,52	4,90	37,37	10,29	0,87	1,31	**78,69**
2002	7,43	11,98	5,03	23,37	10,58	1,02	1,26	**60,69**
2003	6,22	15,07	5,21	33,23	10,73	1,01	1,31	**72,77**
2004	5,23	21,72	5,24	30,22	10,46	0,78	0,99	**74,65**
2005	1,11	24,97	5,62	28,68	10,00	0,92	0,99	**72,28**
2006	0,84	15,47	5,12	30,35	9,88	0,85	1,23	**63,74**
2007	0,80	13,19	5,02	30,93	9,90	0,76	1,22	**61,82**
2008	0,75	20,78	4,96	26,38	9,87	0,68	1,21	**64,62**
2009	0,70	21,11	4,71	37,76	9,80	0,91	1,17	**76,17**
2010	0,60	12,78	4,23	42,23	9,90	0,81	1,07	**71,63**
2011	0,50	9,56	3,71	48,58	9,79	1,22	1,10	**74,47**
2012	0,47	5,23	3,44	52,06	9,67	1,24	1,10	**73,22**
2013	0,45	9,40	3,10	52,96	9,71	1,05	0,98	**77,65**
2014	0,44	14,52	3,34	42,63	9,73	1,00	0,98	**72,64**
2015	0,40	12,92	3,52	45,03	9,64	1,08	0,99	**73,58**
2016	0,28	11,81	3,37	43,37	9,67	1,06	0,97	**70,52**
2017	0,32	12,24	3,46	41,32	9,48	1,19	0,85	**68,87**

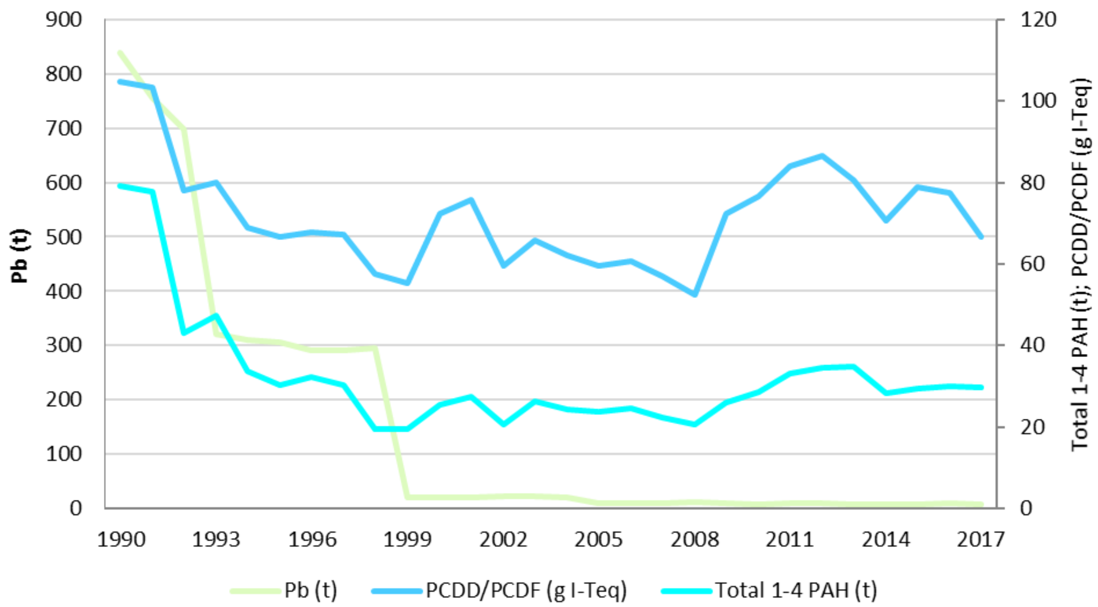


Figure 2.10 *Trend of emission of PAHs (t), dioxins (g I-Teq) and Pb (t)*

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 2017, primary energy production amounted to 461.1 PJ which was by 25 per cent less than in 1990. Most importantly, uneconomical deep coal mines were closed down, but also crude oil and natural gas production decreased. In contrast, imports of energy with 1018.3 PJ in 2017 were by 53% larger than in 1990. As the share of production in consumption is about 41%, our import dependency is quite significant.

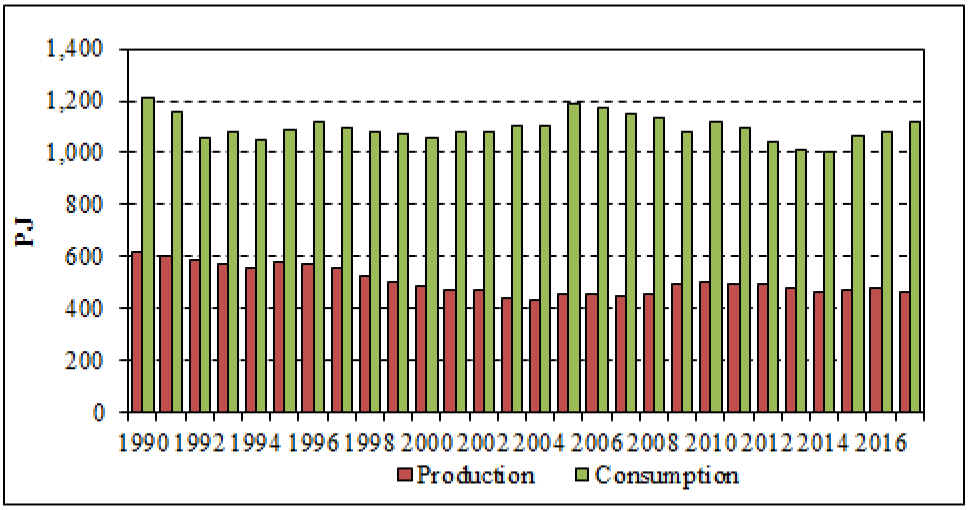


Figure 3.1 *Primary energy balance of Hungary (1990-2017)*

The primary energy use of Hungary was 1121.2 PJ in 2017 which was by 7% and 5% below the levels in 1990 and 2005, respectively. Recently however, since 2014, primary energy consumption has increased by 12%.

In 2017, final domestic electricity use amounted to 39,641 GWh, which was by 4% higher compared to the previous year and the highest in the whole time series. 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 form 4.4% is 2005 to 7.5% in 2017. The last few years saw significant increases in solar electricity production (from 1

GWh in 2011 to 349 GWh in 2017) and also wind power production increased to 758 GWh from 10 GWh in 2005. At the same time, electricity produced from combustible fuels decreased from 21,710 GWh in 2005 to 15,315 GWh in 2017.

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*.

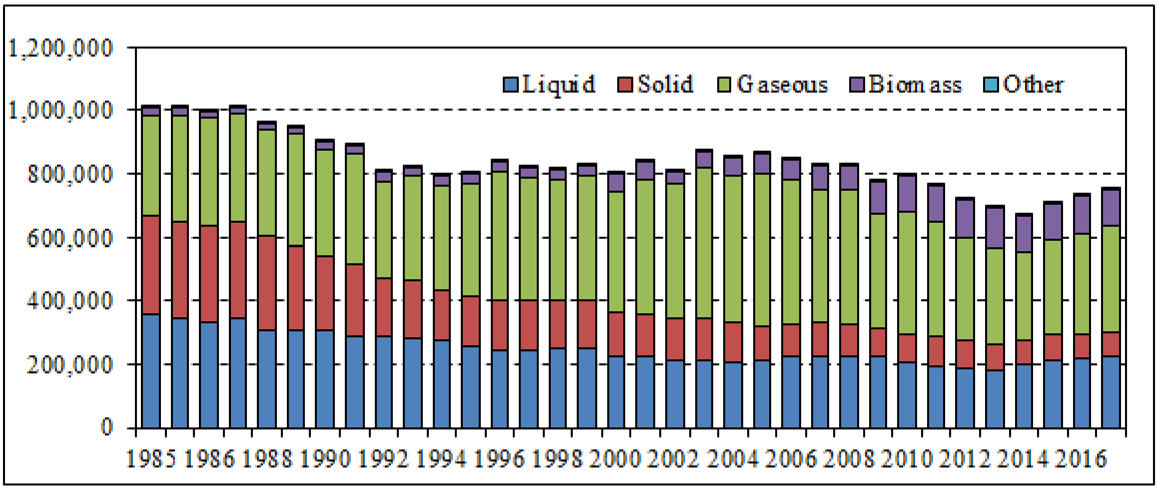


Figure 3.2 *Fuel combustion from 1985 to 2017*

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 2017. 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.

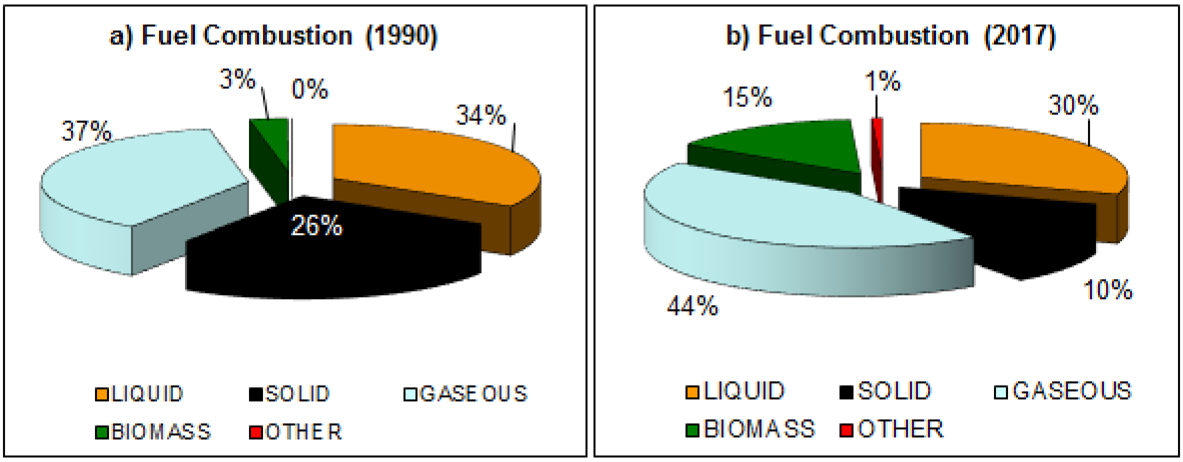


Figure 3.3 *Fuel combustion in 1990 (a) and 2017 (b)*

3.2 GENERAL METHODOLOGICAL DESCRIPTION

The emissions calculations are based on the common method of using emission factors. For 1990-2016, the methodology described in the latest EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 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. (The only differences are coke oven gas and blast furnace gas that are reallocated from autoproducers to iron and steel, and to manufacture of solid fuels, and some industrial waste incineration that are reallocated to commercial/institutional. Also 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 2016 only 3 PJ of fuel combustion was allocated to autoproducer use compared to 172 PJ energy use by public power plants. (We might change this practice by following partly the approach of the IEA, namely allocating all fuel used for own heat demand to the relevant sector, and all the other to general electricity and heat production.)

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 2016 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.

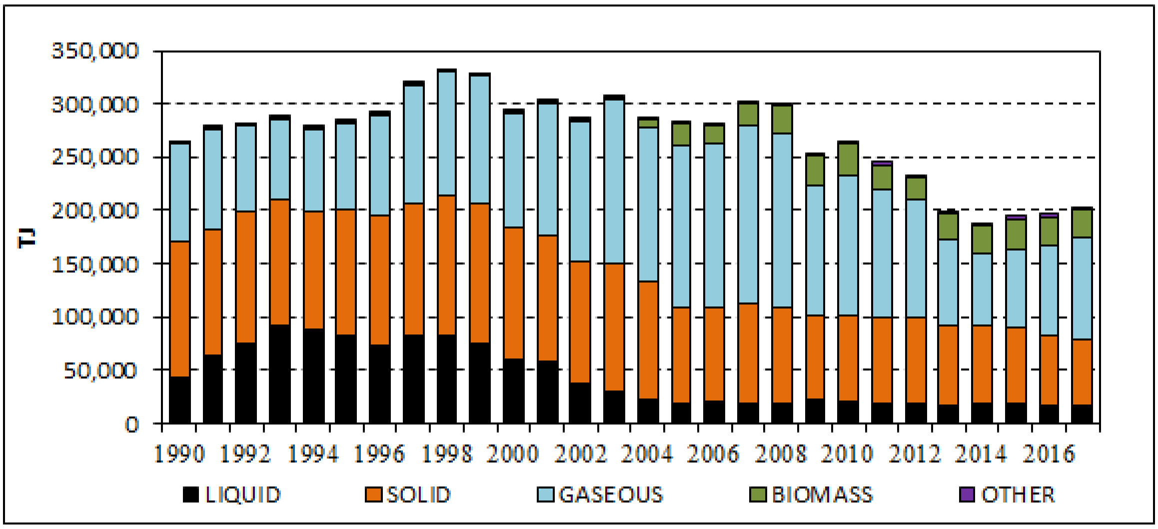


Figure 3.4 *Fuel combustion in energy industries (1990-2017)*

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 fuel consumption of oil refining showed a pronounced drop around 2000 but remained more or less at the same level afterwards. Currently its share is about 12%. Even less significant is manufacture of solid fuels and other energy industries with a portion of 2-4% within energy industries.

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 2017"), the energy consumption of the power plants was 343 PJ in 2017, 1.5% more than in the previous year. In 2017, 51,6% of the used energy sources consisted of nuclear fuel. Natural gas made up 19.4%, while coal made up 16.1% of the energy sources. The renewable energy sources used in the power plants provided 8.9% 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%.

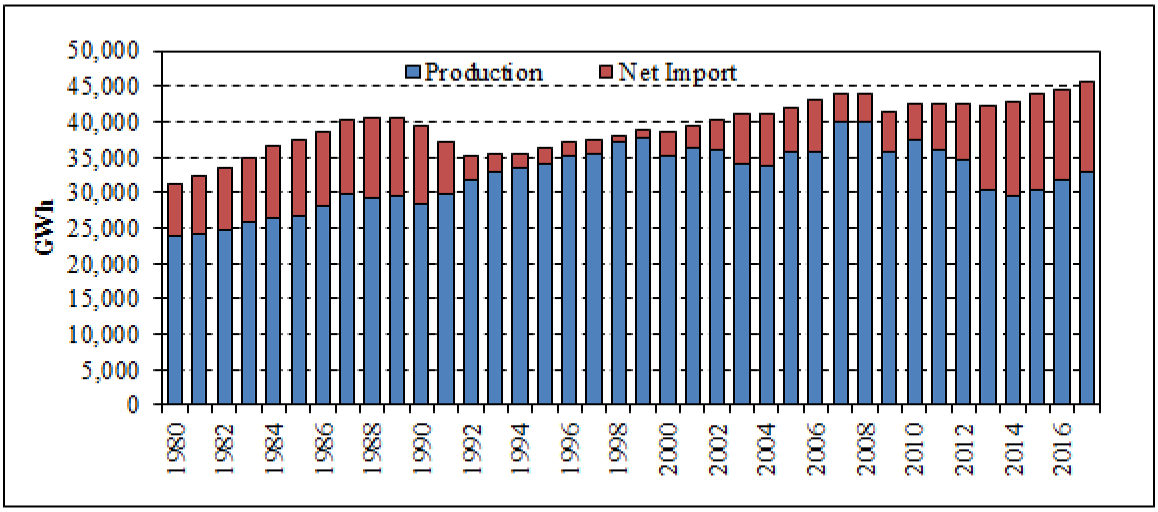


Figure 3.5 *Domestic Electricity Production and Net Import (1980-2017)*

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.

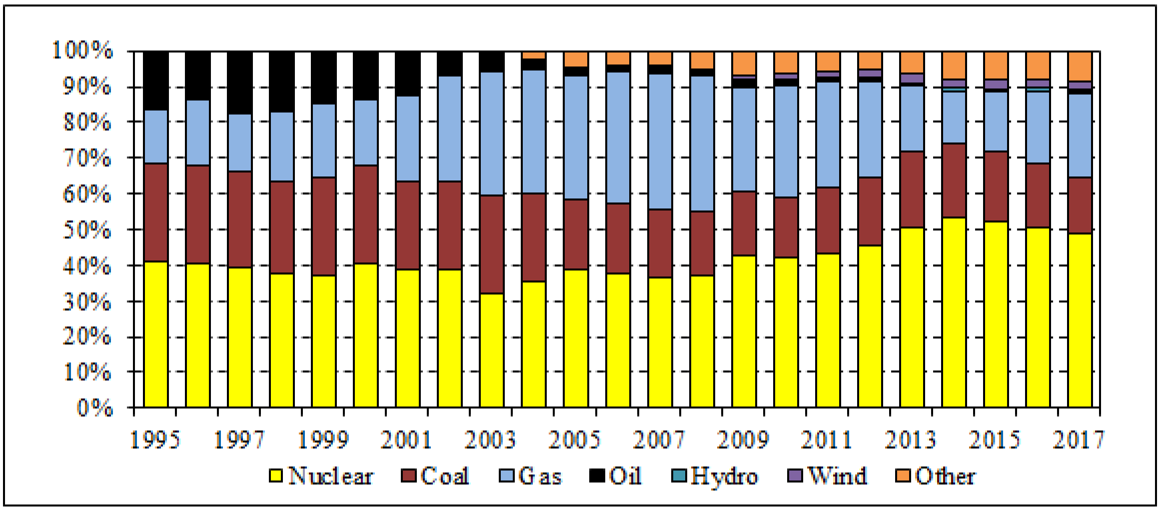


Figure 3.6 *Share of produced electricity by fuel (1995-2017)*

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 neither in 2017.

(Upon Resolution No. 6549/2015 of the Hungarian Energy and Public Utility Regulatory Authority on suspension of electricity generation, in force until 31 December 2018, the four units with 60 MW installed capacity of Vértes Power Plant was put into “constant non-operational” status as from 1 January 2016. Pécs-Tüskésrét Photovoltaic Generator started its operation, with 10 MW, in nominal trial operation, in December 2015. It was included in installed capacity with 10 097 MW on 17 March 2016. Hamburger Hungária Generation Unit started its operation, with 44.7 MW, in nominal trial operation, in November 2015. It was included in installed capacity with 42 MW in July 2016. The operational status of Tisza II. Power Plant (900 MW) changed to ‘constant non-operational’ status as from April 2012. In pursuance of Resolution No. 1815/2013 of the Hungarian Energy and Public Utility Authority, the suspension notice is valid from 1 July 2013 up to 30 June 2016. In 2016, the power plant applied for a further extension of suspension that was granted by the Authority in its Resolution No. 4761/2016 and will remain in force until 30 September 2019. In pursuance of Resolution No. 1814/2013 of the Hungarian Energy and Public Utility Authority, the generation licence of Debrecen Combined Cycle Power Plant (95 MW) was suspended from 1 July 2013 up to 30 June 2016. The application of power plant for further extension of the suspension was approved by the Authority in its Resolution No. 4723/2016 and will remain in force until 30 September 2019. The Combined Cycle Power Plant of Nyíregyháza (47 MW), which had been mothballed as of 1st July 2013, indicated its intention to renew generation in November 2017. Trial operations were successfully implemented in 2017. The accreditation for the provision of ancillary services was not implemented, and actual generation was not commenced in year 2017. Source: Situation of large power plants in Data of the Hungarian Electricity System 2017).

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.

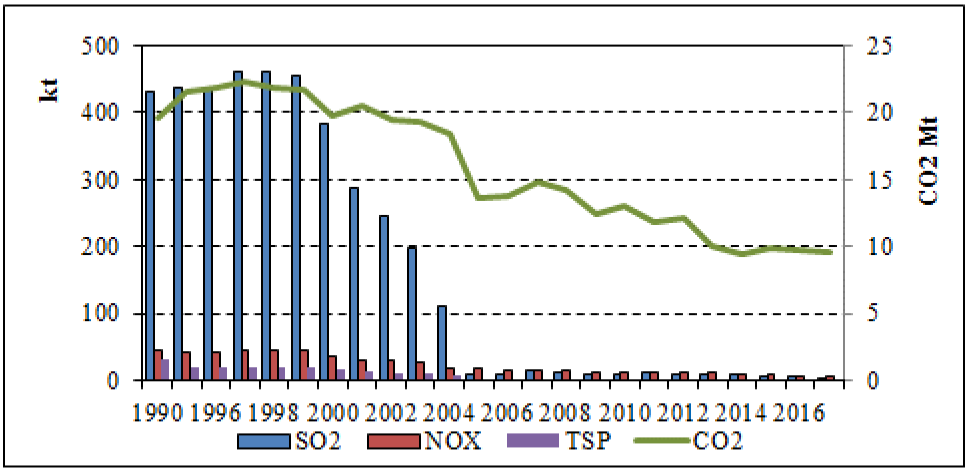


Figure 3.7a *Measured emissions from large electricity plants (1990-2017) Source: Data of the Hungarian Electricity System, 2017*

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 plants, and their effects may be observed in the sharp decrease in the pyrogeneous TSP emissions.

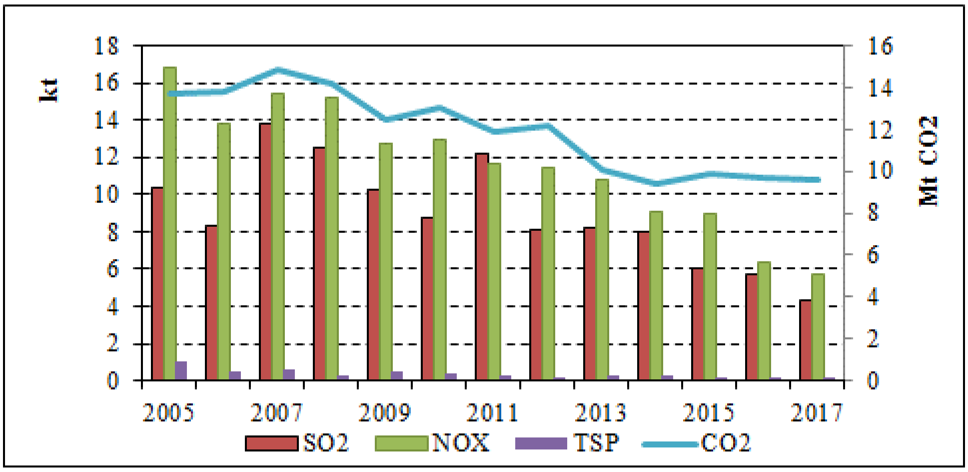


Figure 3.7b *Pollution data of power plants. Source: Data of the Hungarian Electricity System, 2017*

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.

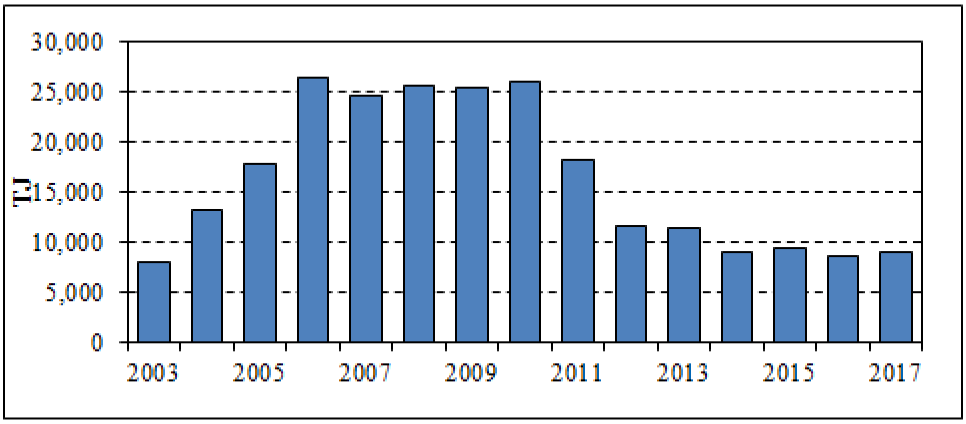


Figure 3.8 *Natural gas use in gas engines (2003-2017)*

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 2005-2017. 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 2016 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. However, data of more plants were analyzed for the last three years, and in case of continuous measurements, reported data were adjusted as described above.

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 2002-2016. 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 2016 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.

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).

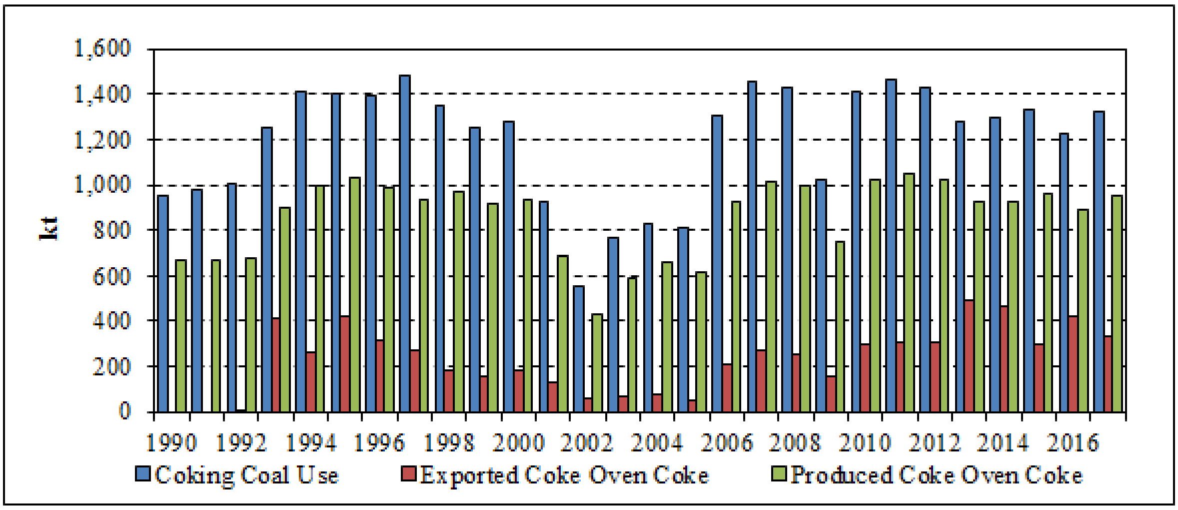


Figure 3.9 *Gas coke distillation in Hungary (1990-2017)*

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.

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 (63% in 2017).

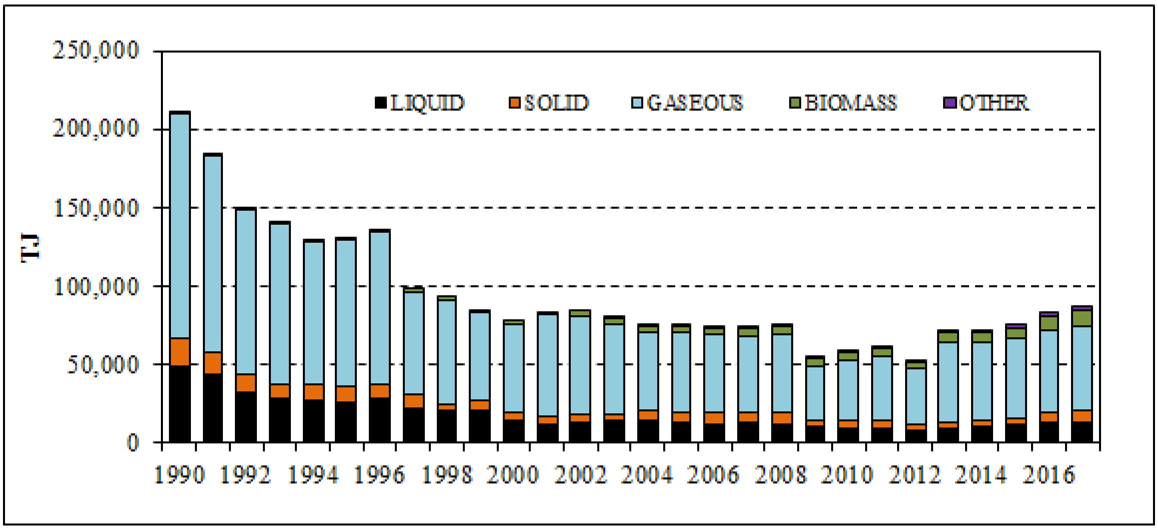


Figure 3.10 *Fuel use in manufacturing industries and consumption (1990-2017)*

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 2003-2015 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 only for alumina production up till 2013.

Activity data

Tier 2 approach requires production based activity data which were received from the Hungarian Central Statistical Office. In 2016, secondary copper and brass (2.959 Gg), secondary zinc (0.98 Gg), secondary aluminum (274 Gg), and alumina (125 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 (1990-2017). 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	2002-2016
SO_x	domestic brown coal	1255	2002-2016
SO_x	domestic coal	3800	1990-2001
SO_x	other liquid fuels	95	2004-2007
SO_x	other liquid fuels	48	2008-2016
NO_x	coal	125	2002-2016
NO_x	liquid fuels	136	2002-2016
CO	coal	105	2002-2016
CO	biomass	141	2002-2016
TSP	other liquid fuel	15	2002-2016
TSP	coal	63	2002-2016
TSP	biomass	85	2002-2016

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. (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

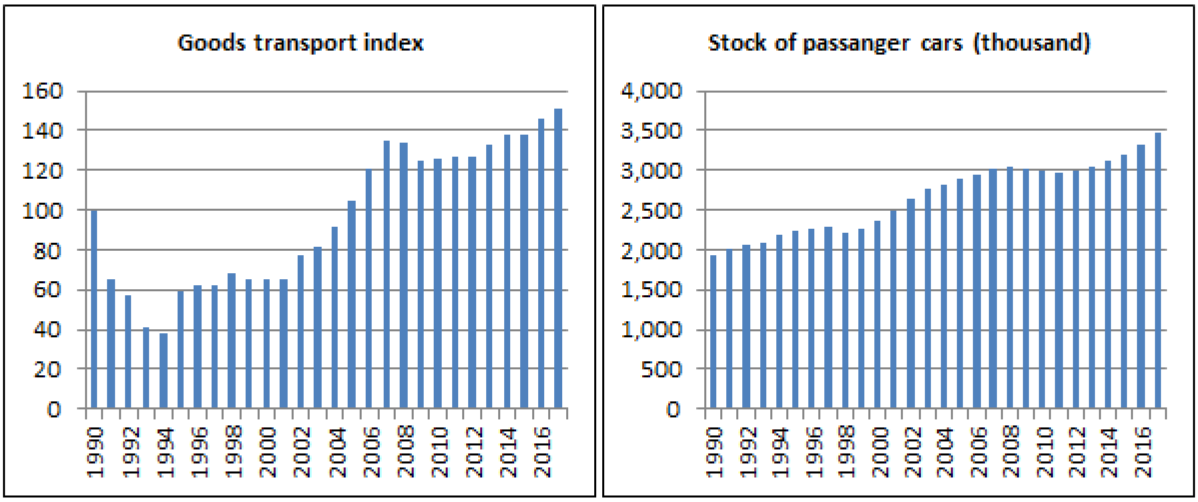
None.

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 (19%), pipeline (12%) 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.

Passenger transport also underwent considerable changes. The stock of passenger cars had more than doubled since 1985 and increased by 79% 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 14.1 years in 2017. (The lowest average age of vehicles (10.3 years) was observed in 2006, before the economic crisis.) *Figure 3.11* summarizes the above-mentioned developments.



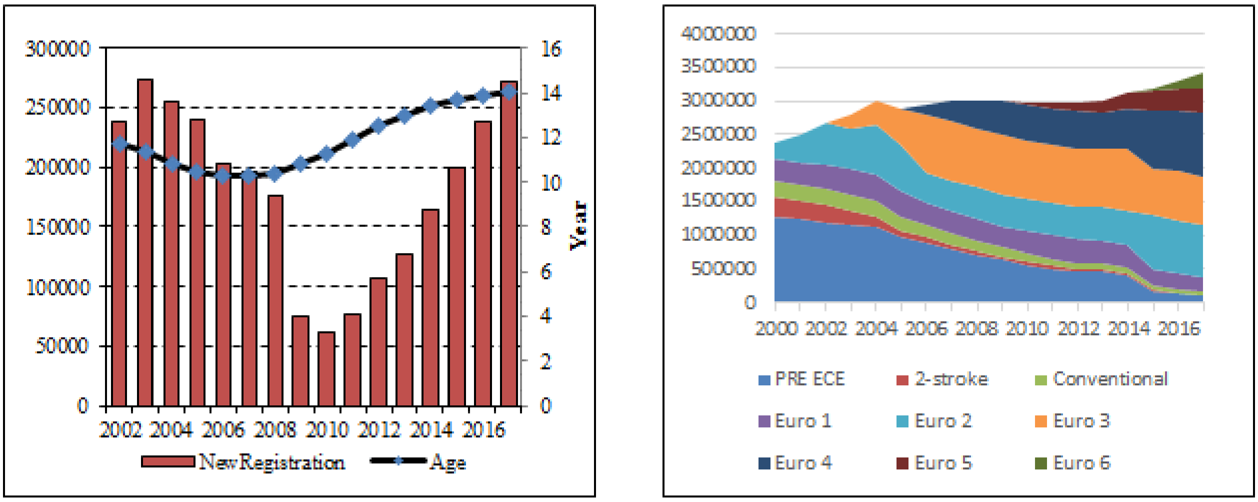


Figure 3.11 *General changes in the transport sector*

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 2017.

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).

Based on information received from the energy statistics provider, natural gas use related to natural gas transport was included earlier under distribution losses. Now a complete time series of emissions from pipeline transport is calculated separately. Figures below illustrate fuel consumption of the sector:

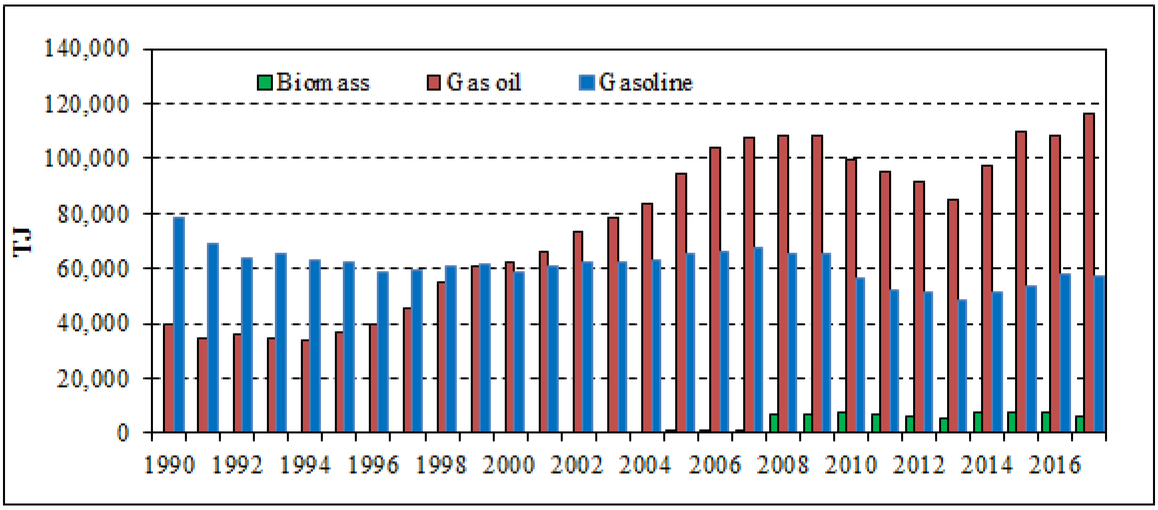


Figure 3.12a *Gasoline, diesel and biomass consumption and total energy use in the Transport Sector (1990-2017)*

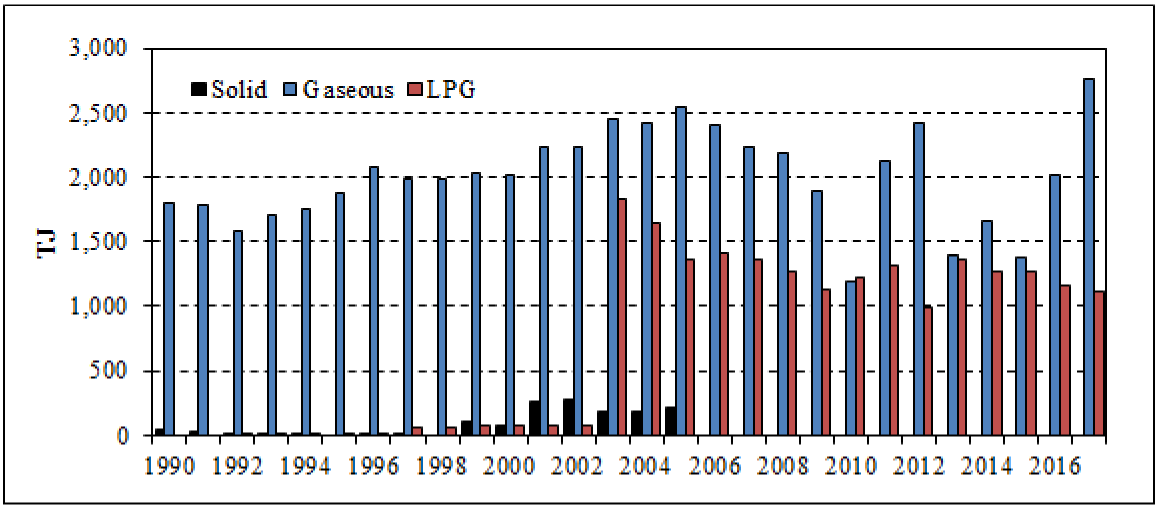


Figure 3.12b *LPG, natural gas and solid fuel combustion in the Transport Sector (1990-2017)*

Figure 3.12 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 (Computer Programme to Calculate Emission from Road Transport) model, specifically version 5.2.0 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. 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
- mileage data

- traffic situations, average speed values
- fuel used
- country-specific data.

As the above data were not obtained from the same source and were not always suitable for direct use. The largest bulk of work was processing the vehicle stock data, since this data ensures the basis for emission calculations performed by COPERT-5. Thus, with respect to the vehicle stock it was crucial to perform work of the utmost precision, therefore, in the course of the work, the vehicle stock related data of the Central Statistical Office (CSO) were used. At the request of the Institute for Transport Sciences, vehicle data tables required to perform the task were extracted from the CSO database. The vehicle stock classifications and emission categorizations for the year 2016 were prepared with the use of these data tables. The data on traffic situations, that is, the percentage of runtime distribution within individual road categories by vehicle category, and, within road categories, the average speed values also by vehicle category were included based on emissions defined in the previous years. These earlier data were based on the results of previous research carried out by the Institute for Transport Sciences. The mileage data were specified based on previous emission calculations with the use of the research outcomes of the Institute for Transport Sciences, as well as based on the annual emission calculation for the year 2009 provided by the Ministry of Environment from the extract of the Regular Environmental Audits database, subsequently corrected based on the annual fuel consumption. The source of the "amount of fuel used" data was the official energy statistics.

The country-specific data was taken partly from the Hungarian Meteorological Service (HMS) (average maximum and minimum temperatures by month), partly from the Hungarian fuel standards (Reid vapor pressure RVP).

In case of larger differences between the calculated fuel consumption and the fuel sold statistics, the input mileage data (km/year) were slightly modified.

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.

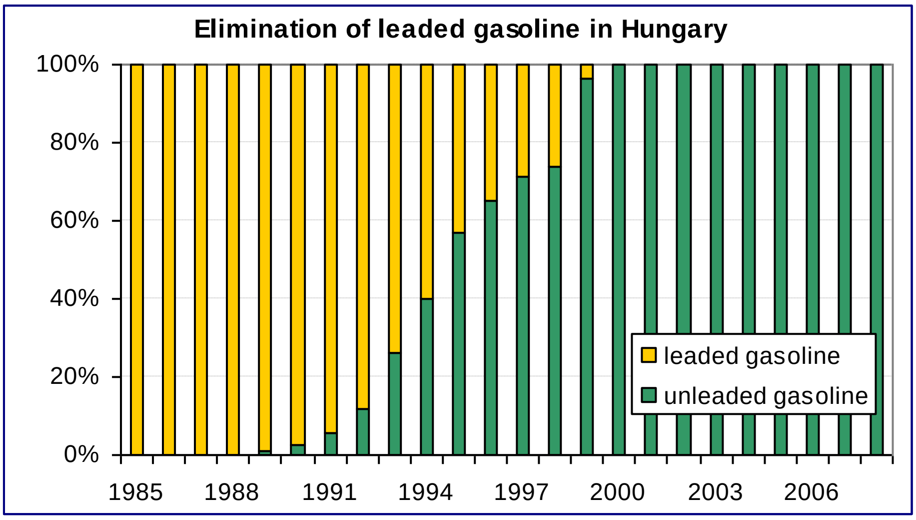


***Figure 3.13** Elimination of leaded gasoline in Hungary*
(Source: Hungarian Petroleum Association (MÁSZ), Annual Reports 1996-2008)

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

Table 3.4 Country specific emission factors in road transport

	1990-92	1993-99	2000-2005	2005-
Lead content of leaded gasoline (g/l)	0.35	0.15	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 (5.2.0) was used for the entire time series.

Source-specific planned improvements

-

3.5.2 AIR TRANSPORT (NFR CODE: 1A3A)

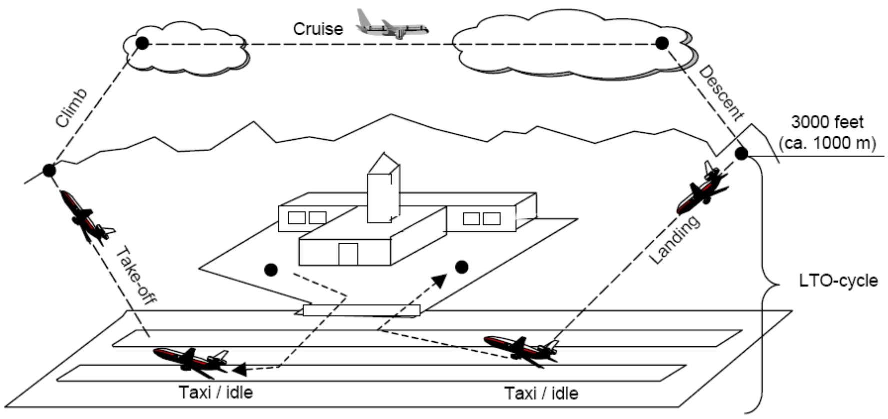
Reported Emissions: Main Pollutants (except NH_3), CO, Particulate Matter
Measured Emissions: None taken into account
Methods: LTO
Emission factors: ICAO, FOI database
Key source: -

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

Updated time series have been submitted based on the "EUROCONTROL Method".

Source-specific planned improvements

It is not planned to change the methodology.

3.5.3 RAILWAY TRANSPORT (NFR CODE 1A3C)

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

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]**
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.

Emission factor values for harmful components [g / ton of fuel]				
Fuel	**Diesel**			**Carbon**
Locomotive type	**line-haul locomotives**	**shunting locomotives**	**railcars**	
NOx	**63**	**54,4**	**39,9**	**2 194**
CO	**18**	**10,8**	**10,8**	**27 367**
NMVOC	**4,8**	**4,6**	**4,7**	
NH_3	**0,01**	**0,01**	**0,01**	
TSP	**1,8**	**3,1**	**1,5**	**10 970**
PM_{10}	**1,2**	**2,1**	**1,1**	
$PM_{2,5}$	**1,1**	**2**	**1**	
N_2O	**0,024**	**0,024**	**0,024**	
CO_2	**3140**	**3190**	**3140**	**380 000**
CH_4	**0,182**	**0,176**	**0,179**	
SO_2 *	**0,2**	**0,2**	**0,2**	**45 497**
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*				

Uncertainties and time-series consistency

The time series is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

For this submission, T2 method was introduced.

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.

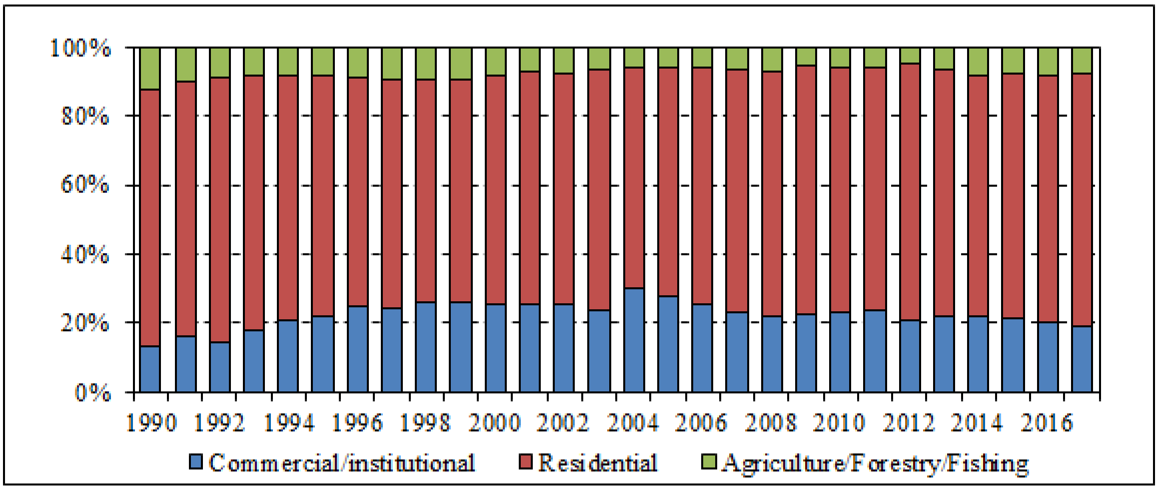


Figure 3.13 *Fuel combustion in the subsectors of the Other Sector (1990-2017)*

Figure 3.13 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 1990-2017, the length of natural gas pipe-network increased from 22,549 km to 84,001 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 3.2 million (73%) since 2010. Residential consumption represented 37% of total inland demand in 2017. Piped gas is available in 91% of all settlements in Hungary, and this figure has not changed much since 2005. 88% of households use natural gas for heating purpose as well. Although individual residential heating became more and more widespread, still 650 thousand dwellings (15% of all dwellings) are supplied with district heating and 600 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 3.14 below. Steadily rising tariffs and the economic crisis were the main reasons of growing biomass use in this sector as well.

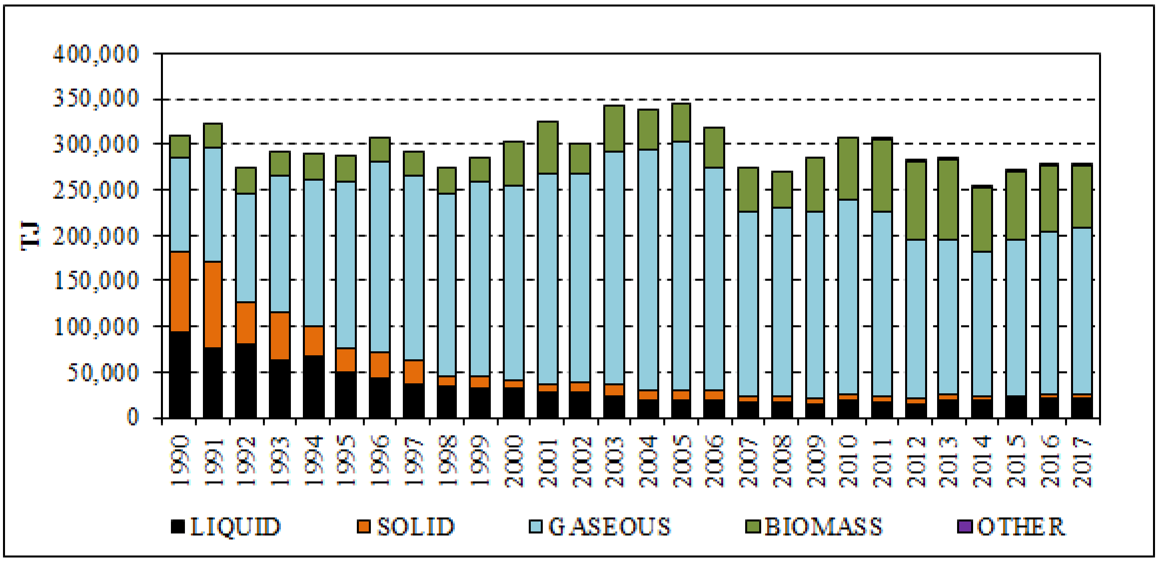


Figure 3.14 *Share of different combusted fuel types in the Other Sector (1990-2017)*

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 3.15 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.

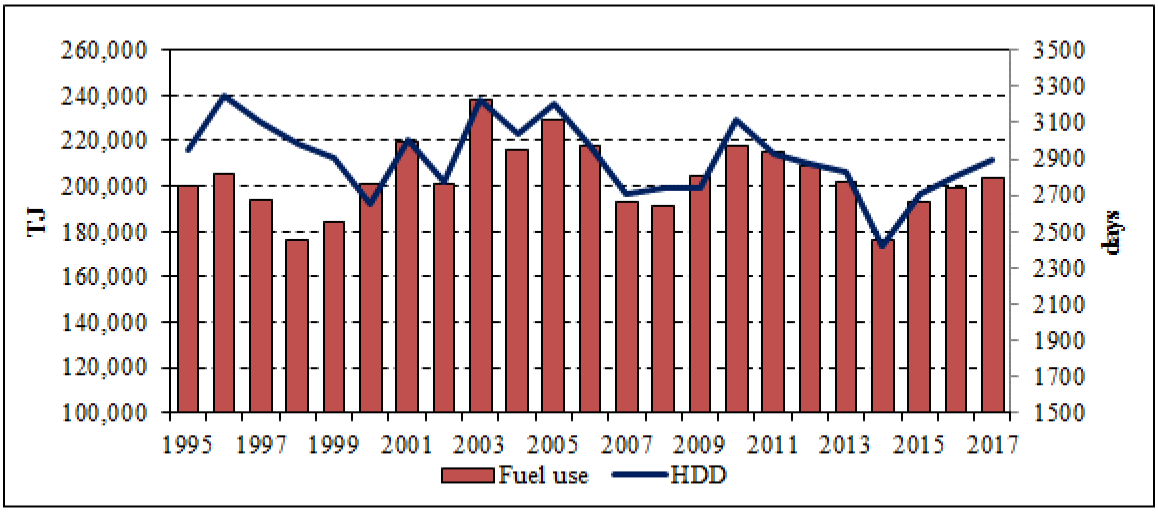


Figure 3.15 *Comparison of residential fuel consumption and HDD between 1995 and 2017*

Another factor is definitely the price. The (nominal) price of pipelined gas increased from 325 to 1360 Ft/10 m^3 between 2000 and 2012. This price increase might have led to increased biomass use as a substitute fuel in the residential sector as it is demonstrated by Figure 3.16. Increased biomass use has specific relevance as regards particulate matter emissions which also showed increasing tendency in that period. 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). Biomass consumption has also decreased in the same period by 13% (but this decrease was probably due to favorable weather conditions).

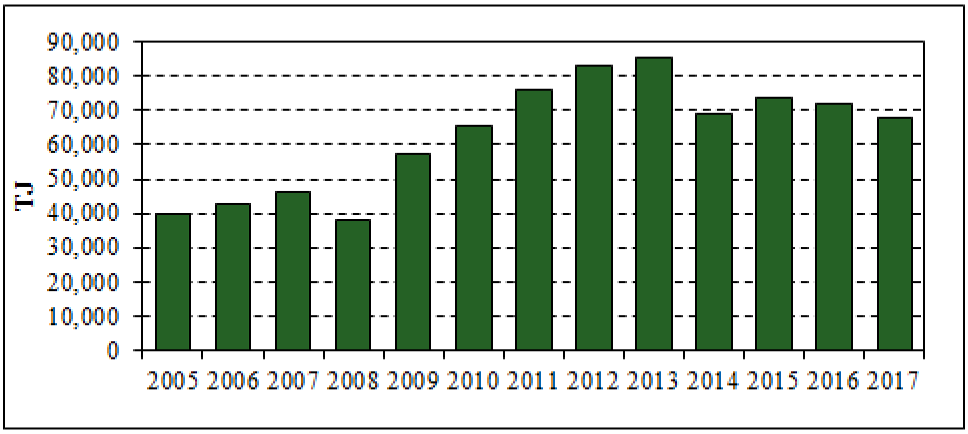


Figure 3.16 *Increase of biomass (wood, wood wastes) use in the residential sector (2005-2017)*

The monthly natural gas consumption of an average household decreased from 127 m3 in 2003 to 94 m3 in 2017. 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, growing biomass use indicate some fuel switch from natural gas to firewood in the residential sector.

Activity data

The joint IEA/Eurostat annual questionnaires served as activity data consistently for the whole time-series (1990-2017). 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] x 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-fuelled 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
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. In addition, revisions were made in the field of solid fuel combustion (coal and biomass) in the residential sector.

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 *1.A* sector. Therefore, mainly NMVOC emissions are reported in sector *1.B*, as it is also suggested by the 2016 EMEP/EEA Guidebook. NO_X, CO and SO_x are to be reported only in *1.B.2.a.iv Refinery*, where process emissions occur and *in1.B.2.c - Venting and flaring* subsector. In the case of heavy metals and PAHs *1.B.1.b - Solid fuel transformation (coking)* subsector is significant. The pollutants reported in the different subsectors are summarized in the following table together with the method used.

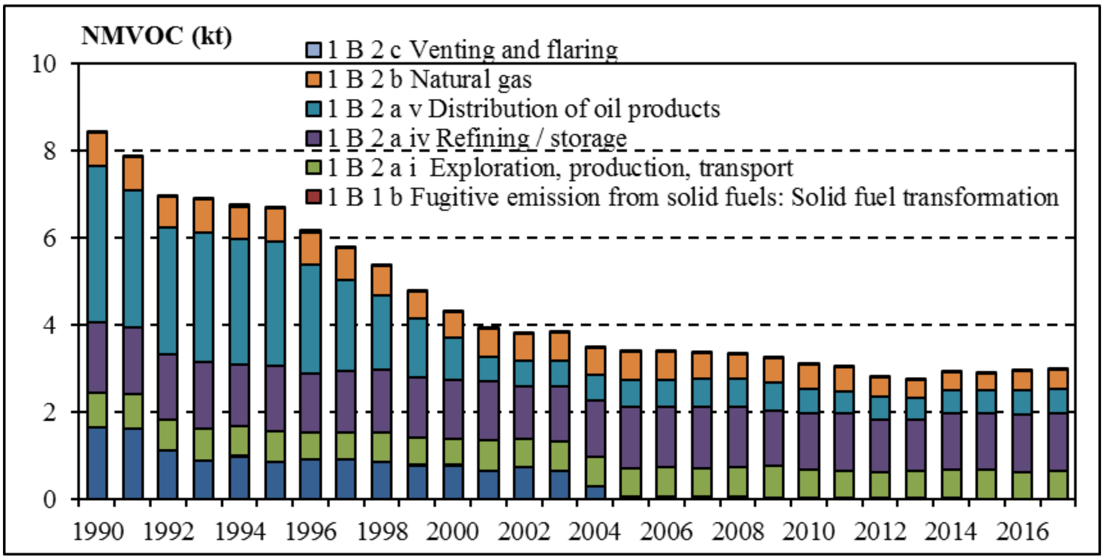
3.1. Table: *Summary of pollutants and emissions estimation methods used within 1B sector*

	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH_3	PMs	CO	HMs	POPs
1 B 1 a Fugitive emission from solid fuels: Coal mining and handling	NA	T3	NA	NA	T1	NA	NA	NA
1 B 1 b Fugitive emission from solid fuels: Solid fuel transformation	IE to 1A	T1	IE to 1A	T1	T1	IE to 1A	T1	T1 - only PAHs
1 B 1 c Other fugitive emissions from solid fuels	NA	NA	NA	NA	NA	NA	NA	NA
1 B 2 a i Exploration, production, transport	NA	T2 + IPCC2006	NA	NA	NA	NA	NA	NA
1 B 2 a iv Refining / storage	T3	T1	T3	T1	T1	T3	T1	T1 (PCDD/F)
1 B 2 a v Distribution of oil products	NA	T1, T2	NA	NA	NA	NA	NA	NE
1 B 2 b Natural gas	NA	T2	NA	NA	NA	NA	NA	NE
1 B 2 c Venting and flaring	T1/T2	T1	T1	NA	T1/T2	T1/T2	T1/T2	T2 - only PAHs

2006 IPCC = see references; for other notation key please see the summary notation key

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. As NMVOC is to be reported also in UNFCCC reporting being an indirect GHG, several NMVOC emission factors from the 2006 IPCC Guidelines are also used. 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.3 Other fugitive emissions from geothermal energy production, peat and other energy extraction not included in 1.B.2* – no emissions are reported. However thermal water extraction is present is Hungary and CH_4 emissions from extraction of thermal water is reported in UNFCCC reporting, the 2016 EMEP/EEA Guidebook suggests to report only NH_3 emissions solely where electricity is produced directly by geothermal energy in this subsector. In Hungary there is heat only production and no electricity or CHP production from geothermal energy, according to HCSO and IEA Energy Statistics.*Trend*

The aggregated trend of emissions in this sector is interesting only in the case of 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 nearly disappearing 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.



3.1. Figure: 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)

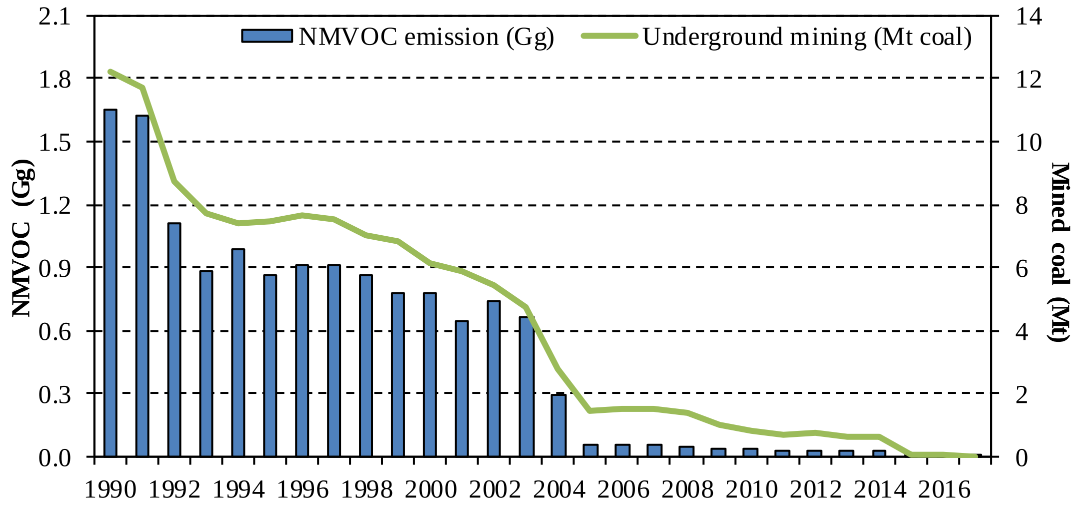
Reported Emissions: NMVOC, TSP, PM_{10}, $PM_{2.5}$
Measured Emissions: NMVOC
Methods: T1, T3
Emission factors: T1, T3

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 2016 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) is measured in the one single underground coal mine still working 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 and 2016 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 relative high (20.75 m^3 CH_4/t coal) in-situ methane content, but the amount of mined coal was almost negligible, however emission was reported together with emissions from underground mines in UNFCCC reporting, so NMVOC emissions also presented at underground mines 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. Since we have not enough information about all abandoned mines back to 1901, default method with default emissions are presented for the entire time-series as first guess. It is planned to revise these methane emissions, because this calculation cannot take account of national features. In recent years after the closure of all underground mines in several coal basin the mine drainage is not pumped anymore that induces the water-table rise and the mine flooding, therefore NMVOC emissions originating from abandoned mines can be negligible too.

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.



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

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 2016 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 together with emissions from underground mines in UNFCCC reporting, so NMVOC emissions also presented at underground mines 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 has been working after the closure of the mine of the last bituminous/sub-bituminous coal fired power plant.

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 is operating, 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 CH_4 and NMVOC emissions because of relative 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.

3.2. Table: *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**

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: 14.03.2019
Reported Emissions: NMVOC, 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

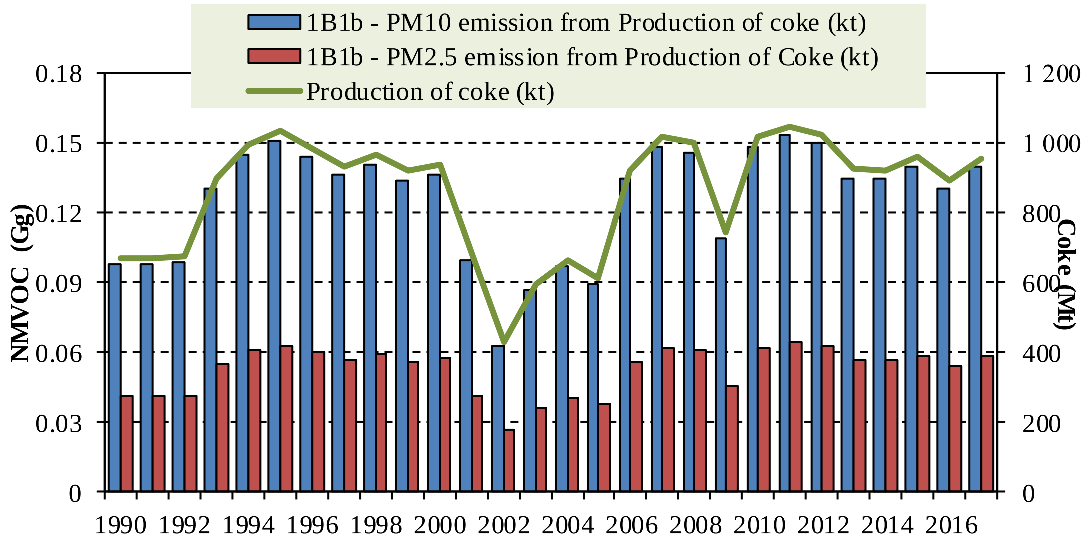
It is important to take into account the definition of the 2016 EMEP/EEA Guidebook in order to avoid double counting and separate the combustion emissions: *"This source category discusses emissions from coke ovens (only fugitive emissions …) and emissions from the production of solid smokeless fuel (during coal carbonisation). 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."* (2016 EMEP/EEA Guidebook) So, emissions from production of coke are reported in this sector using TIER 2 method. **NO_X, SO_x and CO are reported in sector 1.A**. following the suggestion of the 2016 EMEP/EEA Guidebook, since it would not be possible to separate combustion and process emissions otherwise. NMVOC, NH_3, PMs, TSP, several HMs (Pb, Cd, Hg, As, Ni), PCDD/F and PAHs are reported here.

Emission factor

Tier 1 default emission factors of the 2016 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 2016 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.



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

Recalculations, QA/QC activities and planned improvements

None.

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

Last update: 03.2019

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 NO_X, SO_x 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.

3.3. Table: *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*	**0.786**	*8147*	**1.629**	*1790*	*3.580*
1991	*1841*	**0.802**	*7655*	**1.531**	*1567*	*3.134*
1992	*1769*	**0.708**	*7458*	**1.492**	*1463*	*2.926*
1993	*1654*	**0.724**	*7717*	**1.543**	*1488*	*2.976*
1994	*1575*	**0.693**	*7043*	**1.409**	*1445*	*2.890*
1995	*1668*	**0.697**	*7506*	**1.501**	*1427*	*2.854*
1996	*1477*	**0.624**	*6787*	**1.357**	*1345*	2.473
1997	*1360*	**0.636**	*7022*	**1.404**	*1353*	2.092
1998	*1260*	**0.665**	*7171*	**1.434**	*1386*	1.711
1999	*1243*	**0.629**	*6982*	**1.396**	*1402*	1.330
2000	*1136*	**0.602**	*6801*	**1.360**	*1336*	0.950
2001	*1065*	**0.700**	*6842*	**1.368**	*1391*	0.569
2002	*1050*	**0.660**	*6035*	**1.207**	*1409*	**0.576**
2003	*1134*	**0.656**	*6382*	**1.276**	*1427*	**0.583**
2004	*1077*	**0.683**	*6371*	**1.274**	*1442*	**0.590**
2005	*948*	**0.663**	*7032*	**1.406**	*1486*	**0.608**
2006	*886*	**0.689**	*6915*	**1.383**	*1527*	**0.624**
2007	*839*	**0.656**	*7087*	**1.417**	*1575*	**0.644**
2008	*811*	**0.684**	*6967*	**1.393**	*1565*	**0.640**
2009	*791*	**0.724**	*6324*	**1.265**	*1565*	**0.640**
2010	*734*	**0.655**	*6389*	**1.278**	*1372*	**0.561**
2011	*659*	**0.611**	*6594*	**1.319**	*1271*	**0.520**
2012	*649*	**0.576**	*6114*	**1.223**	*1256*	**0.513**
2013	*599*	**0.618**	*5968*	**1.194**	*1160*	**0.474**
2014	*584*	**0.651**	*6507*	**1.301**	*1278*	**0.522**
2015	*623*	**0.663**	*6477*	**1.295**	*1288*	**0.527**
2016	*712*	**0.612**	*6637*	**1.327**	*1390*	**0.568**
2017	*714*	**0.650**	*6525*	**1.305**	*1363*	**0.557**

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)

3.4. Table: *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)	1.B.2.b.iv-v NMVOC (Gg)	1B2c i-ii NMVOC (Gg)	1B2c iii NMVOC (Gg)
1990	*4874*	0.487	0.257	0.0231	0.019
1991	*4976*	0.498	0.256	0.0236	0.018
1992	*4753*	0.475	0.227	0.0225	0.017
1993	*5042*	0.504	0.243	0.0239	0.018
1994	*4851*	0.485	0.245	0.0230	0.016
1995	*4886*	0.489	0.265	0.0231	0.017
1996	*4668*	0.467	0.296	0.0221	0.016
1997	*4369*	0.437	0.281	0.0207	0.016
1998	*3877*	0.388	0.283	0.0184	0.016
1999	*3401*	0.340	0.285	0.0161	0.016
2000	*3194*	0.319	0.279	0.0151	0.016
2001	*3231*	0.323	0.309	0.0153	0.016
2002	*3106*	0.311	0.311	0.0153	0.014
2003	*2945*	0.295	0.339	0.0046	0.015
2004	*3051*	0.305	0.336	0.0031	0.015
2005	*3028*	0.303	0.346	0.0031	0.016
2006	*3095*	0.310	0.327	0.0046	0.016
2007	*2615*	0.262	0.306	0.0031	0.016
2008	*2643*	0.264	0.303	0.0092	0.016
2009	*2968*	0.297	0.262	0.0031	0.015
2010	*2900*	0.290	0.282	0.0030	0.015
2011	*2766*	0.277	0.271	0.0031	0.015
2012	*2234*	0.223	0.240	0.0023	0.014
2013	*1960*	0.196	0.233*	0.0030	0.014
2014	*1858*	0.186	0.213*	0.0044	0.015
2015	*1772**	0.177*	0.223*	0.0028	0.015
2016	*1841*	0.184	0.241	0.0027	0.015
2017	*1818*	0.181	0.271	0.0015	0.015

*Revised IEA activity data

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

Last update: 03.2019
Reported Emissions: NMVOC
Measured Emissions: none

Methods: T2, 2006 IPCC Guidelines
Emission factors: T2, 2006 IPCC Guidelines

NMVOC emissions arising during exploration, production and transport of oil are reported using Tier 2 method from 2016 EMEP/EEA Guidebook complemented by the application of emission factor from 2006 IPCC Guidelines in the case of transportation of oil.

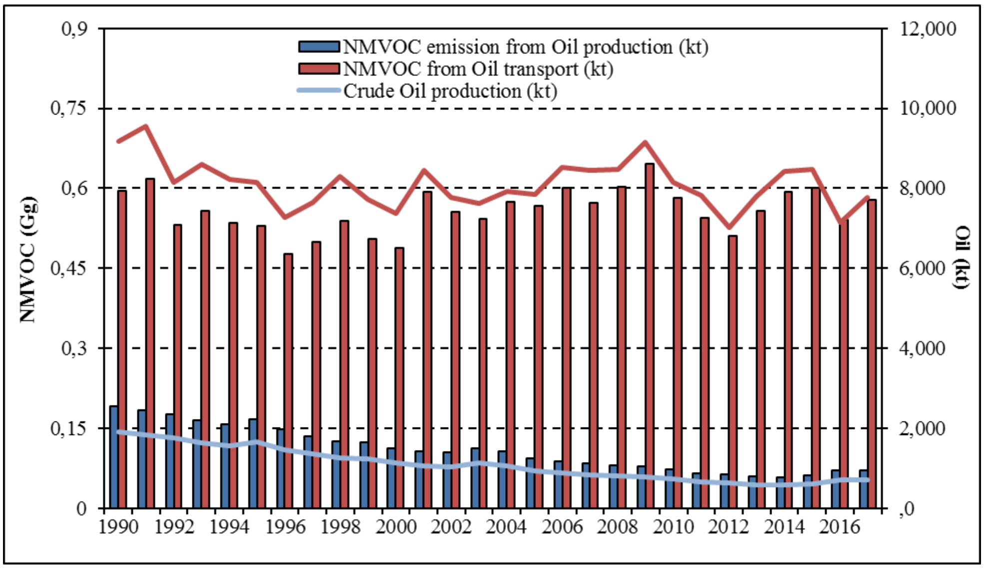
Oil production is not significant in Hungary and the whole production is on-shore of course, so Tier 2 method can be applied. Due to the declaration of the producer company, the exploration and production is performed with high standard equipment that is why emission factors for developed countries are used in the case of 2006 IPCC Guidelines.

Emission factor

The emission factors used are Tier 2 default emission factors from the 2016 EMEP/EEA Guidebook for production and 2006 IPCC Guidelines in the case of transportation.

Activity data

Production of crude oil is available from IEA Energy statistics. Please note that activity data reported in NFR Table is the Total indigenous production of crude oil. However total emissions from subsectors *1B2a i-iii* contain also emissions from oil transport. The same activity data is used for oil transport in CLRTAP and in UNFCCC reporting. It is reported by the service company for UNFCCC reporting purposes as well.



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

Recalculations, QA/QC activities and planned improvements

There was no recalculation in 1.B.2.a i-iii sectors.

3.7.2.2 REFINING / STORAGE (NFR SECTOR 1B2A IV)

Last update: 03.2019
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

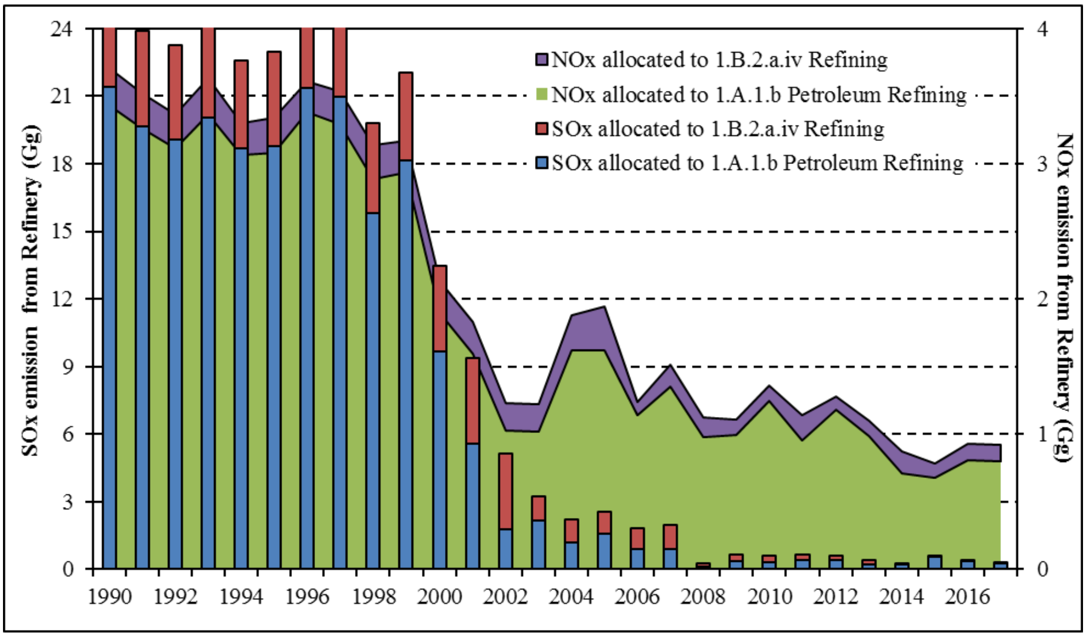
Only emission of NMVOC, SO_2, NO_x, TSP, PMs, CO, HMs and PCDD/F arising from processes are reported in this category. All combustion emissions are reported in category *1.A.1.b.* and refinery venting and flaring emissions are reported in subcategory *1.B.2.c*.

Emission factor

NMVOC and NH_3, HMs and PCDD/F are reported using Tier 1 emission factors from the 2016 EMEP/EEA Guidebook.

Plant specific data on SO_x, NO_x, TSP, and CO of oil refinery is available in LAIR database (see description in chapter 1.5). Thank 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 SO_x and NO_x are presented together on the following Figure.



3.5. Figure: *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 SO_2, NO_x, 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; however it is used only 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 SO_x, NO_x, 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." (2016 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 m^3/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

3.5. Table: *Calculation of TVP in Hungary*

A=	$0.000007047 \times RVP + 0.0132$
B=	$0.0002311 \times RVP - 0.5236$
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**

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

Category	Emission source	NMVOC default EF. (g/m^3 throughput/ kPa TVP)	Abatement efficiency %	True Vapour Pressure (TVP). (kPa)	NMVOC EF g/m^3 (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/m^3**

Using the assumption: *"The assumed liquid gasoline density is 730 kg/m^3"* (2016 EMEP/EEA Guidebook - 1.B.2.a.v. chapter 3.3.2.3.) the 298.5 g/m^3 results **0.4088 kg NMVOC /t gasoline.**

Activity data

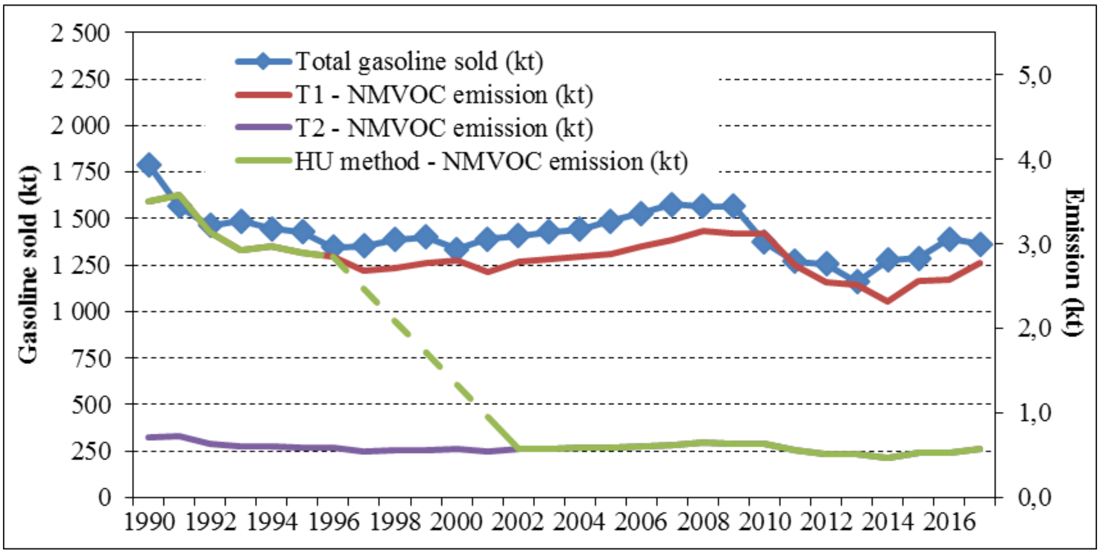
Data on total sold gasoline is available from IEA Energy statistics.

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." (2016 EMEP/EEA Guidebook 1.B.2.a.v, chapter 2)

"Evaporative emissions from diesel vehicles are considered to be negligible due to the presence of heavier hydrocarbons and the relatively low vapour pressure of diesel fuel, and can be neglected in calculations." (2016 EMEP/EEA Guidebook 1.A.3.b.v., chapter 2)

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



3.6***. Figure: 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: 03.2019
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T2
Emission factors: T2, 2006 IPCC Guidelines

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 3.7.7*); therefore, also emissions are decreasing although the subsections of natural gas transmission, distribution and storage are on rise.

Emission factor

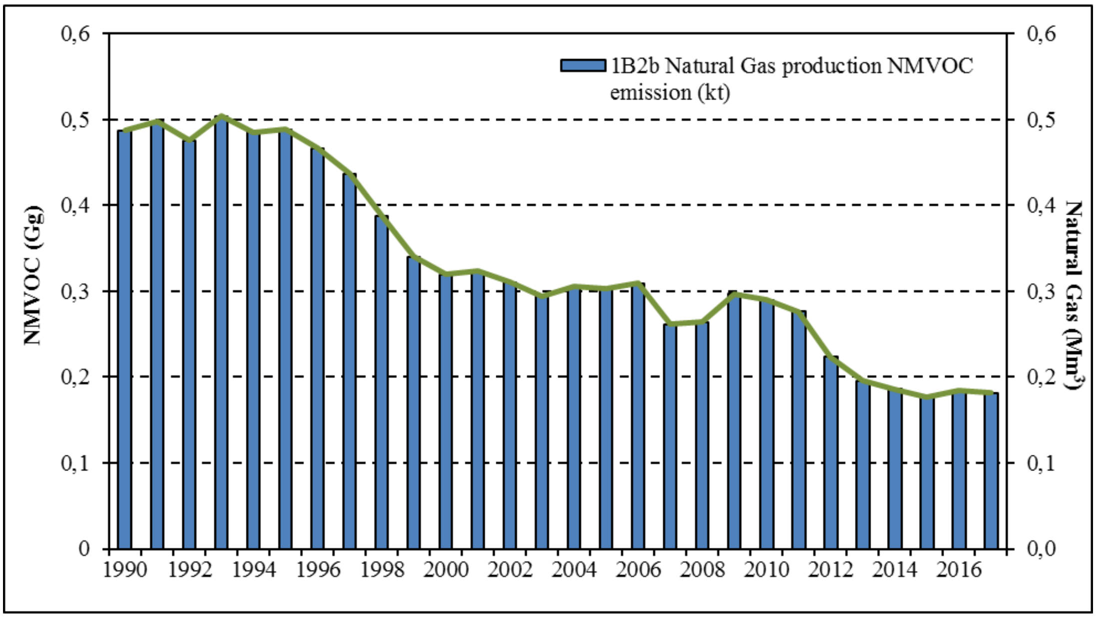
Tier 2 emission factor of the 2016 EMEP/EEA Guidebook is used for production of gas since it is obvious that all production occur on-shore in Hungary. Emission factor for transmission, distribution and storage are taken from 2006 IPCC Guidelines:

3.7. Table: *Default emission factors used in category 1.B.2.b*

	kg NMVOC/m^3 gas	Source of EF
Gas production	**0.0001**	**2016 EMEP/EEA Guidebook**
Gas transmission	7.00E-06	2006 IPCC Guidelines
Gas transmission	4.60E-06	2006 IPCC Guidelines
Gas storage	3.60E-07	2006 IPCC Guidelines
Gas distribution	1.60E-05	2006 IPCC Guidelines

Activity data

Activity data of natural gas production, transmission, distribution and storage are available from IEA Energy Statistics in addition it is reported also by the service company for UNFCCC reporting purposes. Please note that activity data reported in NFR Table is the total indigenous production of natural gas, but total emissions from subsector *1B2b* contain also emissions from gas transmission, distribution and storage.



3.7*. Figure: Natural gas indigenous production and NMVOC emissions*

Recalculations, QA/QC activities and planned improvements

Emissions were recalculated only in case of revised IEA data. Only very minor changes can be observed for 2015 in natural gas production and in inland consumption data for 2013-2015 period, the latter modified only the emissions of distribution.

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

Last update: 03.2019
Reported Emissions: NO_X, SO_x, CO, NMVOC, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, 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. Exclusively in this subcategory also NO_X, SO_x, and CO are reported in addition to NMVOC based on the suggestion of 2016 EMEP/EEA Guidebook.

Emission factor

Tier1 emission factor is used for NMVOC, NO_x, CO for gas production venting and flaring provided in the 2016 EMEP/EEA Guidebook.

In case of oil refinery flaring only NMVOC and SO_x emissions are calculated with Tier 1 emission factors from 2016 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. NO_X, SO_x 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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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.

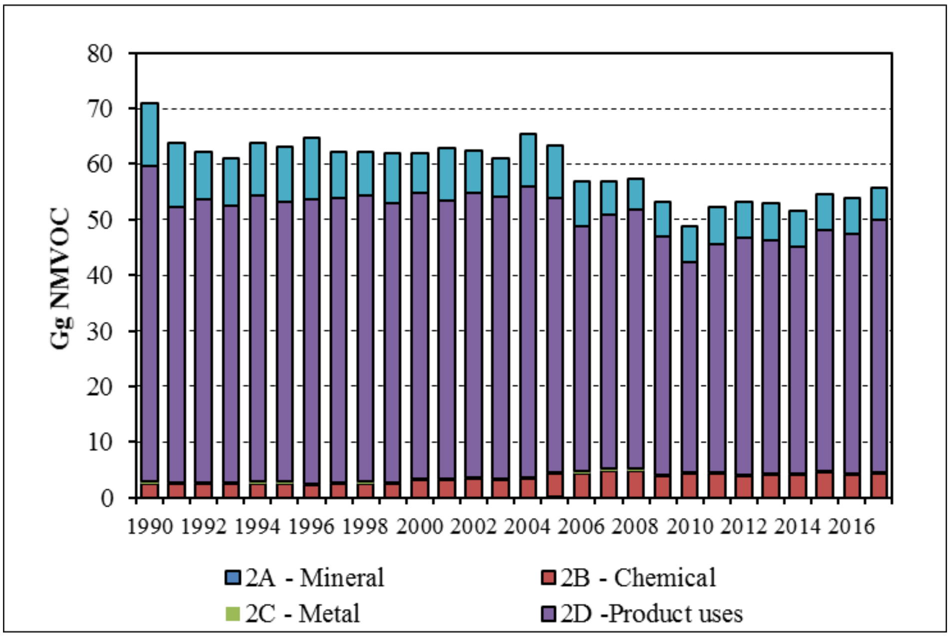
In several cases emission data reported directly by individual companies are taken into account. This data is available in the LAIR (Hungarian Air Emissions Information System) and/ or in E-PRTR reporting (please see more detailed description in chapter 1.5). Where directly reported data is used, activity 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 regional Inspectorates for Environment, Nature. 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

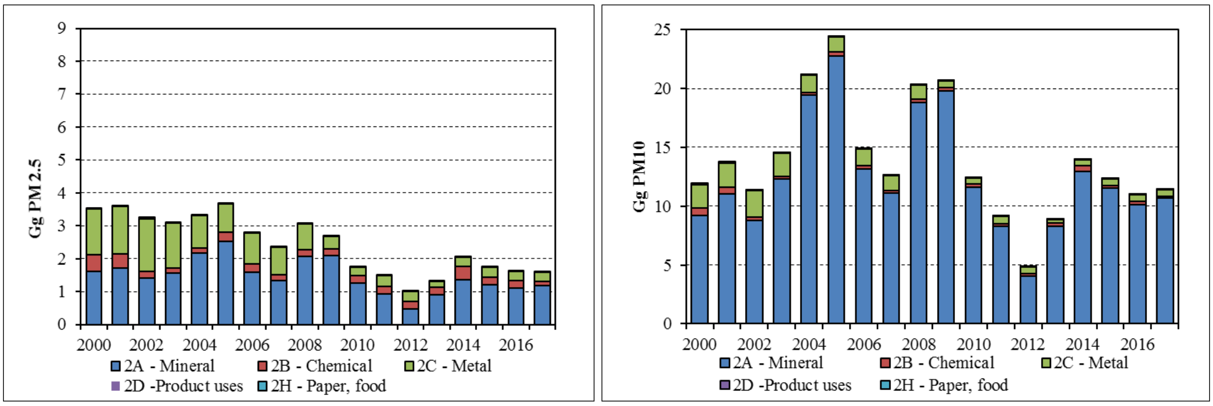
NMVOC emissions determined usually by using default emission factors provided in the 2016 EMEP/EEA Guidebook have the biggest volume in this sector. Direct reporting of NMVOC emission is usually not available because in the LAIR (see description in chapter 1.5 of the IIR) NMVOCs are usually not reported 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. Relatively high jump occurs in 2016, where residential construction increased to a large extent due to government measures.

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

OTHER categories in 2019 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

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 *Table 4.1.1.*

4.1. Table: *Sectors not reported in 2019 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 2018 submission.

4.2 MINERAL PRODUCTS (NFR SECTOR 2.A)

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

Last update: 14.03.2019

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. At the end of the time-series IEFs are very close to the ones described in the EU BAT Ref. document (2013).

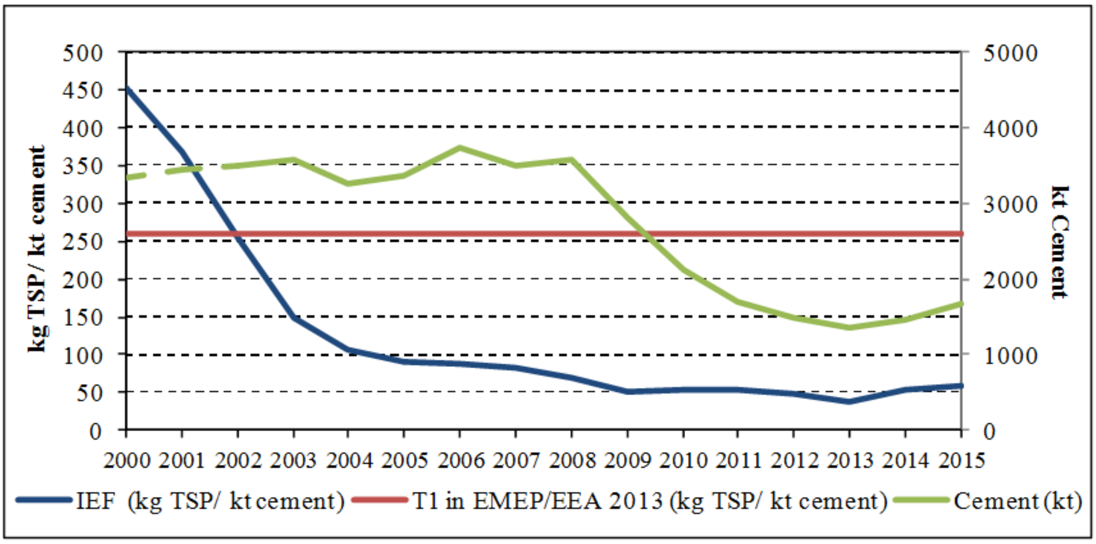
4.3. Table: Implied emission factors for cement production in Hungary, 2000-2017

	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***	***2017***
IEF (g TSP/t clinker)	75	80	82	54	51	24	26	C	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 2019 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: 14.03.2019
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 4.1) that is the same in 2009, 2013 and 2016 versions of the Guidebook.

Table 4.4 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%

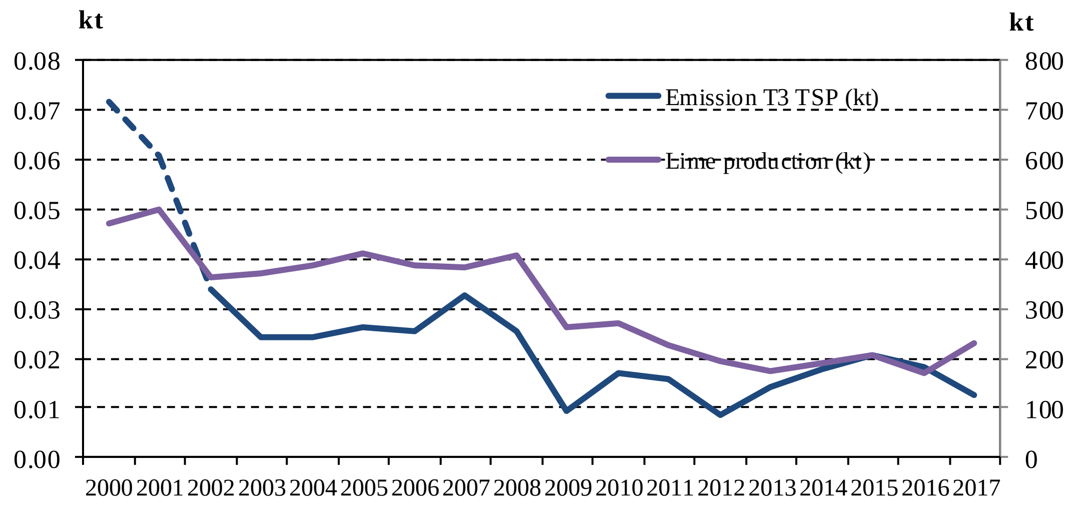
Please note that in this sector Tier 1 emission factors in 2016 EMEP/EEAGuidebooks do not include abatement option (uncontrolled process) therefore they are much higher than Tier 3 implied emission factor. The directly reported plant specific emissions correspond to the Tier 1 emission factor with cc.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

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 - as it is possible to see at the following Figure. 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.



4.4. Figure: Comparison of the plant specific data and emissions calculated with Tier 1 emission factor and 90% abatement efficiency (2000-2017)

Uncertainty, recalculations, QA/QC activities and planned improvements

There was no recalculation in 2019 submission.

It is planned to use reported PM10 values if it will be available for both two plants.

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

Last update: 14.03.2019
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.

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 2019 submission.

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

Last update: 14.03.2019
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.

4.5. Table: Emission factors from 2016 EMEP/EEA Guidebook and emissions in selected years

	T1 in EMEP/EEA 2016 (g /t mineral)	**Emissions in 2000 (kt)**	**Emissions in 2005 (kt)**	**Emissions in 2010 (kt)**	**Emissions in 2015 (kt)**	**Emissions in 2016 (kt)**	**Emissions in 2017 (kt)**
TSP	***102***	2.78	4.32	3.42	4.62	3.78	4.03
PM_{10}	***50***	1.36	2.17	1.68	2.26	1.85	1.97
$PM_{2.5}$	***5***	0.14	0.21	0.17	0.23	0.19	0.20

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 (2000-2017)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
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

Uncertainty, recalculations, QA/QC activities and planned improvements

Mining of ores are not reported in official statistics, but these data are ***published by the Mining and Geological Survey of Hungary (MBFSZ). Unfortunately, MBFSZ publishes statistical data after the deadline of NFR submission, therefore it could be included only one year later. Emissions for 2016 were recalculated in this submission with real value for mining of ores, differences between the 2018 and 2019 are negligible (-0.08%).***

Further verification of activity data is planned.

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

Last update: 14.03.2019

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 was estimated using databases of NIF, from where total length of new roads can be calculated. 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

Correction factor for soil moisture was recalculated using climatic average instead of actual years' data. Remarkable changes can be seen in some years.

Difference between 2019 and 2018 submission	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
TSP (kt)	11.76	20.92	12.30	25.50	52.19	62.44	29.71	22.70	46.75
PM10 (kt)	3.50	6.25	3.67	7.61	15.59	18.66	8.87	6.78	13.96
PM2.5 (kt)	0.35	0.62	0.37	0.76	1.56	1.87	0.89	0.68	1.40
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
TSP (kt)	53.97	29.67	15.56	2.60	18.97	31.71	-5.89	3.63	
PM10 (kt)	16.12	8.87	4.64	0.77	5.67	9.47	-1.76	1.09	
PM2.5 (kt)	1.61	0.89	0.46	0.08	0.57	0.95	-0.18	0.11	

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.

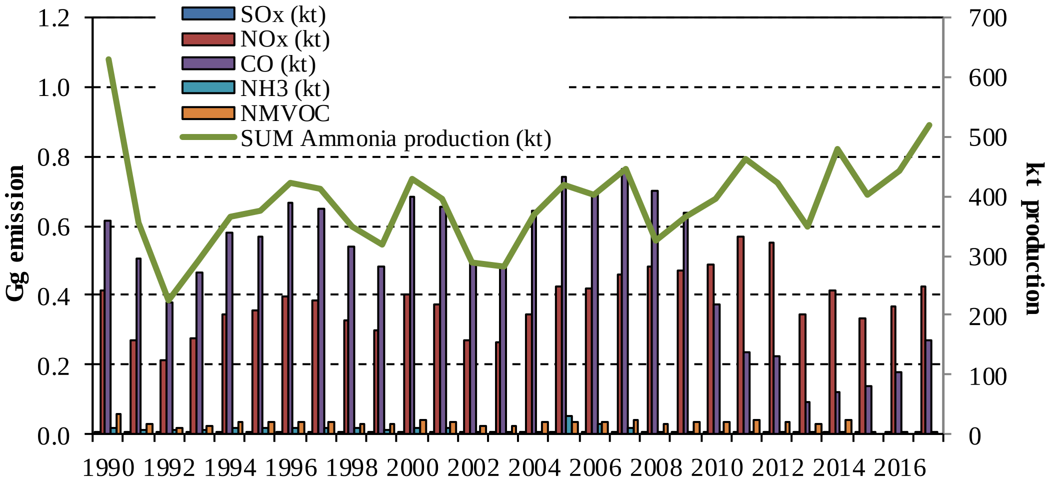
In the case of ammonia and nitric acid production directly reported emission data is used. In this case the quality of the data is verifiable since the same data is reported to E-PRTR, too. Well known company having IPPC permit (including BAT prescribed) and the abatement technology causing a significant 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: 14.03.2019
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.



4.5. ***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

In this submission only NOx, CO and SOx emission were changed for 2016 due to inclusion of emissions of one report from the LAIR database.

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

Last update: 14.03.2019
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.

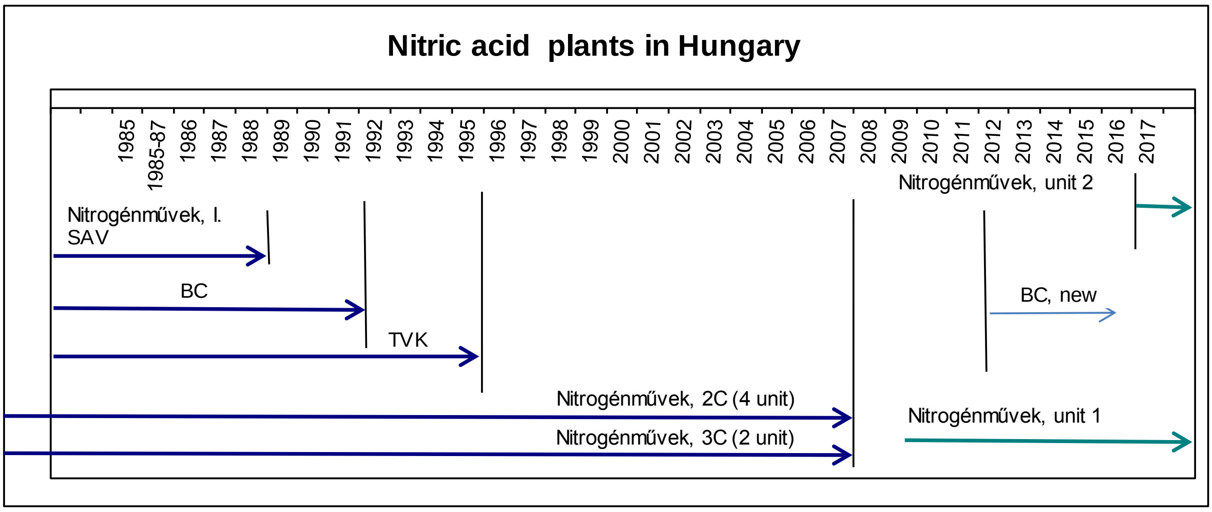
In this industrial sector many changes have been taking place since 1980. Among the old factories using obsolete technologies, one was abandoned in 1988, another in 1991, and a third in 1995.

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 2017 a new nitric acid unit started to work at Nitrogénművek Zrt. increasing the capacity significantly.



4.6***. Figure: Nitric acid plants in Hungary (1985-2017)***

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 is extrapolated as it is presented in the following table. (The extrapolation of implied emission factor means the same as the extrapolation of emissions weighted with activity data.)

The starting and ending dates of the linear interpolation is determined based on the information available on the introduction of different abatement technologies.

The reason for using 2004 implied emission factor for extrapolation of NH_3 emission is that it is the earlier and higher data available. Neither the previous nor the 2016 EMEP/EEA Guidebook includes emission factors for nitric acid process NH_3 emissions, therefore plant specific data is used for all the years in this case.

4.8. Table: *Summary of the implied emission factors used for extrapolation in the NO_x and NH_3 time series*

	NO_x IEF (g/t nitric acid)	**source of the NO_x IEF**	**NH_3 IEF (g/t nitric acid)**	**source of the NH_3 IEF**
1990-1995	**10000**	T1 EF assuming no abatement	*233.86*	directly reported plant specific data of year 2004
1996	*9191.80*	linear interpolation assuming the penetration of abatement technologies	*233.86*	
1997	*8383.60*		*233.86*	
1998	*7575.39*		*233.86*	
1999	*6767.19*		*233.86*	
2000	*5958.99*		*233.86*	
2001	*5150.79*		*233.86*	
2002	*4342.58*		*233.86*	
2003	*3534.38*		*233.86*	

	NO_x IEF (g/t nitric acid)	source of the NO_x IEF	NH_3 IEF (g/t nitric acid)	source of the NH_3 IEF
2004	*2726.18*		***233.86***	
2005	*1917.98*		*233.86*	
2006	*1109.77*		*233.86*	
2007	301.57	T3 - directly reported plant specific data including abatement	139.33	T3 - directly reported plant specific data including abatement
2008	61.18		10.44	
2009	15.56		15.09	
2010	11.70		27.81	
2011	25.40		5.17	
2012	45.72		11.49	
2013	54.26		16.24	
2014	36.73		21.07	
2015	40.77		2.46	
2016	24.70		2.24	
2017	28.65		1.79	

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_2O 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.

EnviNOx technology

The $EnviNO_x$ process is usually located between the final tail gas heater and the tail gas turbine and contains two catalyst beds filled with iron zeolite catalysts operating at the same pressure and temperature and a device for addition NH_3 between the beds. In the first DeN_2O stage, the N_2O abatement is effected simply by the catalytic decomposition of N_2O into N_2 and O_2. Since NO_x content of the tail gas promotes the decomposition of N_2O, the required $DeNO_x$ stage is arranged downstream of the DeN_2O stage. In the second stage, NO_x reduction is carried out using NH_3 as a reducing agent similar to natural gas.

Reactions in the DeN_2O:

$2\ N_2O + 2NO$ ------->$2\ N_2 + 2\ NO_2$

$2\ N_2O$ <------->$2\ NO + O_2$

$2\ N_2O$ ------->$2\ N_2 + O_2$

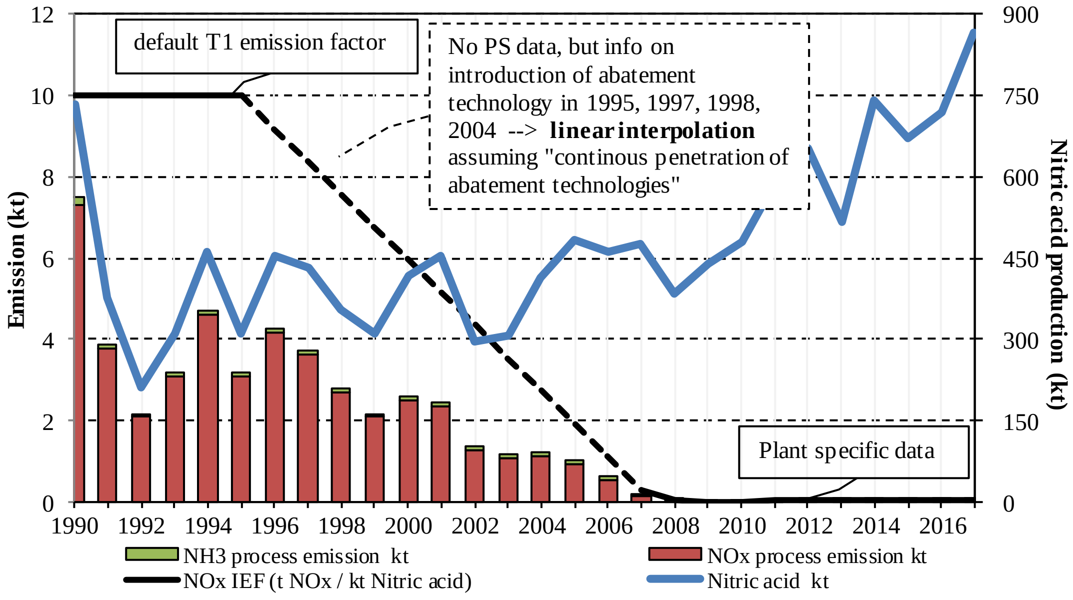
Reactions in the De NO_X:

$6\ NO_2 + 8\ NH_3$ -------> $7\ N_2 + 12\ H_2O$

$4\ NO + O_2 + 4\ NH_3$ -------> $4\ N_2 + 6\ H_2O$

Since this project was realized by means of a flexible mechanism facilitated by the Kyoto Protocol (as N_2O is greenhouse gas), the verification of this fact is possible thanks to the publicly available information published in the Joint Implementation project documentation:

http://ji.unfccc.int/JIITLProject/DB/GSZRV07J6MCQRD8BAZ3MN839PHNZE5/details



*4.7. **Figure: Trend of NO_X and NH_3 emissions and the implied emission factors and production of Nitric acid in Hungary***

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.

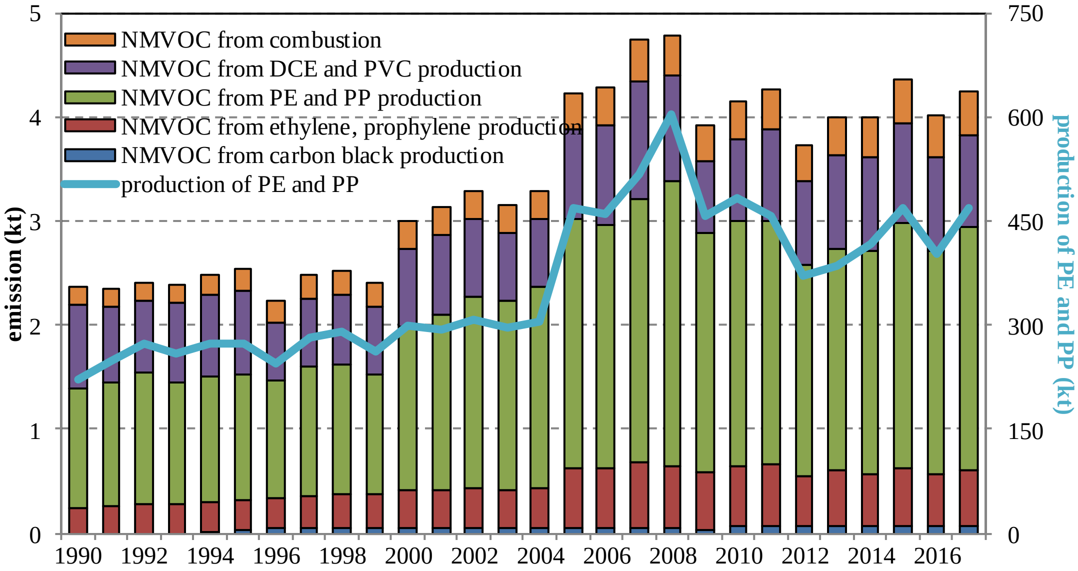
In 2016 submission it was stated that data for 2014 had been extrapolated using production volume and the implied emission factor of last year, because the reported plant specific data seemed to be outlier. Measured emissions were checked, and emissions were corrected for 2013 and 2014 according to the 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 were no recalculations in 2019 submission.

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

Last update: 14.03.2019
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



4.8*. 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.

4.9. 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 + 040507 Polyethylene High Density	NMVOC	**Tier 2 for LD**
	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF
040509 Polypropylene	NMVOC	**Tier 2**
	TSP	**2005-2017: LAIR** 2000-2004: LAIR 2005 IEF
	NMVOC	**Tier 2-(E-PVC)**

SNAP code. activity	Pollutant	Emission factor used
040508 Polyvinylchloride	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.

Further verification and refinement of the directly reported data and the extrapolation used are planned.

Small refinement was made to Hg emissions for the 2014-2016 period.

4.4 METAL PRODUCTION (NFR SECTOR 2.C)

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

Last update: 14.03.2019
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.

4.10. 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

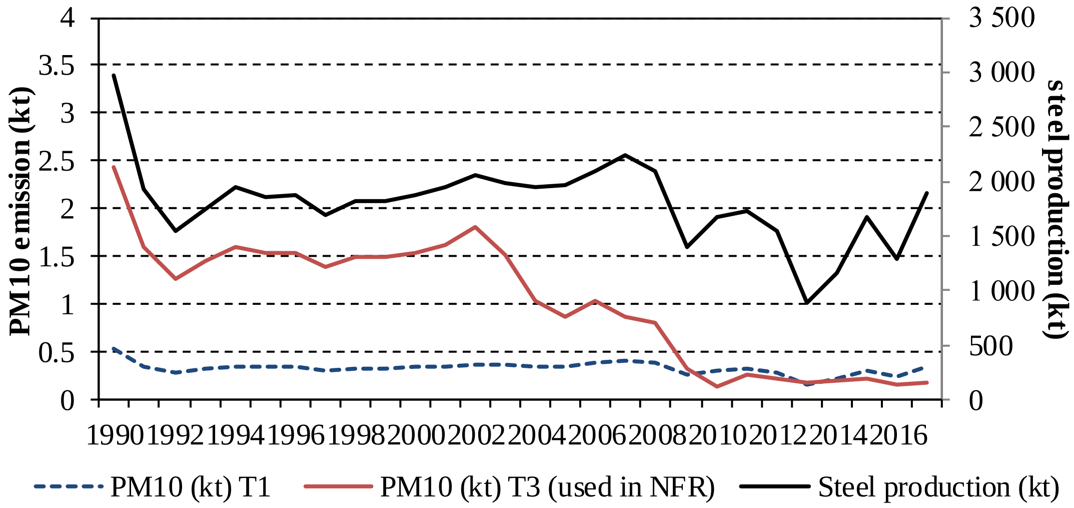
PCDD/F emissions are reported using E-PRTR data. As E-PRTR data is available usually only for year x-3, IEF of the year x-3 and activity data of year x-2 is used. Although the use of E-PRTR data results higher emission of PCDD/F than the use of Tier 1 default factor, former is applied to ensure consistency 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. Unfortunately, no detailed activity data needed for Tier 2 method is available at the moment.

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.



4.9. 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

PCDD/F emission for 2016 was updated with new reported value obtained from E-PRTR database, because E-PRTR data is available usually only for year x-3.

Further analysis and verification of directly reported data and the extrapolation method are still necessary. In addition, further refinement would be possible in the case abatement technologies were available.

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

Last update: 14.03.2019
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 would be needed as well.

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

Last update: 14.03.2018
Reported Emissions: TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cd, Hg, Zn, As, Cu, Ni, PCB, PCDD/F.
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.

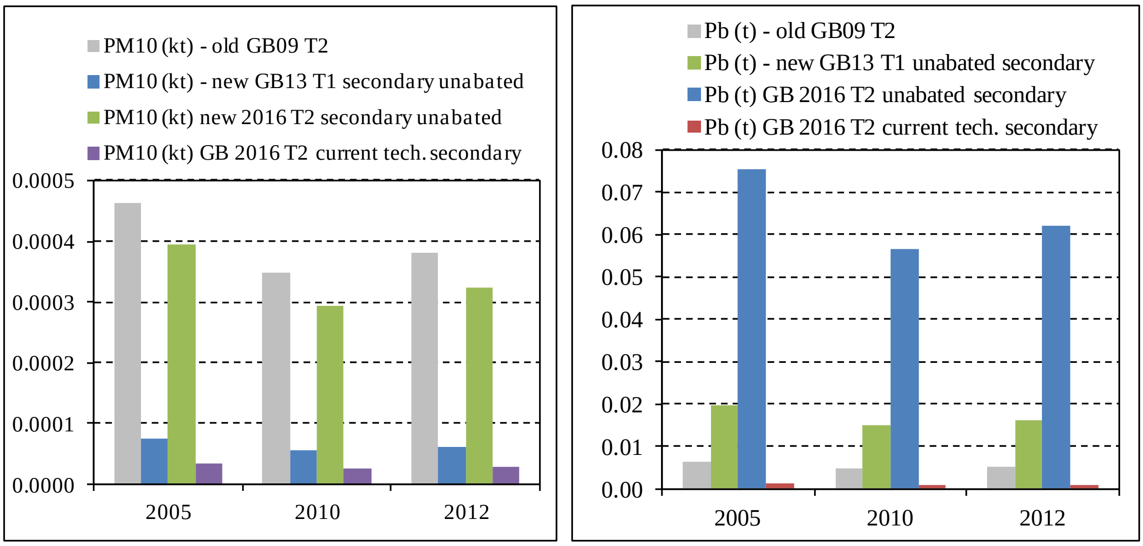
Secondary zinc: TSP, PM_{10}, $PM_{2.5}$.. BC, Pb, Cd, Hg, Zn, PCB, PCDD/F.

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.

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.



4.10. 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

Further search for possible occurrence of secondary metal production in Hungary is needed and verification of activity data.

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

Last update: 14.03.2018
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.

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.

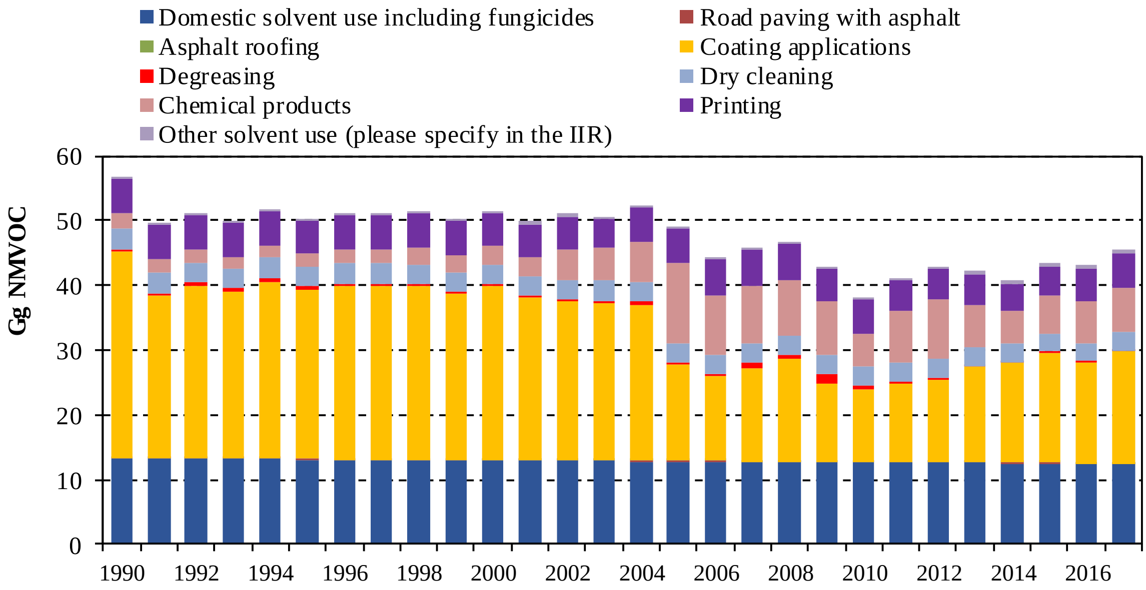


Figure 4.11 NMVOC emissions of product uses

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

Last update: 14.03.2019

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 4.12*).

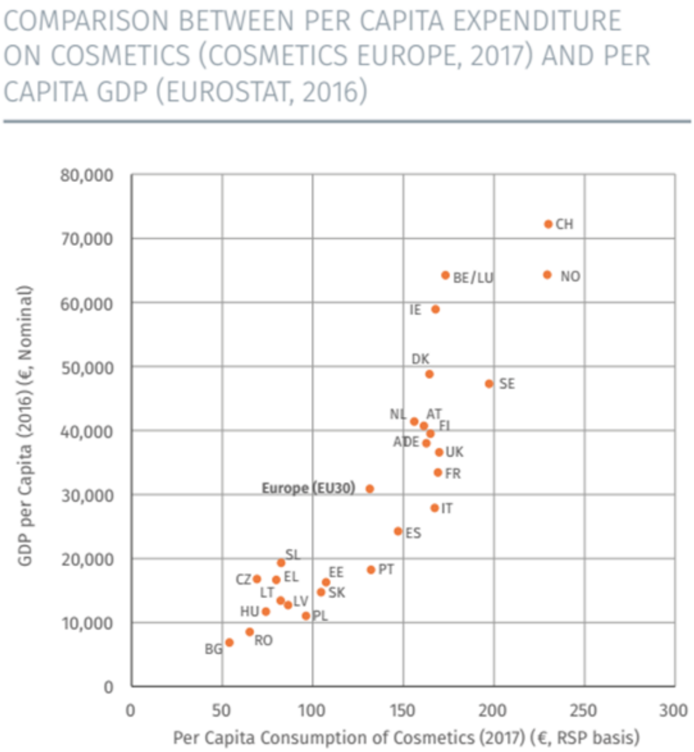


Figure 4.12 Per Capita Consumption of Cosmetics (2017) (€, RSP basis). Source: Cosmetics Europe, 2018

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.

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

Last update: 14.03.2019
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 2016 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.

Small changes can be observed from time to time with the improvement of the database. In the 2019 submission only the 2014-2016 period was recalculated due to changes in LAIR database, but changes are minor. NMVOC emission remained unchanged.

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

Last update: 14.03.2019
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 2016 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

Inclusion of Tier 3 emissions from LAIR database is planned, also activity data for the years 2011-2017 will be modified according to new data from LAIR database.

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

Last update: 14.03.2019
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.

Although the category is key, Tier 1 method is applied yet due to absence of detailed activity data. The activity data needed for Tier 2 (such as amount of paint used for wood preservation, number of cars, busses, trucks and boats painted, mass of wire coated, etc.) is usually not collected, so it should be estimated eventually using other surrogate data. In addition, it is not enough to collect production data in this sector, but import-export data is also needed in order to be able the estimate apparent consumption.

Please note that unfortunately at the moment the trend of emissions reflects only the change of activity data, as Tier 1 method is applied without abatement.

Emission factor

Average of Tier 1 emissions factors from 2016 EMEP/EEA Guidebook of **250 g/kg** paint applied as it was suggested by an earlier review.

Activity data

Paint applied activity data is calculated as apparent consumption (e.g. import-export+production).

Production data from HCSO PRODCOM (in Hungarian: ITO) categorization and trade data from HCSO – Eurostat Combined Nomenclature categorization was used. Exact codes and the detailed time series of the activity data used is presented in the following Table. Please note that numbers in italics need to be further improved. In the case of production these are old data provided by the HCSO to HMS GHG Inventory preparation purposes. In the case of trade, time-series are extrapolated using population as surrogate data, as trade data is available in the HCSO database only from 2003.

Uncertainty, recalculations, QA/QC activities and planned improvements

Please note that in 2012, 2013 and 2014 February submission 150 g / kg paint emission factor was used. This is the lowest value among the Tier 1 emission factor therefore the emission factor has been corrected to the average of the Tier 1 emissions factors (250 g/kg paint applied) in 2014 May submission as the lower value could not be justified.

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. This investigation has not yet finished.

Table 4.5.1 *Activity data and NMVOC emissions in 2.D.3.d sector*

	SUM Prodcom Codes: 203 012 ; 203 021; 203 022 100; 203 022 500; 203 022 700; 203 022 400; 203 023 000	**SUM CN Codes: 3203; 3204; 3205; 3207; 3208; 3210; 3211; 3212; 3213**		
	SUM Paint production	**SUM Paint (imp-exp)**	**SUM PAINT (imp-exp+prod)**	**NMVOC emitted**
	t	**t**	**kt**	**kt**
1990	*100000*	*28062*	*128.06*	**32.02**
1991	*72819*	*28065*	*100.88*	**25.22**
1992	*79119*	*28040*	*107.16*	**26.79**
1993	*75089*	*28000*	*103.09*	**25.77**
1994	*81916*	*27965*	*109.88*	**27.47**
1995	*76830*	*27921*	*104.75*	**26.19**
1996	*78981*	*27867*	*106.85*	**26.71**
1997	*79181*	*27810*	*106.99*	**26.75**
1998	79077	*27737*	*106.81*	**26.70**
1999	74749	*27654*	*102.40*	**25.60**
2000	79678	*27594*	*107.27*	**26.82**
2001	73050	*27526*	*100.58*	**25.14**
2002	70682	*27437*	*98.12*	**24.53**
2003	70091	27370	97.46	**24.37**
2004	72074	24637	96.71	**24.18**
2005	30449	28638	59.09	**14.77**
2006	26324	25753	52.08	**13.02**
2007	31815	26022	57.84	**14.46**
2008	28835	34468	63.30	**15.83**
2009	20474	28118	48.59	**12.15**
2010	13653	31598	45.25	**11.31**
2011	13114	35457	48.57	**12.14**
2012	17379	33927	51.31	**12.83**
2013	21510	37620	59.13	**14.78**
2014	22260	39722	61.98	**15.50**
2015	25830	42572	68.40	**17.10**
2016	22757	39938	62.70	**15.68**
2017	22705	46516	69.22	**17.31**

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

Last update: 14.03.2017
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

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

Last update: 14.03.2019
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T1
Emission factors: T1
Key source: Level NMVOC

NMVOC emissions are reported using default emission factor.

Emission factor

Default emission factor of 0.3 kg/inhabitant/year provided in the 2016 EMEP/EEA Guidebook is used that is the same as in the earlier versions.

Activity data

Data on population is available from HCSO.

Uncertainty, recalculations, QA/QC activities and planned improvements

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 case of dry cleaning there is no capacity limit, therefore the aggregated data from LAIR could be used directly. Unfortunately, filtering the appropriate installation in the database needs modification in the database, therefore recalculation of this sector will be included later.

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

Last update: 14.03.2019
Reported Emissions: NMVOC
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.

The 2016 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 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 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.

Uncertainty, recalculations, QA/QC activities and planned improvements

LAIR database of VOC balance data regulated by the directive 2010/75/EU of the European Parliament and of the Council was checked for manufacturers of pharmaceutical products. Direct emissions from these installations were completed with diffuse emissions, as well. The following table summarizes the changes in this sector:

	difference (in kt) between 2019 and 2018 submissions
2002	1.75
2003	1.88
2004	2.93
2005	4.44
2006	4.80
2007	6.29
2008	6.16
2009	4.59
2010	2.30
2011	4.17
2012	5.86
2013	2.69
2014	0.93
2015	1.73
2016	1.96

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

Last update: 14.03.2019

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.

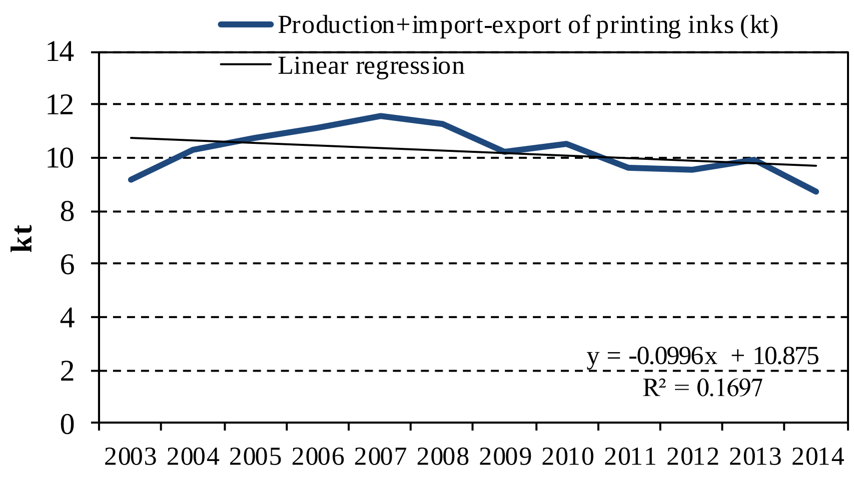
Emission factor

2016 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.



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

Uncertainty, recalculations, QA/QC activities and planned improvements

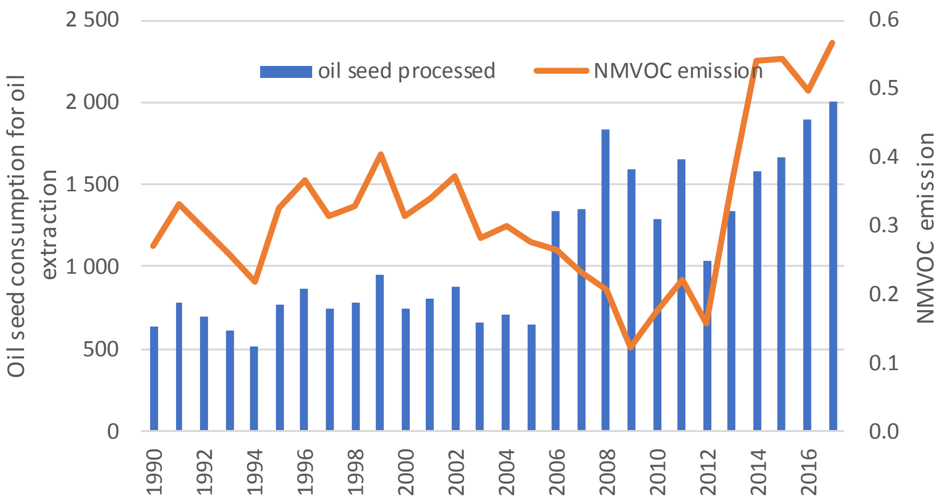
In 2018 investigation was started to use higher Tier method and because Tier 1 method could not reflect changes in technologies, however printing is a fast-developing industrial sector. LAIR database collects VOC balance data for those installation which falls within the scope of the directive 2010/75/EU 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.

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

Last update: 14.03.2019
Reported Emissions: NMVOC
Measured Emissions: none
Methods: T3
Emission factors: T3

This is 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.



4.14. Figure: Oil seed processed and NMVOC emissions (1990-2017)

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: 14.03.2019
Reported Emissions: NO_x, CO, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, Cd, Ni, Zn, Cu, PCDD/F, PAHs, NH_3
Measured Emissions: none
Methods: T2
Emission factors: T2
Key source: Level and trend Cd

The problems of this sector are very similar to sector 2.D.3.g. In addition, here more consumption data is required which makes the estimation even harder. Unfortunately, the availability of consumption data of products is very poor. So, the result of this sector is probably an underestimation due to absence of data however this is a problem not only in Hungary. The only activity reported at the moment within this sector in Hungary is the tobacco consumption since this is the only product where both default Tier 2 emission factors and required activity data are available.

Emission factor

Tier 2 default emission factors for NOx, CO, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, Cd, Ni, Zn, Cu, PCDD/F, PAHs and NH_3 are used from 2016 EMEP/EEA Guidebook.

Activity data

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.

Uncertainty, recalculations, QA/QC activities and planned improvements

NH3 emissions for the whole time-series were added due to recommendation of 2018 review.

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

Last update: 14.03.2019
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 2016 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. For 2016 and 2017 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: 14.03.2019
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 2016 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.

4.11. 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	conf	conf	1201860	157200	6453280	202780	**6.55**
2012	358284	conf	conf	1665720	241300	6387650	202663	**6.39**
2013	476442	177152	conf	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**

4.5.12. WOOD PROCESSING (NFR SECTOR 2.I)

Last update: 14.03.2019
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.

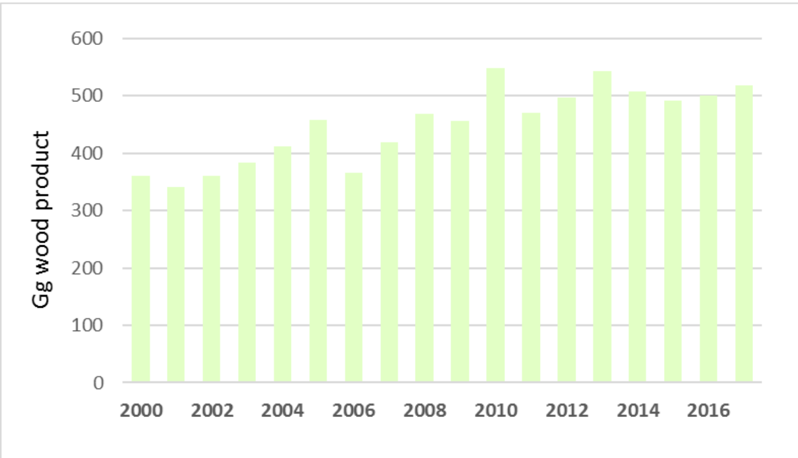
It is only a minor source of emissions and not a key category, thus Tier1 default approach suggested by EMEP/EEA air pollutant emission inventory guidebook 2016 was applied. So, the activity data is the mass of wood products processed.

Emission factor

According to the 2016 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.



Wood production in Hungary

Uncertainty, recalculations, QA/QC activities and planned improvements

None.

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

Last update: 14.03.2018
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 2016 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 2019

Agriculture sector comprises NH_3, NO_x (as NO_2), NMVOC and particulate matter ($PM_{2.5}$, PM_{10} and TSP) emissions from agricultural production.

Following the recommendations of the NECD Review, 2017 the text concerning emissions from 3Dd was revised in the IIR to avoid misleading information, and NO_x emissions from 3Da3 Urine and dung deposited by grazing animals have been included in this submission.

Additionally, some minor recalculation has also been undertaken for NH_3 emissions for the years 2015 and 2016 which have insignificant impact on the national total emissions.

Agricultural emissions were calculated using the most up-to-date, 2016 EMEP/EEA Emission Inventory Guidebook and is described in the following sections.

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 the emission estimate.

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 not been occurring since 1990 and therefore not reported, 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 and 3De Cultivated crops are reported.

Emissions from ‘3Df Use of pesticides’ are not reported, because pesticides containing substances for which there are existing emissions reporting obligations had been banned in Hungary before 2000, therefore ‘NO’ is reported in the NFR Tables.

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 2016 the gross production of agriculture increased, because the output volume of crop production and animal husbandry rose by 13% and 3%, respectively (HCSO, 2017) and remained on the same level in 2017.

5.2 TRENDS IN EMISSIONS

5.2.1 AMMONIA (NH_3)

Agriculture is the main source of NH_3 emissions, with 90.8% share of the national total in 2017 (Table 5.1). Manure management accounts for the bulk of national total ammonia emissions in Hungary, it was responsible for 45.8% and 40.2 Gg share of the total in 2017. Under 3B Swine, Poultry and Cattle accounted for the majority of agricultural total NH_3 emissions. Fertilizer use at 20.0% (17.6 Gg) are the second largest contributor to the national total ammonia emissions. Distribution of main sources of ammonia from agriculture for 2017 is shown in *Figure 5.1*.

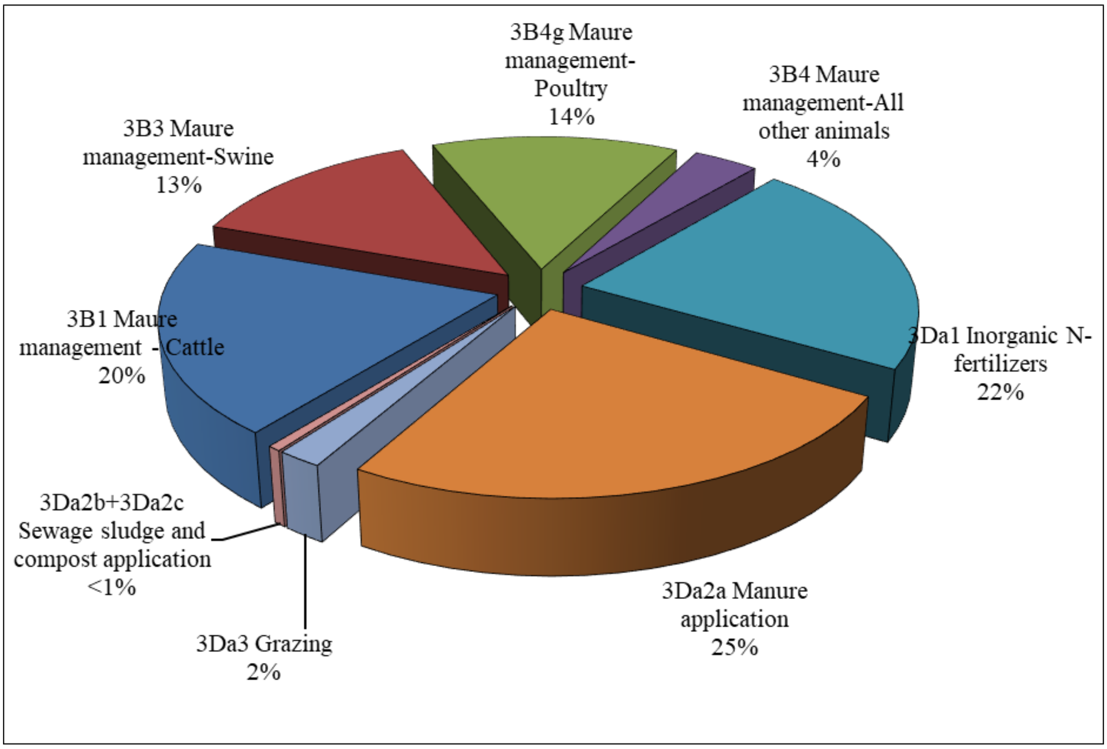
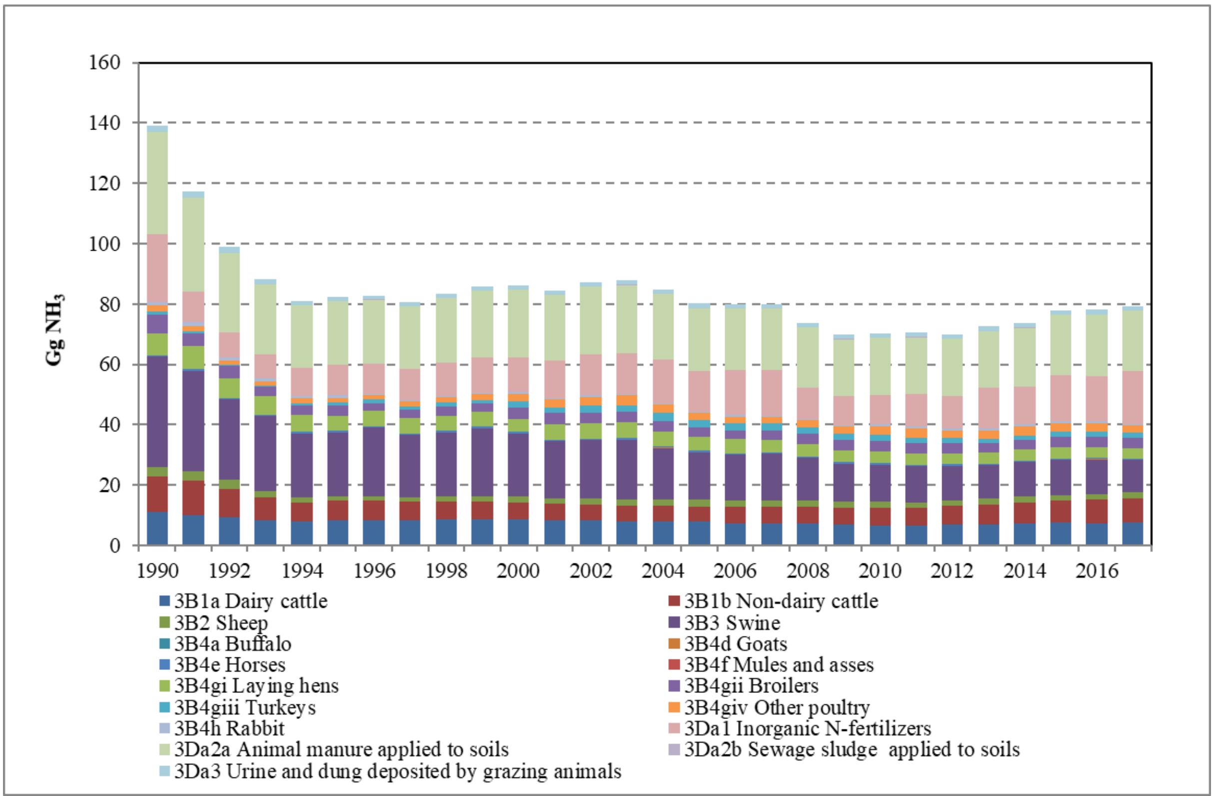


Figure 5.1 Ammonia emissions from Agriculture, 2017

Agricultural NH_3 emissions have decreased by 42.8% since 1990 (*Table 5.1* and *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 2017 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 for ammonia 1990-2017

Year	3.B	3.D	3
	Manure Management	**Crop production and agricultural soils**	**Agriculture Total**
		Gg	
1990	80.6	58.5	139.1
1991	74.0	43.4	117.3
1992	62.4	36.7	99.1
1993	55.4	32.7	88.1
1994	49.6	31.5	81.1
1995	49.7	32.7	82.4
1996	50.2	32.6	82.9
1997	48.1	32.6	80.7
1998	49.5	34.0	83.5
1999	50.6	35.2	85.8
2000	50.7	35.6	86.3
2001	48.9	35.7	84.6
2002	49.8	37.6	87.4
2003	50.1	37.8	87.9
2004	47.1	37.9	85.0
2005	44.3	35.9	80.2
2006	43.2	36.9	80.1
2007	43.0	37.1	80.1
2008	41.8	32.1	73.9
2009	39.7	30.4	70.1
2010	40.0	30.6	70.6
2011	39.3	31.5	70.8
2012	38.8	31.4	70.2
2013	38.8	34.0	72.8
2014	40.1	33.9	74.0
2015	41.1	37.1	78.3
2016	41.2	37.2	78.4
2017	40.2	39.4	79.6
Share in Hungarian total in 2017	**47.0%**	**42.4%**	**89.4%**
Trend 1990-2017	**-50.2%**	**-32.6%**	**-42.8%**
Trend 2005-2017	**-9.3%**	**9.8%**	**-0.8%**



5.2. Figure Emission trend for ammonia from Agriculture 1990-2017

Please note: emissions from Urine and dung deposited onto the soils during grazing of Cattle and emissions from manure application of Swine and Cattle are reported under 3.D

The significantly shrinking urea use also contributed to the decreasing trends. Emissions from 3Da1 Fertilizer use have reduced by 22.2 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 2017 Agriculture accounted for 1.5% (0.7 Gg), 14.2% (9.5 Gg) and 15.1% (14.1 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 2017, 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 9.7% (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 2000-2017 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 counterbalanced 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 5.2* and *Table 5.4*.

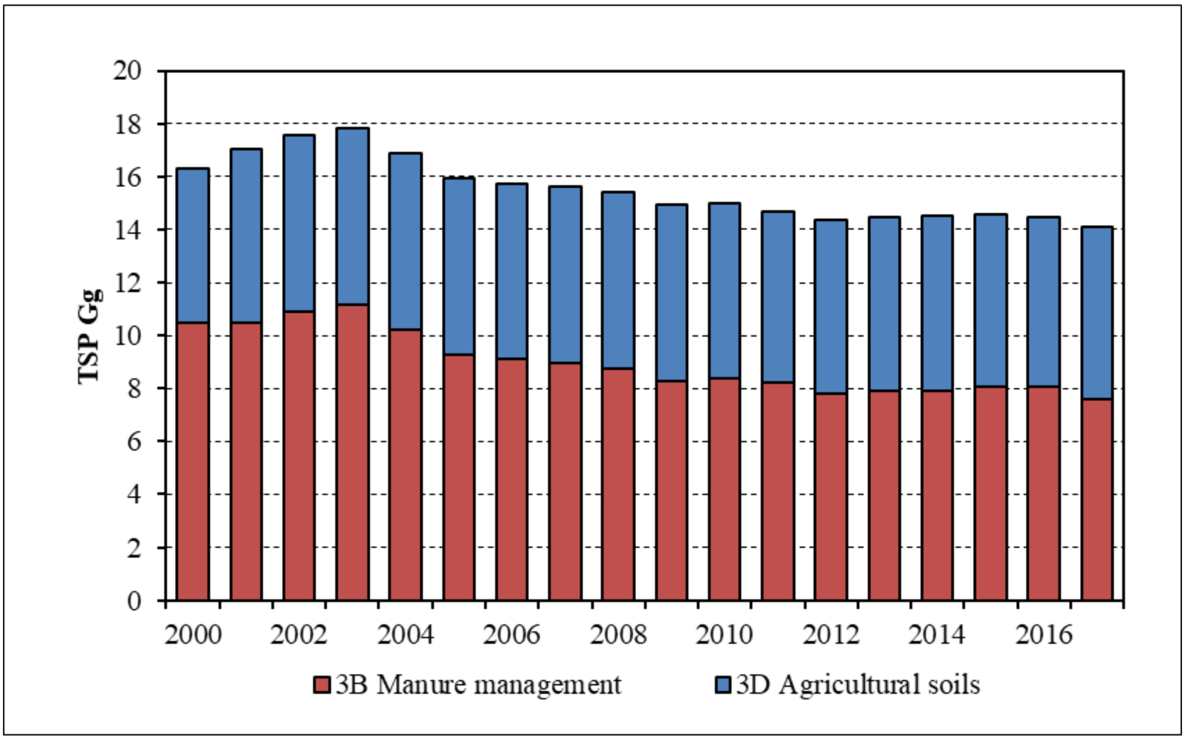


Figure 5.3 TSP emissions from Agriculture, 2000-2017

Table 5.2 Emission trend for agricultural $PM_{2.5}$ 2000-2017

Year	3.B	3.D	3
	Manure Management	Crop production and agricultural soils	Agriculture Total
		Gg	
2000	0.6	0.2	0.8
2001	0.6	0.3	0.8
2002	0.6	0.3	0.8
2003	0.6	0.3	0.9
2004	0.6	0.3	0.8
2005	0.5	0.3	0.8
2006	0.5	0.3	0.8
2007	0.5	0.3	0.8
2008	0.5	0.3	0.8
2009	0.5	0.3	0.7
2010	0.5	0.3	0.8
2011	0.5	0.2	0.8
2012	0.5	0.3	0.7
2013	0.5	0.3	0.7
2014	0.5	0.3	0.8
2015	0.5	0.2	0.8
2016	0.5	0.2	0.8
2017	0.5	0.3	0.7
Share in Hungarian total in 2017	**1.0%**	**0.5%**	**1.5%**
Trend 2000-2017	**-14.6%**	**12.7%**	**-6.9%**
Trend 2005-2017	**-5.9%**	**-2.3%**	**-4.7%**

Table 5.3 Emission trend for agricultural PM_{10} 2000-2017

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total
	Gg		
2000	3.7	5.8	9.5
2001	3.7	6.6	10.3
2002	4.0	6.6	10.6
2003	4.1	6.6	10.7
2004	3.8	6.7	10.5
2005	3.3	6.7	10.0
2006	3.3	6.6	9.9
2007	3.2	6.7	9.9
2008	3.2	6.6	9.9
2009	3.2	6.6	9.8
2010	3.3	6.6	9.9
2011	3.3	6.5	9.8
2012	3.1	6.6	9.7
2013	3.2	6.6	9.7
2014	3.1	6.6	9.7
2015	3.1	6.5	9.6
2016	3.2	6.4	9.7
2017	3.0	6.5	9.5
Share in Hungarian total in 2017	**4.4%**	**9.7%**	**14.2%**
Trend 2000-2017	**-19.3%**	**12.7%**	**0.3%**
Trend 2005-2017	**-11.0%**	**-2.3%**	**-5.2%**

Table 5.4 Emission trend for agricultural TSP 2000-2017

Year	3.B	3.D	3
	Manure Management	Crop production and agricultural soils	Agriculture Total
		Gg	
2000	10.5	5.8	16.3
2001	10.5	6.6	17.1
2002	10.9	6.6	17.5
2003	11.2	6.6	17.8
2004	10.2	6.7	16.9
2005	9.3	6.7	15.9
2006	9.1	6.6	15.7
2007	8.9	6.7	15.6
2008	8.8	6.6	15.4
2009	8.3	6.6	14.9
2010	8.4	6.6	15.0
2011	8.2	6.5	14.7
2012	7.8	6.6	14.4
2013	7.9	6.6	14.4
2014	7.9	6.6	14.5
2015	8.1	6.5	14.6
2016	8.0	6.4	14.5
2017	7.6	6.5	14.1
Share in Hungarian total in 2017	**8.1%**	**7.0%**	**15.1%**
Trend 2000-2017	**-27.9%**	**12.7%**	**-13.5%**
Trend 2005-2017	**-18.3%**	**-2.3%**	**-11.6%**

5.2.3 NO_X

In 2017 the NO_x emissions from agriculture amounted to 21.1 Gg (17.6% of the national total), which is 10.8% 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 2005-2017 a significant increase is detectable due to the increasing fertilizer use in the recent years.

Table 5.5 Trends in emissions for NO_x from 3.B Manure Management 1990-2017

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total
		Gg	
1990	0.8	21.1	21.9
1991	0.8	12.0	12.8
1992	0.7	11.4	12.1
1993	0.6	11.2	11.8
1994	0.5	13.1	13.6
1995	0.5	11.8	12.3
1996	0.5	12.2	12.7
1997	0.5	12.2	12.7
1998	0.5	13.9	14.4
1999	0.5	14.6	15.1
2000	0.5	14.5	15.0
2001	0.5	15.1	15.6
2002	0.5	16.3	16.8
2003	0.5	15.8	16.3
2004	0.4	15.9	16.3
2005	0.4	14.4	14.9
2006	0.4	15.5	15.9
2007	0.4	16.8	17.2
2008	0.4	15.6	16.0
2009	0.4	14.7	15.1
2010	0.4	15.0	15.4
2011	0.4	15.8	16.2
2012	0.4	16.4	16.8
2013	0.4	17.7	18.0
2014	0.4	17.2	17.6
2015	0.4	18.5	18.9
2016	0.4	18.9	19.2
2017	0.4	20.8	21.1

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total
		Gg	
Share in Hungarian total in 2017	**0.3%**	**17.3%**	**17.6%**
Trend 1990-2017	**-56.7%**	**-1.3%**	**-3.5%**
Trend 2005-2017	**-12.5%**	**43.9%**	**42.3%**

5.2.4 NMVOC

In 2017 Agricultural NMVOC emissions amounted to 26.2 Gg and 18.0% share of the national total *(Table 5.6)*. The main agricultural source of MNVOC emissions is the 3B Manure management accounting for 18.0% 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 2.5% of national total. NMVOC emissions have decreased by 42.6% over the period 1990-2017, as a result of the decreasing animal livestock.

Table 5.6 Emission trend for NMVOC from Agriculture1990-2017

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total
		Gg	
1990	41.7	3.9	45.6
1991	37.6	3.9	41.5
1992	32.2	3.5	35.7
1993	27.7	3.3	31.0
1994	25.5	3.6	29.1
1995	25.3	3.7	29.0
1996	24.9	3.7	28.6
1997	24.5	3.7	28.2
1998	24.7	3.6	28.3
1999	24.7	3.2	27.9
2000	25.8	3.2	29.0
2001	25.2	3.6	28.8
2002	25.5	3.7	29.1
2003	25.3	3.7	29.0
2004	24.2	3.7	27.9
2005	22.9	3.7	26.6
2006	22.5	3.6	26.1
2007	22.4	3.7	26.1
2008	22.1	3.7	25.8
2009	21.5	3.7	25.1
2010	21.6	3.6	25.2
2011	21.4	3.6	24.9
2012	21.4	3.6	25.0
2013	21.4	3.6	25.1
2014	22.0	3.6	25.6

Year	3.B Manure Management	3.D Crop production and agricultural soils	3 Agriculture Total
		Gg	
2015	22.7	3.6	26.3
2016	22.9	3.5	26.5
2017	22.6	3.6	26.2
Share in Hungarian total in 2017	**15.5%**	**2.5%**	**18.0%**
Trend 1990-2017	**-45.8%**	**-8.8%**	**-42.6%**
Trend 2005-2017	**-1.5%**	**-2.3%**	**-1.6%**

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 enable 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. 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 1990-2017

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	564	1,053	1,958	8,709	0.1	35	76	4.3	70,326	2,587
1991	527	1,018	1,898	7,809	0.1	39	78	4.2	58,827	2,630
1992	480	834	1,840	6,237	0.1	50	78	4.1	52,168	2,389
1993	436	649	1,315	5,805	0.1	61	73	4.1	43,429	2,149
1994	409	554	994	5,007	0.1	71	76	4.1	44,477	1,909
1995	395	549	1,026	5,023	0.2	76	76	4.1	44,875	1,669
1996	389	546	916	5,494	0.3	81	68	4.1	38,538	1,149
1997	388	521	901	5,013	0.4	86	71	4.1	40,417	1,071
1998	381	494	954	5,247	0.5	90	73	4.1	42,708	1,052
1999	385	489	981	5,609	0.6	95	74	4.1	40,260	1,040
2000	363	479	1,192	5,146	0.7	97	78	3.6	48,562	943
2001	353	443	1,163	4,823	0.8	107	68	3.5	51,074	1,087
2002	345	434	1,138	5,050	0.9	97	63	3.4	51,334	1,180
2003	330	433	1,227	5,078	1.0	95	63	3.3	52,486	1,089
2004	309	424	1,380	4,385	1.1	85	65	3.2	50,492	1,182
2005	300	420	1,447	4,022	1.2	78	67	3.0	46,405	1,003
2006	275	428	1,358	3,944	1.3	81	65	2.3	44,653	1,084
2007	268	442	1,301	4,039	1.4	72	59	2.1	43,160	1,055
2008	264	436	1,270	3,665	1.4	73	58	2.0	45,033	904
2009	258	444	1,261	3,248	1.5	65	60	1.9	44,789	871
2010	245	454	1,203	3,208	2.5	79	66	3.1	46,587	916
2011	251	440	1,159	3,131	3.7	84	73	3.5	46,284	949
2012	256	475	1,179	2,982	3.4	86	76	3.5	43,064	1,367
2013	248	519	1,205	2,944	3.7	85	66	2.7	41,674	1,560
2014	252	538	1,223	3,065	3.7	77	63	2.1	42,683	1,643
2015	252	563	1,194	3,127	3.7	80	61	2.5	44,459	1,610
2016	247	592	1,189	3,021	5.4	84	56	3.2	44,908	1,300
2017	245	618	1,160	2,848	5.8	85	54	4.1	43,091	1,150
Trend 1990-2017	**-57%**	**-41%**	**-41%**	**-67%**	**5725%**	**142%**	**-29%**	**-6%**	**-39%**	**-56%**
Trend 2005-2017	**-18%**	**47%**	**-20%**	**-29%**	**385%**	**9%**	**-20%**	**38%**	**-7%**	**15%**

Source: HCSO. 2018

Table 5.8 Non-Dairy Cattle populations and their trends for 1990-2017

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	17.1	15.7	65.6	74.4
1991	204.7	237.8	162.2	251.9	16.4	14.9	61.8	67.9
1992	164.1	206.5	110.7	219.5	13.1	11.0	55.1	54.0
1993	128.7	162.9	86.2	170.9	9.7	7.0	44.7	38.5
1994	109.1	143.9	68.3	151.2	8.0	5.0	41.2	27.8
1995	107.4	143.4	65.9	149.1	7.9	4.9	42.7	27.5
1996	105.5	139.3	70.1	144.3	7.8	4.8	43.8	30.3
1997	99.5	133.0	63.5	138.8	7.4	4.3	47.3	27.0
1998	98.7	131.8	41.5	137.5	6.9	3.7	49.5	24.3
1999	97.4	130.1	47.8	135.7	6.8	3.6	44.3	23.0
2000	96.0	132.6	36.2	136.7	5.8	2.7	41.9	27.4
2001	88.0	125.9	29.4	131.4	4.8	2.7	37.1	24.0
2002	85.0	124.7	27.0	130.0	4.7	2.2	37.2	22.9
2003	87.8	121.4	26.6	124.4	4.5	2.3	36.0	30.1
2004	81.5	113.7	25.3	122.4	6.0	2.7	34.2	38.5
2005	84.7	109.2	22.6	119.1	5.8	2.0	32.8	43.4
2006	84.6	106.5	30.3	116.9	5.5	2.5	30.6	51.3
2007	86.6	106.2	37.0	116.4	6.2	2.2	33.0	54.7
2008	78.9	109.5	32.1	114.7	6.0	2.3	32.0	60.6
2009	81.5	108.2	31.7	120.2	6.5	2.0	32.5	61.7
2010	75.7	108.2	35.0	120.7	7.2	3.2	35.5	68.5
2011	74.5	105.6	26.4	115.7	7.0	2.6	35.6	72.8
2012	86.9	113.5	31.8	117.5	7.0	4.2	35.6	78.3
2013	89.1	119.6	41.5	130.1	8.2	4.3	35.3	90.5
2014	90.2	122.9	44.2	131.2	8.4	2.7	37.0	101.9
2015	90.3	129.9	43.2	135.7	9.2	3.7	38.3	112.5
2016	98.6	133.3	38.3	138.1	10.1	4.7	39.1	129.9
2017	104.0	138.9	37.8	137.4	10.5	5.2	37.8	146.2
Trend 1990-2017	**-51%**	**-42%**	**-78%**	**-47%**	**-38%**	**-67%**	**-42%**	**96%**
Trend 2005-2017	**23%**	**27%**	**67%**	**15%**	**81%**	**162%**	**15%**	**237%**

Table 5.9 Swine populations and their trends for 1990-2017

Year	**Animal Population 1,000 head**						
	Piglets under 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	1,953	2,626	3,240	27	658	116	89
1991	1,612	2,350	3,091	25	563	104	64
1992	1,310	1,844	2,436	20	487	82	58
1993	1,223	1,744	2,245	18	446	77	52
1994	1,050	1,499	1,958	15	373	66	45
1995	1,107	1,459	1,922	15	405	65	51
1996	1,257	1,524	2,147	16	430	67	53
1997	1,187	1,302	2,039	14	356	57	56
1998	1,247	1,407	2,073	14	364	65	76
1999	1,281	1,503	2,300	15	397	56	57
2000	1,208	1,303	2,144	14	360	57	61
2001	1,261	1,108	1,985	13	342	55	61
2002	1,361	1,137	2,043	13	368	60	68
2003	1,282	1,158	2,151	12	362	56	57
2004	1,064	1,015	1,885	10	309	50	51
2005	999	917	1,702	10	291	51	52
2006	976	933	1,635	9	282	55	53
2007	1,015	934	1,700	8	279	52	50
2008	878	848	1,595	7	250	46	41
2009	757	795	1,374	6	226	45	43
2010	763	752	1,374	6	225	42	45
2011	752	749	1,327	6	218	43	38
2012	707	727	1,257	5	206	42	38
2013	724	684	1,250	5	194	44	43
2014	761	725	1,289	5	199	43	43
2015	784	741	1,308	5	201	45	42
2016	711	666	1,370	4	185	44	41
2017	683	637	1,271	3	175	44	37
Trend 1990-2017	**-65%**	**-76%**	**-61%**	**-88%**	**-73%**	**-62%**	**-58%**
Trend 2005-2017	**-32%**	**-31%**	**-25%**	**-66%**	**-40%**	**-14%**	**-30%**

Table 5.10 Poultry populations and their trends for 1990-2017

Year	**Livestock numbers (1'000 head)**			
	3B4gi	**3B4gii**	**3B4giii**	**3B4giv**
	Laying hens	**Broilers**	**Turkeys**	**Other poultry[2]**
1990	22,735	40,178	1,773	5,640
1991	23,460	29,488	1,253	4,627
1992	20,187	27,393	917	3,672
1993	19,314	19,290	1,080	3,745
1994	17,093	21,667	1,289	4,429
1995	15,733	23,349	1,599	4,194
1996	16,368	16,431	1,979	3,760
1997	15,491	18,816	2,157	3,953
1998	15,824	20,158	2,157	4,568
1999	15,255	17,749	2,084	5,172
2000	13,744	24,224	4,030	6,564
2001	15,397	25,290	3,449	6,938
2002	16,052	23,328	3,790	8,165
2003	16,385	23,645	3,496	8,960
2004	15,399	23,187	4,637	7,269
2005	14,232	22,058	4,037	6,078
2006	14,425	20,269	4,270	5,690
2007	13,064	20,359	4,431	5,306
2008	13,376	21,866	4,071	5,719
2009	12,732	22,365	3,422	6,270
2010	12,545	23,164	3,365	7,514
2011	11,453	23,878	3,153	7,799
2012	11,089	22,004	3,024	6,948
2013	11,840	19,959	2,433	7,442
2014	11,292	21,506	2,693	7,193
2015	11,723	22,964	2,928	6,845
2016	11,247	23,308	3,022	7,331
2017	10,749	23,370	2,888	6,084
Trend 1990-2017	**-53%**	**-42%**	**63%**	**8%**
Trend 2005-2017	**-24%**	**6%**	**-28%**	**0%**

Animal livestock populations, which have significant influence on the air pollution inventory, have decreased considerably over the period 1990-2017. The Swine population have decreased by 67 per cent, whereas the Cattle population dropped by 48 per cent over the period 1990-2017. However, animal livestock has started to increase in the recent years, thus Non-Dairy Cattle livestock has shown a-41% increase over the period 2005-2017.

5.3.1.2 ANIMAL 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 2004-2016 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 2013Hungary 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 2017 are presented in *Table 5.11* and, *Table 5.12* respectively. In case of cattle and swine extrapolation 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%
Cattle<1 year	2.9%	97.1%	3.6%	14.9%
Cattle 1-2 year, heifers	2.9%	97.1%	4.0%	14.9%
Cattle 1-2 year, male	2.7%	97.3%	3.2%	10.9%
Other Cattle> 2 years	4.1%	95.9%	2.0%	17.5%
Beef Cow>2 years	4.6%	95.4%	2.0%	27.8%
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 2017

2017	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%
Cattle<1 year	5.4%	94.6%	7.0%	11.5%
Cattle 1-2 year, heifers	4.3%	95.7%	8.4%	13.1%
Cattle 1-2 year, male	9.2%	90.8%	9.4%	10.2%
Other Cattle> 2 years	0.3%	99.7%	8.4%	20.0%
Beef Cow>2 years	0.4%	99.6%	8.4%	33.5%
Breeding sows	72.0%	28.0%	3.5%	0.0%
Fattening pigs	62.7%	37.3%	3.5%	0.0%

5.3.1.3 NITROGEN EXCRETION

The Tier 2 methodology outlined in the EMEP/EEA Guidebook (EEA, 2016) to calculate ammonia emissions uses a mass flow approach based on the concept of the flow of TAN through the manure management system, which requires data on the nitrogen excretion. Country-specific parameters were used for Dairy Cattle, Non-Dairy Cattle and Swine, based on the methodology developed by the University of Gödöllő in 2013. In case of Cattle the nitrogen-excretion rates were developed based on the nitrogen content of the feed. The amounts of the protein containing feed ingredients in the diet were determined for the whole time-series from the available statistics, Hungarian standards and supplemented with expert judgment. The values of N-excretion were updated for the year 2017, based on the feeding data from the (Farm Accountancy Data Network) FADN data, statistics on mix feed production and the annual milk production.

The N-excretion rates were generally calculated using the Equation 4.19 of the Guidelines (IPCC, 2006). The Nitrogen intakes were determined from the crude protein content of each feed ingredient in the diet for all sub-categories of these animal species. Data on crude protein content 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. The N-intakes were calculated multiplying the crude protein intakes by 0.16, because proteins typically contain 16% nitrogen. The values of fraction of annual nitrogen intakes that is retained by animals and their sources are summarized in *Table 5.13*. The resulted values of N-excretion for Swine are presented in *Table 5.14*, while values of N-excretion for Dairy Cattle and Non-Dairy Cattle are provided in *Table 5.15*, *Table 5.16* and Table 5.17

Table 5.13 $N_{retention}$ rates and their sources

Animal species	$N_{retention}$	Source
Dairy Cattle	0.20	Gls. (IPCC, 2006)
Non-Dairy Cattle	0.07	Gls. (IPCC, 2006)
Swine	0.37	weighted average (2016)
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	0.30	Gls. (IPCC, 2006)
Breeding boars	0.30	Gls. (IPCC, 2006)
Guilts not yet mated	0.34	Fébel and Gundel, 2007
Sows mated for the first time	0.34	Fébel and Gundel, 2007

Table 5.14 Average Nitrogen excretion rates (N_{ex}) for Swine

Sub-categories	Body weight	N-excretion
	kg	kg N/ head*year
Piglets under 20 kg	12	3.0
Young pigs. 20-50 kg	34	8.6
Pigs for fattening over 50 kg	90	12.5
Breeding sows	180	18.5
Breeding boars (1990)	209	21.1
Breeding boars (2015)	180	19.4
Guilts not yet mated	87	9.9
Sows mated for the first time	150	13.8
Swine. weighted average (1990)	63.3	9.7
Swine. weighted average (2017)	65.1	9.6

Table 5.15 Country-specific NH_3 emission factors for 3B1a Dairy Cattle and background data for the period 1990–2017

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	19.6
1991	636	12.91	81	19.1
1992	639	13.10	82	19.3
1993	641	13.03	82	19.3
1994	641	12.92	82	19.2
1995	641	13.67	88	21.1
1996	640	13.87	89	21.3
1997	640	14.01	90	21.6
1998	641	15.10	94	22.7
1999	639	14.94	94	22.6
2000	641	16.13	97	23.5
2001	641	16.58	99	23.9
2002	641	16.86	100	24.3
2003	642	16.86	100	24.4
2004	642	16.80	103	25.1
2005	642	17.61	106	26.0
2006	642	18.37	109	26.8
2007	643	18.83	111	27.2
2008	643	19.10	112	27.5
2009	642	18.67	110	26.9
2010	642	18.84	110	27.0
2011	640	18.73	109	26.8
2012	639	19.46	112	27.4
2013	641	19.55	112	27.5
2014	641	20.39	115	28.5
2015	642	21.10	119	29.6
2016	643	21.28	120	29.9
2017	643	22.02	123	30.8

Table 5.16 Country-specific NH_3 emission factors and background data for 3B1b Non-dairy Cattle, 1990

1990		**<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**
Live weight	**kg**	195	170	415	370	515	575	530	600
N-excretion	**kg N / head*year**	43	41	41	37	62	56	53	71
Emission Factor for 3B1b	**kg NH3 / head * year**	**11.1**	**10.6**	**11.1**	**9.5**	**13.9**	**13.4**	**15.5**	**15.5**

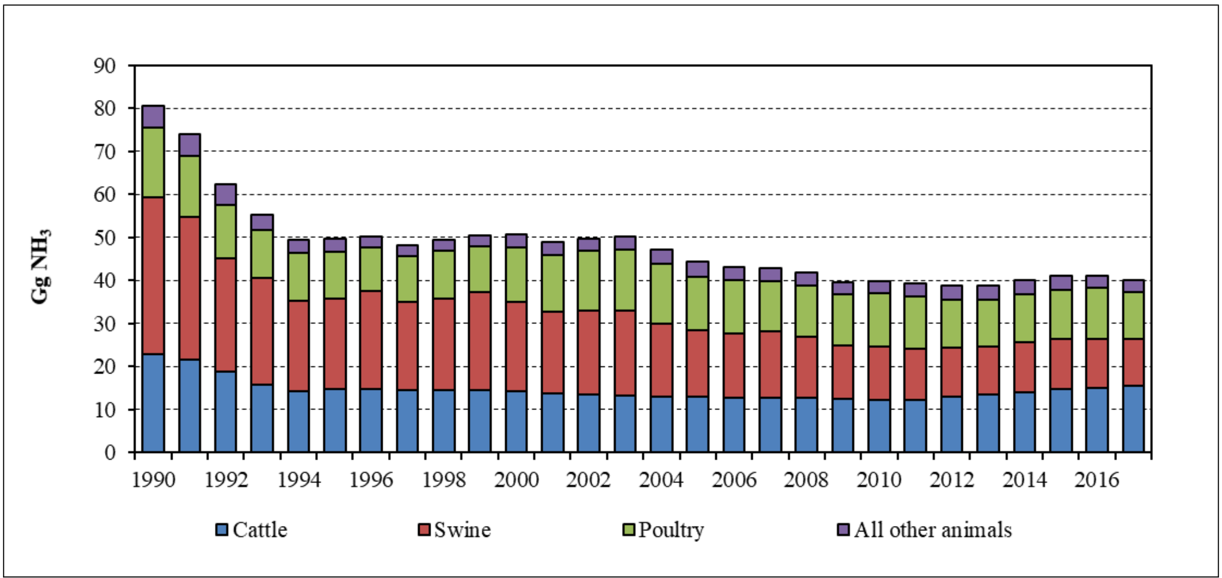
Table 5.17 Country-specific NH3 emission factors and background data for 3B1b Non-dairy Cattle, 2017

2017		**<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**
Live weight	**kg**	195	170	415	370	515	575	530	600
N-excretion	**kg N / head*year**	44	42	46	41	66	60	57	75
Emission Factor for 3B1b	kg NH3 / head * year	12.3	11.6	12.8	11.2	15.0	14.3	16.4	15.6

5.3.2 NH_3

The main source of NH_3 emissions is manure management. 45.8% of the national total NH_3 emissions related to the animal production in 2017. The main part of this emission is connected with, Cattle, Poultry and Swine housing, corresponding to 37%, 27% and 27% of the emissions from 3B (*Figure 5.3*). 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 overbalanced 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 1990-2017



5.3.2.1 METHODOLOGICAL ISSUES

Emissions from 3B1 Cattle, 3B2 Sheep and 3B3 Swine are calculated using the Tier 2 method of the EMEP/EEA Guidebook (EEA, 2016) 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, 2016).

5.3.2.2 ACTIVITY DATA

See Chapter 5.3.1

5.3.2.3 EMISSION FACTORS

Cattle and Swine

Emission factors were calculated by the calculation sheet (4B appendix.xls) provided to the EMEP/EEA Guidebook (EEA, 2013). In the calculation sheet the values of the N excretion, housed-period and the proportion of solid, liquid and yard manure were replaced by the country-specific values year by year for 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 grazing and yard manure and the typical length of grazing period, which was average of 165 days for Dairy Cattle and 179 days for Non-dairy Cattle in 2017. The length of grazing period was surveyed in the course of the Farm Structure Survey, 2013 and 2016. The resulted time period for housing is significantly higher than the EMEP/EEA default values. In case of Dairy Cattle 335 days were estimated whereas for Non-Dairy Cattle 231-324 days were assumed for the year 2017. 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, 2016) were applied. In the calculation all of the manure was assumed to be stored as a conservative approach. Additionally, 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 for Swine are shown in *Table 5.18* and *Table 5.19*.

Table 5.18 NH_3 emission factors for Swine, 2017

Subcategories	**Emission Factors for NH_3 from Swine**		
	3B3 Manure Management	**3Da2a Animal manure applied to soils/ Solid**	**3Da2a Animal manure applied to soils/ Liquid**
	EF_{NH3} (kg NH_3*a^{-1}*AAP^{-1})		
Piglets<20	1.21	0.11	0.42
Piglets 20-50	3.43	0.31	1.20
Pigs>50	4.90	0.45	1.72
Breeding Boars	7.73	0.70	2.71
Breeding Sows	6.00	0.46	2.28
Guilts not yet mated	3.95	0.36	1.38
Sows mated for the first time	5.52	0.50	1.93
Swine (implied value for 2017)	**3.76**	**0.34**	**1.33**

Table 5.19 NH_3 emission factors for Cattle, 2017

Subcategories	Emission Factors for NH_3 from Cattle			
	3B Manure Management	3Da2a Animal manure applied to soils/ Liquid	3Da2a Animal manure applied to soils/ Solid	3Da3 Grazing animals
	EF_{NH3} (kg NH_3*a^{-1}*AAP^{-1})			
Dairy Cattle	**30.85**	**6.17**	**11.61**	**0.70**
Non-Dairy Cattle (Implied 2017)	**13.05**	**1.08**	**5.76**	**0.46**
Cattle<1 year, Male	12.25	1.08	5.36	0.22
Cattle<1 year, Female	11.55	1.02	5.05	0.21
Cattle, 1-2 year, Male	12.83	1.68	5.42	0.20
Heifers 1-2 year	11.17	0.97	4.85	0.23
Cattle, >2 year, Male	14.96	0.90	6.96	0.53
Cattle>2 Heifer for slaughter	14.34	0.86	6.67	0.50
Cattle>2 First calf Heifer	16.44	0.98	7.64	0.58
Cattle>2 Beef Cow	15.59	1.12	7.23	1.10

Sheep

The Tier 1 emission factor for Sheep assumes a 30-day long housing period according to the Table 3.2 of the 2016 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 Microsoft Excel spreadsheet provided to the EMEP/EEA Emission Inventory Guidebook. 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 1.64 kg NH_3 a^{-1} AAP^{-1} for the emission factor for 3B, Housing, Storage and Yard.

Other livestock

This section covers the 3B4a Buffalo, 3B4d Goats, 3B4e Horses, 3B4f Mules and asses, 3B4gi Laying hens, 3B4gii Broilers, 3B4giii Turkeys, 3B4giv Other poultry and 3B4h Other animals (Rabbits) NFR categories. Emission factors were taken from the Table 3.2 of the EMEP/EEA Guidebook (EEA, 2016), using a Tier 1 methodology. However, 3B4gi Laying hens and 3B4gii Broilers are key categories, since the Tier 2 approach should be used, but the required country-specific values for a higher tier are unavailable. The EMEP/EEA Guidebook (EEA, 2016) 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 2017, less than 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, 2016).

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 EMEP/EEA Guidebook (EEA, 2016), 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 2017, 16.0% of the national total NMVOC emissions related to the manure management and 56% of the emission from manure management generated in the Cattle husbandry.

1.1.1.1 METHODOLOGICAL ISSUES

Following the recommendation from the previous NECD Review Tier 2 technology-specific approaches in EMEP/EEA Guidebook (EEA, 2016), 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.

5.3.4.1 ACTIVITY DATA

See chapter 5.3.1.

1.1.1.1 EMISSION FACTORS

Cattle

NMVOC emissions from Cattle (3B1) are estimated using the Tier 2 emission factors, calculated in accordance with the Equations 45-50 of the 2016 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 2016 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 2016 EMEP/EEA Guidebook.

Parameters used to estimate NMVOC emissions from Dairy cattle and Non-dairy cattle are shown in Table 5.20 and Table 5.21, respectively.

Table 5.20 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	2.50	2.74	0.07
1991	89748	0.89	0.62	2.46	9.83	2.81	2.39	2.62	0.07
1992	89647	0.88	0.61	2.44	9.74	2.80	2.40	2.63	0.07
1993	89088	0.88	0.61	2.41	9.63	2.78	2.38	2.61	0.07
1994	88685	0.88	0.61	2.38	9.53	2.76	2.37	2.60	0.07
1995	90300	0.88	0.59	2.35	9.39	2.80	2.45	2.69	0.07
1996	90937	0.88	0.59	2.36	9.42	2.82	2.50	2.75	0.08
1997	91294	0.88	0.59	2.35	9.40	2.83	2.52	2.77	0.08
1998	93931	0.88	0.58	2.40	9.60	2.91	2.62	2.88	0.08
1999	93980	0.88	0.58	2.40	9.59	2.91	2.62	2.89	0.08
2000	96271	0.88	0.58	2.45	9.81	2.98	2.71	2.98	0.08

Year	Feed intake MJ yr^{-1} head^{-1}	X_{house} %	$Frac_{silage}$ %	$E_{NMVOC, sillage\_store}$	$E_{NMVOC, sillage\_feeding}$	$E_{NMVOC, house}$	$E_{NMVOC, manure\_store}$	$E_{NMVOC, appl}$	$E_{NMVOC, graz}$
						kg yr^{-1} head^{-1}			
2001	97536	0.88	0.58	2.48	9.94	3.01	2.76	3.05	0.08
2002	98665	0.87	0.58	2.51	10.04	3.05	2.80	3.12	0.09
2003	98749	0.87	0.58	2.51	10.03	3.04	2.80	3.14	0.09
2004	98847	0.87	0.57	2.47	9.90	3.05	2.74	3.09	0.09
2005	100151	0.87	0.57	2.50	9.99	3.09	2.88	3.26	0.09
2006	102653	0.87	0.57	2.55	10.21	3.16	2.97	3.38	0.09
2007	104255	0.87	0.57	2.58	10.32	3.21	3.03	3.46	0.09
2008	105370	0.87	0.56	2.59	10.37	3.25	3.07	3.52	0.09
2009	104794	0.87	0.56	2.55	10.21	3.23	3.04	3.51	0.09
2010	105063	0.87	0.55	2.54	10.16	3.24	3.04	3.53	0.09
2011	105342	0.87	0.55	2.53	10.12	3.25	3.05	3.55	0.09
2012	107652	0.87	0.55	2.58	10.30	3.32	3.13	3.66	0.09
2013	107812	0.87	0.54	2.57	10.27	3.32	3.13	3.69	0.09
2014	109476	0.87	0.54	2.60	10.40	3.38	3.21	3.84	0.10
2015	111902	0.87	0.54	2.65	10.61	3.45	3.30	4.02	0.10
2016	112986	0.87	0.54	2.67	10.67	3.49	3.34	4.14	0.10
2017	114625	0.87	0.53	2.66	10.63	3.54	3.41	4.22	0.10

Table 5.21 Parameters used to estimate NMVOC emissions from manure management of Non-Dairy cattle, 2017

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}	1.17	1.17	1.98	1.97	2.23	2.14	2.15	1.49
$E_{NMVOC, appl}$	kg yr^{-1} head^{-1}	1.28	1.28	2.28	2.17	2.38	2.28	2.30	1.61
$E_{NMVOC, graz}$	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 5.22 summarizes parameters used in the equations 51-56 of the EMEP/EEA Guidebook (EEA, 2013) to calculate NMVOC emissions from Other poultry.

Table 5.22 Parameters used to estimate NMVOC emissions from manure management of 3B4giv 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 NH3-N $(kg\ TAN)^{-1}$	0.24	0.57	0.17	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
$E_{NH3building}$	kg NH3-N $(kg\ TAN)^{-1}$	0.24	0.16	0.28	Defaults from Table 3.9 of 2016 EMEP/EEA Guidebook
$E_{NH3appl}$	kg NH3-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 $(kg\ VS\ excreted)^{-1}$	0.005684	0.005684	0.009147	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, 2016). 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 5.23*.

Table 5.23 *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 2017 manure management contributed 8.1% to the national total PM emissions given as TSP. 57.3% of the sectorial emissions relates to the poultry production. The second largest contributors are pigs with its 33.7% 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, 2016).

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, 2016), 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, 2016).

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).

5.4.1 METHODOLOGY

Estimations for 3D are estimated in accordance with the EMEP/EEA Guidebook (EEA, 2016). NH_3 emissions from 3Da1 Inorganic N-fertilizer, 3Da2a Cattle and Swine manure applied to soils and 3Da3 Cattle urine and dung deposited during grazing are estimated using Tier 2 methodology, whereas Tier 1 methodologies are used 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.

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 20.0% 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 78.5% of agricultural NO_x emissions.

Emissions have decreased since 1990, because of the significant drop in fertilizer use in 1991. The decrease in the case of NH_3 emissions is more significant due to the reduction in use of urea. Proportion of urea in fertilizer N decreased from about 30% at the beginning of the time series to the current level of 9%. Trend in emissions of NH_3 and NO_x from inorganic fertilizers are shown in Figure 5.4.

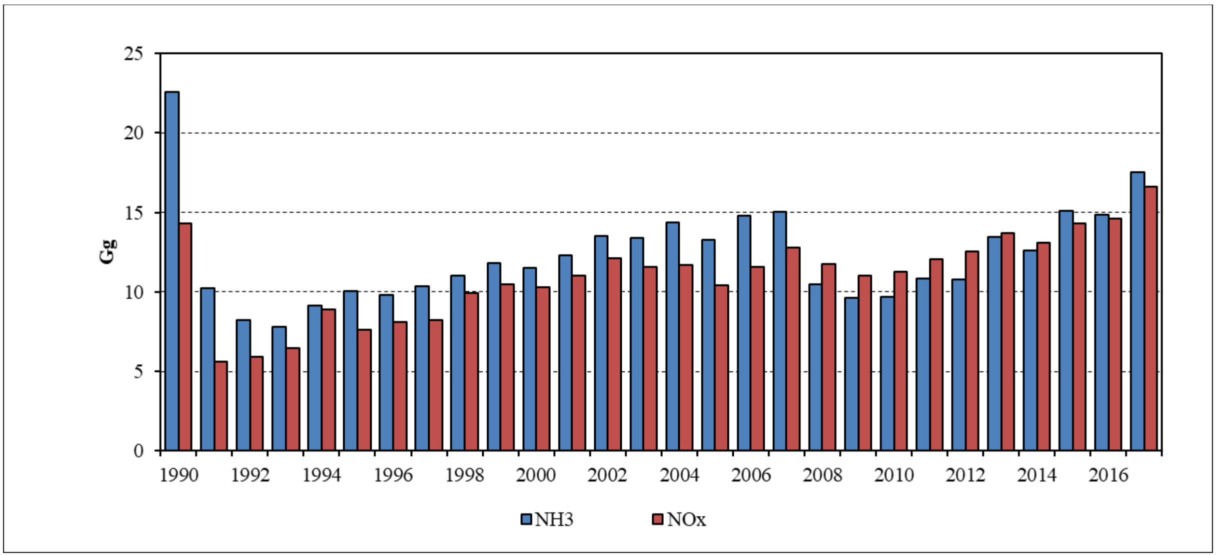


Figure 5.5 NH_3 and NO_x emissions from inorganic N-fertilizers, 1990-2017

5.4.4.1 METHODOLOGICAL ISSUES

The Tier 2 methodology provided in the EMEP/EEA Guidebook (EEA, 2016) 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 are 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; therefore, the total N-content of this fertilizer was disaggregated into ammonium sulphate and ammonium nitrate according to the proportion of the two compounds.)

The 2016 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 5.24 shows the amount of Urea N and 'Other fertilizer-N' applied for the period 1990-2017. 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 3 data suppliers. This is the case of Anhydrous ammonia, therefore all non-Urea fertilizers are published aggregated here.)

Table 5.24 Trends in nitrogen fertilizer application 1990-2017

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	315	346
2014	24	303	327
2015	32	358	390
2016	31	365	396
2017	39	414	453

Year	1'000 t N		
	Urea N	Other Fertilizer N	Total N-content
Trend 1990-2017	-62%	62%	27%
Trend 2005-2017	-17%	94%	74%

Both the total amount of fertilizer N and the types of the fertilizer applied has changed significantly over the period 1990-2017 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 5.24*). 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 2016 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 2016 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 5.5*. 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).

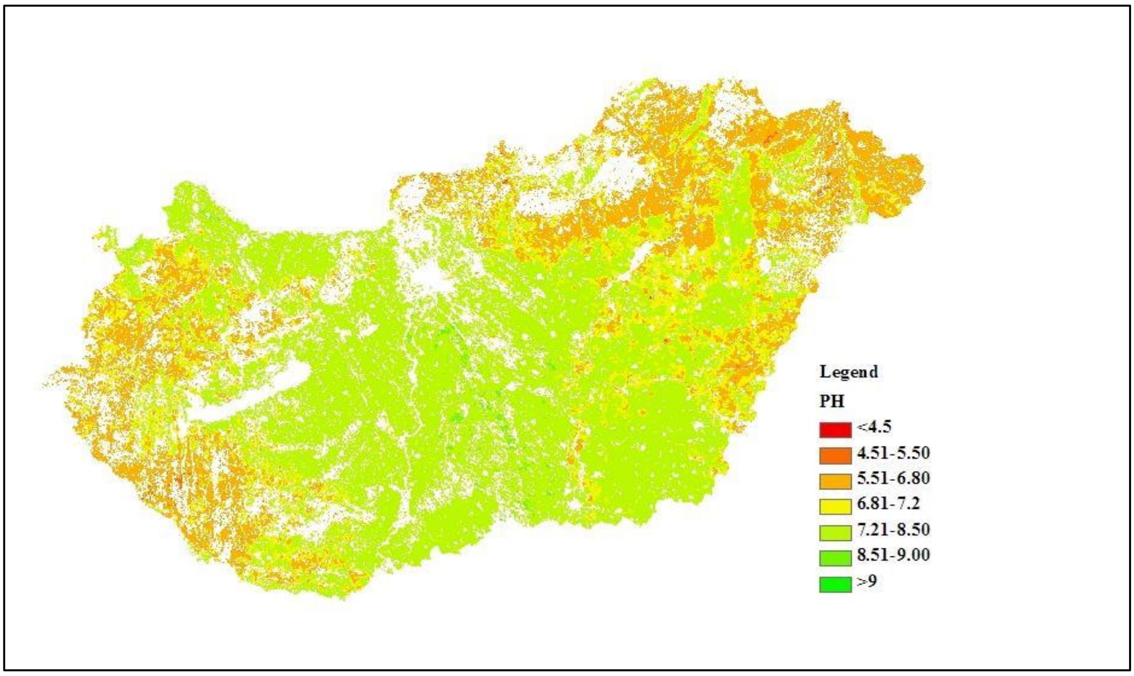


Figure 5.6 Soil acidity in Hungary

Emission factors provided by soil pH in the 2016 EMEP/EEA Guidebook were weighted by the resulted proportions and weighted national average emission factors, given in *Table 5.25*, were calculated for each fertilizer types.

Table 5.25 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 (2017)	**0.042**

NO_x

The Tier 1 methodology of the EMEP/EEA Guidebook (EEA, 2016) 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 2016 EMEP/EEA Guidebook for spreading of slurry and solid manure were applied in proportion of total ammoniacal nitrogen (TAN) as shown in *Table 5.26*.

Table 5.26 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		0.79
Fattening pigs	slurry	0.7	0.4
	solid		0.81
Sows	slurry	0.7	0.29
	solid		0.81
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	0.66
Turkey	solid	0.7	0.54
Ducks	solid	0.7	0.54
Geese	solid	0.7	0.45

Cattle, Swine, Sheep

NH_3 emission factors expressed in terms of kg NH_3 $*a^{-1}*AAP^{-1}$ were calculated using the calculation sheet (4.B appendix.xls) provided to the EMEP/EEA Guidebook (EEA, 2013), similarly, to the calculation of EFs for emissions from housing, storage and yards. For more details and the resulted emission factors see Section 5.3.2.

Other animals (Swine, Buffalo, Goats, Horses, 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, 2016) does not provide emission factor for Rabbits; therefore, the emission factor (0.54 kg NH_3 $*a^{-1}*AAP^{-1}$) 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 2017 (*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 p. 30 of the 2016 EMEP/EEA Guidebook to calculate the NH3 emissions. While a value of 0.04 kg NO_2 (kg N applied)$^{-1}$ provided on p. 32 of the 2016 EMEP/EEA Guidebook was applied to calculate NO_2 emissions.

The 2016 EMEP/EEA Guidebook provides Tier 1 EFs to calculate NH_3 and NO_2 emissions on per capita basis. However, these EFs were deduced from the EFs on per kg N applied. Therefore, values provided in the Annexes on per kg N applied was used as EFs in the estimate to get the most reliable results.

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% in the calculation. The resulted activity data for the period 1990-2017 are shown in *Table 5.27*.

Table 5.27 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	0.19
1991	5.59	0.22
1992	6.47	0.26
1993	7.35	0.29
1994	10.00	0.40
1995	13.36	0.53
1996	12.44	0.50
1997	10.32	0.41
1998	12.52	0.50
1999	9.84	0.39
2000	10.84	0.43
2001	10.56	0.42
2002	11.80	0.47
2003	11.52	0.46
2004	13.28	0.53
2005	22.40	0.90
2006	21.20	0.85
2007	20.16	0.81
2008	24.72	0.99
2009	25.36	1.01
2010	22.72	0.91
2011	20.27	0.81
2012	18.50	0.74
2013	13.55	0.54
2014	15.07	0.60
2015	14.24	0.57
2016	17.69	0.71
2017	15.69	0.71

5.4.6.3 EMISSION FACTORS

The value of 0.13 kg NH_3 (kg N applied)$^{-1}$ given on p. 30 of the 2016 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 on p. 32 of the 2016 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 2016 (*Figure 5.1*).

5.4.7.1 METHODOLOGY

The Tier 1 methodology of the 2016 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 1985-2017 are provided in *Table 5.28*.

Table 5.28 Activity data to estimate emissions from 3.D.a.2.c Other organic fertilizers applied to soils (including compost)

Year	Compost		
	municipal waste [1'000t d.m.]	sewage sludge [1'000t d.m.]	N 1'000t
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
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

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, 2016).

5.4.8 NFR 3DA3 URINE AND DUNG DEPOSITED BY GRAZING ANIMALS

NH3 emissions from Cattle and Sheep

Default emission factors of the 2016 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 5.29 Emission factors for NH3 emissions from animal manure application

Livestock	proportion of TAN	EF [kg NH3-N kg TAN)$^{-1}$]
Cattle	0.6	0.1
Sheep	0.5	0.09

As the Tier 1 default emissions factors for NO_x contains the emissions from grazing, these emissions are reported under the 3B Manure Management sector. Activity data are available under section 5.3 NFR 3.B Manure Management.

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 8.8% share of national total in 2016. While PM2.5, TSP is lesser determinant of national total emissions with contributions of 0.5% and 6.4%, respectively.

PM emissions given in TSP have increased by 12.7% from 2000 to 2017, 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 5.30* shows the estimation of the activity data from the HCSO's statistics for 2017.

Table 5.30 Estimation of area covered by crops for 2017

Sown areas	***Areas [ha]***
Total sown area of main crops	4,334,695
Greenhouse and plastic tunnels	1,994
Nursery gardens	8,918
Fallow lands	144,857
Area covered by crops (calculated)	**4,173,731**

Based on HCSO, 2018

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, 2016) 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 2.5 % share in 2017. NMVOC emissions from crops cultivation have reduced by 8.8% over the period 1990-2017.

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, 2016), Table 3-1.

5.5 NFR 3F FIELD BURNING OF AGRICULTURAL RESIDUES

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 burning of crop residues, without any exception.

According to the legal legislation it was assumed that field burning of crop residues has been not alloweded in Hungary since 1986. According to the estimation of the regional inspectors of the Central (Budapest) Soil and Plant Protection Service illegal field burning of crop residues occured on less than 1% of croplands (Sári 2003, verbal communication),in the period 1986-1989. Therefore, emissions from field burning of crop residues was reported for the period 1985-1989 in the GHG inventory based on this expert judgement, and ‘Field burning of crop residues’ is reported as not occurring for the years after 1990 in the GHG as well as the air pollutant inventory.

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, 2018-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 ones given in the 2016 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 2016 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 2017. 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 2016 EMEP/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 335 days a-1. The significantly longer housing period is the main reason for the higher NH_3 emissions from Dairy Cattle.

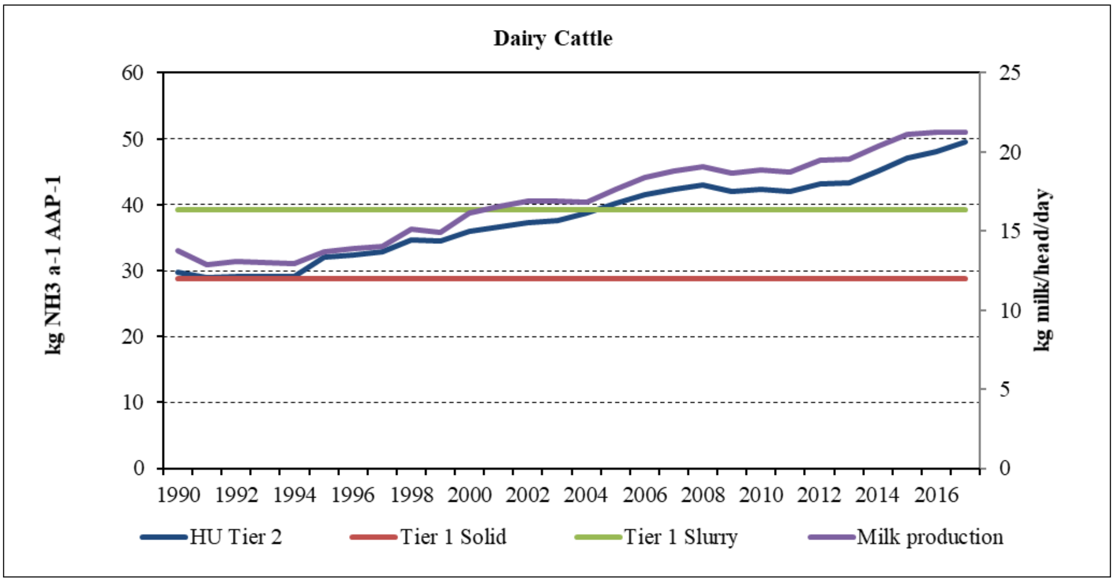


Figure 5.7 Comparison of NH_3 emission factors for Dairy Cattle

Non-dairy Cattle

The country-specific values of IEFs for total NH_3 emissions from Non-dairy Cattle are higher than the IPCC default ones Figure 5.7. However, the difference is more significant than in the case of Dairy Cattle, because of the higher difference between the country-specific values of N excretion rates. Country-specific N excretion rates ranged from 44 to 52 kg N a-1 head-1 between 1990 and 2017. In contrast, the default value is 41 kg N a-1 head-1 in the 2016 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 and the lack of abatement measures 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 17.6 to 20.3 kg NH_3 a-1 head-1 over the inventory period, whereas the default values are 9.2 and 13.4 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.

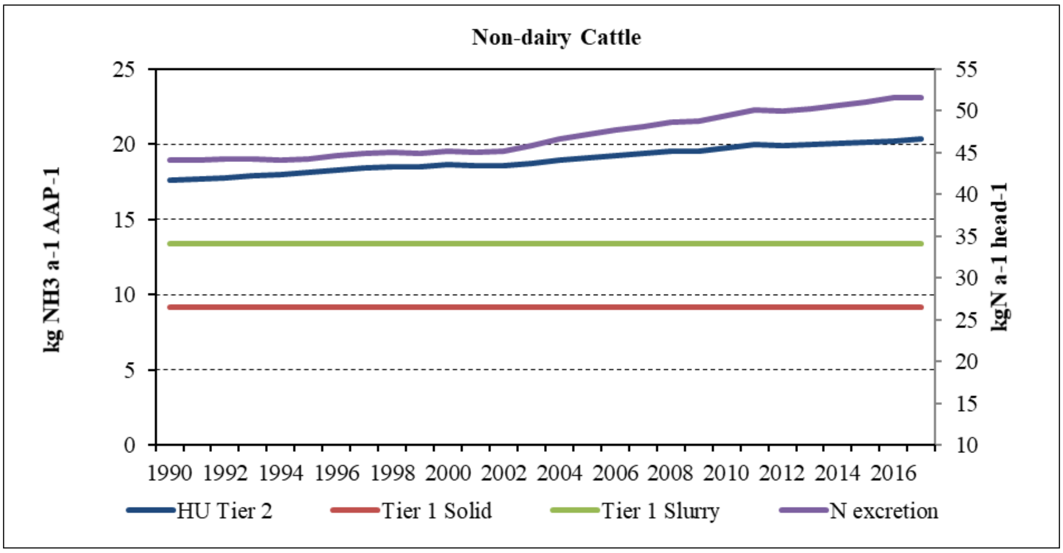


Figure 5.8 Comparison of NH_3 emission factors for Non-dairy Cattle

Swine

The 2016 EMEP/EEA Guidebook provides NH_3 emission factors for sows and fattening pigs separately. Implied emissions factors were calculated based on the Hungarian population of 93% fattening and 7% sows to make a comparison. The resulted default implied emission factors are 7.1 and 7.5 kg NH_3 a-1 head-1 for slurry and solid, respectively (Figure 5.8). The default implied value of N excretion rates is 13.7 kg N a-1 head-1 according to the 2016 EMEP/EEA Guidebook. In contrast, the Hungarian country-specific value ranged from 9.4 to 9.8 kg N a-1 head-1 over the inventory period. The slightly decreasing trend reflects the slightly decreasing trend in weights of fattening pigs. The lower N excretion rates in the Hungarian inventory lead to significantly lower NH_3 emission factors for Swine than the 2016 EMEP/EAA default.

Though the default N excretion rates were sourced from the 2006 IPCC Guidelines according to the foot note of the 2016 EMEP/EEA Guidebook, neither our calculation nor the FAO GHG database justify the EMEP/EEA defaults. The IPCC defaults result in 11 and 12 kg N a-1 head-1 for Western and Eastern-European Swine based on our calculation. Consequently, the NH_3 emission factors for Swine seem to be overestimated.

The recent results of the examination of Hungarian pig feeds also strengthen that the N intake of pigs is relatively low in Hungary.

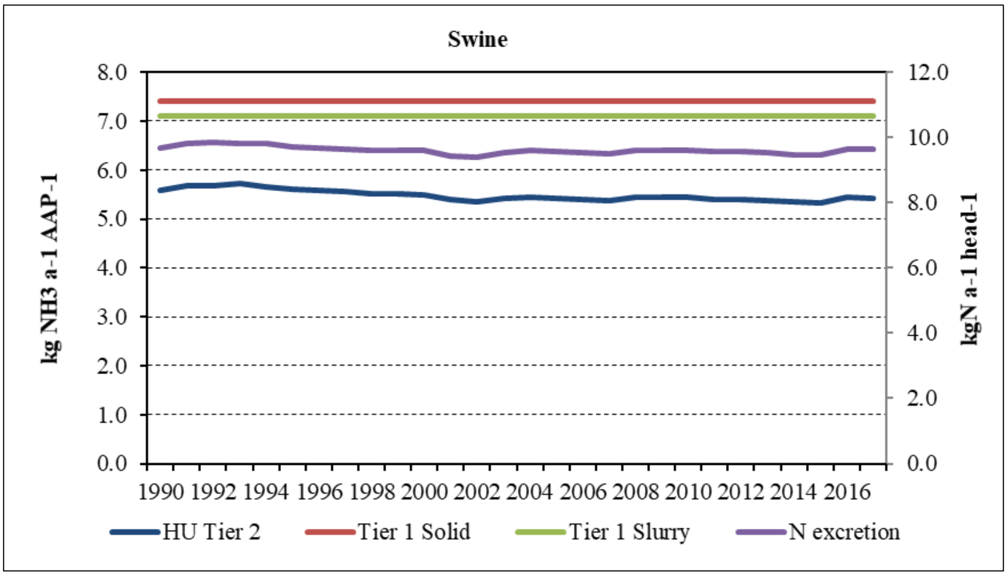


Figure 5.9 Comparison of NH_3 emission factors for Swine

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 A1-1 of the 2016 EMEP/EEA Guidebook, the default emission factor was developed based on IFA sales data for the year 2014, and the Urea N was 14% of the total fertilizer N in the applied statistics. The same proportion for Urea N justifies the quasi-equal emission factors.

At the end of the inventory period the country-specific value resulted in lower emissions, because the Urea-N decreased to 9% of the total fertilizer N, which is half of 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 5.9.

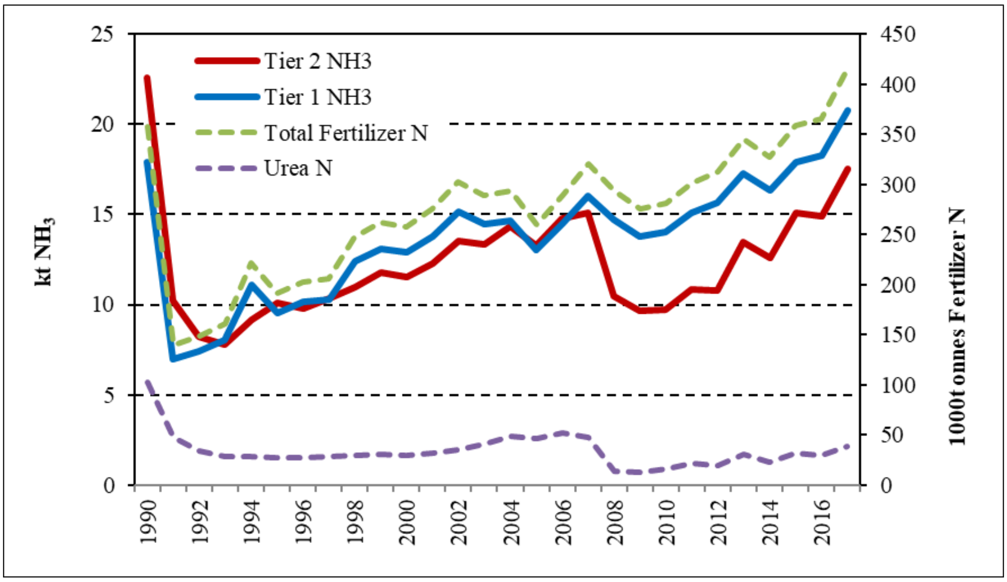


Figure 5.10 Comparison of NH_3 emissions from 3Da1 Inorganic fertilizers, calculated with Tier 1 and Tier 2 emission factors

5.7 RECALCULATIONS

The main focus of this year's improvements was the implementation of all recommendations of the NECD Review, 2017.

5.7.1 CHANGES IN METHODOLOGIES, EFS AND ALLOCATION

Following a recommendation of the NECD Review, 2017 NO_x emissions from 3Da3 Urine and dung deposited by grazing animals have been included in this submission. Inclusion of this emission resulted in a 0.74 Gg and 0.6% increase in the national total NO_x emissions.

Calculation errors concerning totaling of NH_3 emissions from sub-categories of Non-dairy Cattle and Swine were corrected resulting in an insignificant increase in the emissions from 3.B Manure management for the years 2016. Due to the interlinkage between the 3B and 3Da2a emissions this revision resulted in additional changes in the NO_x and NH_3 emissions from 3Da2a. Thus, NH3 emissions decreased by 0.06 Gg, while NOx emissions decreased by 0.002 Gg.

5.7.2 REVISION OF ACTIVITY DATA

Activity data for 3Da1 Inorganic N-fertilizers (includes also urea application) for the year 2016 was revised by the HCSO, resulting in a small increase in the NH_3 and NO_x emissions from 3Da1. Due to this revision NH3 emissions increased by 0.02 Gg and NOx emissions increased by 0.02 Gg.

5.8 PLANNED IMPROVEMENTS

In the frame of the 'Pig Farming Strategy' a multiyear research program started in 2015 to collect data and research results for the international reporting obligations about the Hungarian swine sector. The research program was initiated and coordinated by the Agricultural Ministry. As a first step in the years 2015 and 2016 data on the applied technologies and the 'penetration' (the percentage of the activity that uses a specific technology) were collected. In addition, laboratory measurements of the applied mixed fodders and the excreta started to estimate the up-date values for N-intake and N-excretion and TAN for pigs.

As a second step, the air pollutant inventory will be updated with the new survey data and EFs depending on the data availability and resources.

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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.

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 1.0-1.1 kg/capita/day in the last few years. The total amount of MSW was 3,752 Gg in 2017. Out of this, 1,319 Gg (35%) was recovered by recycling and composting, 608 Gg (16%) was incinerated for energy purposes, and 1,825 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 2017, altogether 4155 kt waste was disposed.

Emission factors

In case of PM emissions, default T1 emission factors were applied from the relevant chapter of the 2016 Guidebook.

Uncertainties and time-series consistency

Due to missing data, the time series of particulate matter emissions is not fully 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

Further improvement of time series consistency is planned especially regarding particulate matter emissions.

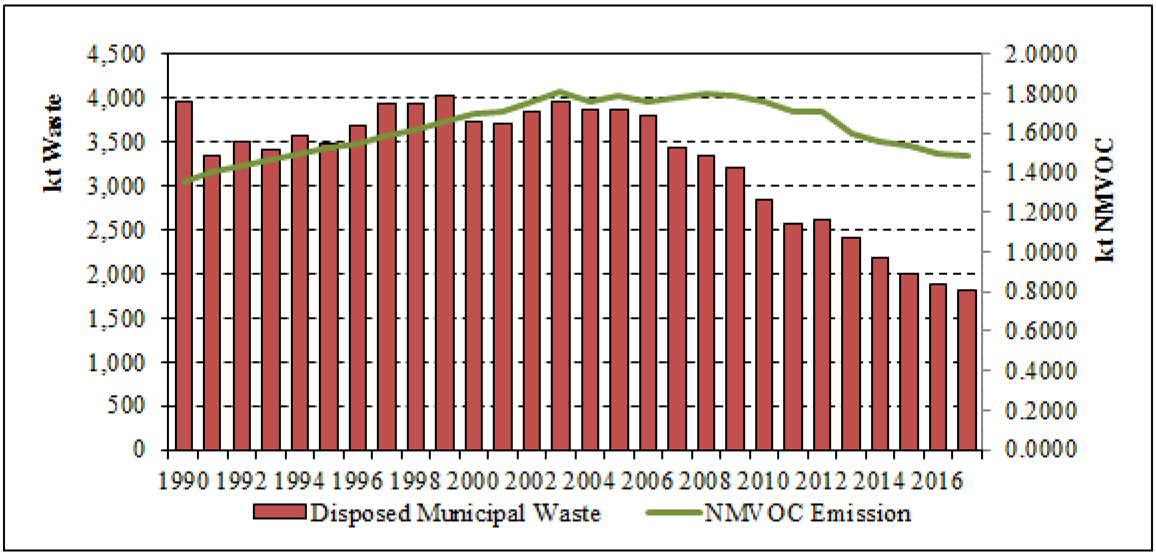

Figure 6.6.1 *Time series of NMVOC emissions from solid waste disposal*

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 2016, 293.969 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.

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 2015 and 2016, 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, NH_3 emission was directly calculated using the default emission factor. Based on the resulting emission, an implied emission factor (t NH_3/TJ biogas) was derived and used for earlier years.

Activity data

For 2015 and 2016, 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 3.3 TJ/kt dm to present a consistent time series of AD in the NFR tables.)

Emission factors

The default value (0.0286 kg NH_3-N/kg N in feedstock) was used from the Guidebook. For the period 2000-2014, an implied emission factor was applied, i.e. 0.3 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

None.

Source-specific planned improvements

None.

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) 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.

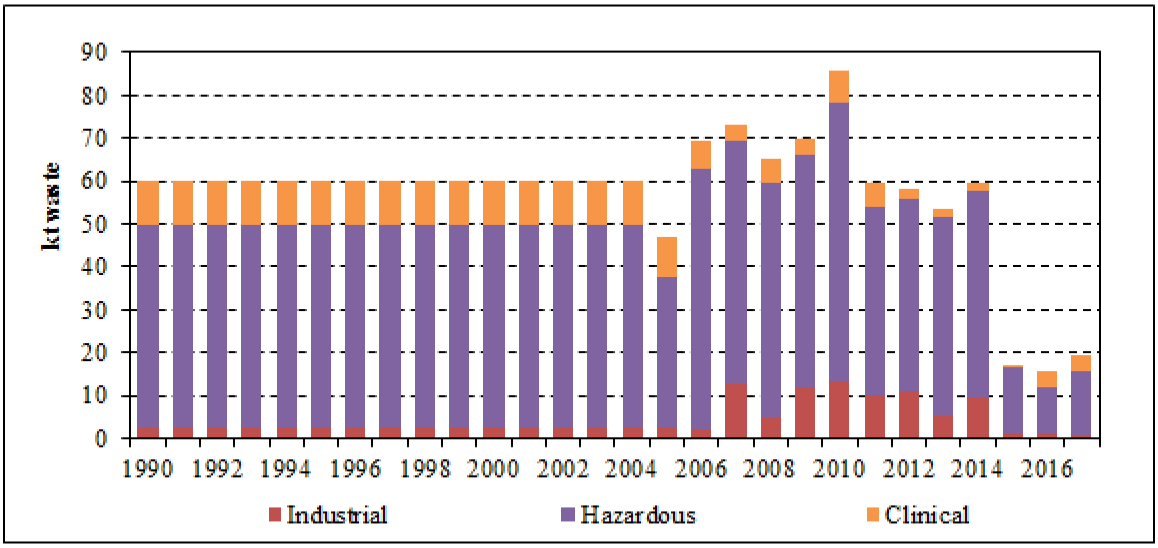

Figure 6.2 *Activity data used for emission calculations (1990-2017)*

As emissions are to be reported separately for different waste categories, the classification system of wastes in HIR according to the European Waste Catalogue was used. Wastes were regarded as 'clinical waste' when classified with waste code '18 Wastes from human or animal health care and/or related research'. All wastes with the waste code '20 Municipal wastes (household waste and similar commercial. industrial and institutional wastes) including separately collected fractions' were included in the 'municipal waste' category. (However, as almost all municipal waste is incinerated with energy recovery, emissions from municipal waste incineration are accounted for in the energy sector.) All other waste types were classified as 'industrial'. Furthermore, within industrial waste hazardous waste was treated separately. All incinerated liquid waste was considered as hazardous.

Emissions from building fires and car fires have been reallocated to 5E Other waste**.**

Based on information from the Hungarian Central Statistical Office, between 2004 and 2015 a bit less than 1200 Gg waste was incinerated on average out of which only 9% 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.

Clinical waste (5C1biii): Previously, country specific emissions factors were used for NOx, CO, TSP, Hg, and PCDD/F. Three clinical waste incinerators are responsible for 59% to 69% of all incinerated hygienic wastes. From the reported plants, specific emissions of these three incinerators implied emission factors were derived and used for the total amount of waste as described in the guidebook. Based on the latest facility level data, however, it seemed to be safer to move back to T1 emission factors except for particulate matter and PCDD/F for which the following country-specific emission factors were kept.

- TSP: 0.07 kg/Mg waste;
- PCDD/F: 560 ng I-TEQ/Mg waste.

Industrial waste (5C1bi), hazardous waste (5C1bii), sewage sludge (5C1biv): Five to six plants incinerated 96% to 100% of all industrial waste without energy recovery. Their reported NOx, SOx, CO, and TSP emissions were used the create country specific emission factors. Three out of the above mentioned five facilities representing 50% of all incinerated wastes also reported measured PCDD/F. For the same reasons, as above, we switched back to T1 emission factors except for PM and PCDD/F.

- TSP: 0.04 kg/Mg waste;
- PCDD/F: 550 ng I-TEQ/Mg waste.

Municipal waste (1A1a): As almost all municipal waste was 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.

- NOx: (before 2003: 1.8 kg/Mg waste);
- SOx: (before 2003: 0.4 kg/Mg waste);
- CO: (before 2003: 0.7 kg/Mg waste);
- TSP: 0.003 kg/Mg waste (before 2003: 0.3);
- Hg: 0.02 g/Mg waste. (before 2005: 1.1);
- As: 0.06 g/Mg waste;
- Pb: 0.19 g/Mg waste (before 2005: 7.3);
- PCDD/F: 23 ng I-TEQ/Mg waste (before 2005: 12.190).

For all other pollutants T1 factors were applied in the following way. The lower emission factors from the new 2016 Guidebook were taken into account only for the period after reconstruction of the incineration plant (i.e. after 2005). For previous years, T1 emission factors from the previous guidebook were used.

Industrial waste (1A1a): 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.

Industrial waste (1.A.2.fi): 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.

Uncertainties and time-series consistency

The time series for the most important source category, i.e. municipal waste incineration is most probably consistent.

Source-specific QA/QC and verification

None.

Source-specific recalculations

Some minor changes occurred due to updated activity data.

Source-specific planned improvements

We will be further analyzing plant specific data to derive more country specific emission factors. The issue of completeness has to be addressed in case of co-firing.

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 National Food Chain Safety Office.

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

None.

Source-specific planned improvements

None.

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 81% of all dwellings were connected to the public sewerage network in 2017 whereas 13% used some domestic sewerage. Thus, we assumed that 6% 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*.

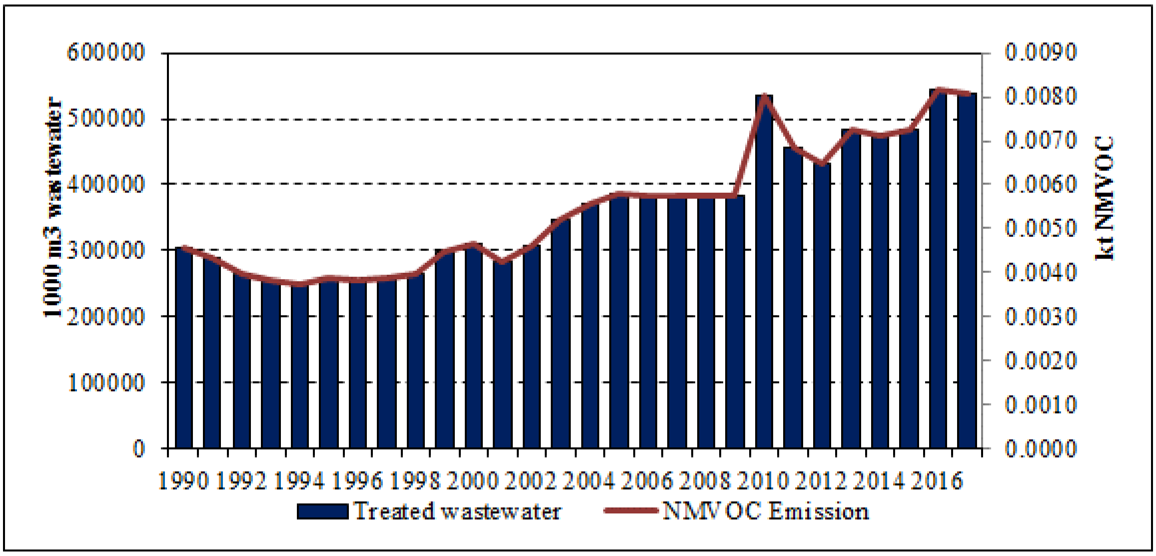

Figure 6.4 *Time series of NMVOC emissions from wastewater handling*

Source-specific QA/QC and verification

None.

Source-specific recalculations

No methodological change has been made.

Source-specific planned improvements

We'll check the possibility to report emissions from industrial wastewater treatment separately.

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

No information is provided in this submission.

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.

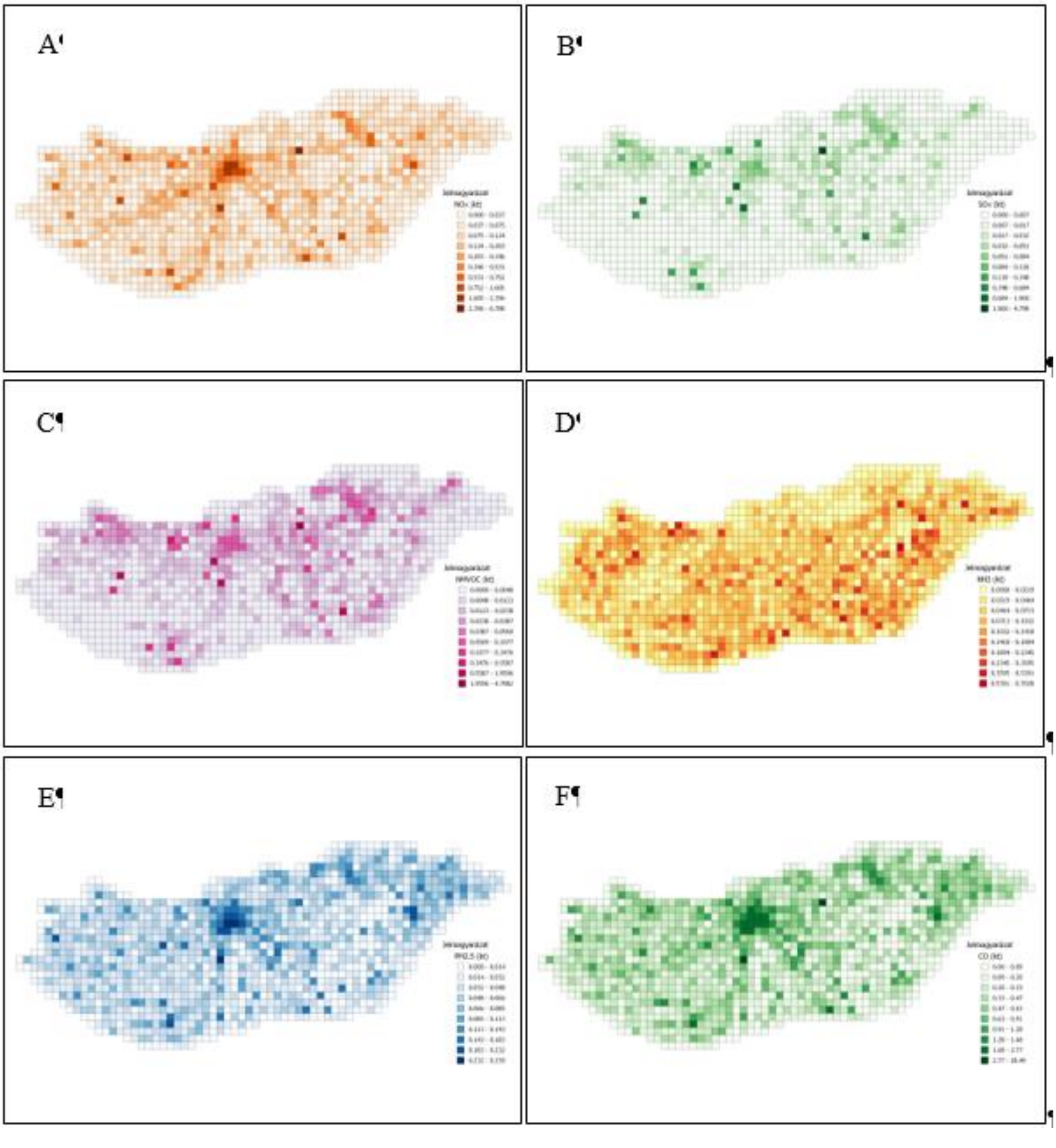

Figure 10.1 *Total gridded emissions for Hungary in a 0.1 x 0.1 degrees resolution for the year 2015. A: NOx emissions, B: SOx emissions, C: NMVOC emissions, D: NH3 emissions, E: PM2.5 emissions, F: CO emissions*

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.

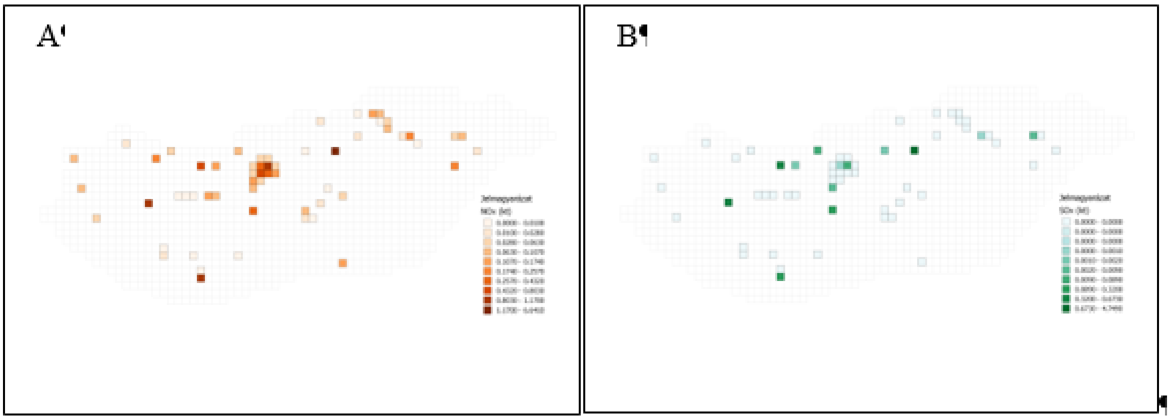

***Figure 10.2** NOx (A) and SOx (B) emissions from public electricity and heat production*

GNFR: B_Industry

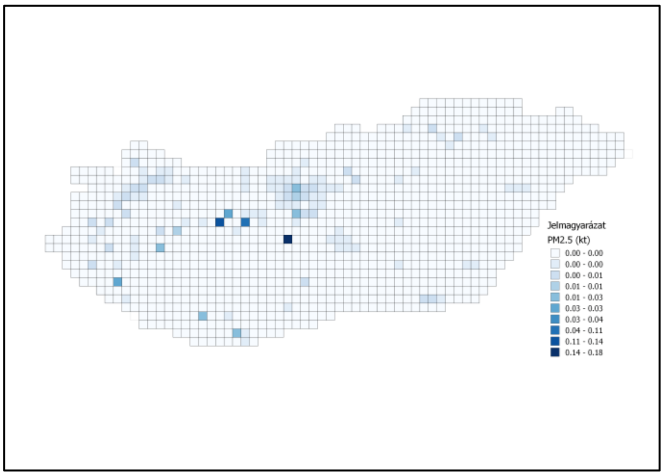

Figure 10.3 PM2.5 emissions from B_Industry in Hungary, 2015

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.

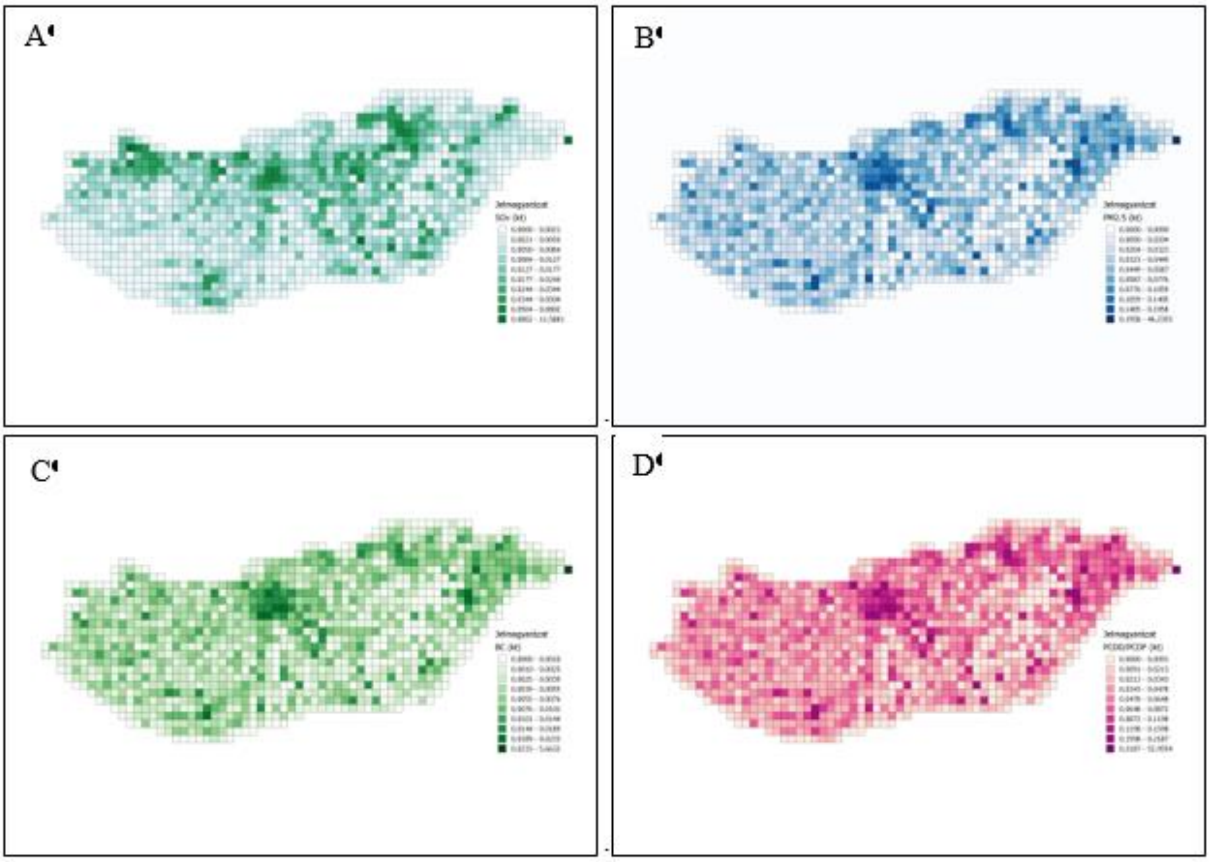

Figure 10.4 *Emissions from buildings (GNFR:C_OtherStationaryComb) A: SOx emissions, B: PM2.5 emissions, C: BC (black carbon) emissions, D: PCDD/F (dioxins and furans) emissions*

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

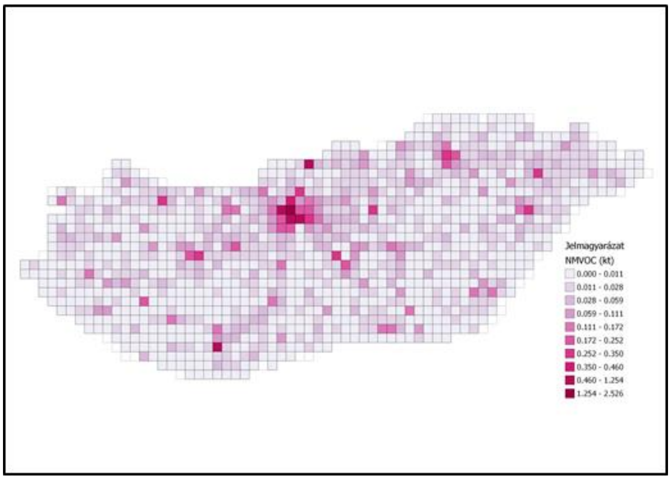

***Figure 10.5** NMVOC emissions from E_Solvents in Hungary, 2015*

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.

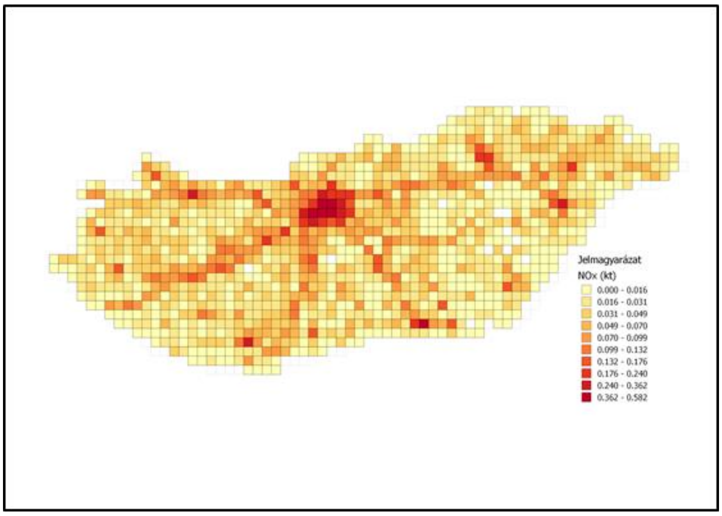

Figure 10.6 *NOx emissions from road transport in Hungary, 2015*

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.

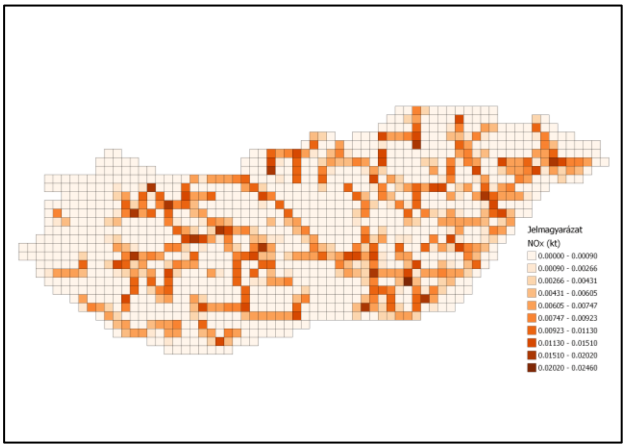

Figure 10.7 *NOx emissions from railways in Hungary, 2015*

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.

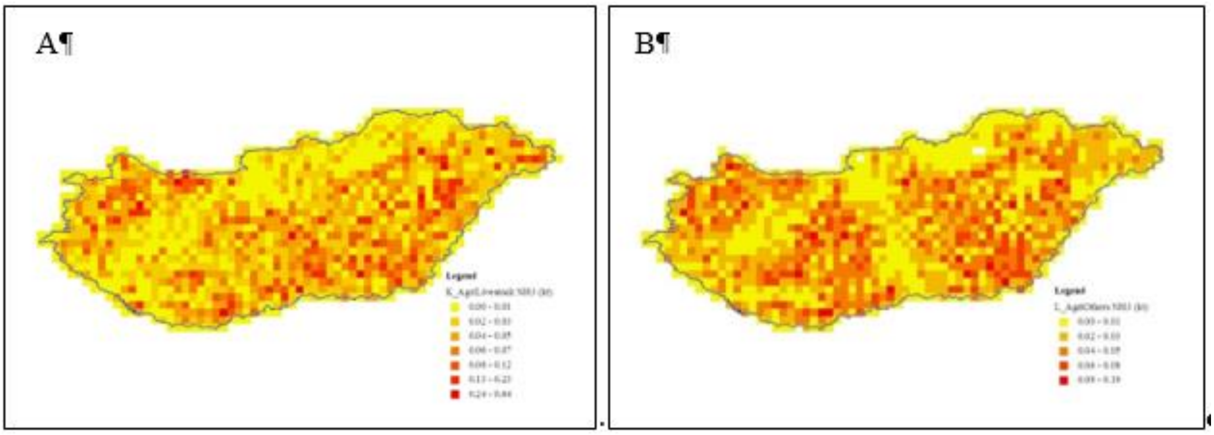

Figure 10.8 *A: NH_3 emissions from GNFR code: K_AgriLivestock. B: NH3 emissions from GNFR code: L_AgriOther.*

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, NH3 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. NH3 emission from latrines was allocated to those homes that were neither connected to the public sewerage network nor domestic septic system was available.

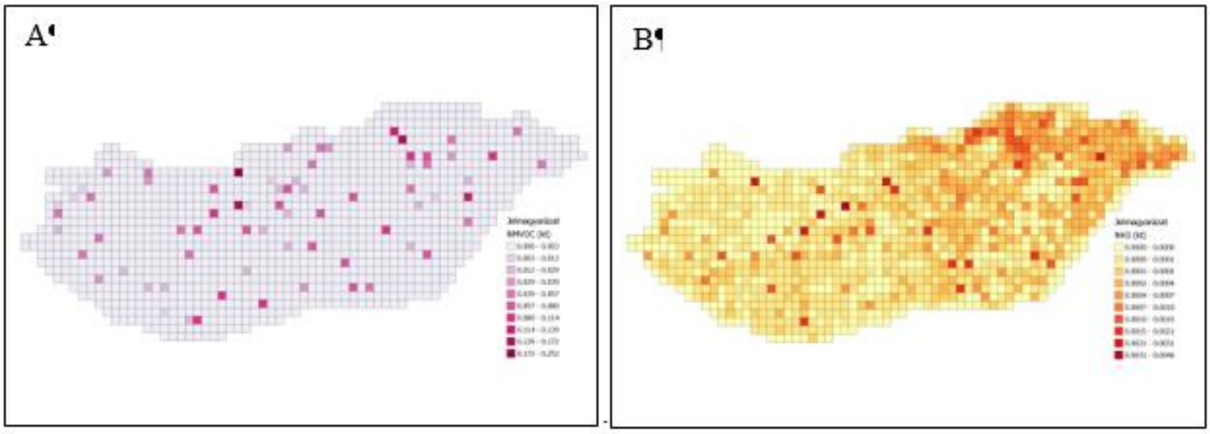

Figure 10.9 *NMVOC (A) and NH3 (B) emission from the waste sector.*

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 the 2018 submission, 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 2016 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	2015	2016	2017
NMVOC from 3B Manure management	21.57	21.36	21.41	21.44	21.99	22.67	22.91	22.60
Adjustment	-21.57	-21.36	-21.41	-21.44	-21.99	-22.67	-22.91	-22.60

11.2.2 NFR 3DE CULTIVATED CROPS (NMVOC)

Emissions were calculated using the Tier 1 methodology presented in the 2016 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	2015	2016	2017
NMVOC emissions from Cultivated crops	3.63	3.57	3.62	3.61	3.64	3.58	3.55	3.59
Adjustment	**-3.63**	**-3.57**	**-3.62**	**-3.61**	**-3.64**	**-3.58**	**-3.55**	**-3.59**

12 ANNEX-1 KEY CATEGORY ANALYSIS

Table A1.1 *Summary of Approach 1 level key category analysis*

Pollutant		NFR category	LEVEL assessment	Contribution to LEVEL (%)	Cumulative total of contributions (%)
NO_x (as NO_2)					
	1A3biii	Road transport: Heavy duty vehicles and buses	19,4168	0,1666	16,66%
	3Da1	Inorganic N-fertilizers (includes also urea application)	14,6193	0,1255	29,21%
	1A3bi	Road transport: Passenger cars	12,8187	0,1100	40,21%
	1A4bi	Residential: Stationary	11,6114	0,0996	50,17%
	1A3bii	Road transport: Light duty vehicles	11,5286	0,0989	60,07%
	1A1a	Public electricity and heat production	11,2667	0,0967	69,74%
	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	7,3678	0,0632	76,06%
	1A4ai	Commercial/institutional: Stationary	4,6025	0,0395	80,01%
NMVOC					
	1A4bi	Residential: Stationary	36,0519	0,2563	25,63%
	2D3d	Coating applications	15,6738	0,1114	36,77%
	2D3a	Domestic solvent use including fungicides	12,4331	0,0884	45,61%
	3B1b	Manure management - Non-dairy cattle	6,8333	0,0486	50,47%
	2H2	Food and beverages industry	6,3954	0,0455	55,02%
	3B1a	Manure management - Dairy cattle	6,0268	0,0428	59,30%
	1A3bi	Road transport: Passenger cars	5,8615	0,0417	63,47%
	2D3h	Printing	5,0467	0,0359	67,06%
	2D3g	Chemical products	4,4558	0,0317	70,23%
	2B10a	Chemical industry: Other (please specify in the IIR)	4,0287	0,0286	73,09%
	3De	Cultivated crops	3,5473	0,0252	75,61%
	2D3f	Dry cleaning	2,9393	0,0209	77,70%
	1A3biv	Road transport: Mopeds & motorcycles	2,9184	0,0207	79,78%

Pollutant		NFR category	LEVEL assessment	Contribution to LEVEL (%)	Cumulative total of contributions (%)
	1A3bv	Road transport: Gasoline evaporation	2,8027	0,0199	81,77%
	1A4bi	Residential: Stationary	36,0519	0,2563	25,63%
SO_x (as SO_2)					
	1A4bi	Residential: Stationary	12,3163	0,5343	53,43%
	1A1a	Public electricity and heat production	6,1109	0,2651	79,94%
	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0,9329	0,0405	83,98%
NH_3					
	3Da2a	Animal manure applied to soils	20,4247	0,2345	23,45%
	3Da1	Inorganic N-fertilizers (includes also urea application)	14,8643	0,1707	40,51%
	3B3	Manure management - Swine	11,4009	0,1309	53,60%
	3B1b	Manure management - Non-dairy cattle	7,6710	0,0881	62,41%
	3B1a	Manure management - Dairy cattle	7,3911	0,0849	70,90%
	1A4bi	Residential: Stationary	5,1838	0,0595	76,85%
	3B4gi	Manure mangement - Laying hens	3,5989	0,0413	80,98%
$PM_{2.5}$					
	1A4bi	Residential: Stationary	45,1467	0,8482	84,82%
PM_{10}					
	1A4bi	Residential: Stationary	46,3051	0,6342	63,42%
	2A5b	Construction and demolition	7,0601	0,0967	73,08%
	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	6,4347	0,0881	81,90%
TSP					
	1A4bi	Residential: Stationary	48,6708	0,4805	48,05%
	2A5b	Construction and demolition	23,5632	0,2326	71,31%
	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	6,4347	0,0635	77,66%
	2A5a	Quarrying and mining of minerals other than coal	3,7830	0,0373	81,39%
	1A4bi	Residential: Stationary	48,6708	0,4805	48,05%

Pollutant		NFR category	LEVEL assessment	Contribution to LEVEL (%)	Cumulative total of contributions (%)
BC					
	1A4bi	Residential: Stationary	5,4704	0,7333	73,33%
	1A3bii	Road transport: Light duty vehicles	0,4650	0,0623	79,57%
	1A3bi	Road transport: Passenger cars	0,3968	0,0532	84,89%
CO					
	1A4bi	Residential: Stationary	315,6234	0,7015	70,15%
	1A3bi	Road transport: Passenger cars	69,8369	0,1552	85,67%
Pb					
	1A4bi	Residential: Stationary	2,7764	0,3131	31,31%
	1A3bvi	Road transport: Automobile tyre and brake wear	1,5617	0,1761	48,92%
	1A1a	Public electricity and heat production	1,3598	0,1534	64,26%
	2C1	Iron and steel production	0,7505	0,0846	72,72%
	2A3	Glass production	0,7058	0,0796	80,68%
Cd					
	1A4bi	Residential: Stationary	0,9473	0,6242	62,42%
	1A1a	Public electricity and heat production	0,1508	0,0993	72,36%
	2G	Other product use (please specify in the IIR)	0,0819	0,0540	77,76%
	2A3	Glass production	0,0494	0,0326	81,01%
Hg					
	1A1a	Public electricity and heat production	0,2165	0,1855	18,55%
	1A4bi	Residential: Stationary	0,1520	0,1303	31,58%
	5C1biii	Clinical waste incineration	0,1488	0,1275	44,33%
	2C1	Iron and steel production	0,1279	0,1096	55,29%
	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	0,0980	0,0840	63,69%
	2B10a	Chemical industry: Other (please specify in the IIR)	0,0968	0,0830	71,99%
	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0,0823	0,0705	79,04%

Pollutant		NFR category	LEVEL assessment	Contribution to LEVEL (%)	Cumulative total of contributions (%)
PCDD/ PCDF (dioxins/ furans)					
	1A4bi	Residential: Stationary	52,1744	0,6480	64,80%
	2C1	Iron and steel production	10,9534	0,1360	78,40%
	5E	Other waste (please specify in IIR)	8,1138	0,1008	88,48%
Total 1-4					
	1A4bi	Residential: Stationary	28,7869	0,911581	91,16%

***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%	26%	53%	6%	85%	63%	70 %	**313%**
2	1A1a	Public electricity and heat production	10%		27%					**36%**
3	1A3bi	Road transport: Passenger cars	11%	4%					16 %	**31%**
4	3Da1	Inorganic N-fertilizers (includes also urea application)	13%			17%				**30%**
5	3Da2a	Animal manure applied to soils				23%				**23%**
6	1A3biii	Road transport: Heavy duty vehicles and buses	17%							**17%**
7	3B1b	Manure management - Non-dairy cattle		5%		9%				**14%**
8	3B3	Manure management - Swine				13%				**13%**
9	3B1a	Manure management - Dairy cattle		4%		8%				**13%**
10	2D3d	Coating applications		11%						**11%**
11	1A3bii	Road transport: Light duty vehicles	10%							**10%**

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	
12	2A5b	Construction and demolition						10%		**10%**
13	2D3a	Domestic solvent use including fungicides		9%						**9%**
14	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products						9%		**9%**
15	1A4cii	Agriculture/Forestry /Fishing: Off-road vehicles and other machinery	6%							**6%**
16	2H2	Food and beverages industry		5%						**5%**
17	3B4gi	Manure mangement - Laying hens				4%				**4%**
18	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel			4%					**4%**
19	1A4ai	Commercial/institutional: Stationary	4%							**4%**
20	2D3h	Printing		4%						**4%**
21	2D3g	Chemical products		3%						**3%**
22	2B10a	Chemical industry: Other (please specify in the IIR)		3%						**3%**
23	3De	Cultivated crops		3%						**3%**
24	2D3f	Dry cleaning		2%						**2%**
25	1A3biv	Road transport: Mopeds & motorcycles		2%						**2%**
26	1A3bv	Road transport: Gasoline evaporation		2%						**2%**
			80%	82%	84%	81%	85%	82%	86 %	

Table A1.3 *Summary of Approach 1 TREND key category analysis*

Pollutant		NFR category	TREND assessment	Contribution to total (%)	Cumulative total of contributions (%)
NOx (as NO_2)					
	1A3bii	Road transport: Light duty vehicles	0,0346	14,25%	14,25%
	3Da1	Inorganic N-fertilizers (includes also urea application)	0,0320	13,19%	27,44%
	1A1a	Public electricity and heat production	0,0263	10,84%	38,29%
	1A3biii	Road transport: Heavy duty vehicles and buses	0,0261	10,74%	49,03%
	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	0,0210	8,66%	57,69%
	2B2	Nitric acid production	0,0154	6,36%	64,05%
	1A3c	Railways	0,0127	5,23%	69,29%
	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0,0114	4,70%	73,99%
	1A3bi	Road transport: Passenger cars	0,0086	3,55%	77,53%
NMVOC					
	1A3bi	Road transport: Passenger cars	0,1403	41,10%	41,10%
	1A4bi	Residential: Stationary	0,0595	17,42%	58,52%
	2D3a	Domestic solvent use including fungicides	0,0208	6,09%	64,61%
	1A3dii	National navigation (shipping)	0,0153	4,47%	69,08%
	2D3g	Chemical products	0,0106	3,12%	72,19%
	2B10a	Chemical industry: Other (please specify in the IIR)	0,0093	2,74%	74,93%
	2D3h	Printing	0,0085	2,50%	77,43%
	3De	Cultivated crops	0,0057	1,66%	79,10%
	1A3biv	Road transport: Mopeds & motorcycles	0,0053	1,56%	80,66%
SO_x (as SO_2)					
	1A1a	Public electricity and heat production	0,0068	33,14%	33,14%
	1A4bi	Residential: Stationary	0,0065	31,83%	64,97%
	1A2gviii	Stationary combustion in manufacturing industries and	0,0013	6,21%	71,18%

Pollutant		NFR category	TREND assessment	Contribution to total (%)	Cumulative total of contributions (%)
		construction: Other (please specify in the IIR)			
	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0,0009	4,60%	75,79%
	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0,0008	3,91%	79,70%
	1B2c	Venting and flaring (oil, gas, combined oil and gas)	0,0007	3,36%	83,05%
NH_3					
	3B3	Manure management - Swine	0,0663	35,11%	35,11%
	1A4bi	Residential: Stationary	0,0276	14,64%	49,75%
	2B10a	Chemical industry: Other (please specify in the IIR)	0,0184	9,77%	59,51%
	3B4giv	Manure management - Other poultry	0,0116	6,13%	65,65%
	3Da1	Inorganic N-fertilizers (includes also urea application)	0,0114	6,02%	71,66%
	3B4giii	Manure mangement - Turkeys	0,0075	3,95%	75,61%
	1A3bi	Road transport: Passenger cars	0,0072	3,79%	79,40%
$PM_{2.5}$					
	1A4bi	Residential: Stationary	0,2336	47,44%	47,44%
	1A1a	Public electricity and heat production	0,0936	19,00%	66,44%
	1A3biii	Road transport: Heavy duty vehicles and buses	0,0250	5,07%	71,51%
	2C1	Iron and steel production	0,0247	5,02%	76,53%
	2A1	Cement production	0,0167	3,40%	79,92%
	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0140	2,84%	82,77%
PM_{10}					
	1A4bi	Residential: Stationary	0,2073	42,77%	42,77%
	1A1a	Public electricity and heat production	0,1188	24,52%	67,28%
	2A5b	Construction and demolition	0,0249	5,14%	72,42%
	2C1	Iron and steel production	0,0179	3,69%	76,11%
	2A1	Cement production	0,0171	3,53%	79,64%

Pollutant		**NFR category**	**TREND assessment**	**Contribution to total (%)**	**Cumulative total of contributions (%)**
	1A3biii	Road transport: Heavy duty vehicles and buses	0,0136	2,81%	82,45%
TSP					
	1A4bi	Residential: Stationary	0,1673	39,45%	39,45%
	1A1a	Public electricity and heat production	0,1045	24,65%	64,10%
	2A5b	Construction and demolition	0,0313	7,38%	71,47%
	2C1	Iron and steel production	0,0176	4,16%	75,64%
	2A5a	Quarrying and mining of minerals other than coal	0,0121	2,85%	78,48%
BC					
	1A4bi	Residential: Stationary	0,2310	49,56%	49,56%
	1A3biii	Road transport: Heavy duty vehicles and buses	0,0744	15,96%	65,52%
	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0460	9,88%	75,39%
	1A3bii	Road transport: Light duty vehicles	0,0250	5,37%	80,76%
CO					
	1A4bi	Residential: Stationary	0,1092	45,50%	45,50%
	1A3bi	Road transport: Passenger cars	0,0939	39,12%	84,62%
Pb					
	1A3bi	Road transport: Passenger cars	0,0090	44,90%	44,90%
	1A4bi	Residential: Stationary	0,0031	15,52%	60,42%
	1A3bvi	Road transport: Automobile tyre and brake wear	0,0019	9,19%	69,60%
	1A1a	Public electricity and heat production	0,0016	7,85%	77,45%
	2A3	Glass production	0,0008	4,13%	81,58%
Cd					
	1A4bi	Residential: Stationary	0,2875	43,05%	43,05%
	1B2c	Venting and flaring (oil, gas, combined oil and gas)	0,1154	17,28%	60,34%
	1A1a	Public electricity and heat production	0,0637	9,53%	69,87%
	2C7a	Copper production	0,0608	9,11%	78,98%
	2G	Other product use (please specify in the IIR)	0,0278	4,17%	83,15%

Pollutant		NFR category	TREND assessment	Contribution to total (%)	Cumulative total of contributions (%)
Hg					
	2B10a	Chemical industry: Other (please specify in the IIR)	0,0467	29,15%	29,15%
	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	0,0189	11,82%	40,96%
	1A4bi	Residential: Stationary	0,0161	10,05%	51,01%
	5C1bv	Cremation	0,0150	9,35%	60,36%
	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0085	5,31%	65,67%
	1A4ai	Commercial/institutional: Stationary	0,0061	3,79%	69,46%
	1B2aiv	Fugitive emissions oil: Refining / storage	0,0059	3,66%	73,12%
	2C1	Iron and steel production	0,0057	3,55%	76,67%
	5C1biii	Clinical waste incineration	0,0050	3,09%	79,77%
	1B2c	Venting and flaring (oil, gas, combined oil and gas)	0,0049	3,03%	82,80%
PCDD/ PCDF (dioxins/ furans)					
	5E	Other waste (please specify in IIR)	0,0496	28,47%	28,47%
	1A4bi	Residential: Stationary	0,0372	21,38%	49,85%
	2C7a	Copper production	0,0185	10,64%	60,49%
	2C1	Iron and steel production	0,0116	6,63%	67,13%
	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	0,0107	6,16%	73,28%
	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	0,0077	4,44%	77,72%
	1A1a	Public electricity and heat production	0,0074	4,24%	81,96%
Total 1-4					
	1A4bi	Residential: Stationary	0,36389	90,02%	90,02%

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%	17%	32%	15%	47%	43%	45%	203%
2	1A3bi	Road transport: Passenger cars	4%	41%		4%			39%	88%
3	1A1a	Public electricity and heat production	11%		33%		19%	25%		87%
4	3B3	Manure management - Swine				35%				35%
5	3Da1	Inorganic N-fertilizers (includes also urea application)	13%			6%				19%
6	1A3biii	Road transport: Heavy duty vehicles and buses	11%				5%	3%		19%
7	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	9%		6%					15%
8	1A3bii	Road transport: Light duty vehicles	14%							14%
9	2B10a	Chemical industry: Other (please specify in the IIR)		3%		10%				13%
10	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	5%		5%					9%
11	2C1	Iron and steel production					5%	4%		9%
12	2A1	Cement production					3%	4%		7%
13	2B2	Nitric acid production	6%							6%
14	3B4giv	Manure management - Other poultry				6%				6%

Rank	**NFR code**	**Category**	**% contributions to pollutant totals for key**							**Sum of KC % contributions**
15	2D3a	Domestic solvent use including fungicides		6%						6%
16	1A3c	Railways	5%							5%
17	2A5b	Construction and demolition						5%		5%
18	1A3dii	National navigation (shipping)		4%						4%
19	3B4giii	Manure mangement - Turkeys				4%				4%
20	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel			4%					4%
21	1B2c	Venting and flaring (oil, gas, combined oil and gas)			3%					3%
22	3B1a	Manure management - Dairy cattle				3%				3%
23	2D3g	Chemical products		3%						3%
24	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery					3%			3%
25	2D3h	Printing		2%						2%
26	3De	Cultivated crops		2%						2%
27	1A3biv	Road transport: Mopeds & motorcycles		2%						2%
			81%	81%	83%	83%	83%	82%	85%	

13 ANNEX-2 RESPONSES TO THE NECD REVIEW OF THE 2018 INVENTORY SUBMISSION

No information is provided in this submission.

14 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 - avaiable 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.