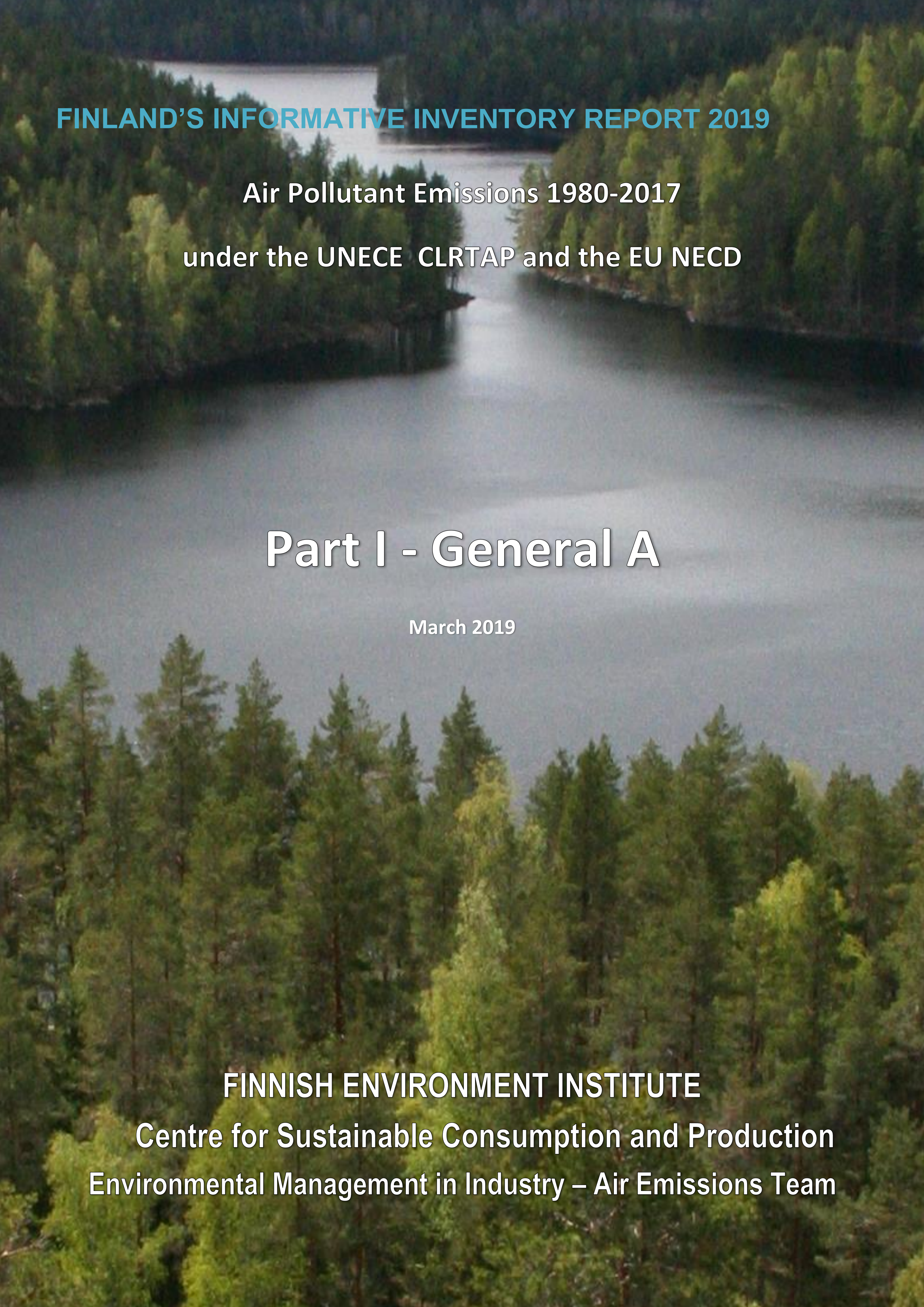

FINLAND'S INFORMATIVE INVENTORY REPORT 2019

Air Pollutant Emissions 1980-2017

under the UNECE CLRTAP and the EU NECD

Part I - General A

March 2019

FINNISH ENVIRONMENT INSTITUTE
Centre for Sustainable Consumption and Production
Environmental Management in Industry – Air Emissions Team

PART 1

GENERAL A

Cover page Part 1: Esa Nikunen (2016) Repovesi, Ympäristöhallinnon kuvapankki

PREFACE

Finland's Informative Inventory Report (IIR) 2019 under the United Nations Economic Commission for Europe's (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and under the EU National Emission Ceilings Directive (NECD) contains information on the organisation of the national air pollutant emissions inventory, on the methods applied in the calculation of emissions for the time series 1980-2019.

The 2018 submission included the first full recalculation of the whole time series. Further QA/QC checks and improved harmonization of the allocation of emissions between the years were carried out to the NFR tables submitted on 15 February 2019, and additional corrections of remaining errors to the resubmission on 15 March 2019.

The IIR is prepared according to the Guidelines for Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution (ECE/EB.AIR/97, 27 January 2010) and its structure follows the template of the Informative Inventory Report. The report is reviewed and completed annually to include updated information.

Part 1A General of the IIR covers general background information, data analysis and explanation of emission trends .Emission data for the years 1980-2017 are summarised in Tables 1.1 - 1.3.
Part 1B General of the IIR provides information on recalculations, projections and inventory improvement.

Methods used to estimate the emissions are presented in Part 2 Energy and Transport, in Part 3 Industry and Product Use and in Part 4 (Agriculture and Waste).

Information of the adjusted NH3 emission inventory is included in Annex 3D

The Finnish emission data as well as the annually submitted IIR can be downloaded from the EIONET CDR website as well as from the Finnish Environmental Administration's website http://www.environment.fi > State of the environment > Air > Air pollutant emissions in Finland (in English). The website is updated annually by 31st March with the latest data and reports.

The air pollutant emission inventory and the Informative Inventory Report under the UNECE CLRTAP and the EU NECD are prepared at the Finnish Environment Institute (SYKE) by the Air Emission Team: Mr Tommi Forsberg, Mr Juha Grönroos, Ms Johanna Mikkola-Pusa, Mr Joonas Munther, Mr Jouko Petäjä and Ms Kristina Saarinen. Transport sector emissions are calculated at VTT Technical Research Centre of Finland (Mr Kari Mäkelä, Ms Heidi Auvinen and Ms Jenny Eckhardt) and at Statistics Finland (Mr Kari Grönfors).

Contact information for the inventory: Kristina Saarinen, email kristina.saarinen@environment.fi, telephone +358 400 148715, address Finnish Environment Institute, P.O.Box 140, FIN-00251 Helsinki, Finland

Helsinki 15th March 2019

Requested information on inclusion of the condensable part of particulate matter emissions is summarized on the next page

A summary of information on the condensable part of particulate matter

The summary presented in the table below on whether the condensable part of particulate matter is included or not in the emissions estimates, covers only those cases where (1) emission data reported by the plants are used in the inventory, or (2) domestic emission factors used in the calculation.

Information on whether the emission factors from the EMEP/EEA Emission Inventory Guidebook include or exclude the condensable part has not thoroughly been studied.

Energy		
NFRs 1A1/1A2	Combustion in the energy production units - TSP emission concentrations are measured in the stack according to the agreed the EN standards (EN 13284-1), which is a gravimetric particle measurement and thus does not cover condensable particles. In cases where PM10 and PM2.5 are calculated from reported TSP emissions or using domestic TSP EFs, the condensable part of PMs is not included.	Part 2 Energy p. 33
NFR 1A4	For small scale wood combustion, country specific emission factors are based on measurements where the condensable part is included. For coal combustion, Guidebook EFs are used and we refer to the knowledge of the Guidebook regarding inclusion or exclusion of condensables.	Part 2 Energy
Transport		
NFR 1A3	For all transport modes Guidebook EFs are used - According to general information, the transport sector standard measurements include dilution of the sample and cooling it to 51 ^{o}C temperature, which enables the measurement to capture most of the condensable part of particulate matter	Part 3 Transport
Industry and product use		
NFR 2	Industrial processes - TSP emission concentrations are measured in the stack according to the agreed the EN standards (EN 13284-1), which is a gravimetric particle measurement and thus does not cover condensable particles. When Guidebook 2016 EFs for particles are used, we refer to the Guidebook in the knowledge of inclusion or exclusion of condensables.	Part 4 IPPU p. 5
Agriculture		
NFR 3F	Field burning - When Guidebook EFs for particles are used, we refer to the Guidebook in the knowledge of inclusion or exclusion of condensables.	Part 5 Agriculture
Waste		
NFR 5C	Waste incineration - TSP emission concentrations are measured in the stack according to the agreed the EN standards (EN 13284-1), which is a gravimetric particle measurement and thus does not cover condensable particles. When Guidebook 2016 EFs for particles are used, we refer to the Guidebook in the knowledge of inclusion or exclusion of condensables.	Part 6 Waste

CONTENTS

PART 1 GENERAL A (Part 1 General B is at the end of the IIR)

SECTORAL METHODOLOGIES

Sub-chapters included under each NFR subcategory
Source category description
Emission trend
Methodological issues
Uncertainty and time series' consistency
Source-specific QA/QC and verification
Source-specific recalculations including changes in response to the review
Source-specific planned improvements

PART 2 - ENERGY

ENERGY (NFR 1)

2.1 Overview of the sector
Source category description
Energy use of waste
Overview of energy consumption

2.2 NFR 1.A.1 Energy industries and NFR 1.A.2 Manufacturing Industries and Construction

2.3 Commercial/Institutional and Residential Plants(NFR 1.A.4)
Household, Gardening Agriculture/Forestry/Fishing and Other Stationary sources

2.4 Fugitive emissions (NFR 1B)
Fugitive Emissions from Solid Fuels (NFR 1.B.1)
Coal mining and handling
Solid fuel transformation
Other fugitive emissions from solid fuels (Wood pellets, Peat)
Fugitive Emissions from oil and natural gas (NFR 1.B.2)
Exploration, production, transport
Refining/storage
Distribution of oil products .
Natural gas .
Venting and flaring
Other fugitive emissions from geothermal energy production, peat and other energy extraction not included in 1 B 2

PART 3 - TRANSPORT

Transport and Off-road mobile sources (NFR 1.A.3)
3.1 Aviation
3.2 Road transport
3.3 Gasoline evaporation
3.4 Tyre and brake wear
3.5 Road abrasion
3.6 Railways, navigation, pipeline compressors
3.7 Navigation
3.8 International maritime navigation
3.9 International inland waterways
4.0 Pipeline compressors
4.1 Off-road mobile sources

PART 4 - IPPU

INDUSTRIAL PROCESSES and PRODUCT USE (NFR 2)

4.7 Other industry (NFR 2H)
Pulp and paper
Food and beverages industry
Other industrial production including production, consumption, storage, transportation or handling of bulk products
Wood processing
Production of POPs
Consumption of POPs and heavy metals

PART 5 AGRICULTURE

AGRICULTURE (NFR 3)

The documentation of the Agricultural Emissions Calculation Model is saved in the 2018 CDR folder "Revised IIR 2018 – Annexes Part 5"

5 Agriculture - Overview of the sector

5.1 Manure Management (NFR 3B)
5.2 Agricultural Soils (NFR 3D)
3 D 1 a Synthetic N-fertilizers
3 D a 2 a Animal manure applied to soils
3 D a 2 b Sewage sludge applied to soils
3 D a 2 c Other organic fertilisers applied to soils
3 D a 3 Urine and dung deposited by grazing animals
3 D a 4 Crop residues applied to soils
3 D b Indirect emissions from managed soils
3 D c Farm-level agricultural operations including storage, handling and transport of agricultural products
3 D d Off-farm storage, handling and transport of bulk agricultural products
3 D e Cultivated crops
3 D f Use of pesticides
5.3 3 F Field burning of agricultural wastes
5.4 Agriculture other (NFR 3 D f)

PART 6 WASTE AND OTHER SOURCES

WASTE (NFR 5)

6 Waste – Overview of the sector

6.1 Solid waste disposal on land
6.2 Composting
6.3 Anaerobic digestion at biogas facilities
6.4 Waste Incineration (NFR 5C)
Municipal waste incineration
Industrial waste incineration including hazardous waste and sewage sludge
Clinical waste incineration
Cremation
6.5 Wastewater Handling (NFR 5D1, 5D2 and 5D3)
Domestic wastewater handling

PART 1 GENERAL B

PART 7 ANNEXES

ABBREVIATIONS

CEPMEIP	Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance
CLRTAP	Convention on Long Range Transboundary Air Pollution
CRF	Common Reporting Format tables, reported to the UNFCCC Secretariat
GNFR	Gridding NFR (emissions gridded for each GNRF aggregated sector)
GPG	IPCC Good Practice Guidance
EEA	European Environment Agency
EMEP	Cooperative programme for the monitoring and evaluation of the long range transmission of air pollutants in Europe (European Monitoring and Evaluation Programme)
E-PRTR	European Pollutant and Transfer Register
EU	European Union
EUMM	Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol, OJ L 49, 19.02.2004
ILMI	Calculation model for emissions from aviation at VTT Technical Research Centre of Finland
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
IPTJ	Air pollutant emission data system at the Finnish Environment Institute SYKE
LCP	Large combustion plant
LIISA	Calculation model for the road transport sector emissions at VTT Technical Research Centre of Finland
LIPASTO	Calculation system for the transport sector emissions at VTT Technical Research Centre of Finland
LPS	Large point sources, equals to the definition of E-PRTR installations
LUKE	Natural Resources Institute Finland (Luonnonvarakeskus)
MEERI	Calculation model for emissions from navigation at VTT Technical Research Centre of Finland
MTT	MTT Agrifood Research Finland
NECD	Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309, 27 November 2001
NFR	Nomenclature for Reporting
SYKE	Finnish Environment Institute
SNAP	Selected Nomenclature for Air Pollution
TIKE	Information Center of the Ministry of Agriculture and Forestry
TYKO	Calculation model for emissions from off-road machinery at VTT Technical Research Centre of Finland
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention for Climate Change
USEPA	United States Environmental Protection Agency
VAHTI	Compliance Monitoring Data System at the Centres for Economic Development, Transport and the Environment
VTT	VTT Technical Research Centre of Finland

Pollutants

As	Arsenic
BC	Black carbon
Cd	Cadmium
Cr	Chromium
Cu	Copper
CO	Carbon monoxide
HCB	Hexachlorobenzene
HCl	Hydrochloric acid
Hg	Mercury
HM	Heavy metals
SO_2	Sulphur dioxide, all sulphur compounds expressed as sulphur dioxide
NH_3	Ammonia
Ni	Nickel
NMVOC	Non-methane volatile organic compounds, 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 the UNECE CLRTAP Reporting Guidelines, the fraction of creosote which exceeds this value of vapour pressure at 293.15 K is considered as a NMVOC
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides, nitric oxide and nitrogen dioxide, expressed as nitrogen dioxide
PAH-4	Polyaromatic hydrocarbons expressed as the sum of benzo(a)pyrene, benzo(b)fluoranthene,benzo(k), fluoranthene and indeno(1,2,3,-cd)pyrene
Pb	Lead
PCDD/F	Dioxins and furans: 1,2,3,7,8-PeCDD; 2,3,4,7,8-PeCDF; 1,2,3,4,7,8-HxCDF;1,2,3,6,7,8-HxCDF
PCB	Polychlorinated biphenyls
PCP	Pentachlorophenol
$PM_{2.5}$	Particulate matter, 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}	Particulate matter, 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
POP	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)
SCCP	Short-chained chlorinated paraffins
TSP	Total suspended particulates. 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
Zn	Zinc

Notation keys

IE	Included elsewhere – Emissions for this source are estimated and included in the inventory but not presented separately for this source (the source where included is indicated).
NA	Not applicable – The source exists but relevant emissions are considered never to occur. Instead of NA, the actual emissions are presented for source categories where both the sources and their emissions are well-known due to availability of bottom-up data (i.e. mainly in the energy and industrial processes sectors). When pointing the value "0.000" with the cursor, the actual emissions can be seen and the value "0.000" is shown due to the rounding of data to three significant decimals.
NE	Not estimated – Emissions occur, but have not been estimated or reported.
NO	Not occurring – A source or process does not exist within the country.
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.
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. – NR is not in use in the Finnish inventory report.

The use of notation keys in the Finnish inventory is explained in the sector specific Chapters 4 - 9.

EXECUTIVE SUMMARY

Changes in chapter	
Update of text	March 2018 KS

i Background information on air pollutants inventories

Responsibilities in the Finnish national system for air emission inventories are divided between Statistics Finland, responsible for greenhouse gas inventories, and the Finnish Environment Institute, responsible for air pollutant emission inventories, as shown in Figure 1.1.

UNECE CLRTAP

The United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP) entered into force in 1983. Under the Convention there are eight protocols: the protocol on Reduction of Sulphur Emissions and their Transboundary Fluxes (entered into force in 1987), protocol on Control of Nitrogen Oxides or their Transboundary Fluxes (entered into force in 1991), protocol on Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (entered into force in 1997), protocol on Further Reduction of Sulphur Emissions (entered into force in 1998), protocol on Persistent Organic Pollutants POPs (entered into force in 2003, protocol on Heavy Metals (entered into force in 2003) and protocol on Abating Acidification, Eutrophication and Ground-level Ozone (entered into force in 2005). Reduction targets and base years for the emission inventories are specified for the substances covered by each Protocol.

The annual reports under the UNECE CLRTAP Convention include emission inventories for sulphur as SO_2, nitrogen oxides, ammonia, non-methane volatile organic compounds (NMVOCs), heavy metals and persistent organic compounds since their base years as specified in the relevant protocols. Projected emissions for sulphur dioxide, nitrogen oxides, ammonia, particulate matter and NMVOCs are reported for the years 2020 and 2050. Methods used to quantify emissions as well as data analysis and other additional information to understand the emission trends as required in the reporting guidelines[1] are included in national Informative Inventory Reports (IIRs) submitted annually.

Finland has annually submitted emission data and inventory reports to the UNECE Secretariat since the 1980's to meet the obligations of the United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP). The inventory reports submitted to the UNECE Secretariat and to the EEA are uploaded to the EIONET CDR (http://cdr.eionet.europa.eu/) as specified in the reporting instructions. Information on air pollutant inventories and submission of reports under the UNECE CLRTAP is provided on the website of Finland's Environmental Administration in Finnish[2], Swedish[3] and English[4].

[1] http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf
[2] http://www.ymparisto.fi/default.asp?node=6323&lan=fi

EU NECD

The aim of Directive 2001/81/EC, revised 2016/2284, of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants is to limit emissions of acidifying and eutrophying pollutants and ozone precursors. The Directive establishes national emission ceilings as benchmarks, for SO_2, NO_x, NH_3, NMVOC and $PM_{2.5}$ emissions. Emission inventories and projections as well as additional data are reported since the 2017 submission according to the revised NEC Directive (Directive 2016/2284) reporting requirements.

Finland has submitted emission inventories to the European Commission and to the EEA annually since the first reporting under the NECD in 2002 for the year 2000 final data. The data and reports are uploaded to the EIONET CDR (http://cdr.eionet.europa.eu/). Detailed information on air pollutant inventories is provided on the website of Finland's Environmental Administration in Finnish[5], Swedish[6] and English[7]

ii Summary of national emissions related to trends

Changes in chapter	
February 2019	KS

Summaries of air pollutant emissions in Finland for the years 1980-2017 are presented in Tables 1.1, 1.2 and 1.3.

The methodology presented in the EMEP EEA Emission Inventory Guidebook has been applied in the inventory and completed by national methods where available, according to the Guidebook principles.

Table 1.1. Summary of main air pollutant emissions in Finland for 1980–2017[8]. Corrections to data reported in 2018 are printed in red.

kt/a	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH_3	CO	$PM_{2.5}$	PM_{10}	TSP	BC
1980	304	NE	584	35	NE				
1981	284	NE	534	35	NE				
1982	279	NE	484	36	NE				
1983	271	NE	372	36	NE		No estimates for total national emissions of particulate matter are available for 1980-1989		
1984	266	NE	368	36	NE				
1985	284	NE	382	36	NE				
1986	286	NE	331	36	NE				
1987	297	230	328	35	NE				
1988	302	241	302	34	NE				
1989	310	234	244	33	NE				
1990	306	230	249	34	754	47	70	97	10
1991	303	221	205	32	726	42	63	84	9

[3] http://www.ymparisto.fi/default.asp?contentid=371537&lan=fi&clan=sv
[4] http://www.ymparisto.fi/default.asp?node=13255&lan=en
[5] http://www.ymparisto.fi/default.asp?node=6323&lan=fi
[6] http://www.ymparisto.fi/default.asp?contentid=371537&lan=fi&clan=sv
[7] http://www.ymparisto.fi/default.asp?node=13255&lan=en
[8] 2000-2010 emissions are available in NFR09 format, 1990-1999 emissions will be recalculated into NFR format in the next years.

kt/a	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH_3	CO	$PM_{2.5}$	PM_{10}	TSP	BC
1992	287	215	156	31	705	38	57	76	9
1993	293	209	138	32	690	35	53	71	9
1994	293	207	123	32	672	34	52	71	8
1995	273	202	105	33	665	32	48	66	8
1996	277	194	109	33	657	31	47	63	7
1997	271	192	101	35	651	30	46	63	7
1998	257	187	93	35	645	28	43	57	7
1999	252	183	92	37	626	28	43	59	7
2000	241	177	82	34	595	26	40	55	6
2001	244	174	96	34	595	27	41	56	7
2002	242	166	90	35	579	27	43	57	7
2003	248	162	101	36	556	27	43	59	6
2004	237	157	84	36	541	26	42	57	6
2005	208	145	70	37	509	25	39	55	6
2006	224	141	83	36	500	25	41	57	5
2007	211	136	81	35	481	24	38	53	5
2008	194	122	67	35	463	23	37	52	5
2009	176	112	59	35	440	22	36	51	5
2010	187	114	66	36/33*	454	24	38	54	6
2011	171	105	60	35/32*	414	21	35	51	5
2012	161	102	50	34/32*	407	21	33	48	5
2013	158	97	48	33/32*	389	20	32	47	5
2014	151	94	44	34/32*	383	19	31	46	5
2015	139	89	41	32/30*	361	18	29	43	4
2016	134	90	40	32/30*	368	18	30	46	4
2017	130	88	35	31/30*	359	18	29	44	4

Remark 1: Due to rounding the sum of subtotals does not equal to total figure
*NH_3 including accepted adjustments under the UNECE CLRTAP for the years 2010-2017

Table 1.2. Summary of heavy metal emissions in Finland for the years 1990–2017.

	Heavy Metals (t/a)								
	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	320	7	1	35	47	150	78		678
1991	236	4	1	24	59	142	61		468
1992	164	3	1	18	47	118	52		370
1993	104	3	1	16	37	105	45		345
1994	73	3	1	11	40	99	44		400
1995	72	2	1	5	35	110	47		401
1996	48	2	1	8	32	103	37		267
1997	31	2	1	13	29	121	38		144
1998	36	2	1	14	30	77	33		148
1999	34	2	1	5	31	61	37		138
2000	30	1	1	4	28	59	35		126
2001	30	2	1	5	25	60	32		129
2002	30	1	1	4	39	63	38		145
2003	25	1	1	4	29	56	35	NE*	124
2004	26	2	1	4	26	54	30		122
2005	21	1	1	3	20	52	26		114
2006	25	1	1	3	25	53	28		117
2007	22	1	1	3	29	40	25		105
2008	20	1	1	3	26	39	22		117
2009	17	1	1	3	17	36	21		116
2010	20	1	1	3	26	38	23		129
2011	19	1	1	3	17	38	20		124
2012	16	1	1	3	18	37	19		127
2013	16	1	1	3	18	38	17		123
2014	17	1	1	3	23	39	17		131
2015	15	1	1	2	17	37	16		117
2016	16	1	1	3	18	37	16		125
2017	16	1	1	2	16	36	15		119

Remark 1: Due to rounding the sum of subtotals does not equal to total figures

[6]The time series for Se emissions is not yet completed.
**The IPPU sector emission value for Cd in 1999 needs to be corrected

Table 1.3. Summary of persistent organic pollutant emissions in Finland for the years 1990–2017.

Year	Persistent Organic Pollutants			
	PCDD/F (g I-TEQ)	PAH-4 (Mg)	HCB (kg)	PCB (kg)
1990	18	7	37	29
1991	19	7	37	25
1992	18	7	37	26
1993	18	7	37	28
1994	19	7	36	29
1995	19	8	36	29
1996	18	8	38	28
1997	18	8	38	30
1998	18	8	38	31
1999	18	8	38	30
2000	19	8	39	30
2001	16	8	18	29
2002	16	9	12	29
2003	14	9	10	30
2004	14	9	26	31
2005	14	9	32	31
2006	15	9	36	32
2007	14	9	38	32
2008	17	10	18	31
2009	12	10	27	21
2010	16	11	9	28
2011	14	10	26	28
2012	15	10	9	25
2013	15	10	17	23
2014	16	10	22	25
2015	14	9	16	24
2016	15	10	60	26
2017	13	10	33	26

Remark 1: Due to rounding the sum of subtotals do not equal to total figures

iii Overview of source category specific emission estimates and trends

The sources of air pollutants are discussed in details in Sections 3 - 10 of this report. For the land use change and forestry sector no air pollutant emissions have been estimated thus far.

Energy

Combustion of fuels in the energy and heat production sectors is the main source of SO_2, NO_x, particulate matter and heavy metal emissions. NMVOC and POP compounds are released especially from small combustion sources. Transport sector is a significant source of NO_x, CO and NMVOC emissions.

Emissions from the energy sector are related to the production, distribution and consumption of fuels and fluctuate from year to year due to the economic trends and variations in the energy supply structure. The availability of hydropower in the integrated Nordic electricity market has a notable effect on the emissions.

In the transport sector, emissions have a decreasing trend though the use of fuels is increasing. One of the most essential emission reduction measures in the transport sector is the EU level agreement with car manufacturers on reducing vehicles' fuel consumption. Emissions from the off-road sector are increasing.

Industrial Processes

Emissions from the industrial processes sector include, among others

- all sulphur compounds reported as sulphur dioxide (SO_2), covering also emissions total reduced sulphur compounds (TRS) from chemical and pulp and paper industries,
- NMVOCs from pulp and paper, chemical and food and drink industries,
- heavy metal, POP and particle emissions from metal industry,
- POP emissions from mineral and chemical industries.

The trends are in general decreasing but variations due to fluctuations in production occur annually.

Solvent and other product use

The inventory of the solvent and other product use sector covers NMVOC compounds, particles, heavy metals and POP compounds. Paint application and printing are the most significant NMVOC sources.

The trends of emissions are generally decreasing. Efforts have been made to include more product use related emissions to the inventory, but in many cases there is lack of both methods and activity data to quantify emissions from many product use sources. Several projects are, however, under way to study emissions from the use of products.

Agriculture

Agriculture is the main source for ammonia emissions and also a source of particle emissions. The main emission sources for ammonia are manure management and fertilizers. The emissions trends are decreasing due to decreases in the numbers of livestock and in nitrogen fertilisation. The decreasing ammonia emission trends are safeguarded in the EU common agricultural policy by adopting support measures encouraging production that minimises the burden on the greenhouse gas balance.

The national emission ceiling for ammonia, set in the EU NEC Directive for 2010, was 31 kilotonnes for Finland. The ceiling has not yet been met. At the time of setting the ceiling for 2010 it was not foreseen that the ceiling would not be met. However, new understanding of the generation and development of ammonia emissions, especially from manure management, as well as identification of some new sources that were not known during the establishment of the ceiling, have been taken into the inventory, and have significantly increased the emissions. Finland applied for an adjustment to the road transport and small scale combustion NH3 emissions, which were accepted, and when applying the accepted adjustments, the emissions are in 2016 and 2017 below the ceiling.

Waste

Emissions from the waste sector include SO_2, NO_x, CO, NMVOC, particulate matter, heavy metals and POPs. The trends of these emissions are generally declining.

1 INTRODUCTION

1.1 Background information on air pollutants emissions and their impact on the environment

Changes in chapter	
Update of text	February 2019 KS

1.1.1 National circumstances relevant to air pollutant emissions

Population and geography

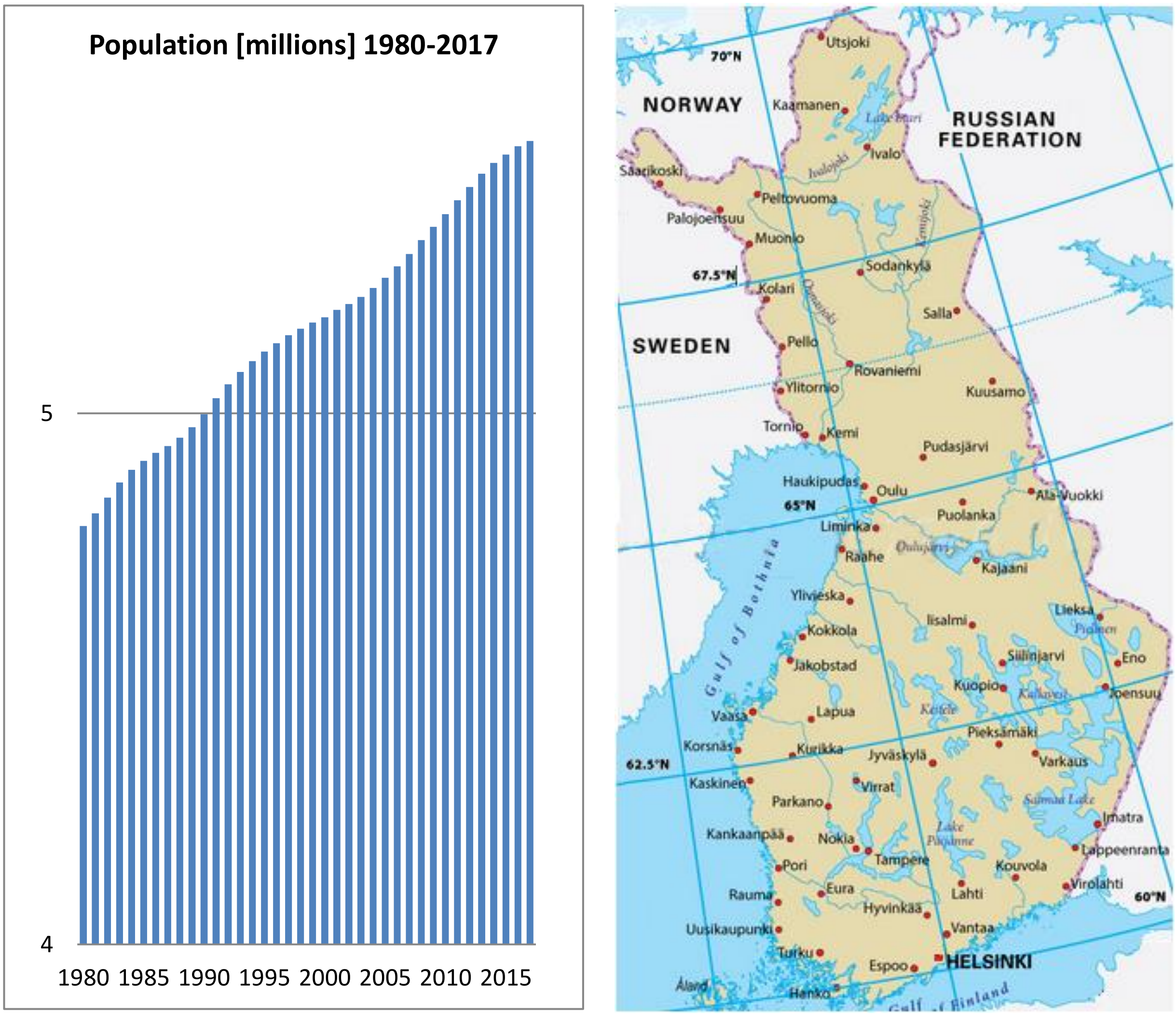

Figure 1.1 Population and geographical location of Finland

The population of Finland was 5 513 130 at the end of 2017 (Figure 1.1). As a result of the low population density, 18 inhabitants per km², and the geographical extent of the country, the average distances travelled for different purposes can be quite long.

Finland is situated at a latitude between 60 and 70 degrees north, with a quarter of the country extending north of the Arctic Circle. With a total area of 338,432 km2, it is Europe's seventh largest country. Nearly all of Finland is situated in the boreal coniferous forest zone, and 72 per cent of the total land area is classified as forest land, while only some 8 per cent is farmed. Finland has more than 34,300 km2 of inland water systems, which represents approximately 10 per cent of its total area. There are some 190,000 lakes and 180,000 islands.

Climate

Finland's northern location increases the demand for energy and natural resources but the cold climate has also forced efficient use of energy.

The climate of Finland displays features of both maritime and continental climates, depending on the direction of air flow. Considering its northern location, the mean temperature in Finland is several degrees higher than in most other areas at these latitudes. The temperature is higher due to the Baltic Sea, because of the inland waters and, above all, as a result of air flows from the Atlantic Ocean, which are warmed by the Gulf Stream. The mean annual temperature is approximately 5.5°C in south-western Finland and decreases towards the northeast.

Winter – Winter begins around mid-October in Lapland and during November in the rest of Finland, while not until December in the southwestern archipelago. The sea and large lakes, where existing, slow down the progress of winter. Winter is the longest season in Finland, lasting for about 100 days in southwestern Finland and 200 days in Lapland. The mean temperature in winter remains below 0°C. North of the Arctic Circle, part of winter is the period known as the "polar night", when the sun does not rise above the horizon at all. In the northernmost corner of Finland, the polar night lasts for 51 days. In southern Finland, the shortest day is about 6 hours long. Permanent snow covers open grounds about two weeks after winter begins. The snow cover is deepest around mid-March, with an average of 60 to 90 cm of snow in eastern and northern Finland and 20 to 30 cm in southwestern Finland. The lakes freeze over in late November and early December. The ice is thickest in early April, at about 50 to 65 cm. In severe winters, the Baltic Sea may ice over almost completely, but in mild winters it remains open except for the far ends of the Gulf of Bothnia and the Gulf of Finland. The coldest temperatures in winter are from -45°C to -50°C in Lapland and eastern Finland; from -35°C to -45°C elsewhere; and -25°C to -35°C over islands and coastal regions. The lowest temperature recorded in Helsinki is -34.3°C (1987). The lowest temperature recorded at any weather station in Finland as of 2010 is -51.5°C (1999).

Spring - In spring, the mean daily temperature rises from 0°C to 10°C. Spring begins in a month earlier in the southern part of the country, early April, and proceeds to Lapland in early May, ranging from 45 to 65 days, and being longest in the maritime islands and coastal regions, because of the coolness of the sea. Once the mean daily temperature exceeds 5°C, the thermal growing season is considered to have begun. This takes place about one month after the beginning of spring: at the end of April in southern Finland and at the end of May in northernmost Lapland. For the real growing season to begin the snow must melt. Melting depends on the amount of snow, elevation and the position of the region relative to the sea. Open areas lose their snow cover within two to three weeks of the beginning of spring, whereas on average the snow in the forest smelts about two weeks later. The lakes usually become ice-free soon after the growing season begins in April in southwestern Finland, in May in the interior and in June in Lapland.

Summer - In summer the mean daily temperature is consistently above 10°C. Summer usually begins in late May in southern Finland and lasts until mid-September, while in Lapland it starts about one month later and ends a month earlier. The regions north of the Arctic Circle are characterized by "polar days", when the sun does not set at all, 73 days in the northernmost area. In southern Finland, the longest day (around Midsummer) is nearly 19 hours long. The highest summer temperatures measured in the Finnish interior are from 32°C to 35°C. Near the sea and over the maritime islands, temperatures over 30°C are extremely rare; the highest temperature ever recorded in Helsinki is 31.6°C. Heat waves, with a maximum daily temperature exceeding 25°C, occur on an average of 10 to 15 days per summer inland in southern and central Finland, and 5 to 10 days in northern Finland and on the coast. In the course of the summer, thunderstorms occur on 8 to 14 days in the interior and 4 to 8 days in coastal areas and northern Lapland.

Autumn - Daily mean temperature in the Autumn remains below 10°C. Autumn begins around the last week of August in northern Finland and about one month later in southwestern Finland. The growing season ends in autumn when the mean daily temperature drops below 5°C around the last week of September in northern Finland and in late October in southwestern Finland.The average length of the growing season is 180 days in the southwestern archipelago, 140 to 175 days elsewhere in southern and central Finland and 100 to 140 days in Lapland. The first snow falls in northern Finland in September and elsewhere in October.

Source: Finnish Meteorological Institute FMI

Economy and industrial activities

Finland has an open economy with prominent service and manufacturing sectors. The main manufacturing industries include electrical and electronics, forest and metal and engineering industries. Foreign trade is important, with exports accounting for about 40 per cent of the gross domestic product (GDP).

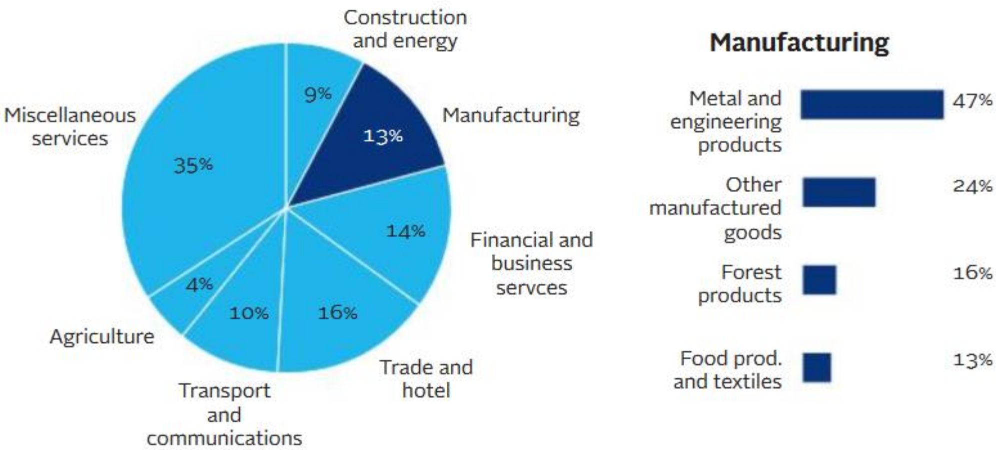

Figure 1.2 Economic Structure Finland (Blue Wings 1/2016)

The total annual energy consumption is around 1 500 PJ, out of which the domestic industry uses approximately half. For decades, the use of primary energy as well as electricity has been increasing, and they reached their top values in the years 2006–2007. Demand rose more rapidly than GDP until 1994. Since then, parallel with the structural changes in the economy, both the energy intensity and the electricity intensity of the economy have decreased. Finland has a high share in non-fossil energy sources in power and heat production, i.e. hydro, nuclear and biomass sources.

Finland has significant forest resources that have led to the development of forest industries. Metal, technology and refinery industries developed due to paying reparations to the Soviet Union and due to the bilateral trade with the Soviet Union. The great depression in the beginning of the 1990’s was due to the collapse of the Soviet Union as well as the unsuccessful monetary policy. Finland recovered from the depression that brought down thousands of enterprises and the mass unemployment through the growth of information technologies, mobile phones and telecommunication services. In 2009 there was a recession with the value of industrial output felling by approximately one third from year before. (Figure 1.3)

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Finland joined the EU in 1995 and the Euro zone in 2001.

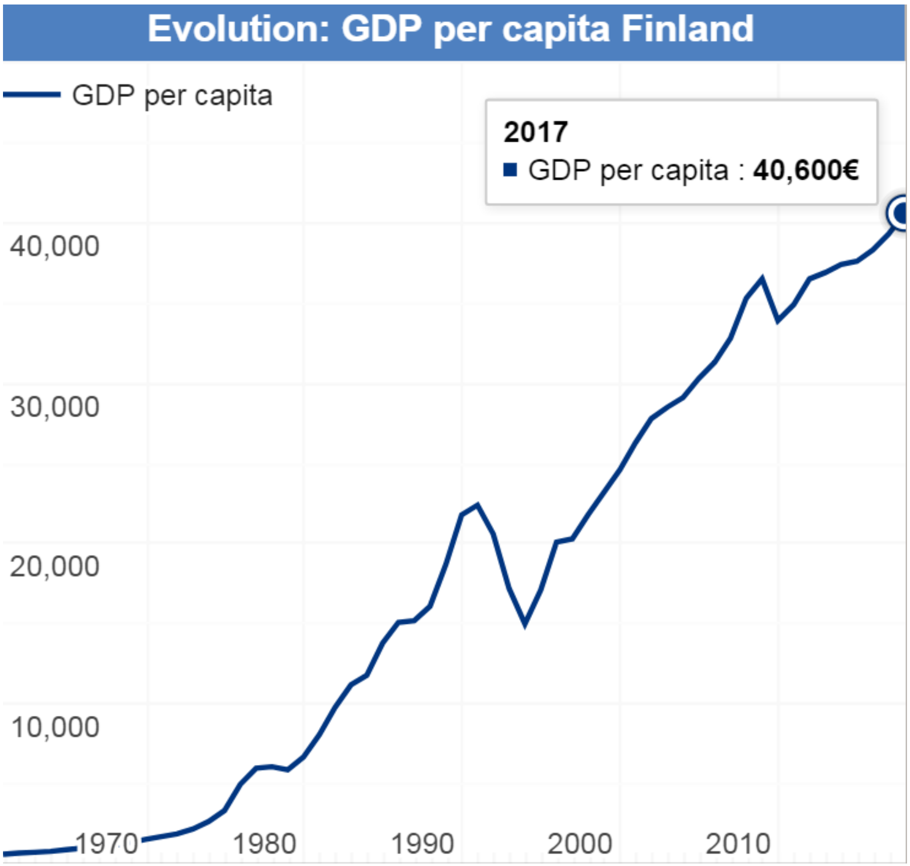


Figure 1.3 GDP evolution 1970-2017 (https://countryeconomy.com/gdp/finland)

Domestic passenger transport, measured in terms of passenger-kilometres, has increased by approximately 22 per cent since 1990. Cars account for around 83 per cent of the total passenger-kilometres. The total number of freight tonne-kilometres in Finland is almost double the EU average, mainly because of the long distances and the industrial structure. Indoor heating is a large source of emissions, however, during the past three decades the consumption of energy per unit of heated space has been reduced significantly, in particular due to tightening building regulations.
(Reference: Finland's 6th National Communication to the UNFCCC, Population Statistics, Statistics Finland)

1.1.2 Environmental Protection

Figure 1.4. Snapshots of Finnish Environment (Finnish Tourist Board, Lumiaro 2014, Lappi 2013, Saarinen 2016)

Finland's low population density and comparatively unspoilt natural environment has given good starting points to facilitate nature conservation. Environmental protection actions have resulted in many of the earlier polluted lakes and rivers to be cleaned up. Air quality has improved around industrial locations and a network of protected area has been built up to safeguard biodiversity. Forests are managed more sensitively than in the past and the overall annual growth rate exceeds the total timber harvest.

Finland has been rated among the world's leading countries in many international comparisons of environmental protection standards, such as the Global Economic Forum's regularly compiled Environmental Sustainability Index. Finland's strengths include highly effective environmental administration and legislations, and the ways environmental protection is considered in all sectors of the society. However, Finland has large ecological footprint and high levels of material and energy consumption.

Measures taken to combat acidification have had the desired effects. Finland's soils are naturally vulnerable to acidification since they only contain low concentrations of calcium to buffer the acidifying effects of sulphur and nitrogen compounds deposited in the soils from airborne pollution. The same applies to forests and inland waters. Farmland soils in Finland have to be regularly limed due to their natural acidity.

In Finland well-planned measures to combat air pollution have led to a considerable reduction in the emissions and acidifying deposits over the last 30 years. Instead, the amount of street dust and long-range transport of ozone have not decreased and emissions from agricultural sources continue to be a problem. While the air quality on average is still, in difficult weather conditions in winter and spring, the amounts of pollutants in certain urban areas may rise to the same level as in cities of about the same size in Central Europe.

Unnatural concentrations of toxic chemicals in the environment do not currently represent health risk in Finland. Emissions of the most hazardous substances have been significantly reduced and Finland does not suffer from large quantities of airborne toxic pollution originating from other countries.

Finland’s winters are too cold for many crop pests to survive, so there is no need to use as much pesticides as in the south. However, in the harsh conditions, even small quantities of hazardous substances can be fateful for sensitive ecosystems and the cold climate can slow the natural degradation of toxic substances.

Chemicals contaminating soil can cause problems decades after the pollution occurs. In Finland there are approximately 20 000 sites potentially suffering from soil contamination. Efforts to remediate such sites intensified in the late 1990s and more recent clean-up work has been initiated at several hundred sites annually.

Air Pollution Control Programmes 2010 and 2030

In 2002 the Finnish Government adopted a national programme establishing the maximum annual emission levels for sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia as from 2010. The programme sets out the measures to reduce emissions in energy production, transport, agriculture and manufacturing industries as well as actions that contribute to emission reduction in working machinery, pleasure boats and residential wood combustion. Finland has successfully reduced emissions in line with the programme, with ammonia emissions as an exception.

The air pollution control programme up to 2030 is currently under preparation and will be finalized by the end of 2018.

International cooperation

The air presents an efficient transport route for gaseous and particulate substances, making it possible for emissions to spread to neighboring regions and even to the other side of the globe. This means that, besides national action in Finland, reaching the air pollution control objectives calls for international collaboration. More than half of the small particle loading and acidifying and eutrophying loading comes to Finland as long-range transboundary pollution. All countries in the world share the same ozone layer, which is why the responsibility for its protection rests with the international community.

The most significant international agreements on which air pollution control and the protection of the ozone layer in Finland are based are:

- UN Convention on Long Range Transboundary Air Pollution to control the transport of air pollutants between countries,
- Vienna Convention and the more detailed Montreal Protocol under it, imposing strict restrictions on the manufacture, consumption and trade of substances that deplete the ozone layer, and
- EU directives and regulations.

1.1.3 Environmental conditions

Air quality in Finland is generally good and the local impacts of air pollution are fairly limited. During periods when certain atmospheric conditions prevail, however – particularly atmospheric inversions in the winter and spring – concentrations of pollutants in the air in Finnish cities may be compared to those observed in cities of similar size elsewhere in Europe.

Acidifying compounds can reach the ground with rain or snow as wet deposition, or in the form of particles or gases as dry deposition. Ecosystems may eventually lose their neutralising or buffering capacity completely, if acid deposition rates persistently exceed the critical levels. Rainfall is naturally slightly acidic, but certain types of air pollutants can increase its acidity considerably. Combustion gases formed during the use of fossil fuels like oil, coal and peat particularly contain oxides of nitrogen and sulphur that can subsequently react in the atmosphere to produce acids that are dissolved in precipitation.

Acidification problems first became evident in the 1960s, when industrial emissions increased rapidly, and efficient methods for cleaning waste gases had not yet been developed. It took some time for action to be taken, although the threat of “acid rain” was clearly serious, with fish disappearing from some lakes, forests dying, and metal structures being rapidly corroded. Ultimately international agreements were signed to force industry and energy production to curb harmful emissions, and these measures have been particularly successful where sulphur emissions are concerned.

Finland carries out extensive monitoring of air quality/deposition and effects in various sectors. Finland participates in all the international effects programmes (ICPs) of the Working Group on Effects of the UNECE CLRTAP and has carried out extensive air quality/deposition monitoring as part of EMEP. Results from these activities have also been published in several national assessment reports and in papers in scientific journals.

Acidification represents a serious threat to many plants and animals, particularly in sensitive aquatic ecosystems. One of the most harmful impacts of acidification is that in acidic conditions toxic aluminium and heavy metal ions are more easily rinsed out of the soil and absorbed by living organisms. The ecosystems most sensitive to acidification are the nutrient-poor lakes and forests of northern Finland, whose natural buffering capacity is already weak. In more fertile regions, soils and the bedrock typically contain higher concentrations of calcium, which helps to prevent acidification.

The concentrations of sulphur compounds declined and buffering capacity increased in all types of lakes in Finland during the 1990s, thanks to dramatic reductions in the atmospheric deposition. Some 5,000 smaller lakes in Finland are now considered to be recovering well from serious acidification problems.

Since the early 1990s stocks of perch (Perca fluviatilis) have been increasing in many lakes in forested areas of southern Finland where fish stocks had suffered badly from acidification in the 1970s and 1980s.

Declining atmospheric deposition has also reduced acidification problems in Finland’s vital groundwater reserves. It may still take decades for groundwater to recover completely, since sulphur compounds and other acidifying impurities are still widely present in the soil, and are only gradually leached out into water courses.

(Ministry of the Environment 2017 Air Pollution Control, http://www.ymparisto.fi/en-US/Climate_and_air/Air_pollution_control and Lyytimäki J. 2014 Environmental protection in Finland, Finnish Environment Institute)

1.2 Institutional arrangements for inventory preparation

Changes in chapter	
November 2017	KS

Responsibilities in the Finnish national system for air emission inventories are divided between Statistics Finland, which is responsible for greenhouse gas inventories under the UNFCCC and the EU CO_2 Monitoring Mechanism Decision, and the Finnish Environment Institute SYKE, which is responsible for air pollutant emissions under the UNECE CLRTAP and the EU Directives (NECD, LCPD). E-PRTR reporting is under the responsibility of the Centres for Economic Development, Transport and the Environment. Energy Authority is the responsible unit for EU ETS data.

The share of responsibilities between the different organizations in the preparation on air emission inventories is illustrated in Figure 1.5.

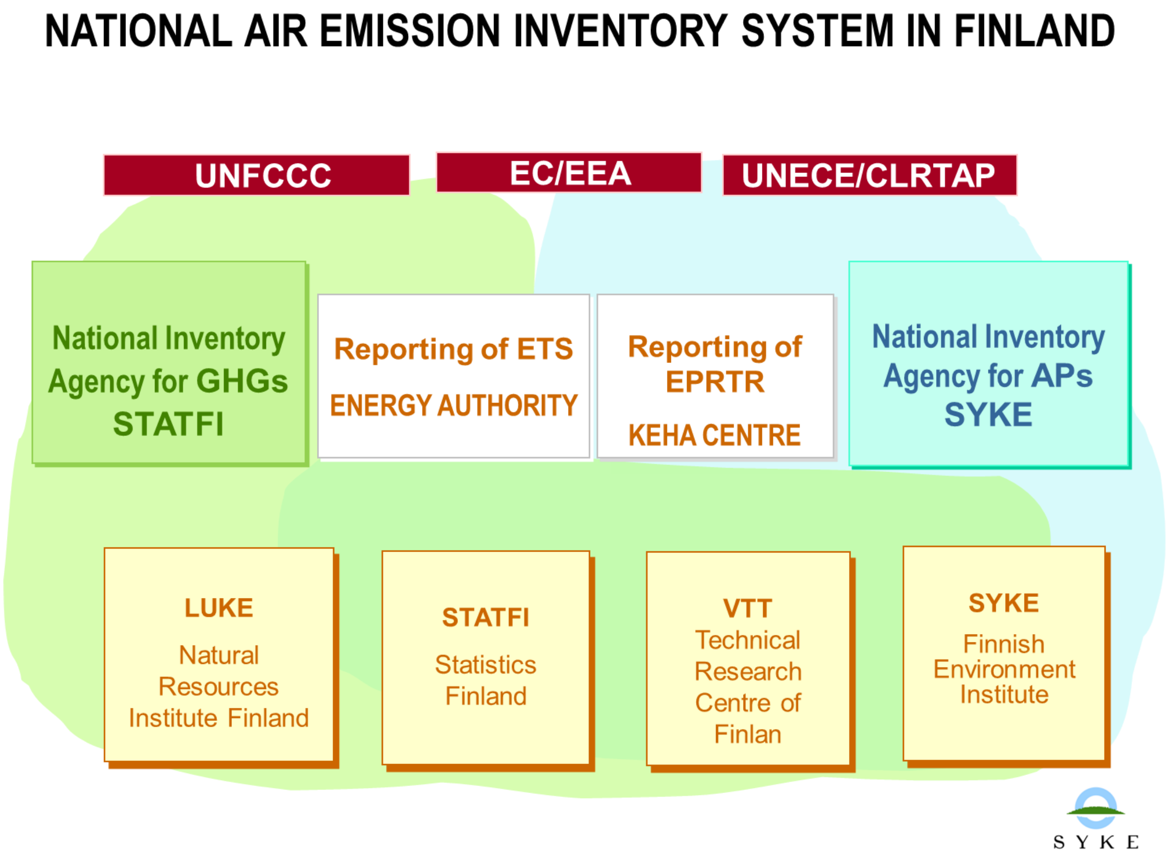


Figure 1.5. National systems for air emission inventories in Finland.

1.3 Brief description of the process of inventory preparation

1.3.1 Organization of the air pollutant inventory

Changes in chapter	
February 2018	KS

The inventory of air pollutant emissions to the UNECE CLRTAP Secretariat is coordinated by, and for the most parts also carried out, at Finnish Environment Institute (SYKE). SYKE also compiles the NFR reporting tables and the Informative Inventory Report (IIR) (Figure 1.6).

In the preparation of the inventory SYKE cooperates with several authorities: Finnish Customs; Finnish Food Safety Authority Evira; Finnish Safety and Chemicals Agency TUKES; Natural Resources Institute LUKE; Ministry of Employment and the Economy; Ministry of the Environment, Ministry of Transport and Communications; National Institute for Health and Welfare THL; National Supervisory Authority for Welfare and Health Valvira; Rescue Services in Finland; Statistics Finland.

Several industrial associations and companies provide data for the preparation of the inventory: Association of Finnish Paint Industry; Chemical Industry Federation of Finland; Confederation of Finnish Construction Industries RT; Finnish Cosmetic, Toiletry and Detergent Association TY; Finavia (aviation and airports); Finnish Energy Industries Finergy, Finnish Food and Drinks Industries' Federation ETL; Finnish Forest Industries Federation; Finnish Petroleum Federation ÖKKLI; Federation of Finnish Technology Industries; First Quantum Minerals Ltd Lemminkäinen Infra Ltd Asphalt Division; Nynas Ltd (specialty oils); Paulig Ltd (coffee); Suomen Hiiva (yeast), Yara (chemicals) as well as the following research institutes: Natural Resources Institute LUKE and VTT Technical Research Centre of Finland.

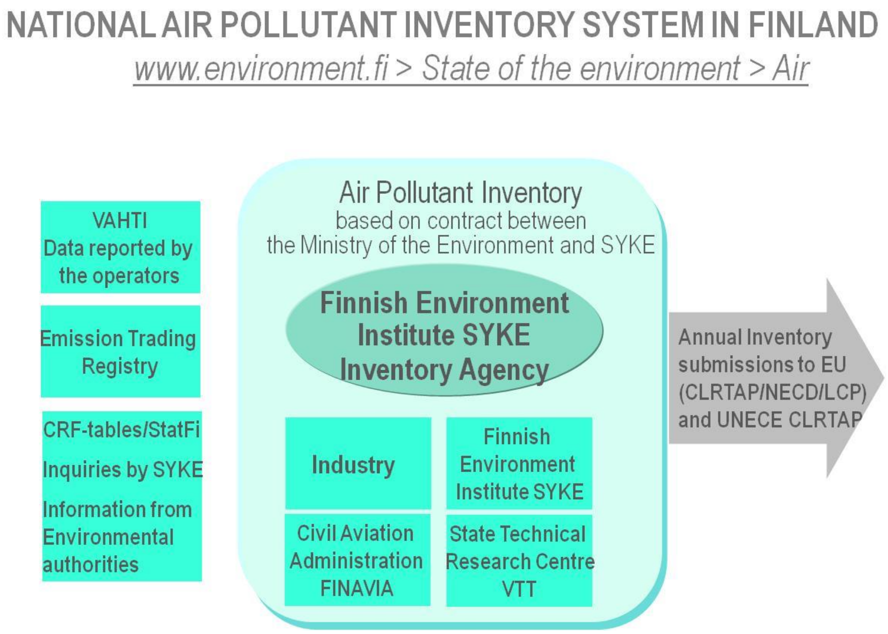


Figure 1.6 Organization of the air pollutant emission inventory in Finland.

1.3.2 Preparation of the inventory

Changes in chapter	
March 2017	KS

Air pollutant inventory agency

The national air pollutant emission inventories under the UNECE CLRTAP and the EU Directives (NECD and LCPD) are carried out at SYKE by the Air Emissions Team. Resources used for the preparation of air pollutant inventories are about 2.5 man years.

The team also participates the national greenhouse gas inventory by carrying out the inventory of F-gases and the waste sector inventory, as well as the NMVOC emission inventory to be reported under the UNFCCC and EU CO_2 Monitoring Mechanism. Resources used for contributing the greenhouse gas inventory are about 0.9 man years.

The annual schedule of the inventory work is presented in Figure 1.7.

Supporting tasks

*D*evelopment and maintaining national release estimation techniques for air pollutants and providing information[9] on the methods to the operators of industrial installations and to environmental authorities is included in the work. The team develops tools for estimating greenhouse gases on the level of municipalities, participates in national and international research and development projects related to air emissions and provides expert services and technical support to the Ministry of the Environment.

Participation in national cooperation with research institutes and industry as well as in international working groups under the UNECE TFEIP, IPCC, OECD and Nordic Council of Ministers as well as in the review programmes under the UNFCCC and CLRTAP/NECD ensure maintaining necessary knowledge and expertise in the preparation of inventories.

Annual schedule of air emission inventories

The annual working schedule of air pollutant and greenhouse gas inventories at Finnish Environment Institute SYKE is provided in Figure 1.7.

[9] Information on national emission estimation methods is provided in Finnish and in Swedish on the website www.ymparisto.fi/paastot

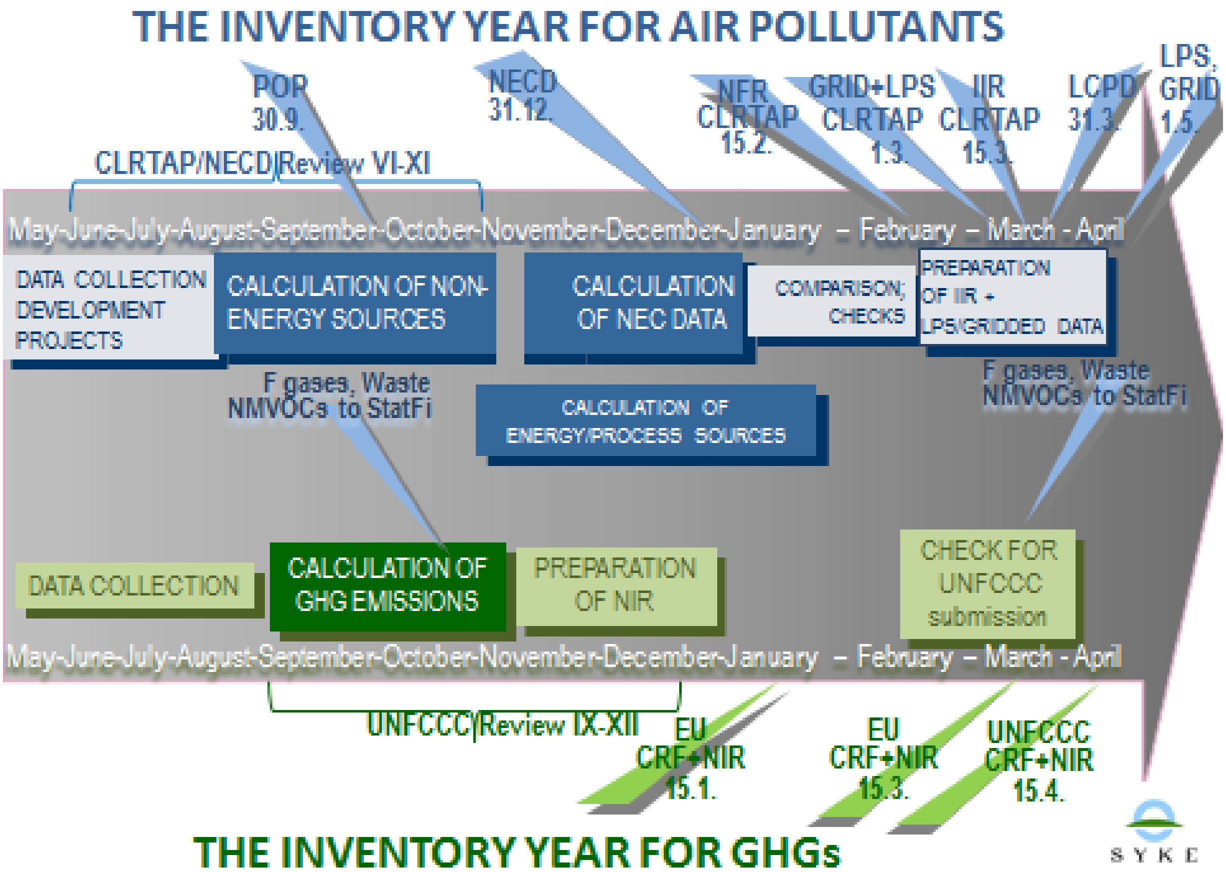


Figure 1.7. Annual schedule of inventory work at SYKE.

1.3.3 Reporting tool IPTJ

Changes in chapter	
Update of text	February 2019 ks

The air pollutant emission data system IPTJ (Ilmapäästötietojärjestelmä) was built up during 2000 – 2003 as a reporting tool for the inventory. IPTJ currently contains emission data for the years 2000 - 2014. During the year 2013 the compilation of data was automated using a Microsoft Visual Studio 2008 extension Business Intelligence Development Studio (BIDS). Microsoft Access based queries were extracted and the syntax converted into a format compatible with Microsoft SQL Server Database and most SQL-compatible database management systems and the SQL queries stored as SQL Server Integration Services (SSIS) packages.

Emission data from 1980 to 2000 have been calculated with the old data system SIPS[10]. Data for the earlier years 1980-1999 is stored in calculation sheets for the sectoral sub-models. Data since 1990 will be incorporated into the IPTJ tool after the energy sector recalculation has been finalized.

Emission data in the IPTJ system is retrievable in different reporting formats: SNAP (Source Nomenclature for Air Pollutants), CRF (Common Reporting Format, IPCC), IPPC (Integrated Pollution Prevention and Control, Council directive 96/61/EC), as well as in IPPC and EPRTR categories. The structure of IPTJ is presented in Figure 1.8.

Spatial emission data calculated at the level of EMEP grids (0.1^o * 0.1^o and 50 km * 50 km) as well as for each municipality (431 municipalities in 2006 and 320 in 2013), provinces (19 in 2013) and Centres for Economic Development, Transport and the Environment (sc. ELY Centres, the number of which were 16 in 2014).

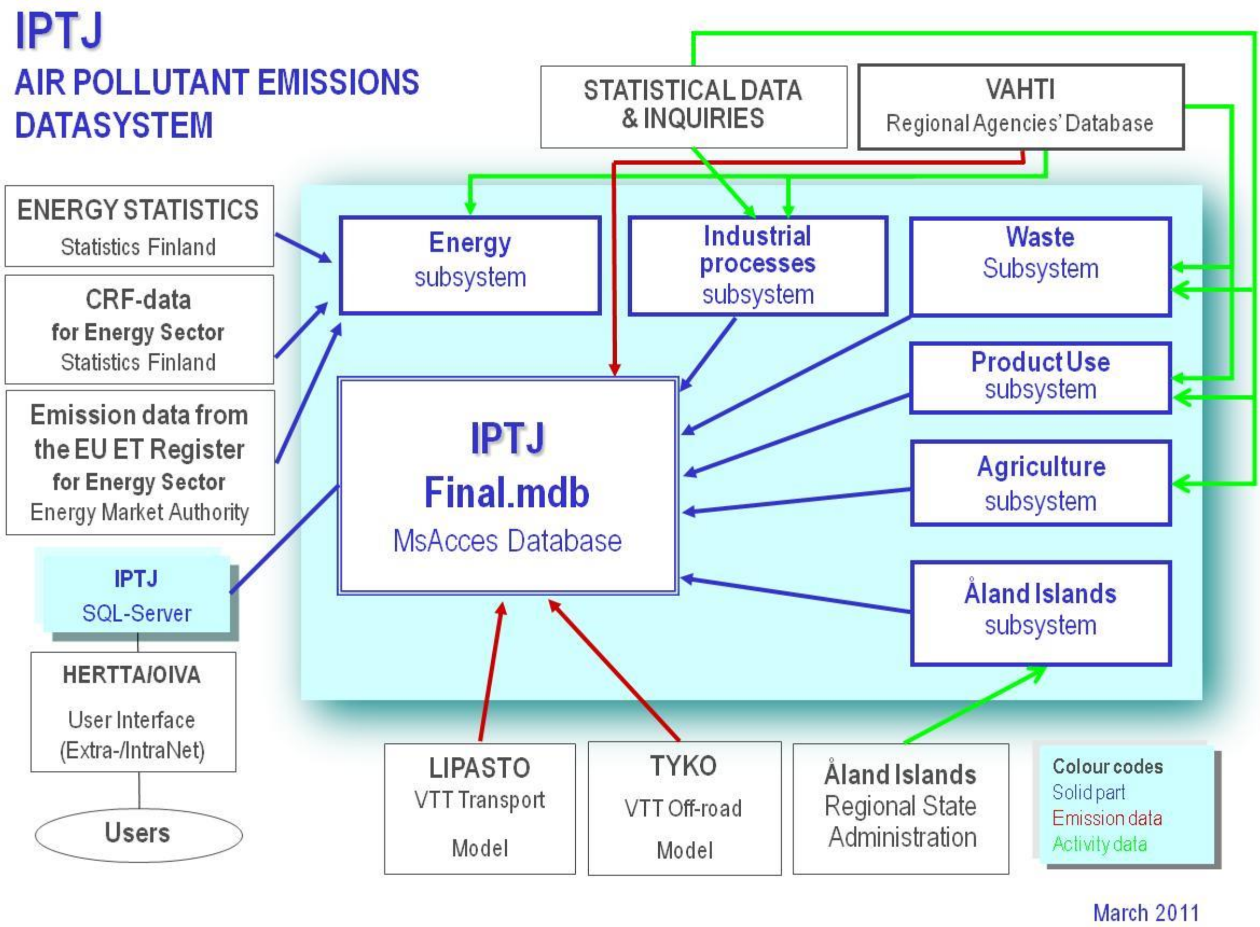


Figure 1.8. Structure of the air pollutant emission data system IPTJ at the Finnish Environment Institute SYKE. Note: the name of the VAHTI system is changed to YLVA in 2018.

[10] SIPS (1998) Suomen ilmapäästöt ja skenaariot (Finnish Air Emissions and Scenarios)

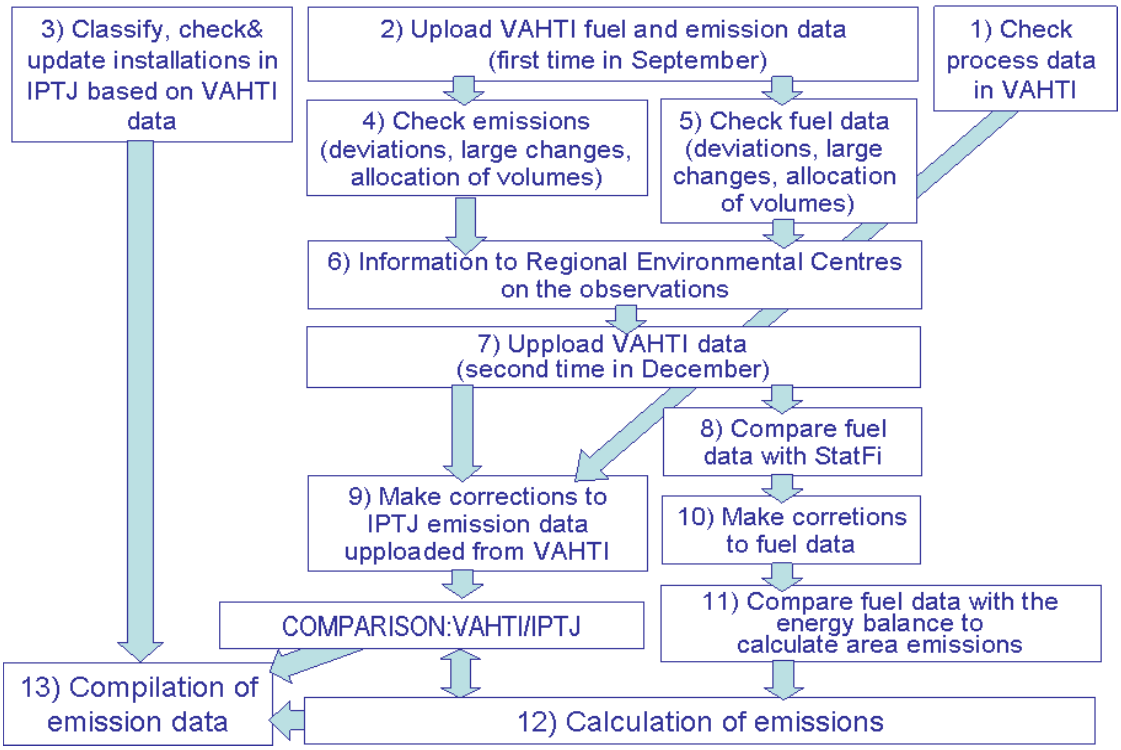
1.3.4 Use of bottom-Up Data in the Emission Inventories

Changes in chapter	
February 2019	KS

The approach

A specific feature of the Finnish emission inventories is the use of data reported by the industrial installations[11]. The installations report their annual emissions to the supervising authorities at the Centres for Economic Development, Transport and the Environment according to the monitoring and reporting obligations determined in their environmental permits. After checking and approving the emission reports by the plants the supervising authorities record the information, including emission data for the supervised period, into their database (YLVA)[12] from where it is available also for emission inventory purposes.

At the Finnish emission inventory agencies (i.e. Finnish Environment Institute for air pollutants and Statistics Finland for greenhouse gases), the data is checked with normal statistical comparisons (e.g. check of magnitude and trend) and according to the IPCC Good Practice Guidelines principles before it is taken into the inventory databases of the inventory agencies. The use of bottom-up data increases the accuracy of the inventory by allowing actually measured emissions to be included into the inventory and covering, for instance, emissions during exceptional situations[13], which otherwise would not easily be captured (Figures 1.9 and 1.10). However, this also brings along additional work load in checking and allocating this information correctly. Results of the quality check carried out for the 2014 energy sector data is presented in Annex 4 of Part 2 of the IIR.



[11] This data is reported by the operators according to the reporting obligation in the environmental permit, as described in Chapter 1.3.3 first paragraph.
[12] Database for the supervising authority
[13] Such as malfunctioning of abatement technique, accidental releases due to process failures etc.

Figure 1.9. Processing of emission data reported by the plants for use in the air pollutant emission inventory, Part 1. (Note; the name of VAHTI has been changed to YLVA in 2018)

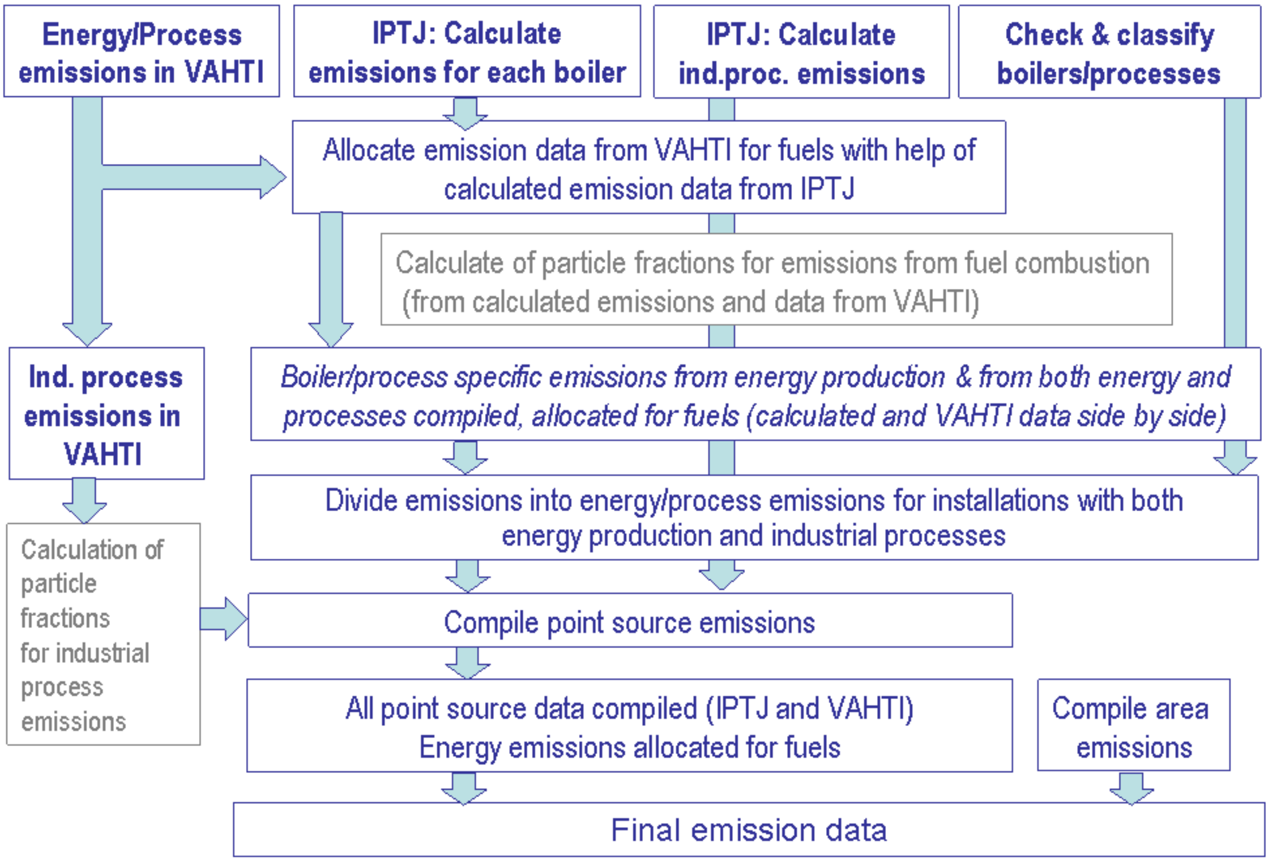


Figure 1.10. Processing of emission data reported by the plants for use in the air pollutant emission inventory, Part 2. (Note; the name of VAHTI has been changed to YLVA in 2018)

YLVA database

The Centres for Economic Development, Transport and the Environment (ELY Centres[14]) process environmental permits and monitor the compliance of activities to the requirements. The operators report data and information according to the monitoring and reporting obligations in their permits. The data is collected into the central YLVA database of the ELY Centres (Figure 1.11 to be updated to the next submission).

YLVA includes information and data on wastes generated, wastewater discharges and emission into the air. This baseline data is used by the ELY Centres in their work for supervising the activities. Emission data is also available to the inventory agencies for the use in emission inventories.

YLVA contains information on how facilities comply with the environmental regulations. A case management tool is incorporated into the system and the user interface makes it possible to add new customers, change or add customer data, retrieve reports from database and write inspection

[14] https://www.ely-keskus.fi/en/web/ely-en/

reports. The system includes mapping functions and a calendar to remind the inspector of time limits. Currently, there are 800 active users of the system.

YLVA is a customer information system. The information recorded of the customer (i.e. an industrial plant) include, for example:

- facility identification details
- contact persons at the facility and environmental administration
- environmental permit conditions
- environment insurance information
- discharge points (stacks and sewers)
- information on process techniques and existing
- release control techniques
- information on fuels used
- information on landfills
- information on releases to air, water and wastes as well as related analysis data
- information on energy production and other production
- information on consumption of raw materials and water

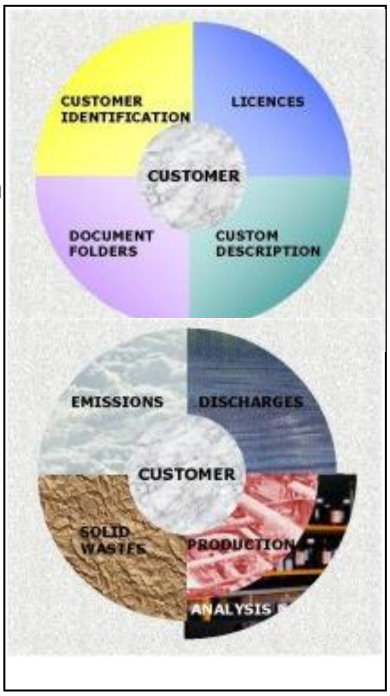


Figure 1.11. Structure of the VAHTI database (to be updated to show the new YLVA database to the next submission).

The operators of installations (i.e. energy producers, industrial installations, fish farmers, peat producers, waste management, wastewater treatment plants) that have an environmental permit report information to the ELY Centres through a national portal (TYVI), which is the same one used for reporting on taxation (see chapter 2.3.6.4 and Figure 1.12). After checking and approving the data the supervising authorities record the data into the YLVA database from where it is available also for emission inventory purposes.

The coverage of installations in the Finnish environmental legislation is wider than in the European Union's IPPC Directive. YLVA database includes information of about 31 000 clients out of which about 28 000 are currently in operation and about 3 000 out of operation. Out of these only about 600 installations fall under the European Union's IPPC Directive. In 2006, 3 401 facilities sent their emission reports to the authorities. The number of facilities that reported information in 2015 on emissions to air, water or on wastes is presented in Table 1.4.

Table 1.4 Facilities reporting information to VAHTI in 2015. (to be updated to the contents of YLVA)

Activity	Water	Air	Waste
Energy production and industrial installations	1 110	623	770
Municipalities	384	6	261
Fish farms	169	0	20
Others	111	421	1 096
Total	1 774	1 050	2 147

Small facilities as well as part of the medium sized facilities, such as small animal shelters and petrol stations, are not yet requested to report to the authorities.

Air pollutant reporting obligations for plant operators

Annual emissions reporting under the environmental permit

In the environmental permit, or in a plant specific emission monitoring and reporting programme annexed to the permit, requirements are determined on what the operator (i.e. a person or a legal person in charge of a facility) must report to the authorities. The annual reporting obligation of an installation concerns emissions for which the installation has an emission limit value (ELV) in the environmental permit. The monitoring system for these substances is stipulated together with the ELV for these compounds. In the environmental permits ELVs are usually given for emissions of sulphur (as SO_2), particles (as TSP or PM_{10}) and nitrogen oxides (as NO_2), in some cases also for heavy metals, NMVOCs, ammonia, POPs and halogens, but not for greenhouse gases (carbon dioxide, methane, nitrous oxide or F-gases).

E-PRTR reporting

Emissions falling under the European Pollutant Release and Transfer Register (E-PRTR)[15] reporting scheme are reported as total emissions for an industrial site. Those air pollutants that are not included in the reporting requirements under the environmental permits may, however, fall under the reporting requirement of the E-PRTR.

Format and procedure of reporting

The plants report the emissions by individual boilers and processes or as total emissions for an industrial site, according to how the data is stipulated to be reported in the environmental permit.

The operators also report on the types, characteristics and consumption of fuels, though this data may not be as complete as emission data. Information on waste amounts, with official classification codes, to solid waste disposal sites, and wastewater handling data are available from YLVA.

The operators may submit emission reports to the supervising authorities as hard copies, electronically by email or through the Internet (Figure 1.12). The larger industrial installations have systems, which allow direct information flow from the plant information systems to the supervising authority.

The emission data is always checked by the supervising authority before it is recorded into YLVA.

When the operator chooses to send the data over the Internet using the national authorities' centralized data collection system (TYVI)[16] the data is automatically checked for completeness and only the completed data set will be sent to the authorities for further checking.

[15] According to the Finnish Environmental Protection Act paragraph 27.2 the Environmental Protection Register contains information about emission reports and monitoring connected to the environmental permits. The Regional Environmental Centres and municipal authorities are responsible for collecting the data from the operators. This data, as well as the data reported under the EPER or E-PRTR obligations are recorded into the VAHTI data system from where it is available for inventory purposes.

[16] The centralized data collection system TYVI is a consultant service used in various data collection procedures from the companies to the governmental authorities. In addition to the environmental administration also to e.g. the tax authority, the customs and statistics uses the data collection service.

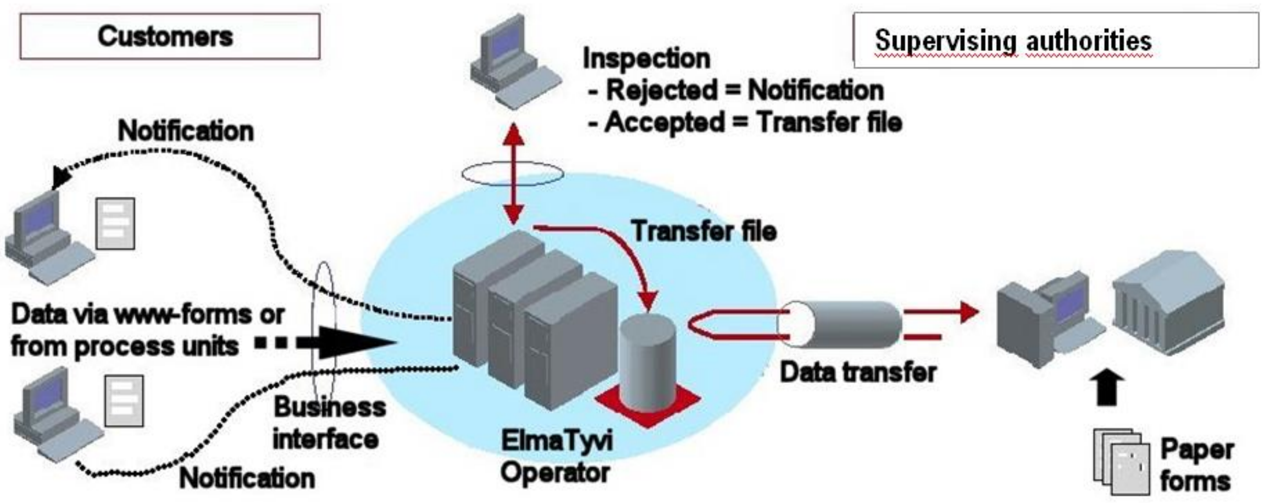


Figure 1.12. Reporting options for the operators.

QA/QC carried out by the supervising authority

When receiving the emission report from the operator the supervising authority checks the correctness of the data as well whether the data is produced according to the methods agreed upon in the environmental permit or in a separate monitoring programme for the plant. The methods usually include the use of international standards or approved in-house methods. The principles of the EU IPPC Reference Document on Monitoring of Emissions (Monitoring BREF) are also followed.

Programme to improve point source data

In 2011-2013 a project (TIVA2) was running in the environmental administration to integrate the contents of YLVA database with corrected and completed data from air and wastewater databases at SYKE to provide the end-users of data the latest and corrected information through a new interface. This means that cross-checks and corrections made e.g. in the air pollutant emission inventory are included in the data available through the new system. The new interface is planned to serve also the needs of a national PRTR system.

Use of EU ETS data

The operators report emissions of carbon dioxide as well as fuel data to the Energy Market Authority that keeps the Emission Trading Register. The annual emission data in the EU ETS was earlier reported mainly on process level but recently only on the level of facilities. This data is available for emission inventory purposes for Statistics Finland and the Finnish Environment Institute.

More details of the use of ETS data in the inventory is provided under the Energy sector in Chapter 4.2.4 Source specific QA/QC and verification.

How data reported to authorities is handled in the inventory

For all substances falling under the substances list of the CLRTAP, default emissions are calculated in the inventory system. These default emissions are used in the preparation of the national inventory. In case the operator reports any emission values, these are compared against the default values calculated in the inventory system and in case found reasonable, included in the inventory instead of the default values. In unclear cases, the inventory agency contacts the supervising authorities or the plant operator directly to confirm the correctness of the reported value and the reason behind any deviating values. The comparison between the calculated default values and data reported by the operator can be seen as part of a verification process for both data sets.

In cases where the operator reports only the total emissions of a site, the default emissions calculated for energy production activities (e.g. boilers, turbines etc.) for the site, are used to allocate the total emissions of the site under relevant NFR categories as follows: the default emission value(s) calculated for energy production are subtracted from the total emission of a site and the remainder is reported under the relevant NFR sector (e.g. under an industrial processes sector).

1.3.5 Inter-comparison with greenhouse gas emission inventory data

The calculation systems for the air emissions inventories under the UNECE CLRTAP and EU NECD are separate from the GHG calculation system, but use mostly the same basic data sources for calculating emissions from fuel combustion. The independence of the calculation systems is used as a verification tool for the inventories, and moreover, as a source of additional corrections in point source data. Comparisons between the data in these two calculations systems are performed continuously during the inventory preparation. The annual calculation at Finnish Environment Institute SYKE is performed a bit later than the GHG inventory and, thus, the source data set usually includes more updated data than used in the preliminary EU GHG inventory. The thorough comparison between the Air pollutant and GHG inventories in accordance with the EU Regulation 525/2013 is performed after 15 February and the differences are either corrected or accounted for by the 15 March submissions.

The inter-comparison between Statistics Finland and the Finnish Environment Institute is carried out with data related to the fuel combustion source categories at the aggregation level allowed for statistical confidentiality as presented in Figure 1.13. The inter-comparison is explained in more details under Energy sector in Chapter 4.2.4 Source-specific QA/QC and verification.

The observed omissions and errors are corrected to both inventories according to the results of the inter-comparison. The remaining differences are explained in Chapter 2.4.3. and the results of the comparison of possible differences in the regular annual reports are presented in Appendix 2.

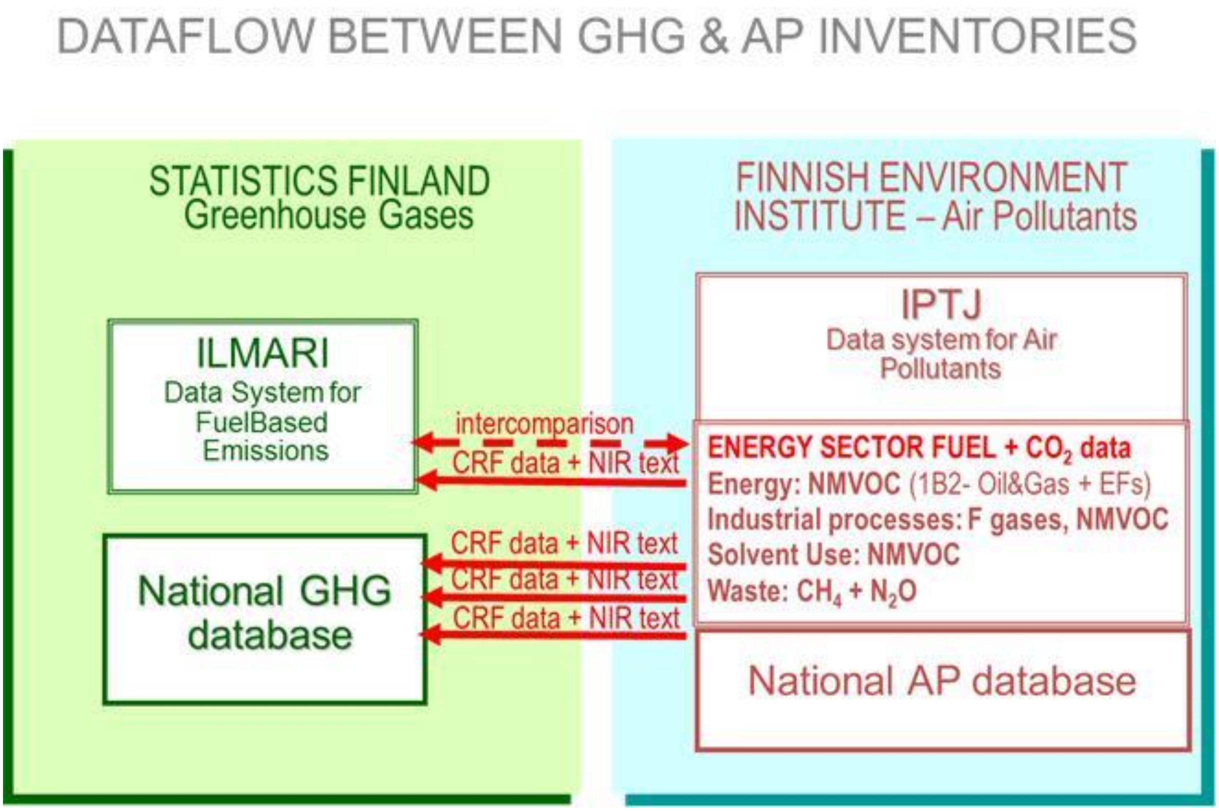


Figure 1.13. Inter-comparison of air emissions inventory data between Statistics Finland and SYKE.

1.4 Methods and data sources

1.4.1 Methodology

Changes in chapter	
Update of text	November 2017 KS

The EMEP/EEA Emission Inventory Guidebook methodology and national methods are used in the preparation of air pollutant emission inventories. Country specific emission factors and compliance data reported by the operators or emissions estimated by the industrial associations are used when ever they provide better estimates of the national circumstances than the default values.

The Nomenclature for Reporting (NFR) tables are used in reporting the emission figures under the UNECE CLRTAP and the EU NECD.

In this report, compilation of emission data for 2016 is described in details while the compilation of the data for the earlier years is presented at a more general level.

No comprehensive recalculations have been made to the time series, although new sources have been added and major errors identified have been corrected for the earlier years, too.

1.4.2 Differences in the methods between the submissions in 2017 and in 2018

Changes in chapter
March 2019

The purpose is to provide in this chapter a summary of methodological changes in the present inventory compared to the methods used in the previous years, such as introduction of more accurate calculation methods or improved activity data. Recalculations for the whole time series are currently underway and the results will be reported partly in the submission 15 March 2018 and in an additional submission later in spring 2018 after thorough quality checks have been made successfully. A complete recalculation of the inventory was pending for 15 years due to lack of resources allocated to the finalization of the recalculation in the energy sector. Due to the structure of the inventory (see chapter 2.3.2.) this also prevented a complete recalculation of emissions in the industrial processes sector.

Improvements are carried out to follow the latest versions of the EMEP/EEA Emission Inventory Guidebook and on ad hoc basis to correct obvious errors identified in the data for the earlier years More details on improvements carried out for the reporting in 2018 are presented in Chapters 4 – 9, and summarised in Chapter 14.

1.4.3 Differences between emission data reported under different reporting obligations and cooperation between inventory agencies

Changes in chapter	
Update of text	March 2019 KS

This chapter explains differences between the submissions to the UNECE CLRTAP Secretariat and to the EU NECD to the UNFCCC Secretariat and to the Commission under the European Union CO2 and other greenhouse gas Monitoring Mechanism.

A quantification of differences in the 2019 submissions to the UNFCCC, CLRTAP and NECD regarding data for 2017 are presented in Tables 1.5a and 1.5b.

Table 1.5a Differences UNFCCC-CLRTAP-NECD - Agricultural NOx and NMVOC included

Submissions				Difference %		
2017	UNFCCC	CLRTAP	NECD	UNFCCC-CLRTAP	UNFCCC-NECD	CLRTAP-NECD
SOx	35.284	35.020	35.020	0.7	0.7	0
NOx	124.907	129.850	129.850	-4.0	-4.0	0
NMVOC	100.917	88.323	88.323	12.5	12.5	0
CO	326.117	359.082	359.082	-10.1	-10.1	0

Table 1.5b Differences UNFCCC-CLRTAP-NECD - Agricultural NOx and NMVOC excluded

Submissions				Difference %		
2017	UNFCCC	CLRTAP	NECD	UNFCCC-CLRTAP	UNFCCC-NECD	CLRTAP-NECD
SOx	35.284	35.020	35.020	0.7	0.7	0
NOx	124.907	120.500	120.500	3.5	3.5	0
NMVOC	100.917	71.780	71.780	28.9	28.9	0
CO	326.117	359.082	359.082	-10.1	-10.1	0

The differences for NOx and NMVOC emissions are because emissions from agriculture are not yet included in the greenhouse gas inventory. For NMVOC, the additional differences originate from the method used to calculate emissions from small scale wood combustion.

In addition, some minor differences generally exist for SO_2, NO_x, NMVOC and CO emissions, due to the following reasons:

(1) Energy sector emission data in Finland is calculated in two different calculation systems:

- The data submitted to the UNFCCC Secretariat and to the EU Commission under the CO_2 Monitoring Mechanism Decision is calculated at Statistics Finland, which is the National Inventory Agency for Greenhouse Gas Inventories.
- The data submitted to the UNECE CLRTAP Secretariat and the EU Commission under the EU NECD is calculated at the Finnish Environment Institute, which is responsible for the national inventory of air pollutants and point source inventories (e.g. LCPD).

(2) Allocation of data in the CRF and NFR tables: harmonization of the allocation of emissions has some inherent challenges due to the different reporting formats (CRF and NFR). For instance, it is not always possible to report the same activities under the corresponding CRF/NFR source categories because certain sources fall under a CFR category in the greenhouse gas inventory, while air pollutants generated from the same activity are not related to the given CRF/NFR category and are therefore reported under the main activity of the plant.

(3) The allocation of point sources in the CRF and NFR inventory categories differs somewhat in the data systems of the two institutes. Further cooperation will be carried out during 2017-2019 to harmonize the allocation where possible.

(4) Currently in the time series of the inventories there are certain differences, some of which are related to a different timing of uploading point source data from the compliance reporting database VAHTI (Chapter 2.3.3), as the contents of YLVA is being improved by completing and correcting the data throughout the year, for both the current and the historical years. In cases where deficient data is not corrected in YLVA database, the inventory agencies cooperate to use corrected data in their inventories. Some differences between the two energy sector inventories may also be related to errors and omissions in the inventory databases at Finnish Environment Institute or Statistics Finland. Efforts are made to ensure consistency of the data.

The annual inter-comparisons between Statistics Finland and Finnish Environment Institute are explained in Chapter 2.3.4.

Benefits of the cooperation

Due to intensive cooperation of energy experts at Statistics Finland and SYKE, the two inventory approach in calculation of energy sector emissions can be regarded as an efficient QA/QC tool because errors and omissions are efficiently identified and corrected where found.

NMVOC emissions

NMVOC emissions for other sources than energy are calculated at Finnish Environment Institute and integrated into the CRF tables reported under the UNFCCC and EU MM. Thus the emission data, activity data and methodologies are the same in all of these inventories. Energy sector NMVOC emissions are calculated in both Statistics Finland and SYKE's calculation systems using the same emission factors. In the 2017 reporting emissions for small scale combustion sources are calculated by the new technology specific model under the CLRTAP and NECD while not yet included in the UNFCCC reporting, where adoption of the new model is underway.

Nitrogen/NH_3 emissions

Nitrogen emissions used as input data in the greenhouse gas inventory are calculated at LUKE (Agrifood Finland) for the use of agriculture sector greenhouse gas emission inventory. The emissions are calculated in the same model (see Chapter 7.1.2 Nitrogen model) as ammonia emissions in the air pollutant emission inventory. The model is accessible for both institutes through the Internet. This guarantees that the source data and emissions are the same in both inventories.

1.4.4 Possible differences between the emission inventory reports under the UNECE CLRTAP and the EU NECD

Changes in chapter	
Update of text	February 2017 KS

Since the revision of the NECD and adoption of the same reporting requirements than the CLRTAP, no differences will be in the reported emissions because a copy of the data submitted under the CLRTAP is reported under the NECD.

The inventories under the UNECE CLRTAP and under the EU NECD are both calculated in the same inventory system at Finnish Environment Institute.

1.5 Key categories

Changes in chapter	
Update of text	March 2019 TF, KS

According to the Good Practice Guidance for the CLRTAP Emission Inventories, "a key parameter is a parameter that has significant influence on either the inventory of total emissions or trend or their uncertainties". In the CLRTAP Good Practice Guidance, several methods to perform a sensitivity analysis (to find the key parameters) are described. The results of the key category analysis are in accordance with the results received from the RepDab-tool.

The results of the key category analysis are used in prioritizing the inventory improvements. For the Finnish 2018 submission inventory, two of these methods are utilised to find the key parameters, as described below (Tier 1 and Tier 2).

Presentation of key categories for the base years of pollutants will be added to the submission in 2019.

Tier 1 method

A simple approach is used for level evaluation (presented in the EMEP/EEA emission inventory guidebook 2013). The emission categories are sorted according to their contribution to emissions in 2016 for each pollutant. The key categories are those that represent together 80% of the emissions. This approach is applied at the third NFR level.

Tier 2 method
The key category analysis was also carried out at Tier 2 level and the results are used in further development of the inventory but are not published as in many cases the dominating values are measured at large point sources.

Results of the key category analysis

The combined results of the level and trend analysis for the 2019 submission are presented below:

NOx

NFR Code	Pollutant	Identification criteria
1A1a	NOx	L1, T1
1A2d	NOx	L1, T1
1A3biii	NOx	L1, T1
1A3bi	NOx	L1, T1
1A3dii	NOx	L1, T1
1A4bi	NOx	L1, T1
1A3bii	NOx	L1, T1
1A4cii	NOx	L1, T1
1A5a	NOx	L1, T1
1A2gvii	NOx	L1
3Da1	NOx	L1

NMVOC

NFR Code	Pollutant	Identification criteria
1A4bi	NMVOC	L1, T1
2D3d	NMVOC	L1, T1
3B1a	NMVOC	L1, T1
2D3a	NMVOC	L1, T1
3B1b	NMVOC	L1, T1
1A4aii	NMVOC	L1, T1
1A3bi	NMVOC	L1, T1
1A1a	NMVOC	L1, T1
1B2aiv	NMVOC	L1
1A3dii	NMVOC	L1
1B2av	NMVOC	L1
3Da2a	NMVOC	L1
2D3g	NMVOC	L1
2B10a	NMVOC	L1
2D3i	NMVOC	L1
2H2	NMVOC	L1
2H1	NMVOC	L1
1A3bv	NMVOC	T1
2D3h	NMVOC	T1
1A3biii	NMVOC	T1
2D3c	NMVOC	T1

SOx

NFR Code	Pollutant	Identification criteria
1A1a	SOx	L1, T1
1A1b	SOx	L1, T1
1A2b	SOx	L1, T1
1A2d	SOx	L1, T1
2B10a	SOx	L1, T1
1A5a	SOx	L1, T1
2H1	SOx	L1, T1
1A4ai	SOx	L1
1A2a	SOx	T1
1A2f	SOx	T1
1A3biii	SOx	T1

NH3

NFR Code	Pollutant	Identification criteria
3Da2a	NH3	L1, T1
3B1b	NH3	L1, T1
3B3	NH3	L1, T1
3B4h	NH3	L1, T1
3Da1	NH3	L1, T1
1A4bi	NH3	L1, T1
3B1a	NH3	L1
1A3bi	NH3	T1
3B4gii	NH3	T1
2H1	NH3	T1
3B4e	NH3	T1

PM2.5

NFR Code	Pollutant	Identification criteria
1A4bi	PM2.5	L1, T1
1A2d	PM2.5	L1, T1
1A3bvi	PM2.5	L1, T1
1A3bi	PM2.5	L1, T1
1B1c	PM2.5	L1
1A3bvii	PM2.5	L1
2H2	PM2.5	L1
1A1a	PM2.5	L1
1A2gvii	PM2.5	L1
1A3dii	PM2.5	L1
1A3bii	PM2.5	L1
1A3biii	PM2.5	T1
2C1	PM2.5	T1
1A1a	PM2.5	T1
1A4cii	PM2.5	T1
2H1	PM2.5	T1

PM10

NFR Code	Pollutant	Identification criteria
1A4bi	PM10	L1, T1
1A3bvii	PM10	L1, T1
1A2d	PM10	L1, T1
3Dc	PM10	L1, T1
1A1a	PM10	L1, T1
1A3bvi	PM10	L1, T1
1A5a	PM10	L1, T1
1B1c	PM10	L1
2H2	PM10	L1
2B10a	PM10	L1
1A3biii	PM10	T1
2C1	PM10	T1
1A3bi	PM10	T1
2H1	PM10	T1

TSP

NFR Code	Pollutant	Identification criteria
1A3bvii	TSP	L1, T1
1A4bi	TSP	L1, T1
1A5a	TSP	L1, T1
1A1a	TSP	L1, T1
1A2d	TSP	L1, T1
1A3bvi	TSP	L1, T1
3Dc	TSP	L1
1B1c	TSP	L1
1A4ci	TSP	L1
2A5c	TSP	L1
2C1	TSP	T1
1A3biii	TSP	T1

BC

NFR Code	Pollutant	Identification criteria
1A4bi	BC	L1, T1
1A2gvii	BC	L1, T1
1A3bi	BC	L1, T1
1A3bii	BC	L1
1A3bvi	BC	L1
1A3biii	BC	T1
1A4cii	BC	T1

1A2f	TSP	T1
1A3bi	TSP	T1
2H1	TSP	T1
1A2gviii	TSP	T1

CO

NFR Code	Pollutant	Identification criteria
1A4bi	CO	L1, T1
1A4aii	CO	L1, T1
1A3bi	CO	L1, T1
1A4bii	CO	L1, T1
1A2d	CO	L1
1A3dii	CO	L1

Pb

NFR Code	Pollutant	Identification criteria
1A2d	Pb	L1, T1
1A1b	Pb	L1, T1
1A1a	Pb	L1, T1
1A2f	Pb	L1, T1
2G	Pb	L1
1A5a	Pb	L1
1A3bi	Pb	T1
2C7c	Pb	T1

Cd

NFR Code	Pollutant	Identification criteria
1A2d	Cd	L1, T1
1A4bi	Cd	L1, T1
1A1a	Cd	L1, T1
1A5a	Cd	L1, T1
1A1b	Cd	L1
2C7c	Cd	T1
2C6	Cd	T1

Hg

NFR Code	Pollutant	Identification criteria
1A1a	Hg	L1, T1
1A2d	Hg	L1, T1
2C1	Hg	L1, T1
2B10a	Hg	L1, T1
1A2f	Hg	L1, T1
1A4bi	Hg	L1
1A2gviii	Hg	T1

As

NFR Code	Pollutant	Identification criteria
1A1a	As	L1, T1
1A1b	As	L1, T1
1A2f	As	L1, T1
2C7c	As	L1, T1
1A4ci	As	L1
1A2d	As	L1

Cr

NFR Code	Pollutant	Identification criteria
1A1b	Cr	L1, T1
2C1	Cr	L1, T1
1A2f	Cr	L1, T1
1A4bi	Cr	L1, T1
1A1a	Cr	L1, T1
1A3bvi	Cr	L1, T1
1A2d	Cr	T1

Cu

NFR Code	Pollutant	Identification criteria
1A3bvi	Cu	L1, T1
1A1a	Cu	L1
1A1b	Cu	L1
2C7c	Cu	T1

Ni

NFR Code	Pollutant	Identification criteria
1A2f	Ni	L1, T1
2C7b	Ni	L1, T1
1A4bi	Ni	L1, T1
1A1b	Ni	L1, T1
1A5a	Ni	L1, T1
2C1	Ni	L1, T1
1A1a	Ni	L1
1A4ci	Ni	L1
2C7b	Ni	T1

Zn

NFR Code	Pollutant	Identification criteria
1A4bi	Zn	L1, T1
1A1a	Zn	L1, T1
1A3bvi	Zn	L1, T1
1A5a	Zn	L1
1A1b	Zn	L1
1A4ci	Zn	L1
2C1	Zn	T1
2C7c	Zn	T1
2C6	Zn	T1

PCDD/F

NFR Code	Pollutant	Identification criteria
1A1a	PCDD/F	L1, T1
1B1b	PCDD/F	L1, T1
1A4bi	PCDD/F	L1, T1
5E	PCDD/F	L1, T1
2C1	PCDD/F	L1, T1
1A2d	PCDD/F	L1
2C3	PCDD/F	L1
1A3bi	PCDD/F	L1
2B10a	PCDD/F	T1

PAH-4

NFR Code	Pollutant	Identification criteria
1A4bi	PAH-4	L1, T1
1A1a	PAH-4	T1
2C1	PAH-4	T1
1A2gviii	PAH-4	T1
1B1b	PAH-4	T1
1A2d	PAH-4	T1

HCB

NFR Code	Pollutant	Identification criteria
2B10a	HCB	L1, T1
2C7a	HCB	L1, T1
3Df	HCB	T1

PCB

NFR Code	Pollutant	Identification criteria
2C1	PCB	L1, T1
1A4bi	PCB	L1, T1
1B1b	PCB	L1, T1
1A2d	PCB	T1
1A2a	PCB	T1
1A2f	PCB	T1

Trend analysis

The key category assessment by trend for the 2019 submission is presented below.

NOx

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A3bi	69.419	305.762	13.585	129.85	Gg	0.052	24.848	24.848	x
1A2d	18.162	305.762	18.586	129.85	Gg	0.036	16.997	41.845	x
1A3biii	58.866	305.762	14.340	129.85	Gg	0.035	16.662	58.507	x
1A4bi	6.153	305.762	5.383	129.85	Gg	0.009	4.330	62.837	x
1A3dii	9.130	305.762	6.507	129.85	Gg	0.009	4.111	66.948	x

1A1a	59.539	305.762	22.673	129.85	Gg	0.009	4.083	71.031	x
1A5a	2.271	305.762	3.260	129.85	Gg	0.008	3.588	74.619	x
1A3bii	5.971	305.762	4.762	129.85	Gg	0.007	3.480	78.099	x
1A4cii	12.825	305.762	3.460	129.85	Gg	0.006	3.106	81.205	x
3Da2a	2.986	305.762	2.943	129.85	Gg	0.005	2.618	83.823	
3Da1	9.112	305.762	5.542	129.85	Gg	0.005	2.614	86.437	
1A2a	3.588	305.762	3.191	129.85	Gg	0.005	2.606	89.042	
1A2gviii	2.408	305.762	2.017	129.85	Gg	0.003	1.554	90.596	
1A2gvii	12.381	305.762	6.170	129.85	Gg	0.003	1.425	92.022	
1A1b	3.320	305.762	2.102	129.85	Gg	0.002	1.083	93.104	
1A3ai(i)	0.251	305.762	0.736	129.85	Gg	0.002	0.984	94.089	
1A2c	2.011	305.762	1.399	129.85	Gg	0.002	0.852	94.941	
1A4ci	1.385	305.762	1.067	129.85	Gg	0.002	0.748	95.689	
1A5b	0.087	305.762	0.481	129.85	Gg	0.001	0.694	96.383	
1A3c	4.212	305.762	1.410	129.85	Gg	0.001	0.591	96.974	
1A4bii	0.170	305.762	0.315	129.85	Gg	0.001	0.380	97.354	
1A4ciii	3.580	305.762	1.715	129.85	Gg	0.001	0.305	97.659	
1A3biv	0.065	305.762	0.216	129.85	Gg	0.001	0.295	97.954	
1A2f	5.230	305.762	2.053	129.85	Gg	0.001	0.263	98.216	
1A4aii	5.711	305.762	2.583	129.85	Gg	0.001	0.246	98.462	
3Da3	0.732	305.762	0.459	129.85	Gg	0.0005	0.231	98.693	
2B2	0.744	305.762	0.444	129.85	Gg	0.0004	0.200	98.894	
1A2b	0.678	305.762	0.184	129.85	Gg	0.0003	0.162	99.056	
1A4ai	2.539	305.762	1.172	129.85	Gg	0.0003	0.147	99.203	
1A2e	1.195	305.762	0.422	129.85	Gg	0.0003	0.134	99.336	
3B1b	0.111	305.762	0.132	129.85	Gg	0.0003	0.132	99.468	
3B4gii	0.026	305.762	0.080	129.85	Gg	0.0002	0.107	99.575	
1A3aii(i)	0.311	305.762	0.180	129.85	Gg	0.0002	0.074	99.650	
3B4h	0.041	305.762	0.057	129.85	Gg	0.0001	0.063	99.712	
3Da2b	0.088	305.762	0.003	129.85	Gg	0.0001	0.053	99.766	
3F	0.113	305.762	0.076	129.85	Gg	0.0001	0.044	99.810	
2B10a	0.061	305.762	0.001	129.85	Gg	0.0001	0.039	99.849	
3B4e	0.016	305.762	0.030	129.85	Gg	0.0001	0.037	99.885	
3B3	0.067	305.762	0.007	129.85	Gg	0.0001	0.033	99.919	
3B1a	0.133	305.762	0.041	129.85	Gg	0.0001	0.025	99.944	
3B4gi	0.041	305.762	0.033	129.85	Gg	0.0001	0.024	99.968	
3B2	0.007	305.762	0.011	129.85	Gg	0.00003	0.013	99.981	
3B4giii	0.001	305.762	0.009	129.85	Gg	0.00003	0.013	99.994	
2G	0.010	305.762	0.006	129.85	Gg	0.00001	0.003	99.997	
1A3ei	0.009	305.762	0.003	129.85	Gg	0.000003	0.001	99.999	
3B4giv	0.005	305.762	0.003	129.85	Gg	0.000002	0.001	100	
3B4d	0.001	305.762	0.0004	129.85	Gg	0.000001	0.0003	100	

NMVOC

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A3bi	50.696	230.419	2.040	88.323	Gg	0.075	22.900	22.900	x
1A4bi	14.199	230.419	21.792	88.323	Gg	0.071	21.526	44.425	x
1A3bv	13.655	230.419	1.410	88.323	Gg	0.017	5.035	49.461	x
3B1a	7.368	230.419	6.368	88.323	Gg	0.015	4.666	54.126	x
2D3a	2.847	230.419	4.220	88.323	Gg	0.014	4.120	58.246	x
2D3d	28.675	230.419	7.931	88.323	Gg	0.013	4.030	62.276	x
2D3h	8.800	230.419	0.604	88.323	Gg	0.012	3.646	65.923	x
3B1b	3.458	230.419	3.956	88.323	Gg	0.011	3.463	69.385	x
1A3biii	7.843	230.419	0.408	88.323	Gg	0.011	3.421	72.806	x
2D3c	6.260	230.419	0.174	88.323	Gg	0.010	2.93	75.736	x
1A4aii	12.107	230.419	2.762	88.323	Gg	0.008	2.473	78.209	x
1A1a	0.482	230.419	1.596	88.323	Gg	0.006	1.858	80.067	x
3Da2a	3.179	230.419	2.529	88.323	Gg	0.006	1.725	81.792	
2D3i	2.085	230.419	2.076	88.323	Gg	0.006	1.681	83.473	
1A4cii	6.642	230.419	1.425	88.323	Gg	0.005	1.476	84.949	
2B10a	7.836	230.419	2.086	88.323	Gg	0.004	1.209	86.158	
2I	1.070	230.419	1.315	88.323	Gg	0.004	1.191	87.349	
2H2	2.523	230.419	1.788	88.323	Gg	0.004	1.081	88.430	
1A3dii	9.646	230.419	2.955	88.323	Gg	0.003	0.978	89.408	
3B4h	1.237	230.419	1.173	88.323	Gg	0.003	0.920	90.327	
2D3g	3.956	230.419	2.124	88.323	Gg	0.003	0.801	91.128	
1A4bii	1.031	230.419	0.973	88.323	Gg	0.003	0.760	91.888	
3De	1.062	230.419	0.960	88.323	Gg	0.002	0.728	92.616	
1A3bii	2.465	230.419	0.398	88.323	Gg	0.002	0.720	93.337	
2D3e	2.638	230.419	0.508	88.323	Gg	0.002	0.663	94.000	
1B2aiv	6.600	230.419	3.026	88.323	Gg	0.002	0.654	94.654	
2H1	2.966	230.419	1.616	88.323	Gg	0.002	0.631	95.284	
3B4gii	0.191	230.419	0.547	88.323	Gg	0.002	0.624	95.909	
1A3biv	2.767	230.419	1.437	88.323	Gg	0.002	0.496	96.405	
1A4ci	0.146	230.419	0.429	88.323	Gg	0.002	0.491	96.896	
1A2gvii	2.093	230.419	1.166	88.323	Gg	0.002	0.478	97.374	
1A5a	0.143	230.419	0.270	88.323	Gg	0.001	0.283	97.657	
2C1	1.027	230.419	0.186	88.323	Gg	0.001	0.273	97.930	
3B4e	0.153	230.419	0.251	88.323	Gg	0.001	0.253	98.183	
1A2gviii	0.233	230.419	0.233	88.323	Gg	0.001	0.189	98.372	
1B2b	0.255	230.419	0.239	88.323	Gg	0.001	0.187	98.559	
3B2	0.106	230.419	0.169	88.323	Gg	0.001	0.170	98.728	
1B2av	7.738	230.419	2.847	88.323	Gg	0.001	0.157	98.885	
3B3	0.470	230.419	0.292	88.323	Gg	0.0005	0.147	99.032	

3B4gi	0.236	230.419	0.185	88.323	Gg	0.0004	0.125	99.157	
1A3ai(i)	0.056	230.419	0.102	88.323	Gg	0.0003	0.106	99.262	
1A1b	0.011	230.419	0.062	88.323	Gg	0.0002	0.075	99.338	
1B1b	0.037	230.419	0.067	88.323	Gg	0.0002	0.069	99.406	
3F	0.253	230.419	0.149	88.323	Gg	0.0002	0.068	99.474	
1A5b	0.028	230.419	0.058	88.323	Gg	0.0002	0.062	99.536	
2D3b	0.900	230.419	0.391	88.323	Gg	0.0002	0.061	99.597	
1A2d	0.738	230.419	0.323	88.323	Gg	0.0002	0.054	99.651	
1A2a	0.131	230.419	0.019	88.323	Gg	0.0001	0.041	99.692	
1A4ai	0.152	230.419	0.088	88.323	Gg	0.0001	0.039	99.731	
3B4giii	0.006	230.419	0.029	88.323	Gg	0.0001	0.036	99.767	
3Da3	0.104	230.419	0.064	88.323	Gg	0.0001	0.032	99.799	
1A4ciii	0.144	230.419	0.076	88.323	Gg	0.0001	0.027	99.826	
2C7b	0.010	230.419	0.023	88.323	Gg	0.0001	0.025	99.851	
2B10b	0.134	230.419	0.070	88.323	Gg	0.0001	0.025	99.876	
1A3c	0.234	230.419	0.075	88.323	Gg	0.0001	0.019	99.894	
1A2e	0.032	230.419	0.027	88.323	Gg	0.0001	0.019	99.913	
5D2	0.022	230.419	0.018	88.323	Gg	0.00004	0.013	99.926	
2G	0.027	230.419	0.020	88.323	Gg	0.00004	0.012	99.938	
2A1	0.054	230.419	0.029	88.323	Gg	0.00004	0.011	99.949	
1A3aii(i)	0.056	230.419	0.029	88.323	Gg	0.00004	0.011	99.959	
5D1	0.003	230.419	0.009	88.323	Gg	0.00004	0.011	99.970	
5A	0.234	230.419	0.083	88.323	Gg	0.00003	0.009	99.979	
2L	0.013	230.419	0.001	88.323	Gg	0.00002	0.005	99.984	
1A2f	0.017	230.419	0.010	88.323	Gg	0.00002	0.005	99.989	
3B4d	0.004	230.419	0.004	88.323	Gg	0.00001	0.003	99.993	
1A2c	0.017	230.419	0.005	88.323	Gg	0.00001	0.002	99.995	
2C6	0.001	230.419	0.001	88.323	Gg	0.000004	0.001	99.996	
2C2	NO	230.419	0.001	88.323	Gg	0.000004	0.001	99.997	
1A2b	0.002	230.419	0.001	88.323	Gg	0.000003	0.001	99.998	
2C7a	NO	230.419	0.001	88.323	Gg	0.000002	0.001	99.999	
2C7c	0.025	230.419	0.010	88.323	Gg	0.000002	0.001	99.999	
3B4giv	0.038	230.419	0.014	88.323	Gg	0.000002	0.001	100	
2A3	0.001	230.419	0.0005	88.323	Gg	0.0000002	0.0001	100	
1A3ei	0.00004	230.419	0.00005	88.323	Gg	0.0000001	0.00004	100	

SOx

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A2d	38.474	248.768	2.423	35.020	Gg	0.012	17.883	17.883	x
1A1b	21.787	248.768	5.936	35.020	Gg	0.012	17.139	35.022	x
2H1	22.811	248.768	0.980	35.020	Gg	0.009	13.328	48.351	x

1A2b	8.098	248.768	3.111	35.020	Gg	0.008	11.777	60.128	x
1A1a	76.689	248.768	12.092	35.020	Gg	0.005	7.745	67.872	x
1A2a	9.223	248.768	0.577	35.020	Gg	0.003	4.309	72.181	x
2B10a	13.894	248.768	1.465	35.020	Gg	0.002	2.932	75.114	x
1A5a	6.030	248.768	1.281	35.020	Gg	0.002	2.583	77.697	x
1A2f	3.035	248.768	0.808	35.020	Gg	0.002	2.273	79.970	x
1A3biii	2.738	248.768	0.015	35.020	Gg	0.001	2.214	82.184	x
1A4ai	10.136	248.768	1.085	35.020	Gg	0.001	2.046	84.229	
2C1	2.867	248.768	0.7300	35.020	Gg	0.001	1.953	86.182	
1B1b	0.795	248.768	0.394	35.020	Gg	0.001	1.685	87.867	
1A4ci	3.428	248.768	0.731	35.020	Gg	0.001	1.487	89.354	
1A4bi	4.815	248.768	0.901	35.020	Gg	0.001	1.333	90.687	
1A3bi	1.769	248.768	0.027	35.020	Gg	0.001	1.324	92.012	
1A2c	6.607	248.768	0.755	35.020	Gg	0.001	1.044	93.056	
1A3dii	1.650	248.768	0.084	35.020	Gg	0.001	0.888	93.943	
1A2gviii	5.632	248.768	0.650	35.020	Gg	0.001	0.853	94.796	
1A2gvii	0.993	248.768	0.004	35.020	Gg	0.001	0.811	95.607	
1A4cii	0.986	248.768	0.003	35.020	Gg	0.001	0.811	96.418	
2C7a	0.0002	248.768	0.109	35.020	Gg	0.0004	0.649	97.067	
1A3bii	0.736	248.768	0.003	35.020	Gg	0.0004	0.599	97.666	
1A2e	4.289	248.768	0.696	35.020	Gg	0.0004	0.551	98.217	
1A3c	0.438	248.768	0.0002	35.020	Gg	0.0002	0.367	98.583	
1A4aii	0.442	248.768	0.002	35.020	Gg	0.0002	0.360	98.943	
1A3ai(i)	0.021	248.768	0.045	35.020	Gg	0.0002	0.249	99.192	
1A5b	0.007	248.768	0.039	35.020	Gg	0.0002	0.230	99.422	
2C7b	0.004	248.768	0.038	35.020	Gg	0.0001	0.222	99.644	
1A4ciii	0.195	248.768	0.0003	35.020	Gg	0.0001	0.162	99.805	
1A3aii(i)	0.021	248.768	0.012	35.020	Gg	0.00004	0.056	99.862	
3F	0.015	248.768	0.011	35.020	Gg	0.00004	0.052	99.914	
2D3i	0.089	248.768	0.005	35.020	Gg	0.00003	0.045	99.958	
2G	0.001	248.768	0.004	35.020	Gg	0.00002	0.023	99.981	
1A4bii	0.010	248.768	0.0004	35.020	Gg	0.000004	0.006	99.987	
2C7c	0.001	248.768	0.001	35.020	Gg	0.000003	0.005	99.992	
2C2	NO	248.768	0.001	35.020	Gg	0.000002	0.003	99.995	
1A3biv	0.007	248.768	0.001	35.020	Gg	0.000002	0.002	99.997	
2D3g	0.002	248.768	0.00002	35.020	Gg	0.000001	0.002	99.999	
2L	NO	248.768	0.0002	35.020	Gg	0.000001	0.001	100	
1A3ei	0.000002	248.768	0.000002	35.020	Gg	1E-08	0.00001	100	

NH3

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
3Da1	3.733	34.212	1.867	31.083	Gg	0.045	18.474	18.474	x
3B3	4.207	34.212	2.848	31.083	Gg	0.028	11.803	30.277	x
3B4h	1.837	34.212	2.586	31.083	Gg	0.027	11.113	41.390	x

3B1b	4.461	34.212	4.818	31.083	Gg	0.022	9.256	50.646	x
1A3bi	0.240	34.212	0.878	31.083	Gg	0.019	7.992	58.638	x
3B4gii	0.210	34.212	0.642	31.083	Gg	0.013	5.462	64.100	x
2H1	0.542	34.212	0.048	31.083	Gg	0.013	5.382	69.482	x
3Da2a	8.689	34.212	7.463	31.083	Gg	0.013	5.228	74.710	x
1A4bi	0.831	34.212	1.176	31.083	Gg	0.012	5.099	79.809	x
3B4e	0.386	34.212	0.652	31.083	Gg	0.009	3.648	83.457	x
2B10a	0.582	34.212	0.295	31.083	Gg	0.007	2.828	86.285	
3B4gi	1.000	34.212	0.700	31.083	Gg	0.006	2.527	88.813	
5E	0.275	34.212	0.379	31.083	Gg	0.004	1.566	90.378	
3B4giv	0.197	34.212	0.059	31.083	Gg	0.004	1.462	91.841	
2D3i	0.097	34.212	0.194	31.083	Gg	0.003	1.287	93.127	
3B2	0.054	34.212	0.155	31.083	Gg	0.003	1.287	94.414	
3B1a	5.310	34.212	4.925	31.083	Gg	0.003	1.223	95.637	
3B4giii	0.010	34.212	0.072	31.083	Gg	0.002	0.767	96.403	
5B1	0.035	34.212	0.089	31.083	Gg	0.002	0.689	97.093	
3Da2b	0.060	34.212	0.002	31.083	Gg	0.002	0.635	97.728	
2C1	0.003	34.212	0.043	31.083	Gg	0.001	0.485	98.213	
3Da3	1.050	34.212	0.926	31.083	Gg	0.001	0.342	98.555	
3F	0.109	34.212	0.074	31.083	Gg	0.001	0.300	98.856	
2G	0.042	34.212	0.014	31.083	Gg	0.001	0.299	99.154	
2C7b	0.100	34.212	0.069	31.083	Gg	0.001	0.265	99.419	
1A3biii	0.010	34.212	0.027	31.083	Gg	0.001	0.211	99.63	
2L	0.020	34.212	0.027	31.083	Gg	0.0002	0.101	99.731	
1A3bii	0.005	34.212	0.010	31.083	Gg	0.0002	0.063	99.793	
5D1	0.001	34.212	0.003	31.083	Gg	0.0001	0.030	99.823	
1A4ai	0.003	34.212	0.005	31.083	Gg	0.0001	0.026	99.85	
3B4d	0.004	34.212	0.006	31.083	Gg	0.0001	0.025	99.875	
1A4ci	0.011	34.212	0.012	31.083	Gg	0.0001	0.023	99.898	
1A1a	0.001	34.212	0.003	31.083	Gg	0.00005	0.020	99.919	
1B1b	0.002	34.212	0.003	31.083	Gg	0.00005	0.019	99.937	
1A3biv	0.001	34.212	0.002	31.083	Gg	0.00004	0.017	99.954	
1A2gviii	NO	34.212	0.001	31.083	Gg	0.00004	0.015	99.969	
2D3g	0.003	34.212	0.004	31.083	Gg	0.00003	0.014	99.983	
1A2gvii	0.002	34.212	0.003	31.083	Gg	0.00002	0.007	99.99	
1A3c	0.0004	34.212	0.0001	31.083	Gg	0.00001	0.003	99.993	
2C7c	0.0002	34.212	0.00003	31.083	Gg	0.00001	0.002	99.995	
1A4ciii	0.0004	34.212	0.0002	31.083	Gg	0.000005	0.002	99.997	
1A3dii	0.001	34.212	0.001	31.083	Gg	0.000003	0.001	99.998	
1A4cii	0.002	34.212	0.002	31.083	Gg	0.000002	0.001	99.999	
1A4bii	0.0001	34.212	0.0001	31.083	Gg	0.000001	0.0005	100	
1A5a	0.0001	34.212	0.0001	31.083	Gg	0.000001	0.0002	100	
1A4aii	0.001	34.212	0.001	31.083	Gg	0.0000003	0.0001	100	

PM2.5

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A4bi	7.174	46.463	9.246	17.800	Gg	0.140	38.289	38.289	x
1A2d	9.979	46.463	1.410	17.800	Gg	0.052	14.218	52.508	x
1A3biii	4.287	46.463	0.233	17.800	Gg	0.030	8.303	60.811	x
2C1	3.152	46.463	0.186	17.800	Gg	0.022	6.015	66.826	x
1A3bi	2.540	46.463	0.321	17.800	Gg	0.014	3.843	70.669	x
1A1a	2.525	46.463	0.370	17.800	Gg	0.013	3.521	74.190	x
1A3bvi	0.519	46.463	0.616	17.800	Gg	0.009	2.456	76.646	x
1A4cii	1.620	46.463	0.245	17.800	Gg	0.008	2.211	78.857	x
2H1	1.420	46.463	0.225	17.800	Gg	0.007	1.879	80.735	x
1A3bvii	0.407	46.463	0.474	17.800	Gg	0.007	1.876	82.611	
2H2	0.303	46.463	0.375	17.800	Gg	0.006	1.528	84.140	
1A2f	0.745	46.463	0.046	17.800	Gg	0.005	1.412	85.552	
1A2gvii	1.402	46.463	0.346	17.800	Gg	0.004	1.123	86.675	
2A5b	0.504	46.463	0.004	17.800	Gg	0.004	1.117	87.792	
1A2gviii	0.688	46.463	0.094	17.800	Gg	0.004	0.997	88.789	
1B1c	1.085	46.463	0.575	17.800	Gg	0.003	0.94	89.729	
1A5a	0.307	46.463	0.237	17.800	Gg	0.003	0.706	90.435	
1A3dii	0.548	46.463	0.322	17.800	Gg	0.002	0.658	91.093	
2C2	0.014	46.463	0.110	17.800	Gg	0.002	0.615	91.708	
1A3bii	1.079	46.463	0.315	17.800	Gg	0.002	0.58	92.289	
2B6	0.248	46.463	0.001	17.800	Gg	0.002	0.552	92.840	
3Dc	0.268	46.463	0.195	17.800	Gg	0.002	0.544	93.384	
1A4aii	0.994	46.463	0.289	17.800	Gg	0.002	0.539	93.923	
3F	0.287	46.463	0.191	17.800	Gg	0.002	0.480	94.403	
1A2a	0.217	46.463	0.006	17.800	Gg	0.002	0.456	94.859	
2C7c	0.201	46.463	0.005	17.800	Gg	0.002	0.422	95.280	
1B2aiv	0.189	46.463	0.002	17.800	Gg	0.002	0.417	95.697	
1A4ai	0.538	46.463	0.136	17.800	Gg	0.002	0.415	96.112	
2D3i	0.064	46.463	0.092	17.800	Gg	0.001	0.396	96.508	
1A4ci	0.277	46.463	0.169	17.800	Gg	0.001	0.369	96.876	
1A2c	0.259	46.463	0.037	17.800	Gg	0.001	0.366	97.242	
1A2e	0.19	46.463	0.015	17.800	Gg	0.001	0.341	97.583	
2I	0.131	46.463	0.00001	17.800	Gg	0.001	0.297	97.879	
2A3	0.124	46.463	0.006	17.800	Gg	0.001	0.247	98.126	
2G	0.153	46.463	0.090	17.800	Gg	0.001	0.185	98.312	
2A5a	0.068	46.463	0.0004	17.800	Gg	0.001	0.151	98.463	
2D3b	0.087	46.463	0.058	17.800	Gg	0.001	0.147	98.611	
2B10a	0.738	46.463	0.259	17.800	Gg	0.001	0.141	98.751	
1A5b	0.004	46.463	0.021	17.800	Gg	0.0004	0.117	98.868	
1A2b	0.052	46.463	0.004	17.800	Gg	0.0004	0.097	98.966	
2C7d	0.024	46.463	0.025	17.800	Gg	0.0003	0.094	99.060	
3B1b	0.043	46.463	0.032	17.800	Gg	0.0003	0.090	99.150	

1A3biv	0.057	46.463	0.035	17.800	Gg	0.0003	0.080	99.230	
3B1a	0.132	46.463	0.064	17.800	Gg	0.0003	0.078	99.308	
1A4ciii	0.074	46.463	0.041	17.800	Gg	0.0003	0.072	99.380	
1A1b	0.096	46.463	0.025	17.800	Gg	0.0002	0.068	99.448	
2A5c	0.049	46.463	0.029	17.800	Gg	0.0002	0.058	99.505	
2A2	0.026	46.463	0.0005	17.800	Gg	0.0002	0.056	99.561	
2C7a	0.026	46.463	0.0004	17.800	Gg	0.0002	0.055	99.617	
5E	0.299	46.463	0.107	17.800	Gg	0.0002	0.046	99.663	
3B4h	0.013	46.463	0.012	17.800	Gg	0.0002	0.044	99.707	
3B4gii	0.003	46.463	0.008	17.800	Gg	0.0001	0.041	99.747	
1A4bii	0.015	46.463	0.012	17.800	Gg	0.0001	0.038	99.785	
1A3c	0.084	46.463	0.026	17.800	Gg	0.0001	0.036	99.822	
2D3g	0.016	46.463	0.001	17.800	Gg	0.0001	0.032	99.854	
3B4e	0.004	46.463	0.006	17.800	Gg	0.0001	0.028	99.881	
1A3ai(i)	0.003	46.463	0.005	17.800	Gg	0.0001	0.025	99.906	
3B4gi	0.014	46.463	0.009	17.800	Gg	0.0001	0.024	99.93	
3B4giii	0.001	46.463	0.003	17.800	Gg	0.0001	0.016	99.946	
2L	0.054	46.463	0.019	17.800	Gg	0.00005	0.013	99.958	
3B2	0.001	46.463	0.002	17.800	Gg	0.00003	0.007	99.966	
2B10b	0.001	46.463	0.001	17.800	Gg	0.00002	0.007	99.972	
5C1bv	0.0003	46.463	0.001	17.800	Gg	0.00002	0.005	99.977	
1B1b	0.003	46.463	0.002	17.800	Gg	0.00002	0.005	99.982	
2D3d	0.0003	46.463	0.001	17.800	Gg	0.00001	0.004	99.986	
3B3	0.004	46.463	0.002	17.800	Gg	0.00001	0.004	99.990	
3B4giv	0.0005	46.463	0.001	17.800	Gg	0.00001	0.004	99.994	
1A3aii(i)	0.002	46.463	0.001	17.800	Gg	0.00001	0.002	99.996	
2C3	0.001	46.463	0.00002	17.800	Gg	0.00001	0.001	99.998	
2D3e	0.001	46.463	0.00003	17.800	Gg	0.00001	0.001	99.999	
1B2av	NO	46.463	0.0001	17.800	Gg	0.000003	0.001	100	
3B4d	0.00004	46.463	0.00005	17.800	Gg	0.000001	0.0002	100	
5A	0.0002	46.463	0.0001	17.800	Gg	0.0000001	0.00004	100	

PM10

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A4bi	7.545	70.398	9.569	29.179	Gg	0.092	23.447	23.447	x
1A2d	13.791	70.398	1.948	29.179	Gg	0.054	13.715	37.162	x
1A3bvii	4.766	70.398	5.588	29.179	Gg	0.051	13.151	50.313	x
1A1a	7.747	70.398	1.159	29.179	Gg	0.029	7.468	57.781	x
1A3biii	4.287	70.398	0.233	29.179	Gg	0.022	5.619	63.400	x
2C1	4.059	70.398	0.203	29.179	Gg	0.021	5.386	68.787	x
3Dc	2.117	70.398	1.620	29.179	Gg	0.011	2.701	71.488	x
1A3bi	2.540	70.398	0.321	29.179	Gg	0.010	2.664	74.152	x
1A5a	0.497	70.398	0.931	29.179	Gg	0.010	2.639	76.790	x

1A3bvi	0.921	70.398	1.093	29.179	Gg	0.010	2.589	79.38	x
2H1	1.965	70.398	0.288	29.179	Gg	0.007	1.914	81.294	x
1A2f	1.329	70.398	0.102	29.179	Gg	0.006	1.634	82.928	
1A4cii	1.620	70.398	0.245	29.179	Gg	0.006	1.551	84.479	
1A2gviii	1.483	70.398	0.239	29.179	Gg	0.005	1.367	85.846	
2A5b	0.796	70.398	0.017	29.179	Gg	0.004	1.141	86.987	
2H2	0.320	70.398	0.386	29.179	Gg	0.004	0.923	87.910	
1A2a	0.606	70.398	0.014	29.179	Gg	0.003	0.865	88.775	
1A2gvii	1.402	70.398	0.346	29.179	Gg	0.003	0.854	89.629	
1A4ci	0.418	70.398	0.355	29.179	Gg	0.003	0.660	90.289	
2C7d	0.287	70.398	0.298	29.179	Gg	0.003	0.651	90.939	
1B1c	1.544	70.398	0.819	29.179	Gg	0.003	0.650	91.590	
1A2c	0.541	70.398	0.058	29.179	Gg	0.002	0.606	92.196	
2C7c	0.408	70.398	0.006	29.179	Gg	0.002	0.592	92.788	
2C2	0.020	70.398	0.156	29.179	Gg	0.002	0.536	93.324	
1A4ai	0.855	70.398	0.211	29.179	Gg	0.002	0.521	93.845	
1A2e	0.438	70.398	0.041	29.179	Gg	0.002	0.510	94.355	
1A3bii	1.079	70.398	0.315	29.179	Gg	0.002	0.482	94.837	
1A4aii	0.994	70.398	0.289	29.179	Gg	0.002	0.447	95.283	
1B2aiv	0.312	70.398	0.009	29.179	Gg	0.002	0.439	95.722	
2B6	0.248	70.398	0.001	29.179	Gg	0.001	0.369	96.091	
2B10a	1.156	70.398	0.378	29.179	Gg	0.001	0.369	96.460	
1A3dii	0.560	70.398	0.329	29.179	Gg	0.001	0.352	96.811	
2A5a	0.230	70.398	0.004	29.179	Gg	0.001	0.333	97.144	
2I	0.271	70.398	0.023	29.179	Gg	0.001	0.326	97.471	
2A5c	0.478	70.398	0.277	29.179	Gg	0.001	0.286	97.756	
3F	0.301	70.398	0.201	29.179	Gg	0.001	0.277	98.033	
3B4gii	0.03	70.398	0.080	29.179	Gg	0.001	0.248	98.281	
2A3	0.142	70.398	0.006	29.179	Gg	0.001	0.192	98.472	
1A2b	0.134	70.398	0.006	29.179	Gg	0.001	0.179	98.651	
3B4gi	0.189	70.398	0.127	29.179	Gg	0.001	0.176	98.826	
2A2	0.072	70.398	0.002	29.179	Gg	0.0004	0.099	98.926	
2G	0.153	70.398	0.090	29.179	Gg	0.0004	0.097	99.023	
2D3b	0.095	70.398	0.064	29.179	Gg	0.0003	0.088	99.111	
3B1b	0.065	70.398	0.048	29.179	Gg	0.0003	0.076	99.187	
2D3i	0.187	70.398	0.098	29.179	Gg	0.0003	0.073	99.261	
1A5b	0.004	70.398	0.021	29.179	Gg	0.0003	0.072	99.333	
5E	0.299	70.398	0.107	29.179	Gg	0.0002	0.063	99.396	
1A1b	0.225	70.398	0.077	29.179	Gg	0.0002	0.061	99.456	
3B4giii	0.003	70.398	0.016	29.179	Gg	0.0002	0.053	99.510	
3B4h	0.026	70.398	0.025	29.179	Gg	0.0002	0.051	99.561	
3B1a	0.203	70.398	0.098	29.179	Gg	0.0002	0.051	99.612	
2C7a	0.034	70.398	0.001	29.179	Gg	0.0002	0.049	99.660	
3B3	0.086	70.398	0.048	29.179	Gg	0.0002	0.045	99.706	
1A3biv	0.057	70.398	0.035	29.179	Gg	0.0002	0.043	99.749	
1A4ciii	0.076	70.398	0.042	29.179	Gg	0.0001	0.037	99.785	

1A3c	0.089	70.398	0.027	29.179	Gg	0.0001	0.034	99.819	
2B10b	0.007	70.398	0.012	29.179	Gg	0.0001	0.031	99.851	
3B4e	0.006	70.398	0.010	29.179	Gg	0.0001	0.026	99.877	
1A4bii	0.015	70.398	0.012	29.179	Gg	0.0001	0.022	99.898	
2D3g	0.017	70.398	0.001	29.179	Gg	0.0001	0.021	99.920	
2L	0.081	70.398	0.029	29.179	Gg	0.0001	0.016	99.936	
3B4giv	0.004	70.398	0.006	29.179	Gg	0.0001	0.015	99.951	
1A3ai(i)	0.003	70.398	0.005	29.179	Gg	0.0001	0.015	99.966	
3B2	0.002	70.398	0.005	29.179	Gg	0.0001	0.013	99.979	
1B1b	0.008	70.398	0.005	29.179	Gg	0.00003	0.006	99.986	
2D3d	0.0004	70.398	0.001	29.179	Gg	0.00002	0.004	99.990	
5C1bv	0.0003	70.398	0.001	29.179	Gg	0.00001	0.003	99.993	
2C3	0.002	70.398	0.0001	29.179	Gg	0.00001	0.003	99.995	
2D3e	0.002	70.398	0.0001	29.179	Gg	0.00001	0.002	99.998	
1A3aii(i)	0.002	70.398	0.001	29.179	Gg	0.000005	0.001	99.999	
1B2av	NO	70.398	0.0001	29.179	Gg	0.000002	0.0005	100	
3B4d	0.0001	70.398	0.0002	29.179	Gg	0.000001	0.0004	100	
5A	0.001	70.398	0.001	29.179	Gg	3E-08	0.00001	100	

TSP

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A3bvii	9.531	95.056	11.176	43.614	Gg	0.072	16.982	16.982	x
1A4bi	7.960	95.056	9.981	43.614	Gg	0.067	15.797	32.780	x
1A2d	16.699	95.056	2.259	43.614	Gg	0.057	13.487	46.267	x
1A5a	0.650	95.056	3.225	43.614	Gg	0.031	7.305	53.572	x
1A1a	11.747	95.056	2.572	43.614	Gg	0.03	7.033	60.605	x
2C1	5.545	95.056	0.245	43.614	Gg	0.024	5.739	66.344	x
1A3biii	4.287	95.056	0.233	43.614	Gg	0.018	4.328	70.672	x
1A3bvi	1.266	95.056	1.502	43.614	Gg	0.010	2.299	72.971	x
1A2f	2.433	95.056	0.207	43.614	Gg	0.010	2.271	75.242	x
1A3bi	2.540	95.056	0.321	43.614	Gg	0.009	2.108	77.350	x
2H1	2.389	95.056	0.342	43.614	Gg	0.008	1.882	79.232	x
1A2gviii	2.663	95.056	0.538	43.614	Gg	0.007	1.707	80.938	x
1A4ci	0.605	95.056	0.952	43.614	Gg	0.007	1.682	82.621	
3Dc	2.117	95.056	1.620	43.614	Gg	0.007	1.618	84.239	
1A4cii	1.620	95.056	0.245	43.614	Gg	0.005	1.243	85.482	
1A2a	1.098	95.056	0.023	43.614	Gg	0.005	1.199	86.682	
2A5b	1.014	95.056	0.051	43.614	Gg	0.004	1.035	87.716	
2C7c	0.855	95.056	0.011	43.614	Gg	0.004	0.953	88.669	
2C7d	0.612	95.056	0.634	43.614	Gg	0.004	0.882	89.551	
1A2gvii	1.402	95.056	0.346	43.614	Gg	0.003	0.741	90.292	
2H2	0.329	95.056	0.393	43.614	Gg	0.003	0.605	90.897	
1A2e	0.753	95.056	0.112	43.614	Gg	0.002	0.584	91.481	

1A2c	0.644	95.056	0.067	43.614	Gg	0.002	0.570	92.051
2B10a	1.409	95.056	0.435	43.614	Gg	0.002	0.527	92.578
1A4ai	1.068	95.056	0.296	43.614	Gg	0.002	0.483	93.061
3B4gi	0.897	95.056	0.601	43.614	Gg	0.002	0.473	93.534
1A3bii	1.079	95.056	0.315	43.614	Gg	0.002	0.450	93.984
2A5a	0.400	95.056	0.007	43.614	Gg	0.002	0.440	94.424
2C2	0.023	95.056	0.183	43.614	Gg	0.002	0.430	94.854
1B2aiv	0.442	95.056	0.033	43.614	Gg	0.002	0.425	95.280
2D3i	0.598	95.056	0.104	43.614	Gg	0.002	0.425	95.705
1B1c	2.363	95.056	1.251	43.614	Gg	0.002	0.417	96.122
1A4aii	0.994	95.056	0.289	43.614	Gg	0.002	0.416	96.538
1A2b	0.363	95.056	0.013	43.614	Gg	0.002	0.384	96.922
2A5c	1.218	95.056	0.707	43.614	Gg	0.002	0.370	97.292
2I	0.590	95.056	0.127	43.614	Gg	0.002	0.359	97.652
3B4gii	0.060	95.056	0.161	43.614	Gg	0.001	0.333	97.985
2B6	0.248	95.056	0.001	43.614	Gg	0.001	0.281	98.265
2A2	0.174	95.056	0.006	43.614	Gg	0.001	0.184	98.450
1A3dii	0.565	95.056	0.332	43.614	Gg	0.001	0.181	98.630
3B3	0.518	95.056	0.309	43.614	Gg	0.001	0.178	98.808
2A3	0.158	95.056	0.007	43.614	Gg	0.001	0.164	98.972
3F	0.305	95.056	0.204	43.614	Gg	0.001	0.159	99.131
3B1b	0.142	95.056	0.105	43.614	Gg	0.0004	0.098	99.230
5E	0.299	95.056	0.107	43.614	Gg	0.0003	0.076	99.306
3B4h	0.059	95.056	0.056	43.614	Gg	0.0003	0.072	99.378
1A1b	0.545	95.056	0.223	43.614	Gg	0.0003	0.068	99.446
2D3b	0.126	95.056	0.085	43.614	Gg	0.0003	0.067	99.513
2B10b	0.023	95.056	0.037	43.614	Gg	0.0003	0.065	99.578
2G	0.153	95.056	0.090	43.614	Gg	0.0002	0.050	99.628
1A5b	0.004	95.056	0.021	43.614	Gg	0.0002	0.049	99.677
2C7a	0.043	95.056	0.001	43.614	Gg	0.0002	0.047	99.724
3B4e	0.014	95.056	0.021	43.614	Gg	0.0002	0.037	99.761
3B4giii	0.003	95.056	0.016	43.614	Gg	0.0002	0.036	99.798
1A3c	0.094	95.056	0.029	43.614	Gg	0.0001	0.035	99.832
3B1a	0.445	95.056	0.215	43.614	Gg	0.0001	0.027	99.859
1A3biv	0.057	95.056	0.035	43.614	Gg	0.0001	0.023	99.883
3B2	0.005	95.056	0.011	43.614	Gg	0.0001	0.021	99.904
2D3g	0.019	95.056	0.001	43.614	Gg	0.0001	0.018	99.921
1A4ciii	0.077	95.056	0.042	43.614	Gg	0.0001	0.017	99.938
1A4bii	0.015	95.056	0.012	43.614	Gg	0.0001	0.013	99.951
1A3ai(i)	0.003	95.056	0.005	43.614	Gg	0.00004	0.010	99.961
2L	0.093	95.056	0.039	43.614	Gg	0.00004	0.009	99.970
1B1b	0.019	95.056	0.012	43.614	Gg	0.00004	0.008	99.979
3B4giv	0.012	95.056	0.008	43.614	Gg	0.00003	0.008	99.987
2D3d	0.001	95.056	0.002	43.614	Gg	0.00001	0.003	99.990
2D3e	0.003	95.056	0.0002	43.614	Gg	0.00001	0.003	99.993
2C3	0.003	95.056	0.0001	43.614	Gg	0.00001	0.003	99.996

5C1bv	0.0003	95.056	0.001	43.614	Gg	0.00001	0.002	99.998	
1A3aii(i)	0.002	95.056	0.001	43.614	Gg	0.000003	0.001	99.999	
3B4d	0.0003	95.056	0.0004	43.614	Gg	0.000002	0.001	99.999	
1B2av	NO	95.056	0.0001	43.614	Gg	0.000001	0.0003	100	
5A	0.003	95.056	0.001	43.614	Gg	0.000001	0.0003	100	

BC

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A4bi	2.036	9.812	2.670	4.113	Gg	0.185	43.774	43.774	x
1A3biii	2.272	9.812	0.123	4.113	Gg	0.084	19.976	63.749	x
1A3bi	1.370	9.812	0.167	4.113	Gg	0.041	9.801	73.551	x
1A4cii	0.877	9.812	0.119	4.113	Gg	0.025	5.990	79.541	x
1A2gvii	0.869	9.812	0.215	4.113	Gg	0.015	3.608	83.149	x
1A3bvi	0.140	9.812	0.166	4.113	Gg	0.011	2.580	85.729	
1A3bii	0.591	9.812	0.173	4.113	Gg	0.008	1.796	87.524	
1A1a	0.222	9.812	0.023	4.113	Gg	0.007	1.697	89.221	
1A3bvii	0.079	9.812	0.093	4.113	Gg	0.006	1.436	90.657	
1A2gviii	0.149	9.812	0.006	4.113	Gg	0.006	1.362	92.018	
1A2d	0.146	9.812	0.011	4.113	Gg	0.005	1.223	93.241	
1A4aii	0.261	9.812	0.064	4.113	Gg	0.005	1.098	94.339	
1A4ai	0.153	9.812	0.027	4.113	Gg	0.004	0.899	95.239	
1A5a	0.092	9.812	0.068	4.113	Gg	0.003	0.717	95.956	
1A2f	0.078	9.812	0.005	4.113	Gg	0.003	0.673	96.628	
1A3dii	0.069	9.812	0.053	4.113	Gg	0.002	0.585	97.214	
1A2e	0.044	9.812	0.003	4.113	Gg	0.002	0.367	97.581	
1A2c	0.053	9.812	0.008	4.113	Gg	0.001	0.330	97.910	
1A4ci	0.054	9.812	0.011	4.113	Gg	0.001	0.279	98.190	
2H1	0.036	9.812	0.004	4.113	Gg	0.001	0.267	98.457	
2C2	0.001	9.812	0.011	4.113	Gg	0.001	0.250	98.707	
1A5b	0.002	9.812	0.010	4.113	Gg	0.001	0.229	98.936	
3F	0.037	9.812	0.024	4.113	Gg	0.001	0.199	99.135	
1A2a	0.017	9.812	0.001	4.113	Gg	0.001	0.153	99.288	
1A3c	0.055	9.812	0.017	4.113	Gg	0.001	0.144	99.432	
2C1	0.011	9.812	0.001	4.113	Gg	0.0004	0.098	99.530	
1A2b	0.012	9.812	0.001	4.113	Gg	0.0004	0.094	99.625	
1A4ciii	0.024	9.812	0.013	4.113	Gg	0.0003	0.073	99.698	
1A3biv	0.006	9.812	0.005	4.113	Gg	0.0002	0.055	99.753	
1A1b	0.011	9.812	0.002	4.113	Gg	0.0002	0.054	99.807	
1A3ai(i)	0.001	9.812	0.003	4.113	Gg	0.0002	0.049	99.856	
2B6	0.004	9.812	0.00002	4.113	Gg	0.0002	0.044	99.900	
5E	0.027	9.812	0.009	4.113	Gg	0.0002	0.044	99.944	
2D3b	0.005	9.812	0.003	4.113	Gg	0.0001	0.030	99.974	
5C1bv	0.0001	9.812	0.0005	4.113	Gg	0.00004	0.011	99.985	

2B10a	0.002	9.812	0.001	4.113	Gg	0.00002	0.006	99.991	
1A3aii(i)	0.001	9.812	0.001	4.113	Gg	0.00002	0.004	99.995	
2G	0.001	9.812	0.0004	4.113	Gg	0.00001	0.003	99.998	
1A4bii	0.004	9.812	0.002	4.113	Gg	0.000004	0.001	99.999	
2A3	0.0001	9.812	0.000003	4.113	Gg	0.000003	0.001	99.999	
2A2	0.00003	9.812	0.000002	4.113	Gg	0.000001	0.0003	100	
2C7a	0.00002	9.812	0.0000001	4.113	Gg	0.000001	0.0002	100	
2C3	0.00002	9.812	0.000001	4.113	Gg	0.000001	0.0002	100	
2D3i	NO	9.812	0.000002	4.113	Gg	0.0000002	0.0001	100	
1B1b	0.000004	9.812	0.000001	4.113	Gg	0.0000001	0.00002	100	

CO

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A3bi	422.317	753.386	28.890	359.082	Gg	0.229	45.519	45.519	x
1A4bi	114.893	753.386	161.491	359.082	Gg	0.142	28.181	73.700	x
1A4aii	24.539	753.386	33.029	359.082	Gg	0.028	5.633	79.332	x
1A4bii	22.172	753.386	25.323	359.082	Gg	0.020	3.896	83.228	x
1A1a	4.366	753.386	13.449	359.082	Gg	0.015	3.002	86.23	
1A3dii	22.554	753.386	19.309	359.082	Gg	0.011	2.260	88.490	
1A5a	0.749	753.386	8.464	359.082	Gg	0.011	2.141	90.631	
1A3bii	22.393	753.386	2.717	359.082	Gg	0.011	2.101	92.731	
1A2d	29.503	753.386	19.783	359.082	Gg	0.008	1.511	94.242	
1A2gvii	7.958	753.386	7.461	359.082	Gg	0.005	0.968	95.210	
1A3biii	15.069	753.386	3.544	359.082	Gg	0.005	0.961	96.171	
1A3biv	7.906	753.386	6.622	359.082	Gg	0.004	0.753	96.924	
1A2f	16.11	753.386	4.831	359.082	Gg	0.004	0.752	97.676	
1A2a	7.192	753.386	1.083	359.082	Gg	0.003	0.619	98.295	
1A4ci	1.806	753.386	2.113	359.082	Gg	0.002	0.330	98.626	
1A2gviii	4.413	753.386	3.201	359.082	Gg	0.001	0.290	98.915	
1A1b	0.575	753.386	1.017	359.082	Gg	0.001	0.196	99.111	
3F	3.694	753.386	2.450	359.082	Gg	0.001	0.182	99.293	
1A3ai(i)	0.231	753.386	0.741	359.082	Gg	0.001	0.167	99.460	
1A4ai	1.048	753.386	0.995	359.082	Gg	0.001	0.131	99.591	
1A4cii	18.799	753.386	9.432	359.082	Gg	0.001	0.125	99.715	
1A5b	1.532	753.386	1.115	359.082	Gg	0.001	0.102	99.817	
2C1	0.464	753.386	0.591	359.082	Gg	0.0005	0.098	99.915	
2C7a	0.223	753.386	0.008	359.082	Gg	0.0001	0.026	99.941	
1A3c	0.548	753.386	0.183	359.082	Gg	0.0001	0.021	99.962	
1A2c	0.483	753.386	0.274	359.082	Gg	0.0001	0.012	99.973	
2G	0.315	753.386	0.193	359.082	Gg	0.0001	0.011	99.985	
1A4ciii	0.442	753.386	0.252	359.082	Gg	0.0001	0.011	99.995	
1A2e	0.382	753.386	0.174	359.082	Gg	0.00001	0.002	99.997	
1A3aii(i)	0.605	753.386	0.296	359.082	Gg	0.00001	0.002	99.999	

1A2b	0.102	753.386	0.051	359.082	Gg	0.000003	0.001	100	
1A3ei	0.001	753.386	0.001	359.082	Gg	0.000001	0.0002	100	

Pb

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A3bi	166.003	320.297	0.002	15.576	Mg	0.025	30.271	30.271	x
1A2d	6.199	320.297	4.021	15.576	Mg	0.012	13.952	44.223	x
2C7c	80.081	320.297	0.422	15.576	Mg	0.011	13.024	57.247	x
1A1b	2.096	320.297	3.255	15.576	Mg	0.010	11.827	69.074	x
1A1a	7.480	320.297	2.024	15.576	Mg	0.005	6.229	75.303	x
1A2f	2.873	320.297	1.763	15.576	Mg	0.005	6.089	81.392	x
2C1	34.463	320.297	0.365	15.576	Mg	0.004	4.919	86.311	
2G	0.310	320.297	1.021	15.576	Mg	0.003	3.774	90.086	
1A5a	0.262	320.297	0.758	15.576	Mg	0.002	2.797	92.883	
1A4bi	0.812	320.297	0.569	15.576	Mg	0.002	1.985	94.867	
1A4ci	0.249	320.297	0.410	15.576	Mg	0.001	1.492	96.359	
1A3bii	6.400	320.297	0.0002	15.576	Mg	0.001	1.167	97.526	
1A2gviii	0.623	320.297	0.206	15.576	Mg	0.001	0.659	98.185	
1A3bvi	6.208	320.297	0.421	15.576	Mg	0.0004	0.447	98.632	
1A4ai	0.317	320.297	0.090	15.576	Mg	0.0002	0.280	98.912	
1A3biv	1.300	320.297	0.0001	15.576	Mg	0.0002	0.237	99.148	
1A2b	1.122	320.297	0.001	15.576	Mg	0.0002	0.202	99.350	
1A2e	1.645	320.297	0.132	15.576	Mg	0.0002	0.194	99.544	
1A2a	0.769	320.297	0.007	15.576	Mg	0.0001	0.112	99.657	
1A2c	0.301	320.297	0.033	15.576	Mg	0.0001	0.067	99.724	
2C7a	0.374	320.297	0.002	15.576	Mg	0.0001	0.060	99.784	
2C2	0.001	320.297	0.016	15.576	Mg	0.00005	0.060	99.844	
1A3aii(i)	0.282	320.297	0.027	15.576	Mg	0.00004	0.049	99.894	
1A3dii	0.015	320.297	0.013	15.576	Mg	0.00004	0.045	99.938	
2C6	0.0004	320.297	0.004	15.576	Mg	0.00001	0.014	99.952	
1A4ciii	0.007	320.297	0.004	15.576	Mg	0.00001	0.013	99.965	
1B1b	0.022	320.297	0.004	15.576	Mg	0.00001	0.010	99.975	
3F	0.003	320.297	0.002	15.576	Mg	0.00001	0.008	99.982	
2C3	0.066	320.297	0.001	15.576	Mg	0.00001	0.007	99.990	
2B10a	0.001	320.297	0.001	15.576	Mg	0.000003	0.004	99.993	
5C1bv	0.0002	320.297	0.001	15.576	Mg	0.000003	0.003	99.997	
1A3biii	0.0005	320.297	0.001	15.576	Mg	0.000002	0.003	99.999	
5E	0.001	320.297	0.0003	15.576	Mg	0.000001	0.001	100	

Cd

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C7c	4.203	6.663	0.010	0.956	Mg	0.089	38.409	38.409	x
1A2d	0.353	6.663	0.309	0.956	Mg	0.039	16.729	55.138	x
1A4bi	0.118	6.663	0.161	0.956	Mg	0.022	9.307	64.445	x
1A1a	0.196	6.663	0.148	0.956	Mg	0.018	7.749	72.194	x
2C6	0.850	6.663	0.013	0.956	Mg	0.016	7.041	79.235	x
1A5a	0.005	6.663	0.077	0.956	Mg	0.011	4.952	84.187	x
1A1b	0.048	6.663	0.074	0.956	Mg	0.010	4.357	88.545	
2C1	0.390	6.663	0.005	0.956	Mg	0.008	3.273	91.818	
1A2f	0.069	6.663	0.044	0.956	Mg	0.005	2.234	94.052	
1A4ci	0.022	6.663	0.027	0.956	Mg	0.004	1.520	95.572	
2G	0.028	6.663	0.020	0.956	Mg	0.002	1.034	96.607	
3F	0.027	6.663	0.020	0.956	Mg	0.002	1.026	97.633	
1A2gviii	0.068	6.663	0.020	0.956	Mg	0.002	0.678	98.311	
1A4ai	0.010	6.663	0.010	0.956	Mg	0.001	0.571	98.882	
1A2gvii	0.003	6.663	0.003	0.956	Mg	0.0004	0.190	99.072	
2C3	0.023	6.663	0.001	0.956	Mg	0.0004	0.159	99.231	
1A2a	0.016	6.663	0.0002	0.956	Mg	0.0003	0.138	99.369	
1A4cii	0.003	6.663	0.003	0.956	Mg	0.0003	0.138	99.508	
1A2e	0.036	6.663	0.003	0.956	Mg	0.0003	0.129	99.637	
1A3bvi	0.001	6.663	0.002	0.956	Mg	0.0002	0.098	99.735	
1A4aii	0.002	6.663	0.002	0.956	Mg	0.0002	0.085	99.819	
1A3dii	0.001	6.663	0.001	0.956	Mg	0.0001	0.054	99.874	
5E	0.002	6.663	0.001	0.956	Mg	0.0001	0.023	99.897	
1A4bii	0.0002	6.663	0.0003	0.956	Mg	0.00004	0.016	99.913	
1A3bi	0.0004	6.663	0.0003	0.956	Mg	0.00004	0.016	99.929	
1A4ciii	0.001	6.663	0.0003	0.956	Mg	0.00003	0.014	99.943	
1B1b	0.0001	6.663	0.0002	0.956	Mg	0.00003	0.011	99.954	
2C7a	0.0002	6.663	0.0002	0.956	Mg	0.00003	0.011	99.965	
2C2	0.003	6.663	0.0003	0.956	Mg	0.00002	0.010	99.975	
5C1bv	0.00004	6.663	0.0001	0.956	Mg	0.00002	0.009	99.984	
1A3c	0.001	6.663	0.0002	0.956	Mg	0.00002	0.007	99.991	
1A3biii	0.00005	6.663	0.0001	0.956	Mg	0.00001	0.004	99.995	
1A2c	0.003	6.663	0.0005	0.956	Mg	0.00001	0.003	99.998	
1A3bii	0.00003	6.663	0.00002	0.956	Mg	0.000002	0.001	99.999	
1A2b	0.0001	6.663	0.00001	0.956	Mg	0.000001	0.001	100	
1A3biv	0.000003	6.663	0.00001	0.956	Mg	0.000001	0.0005	100	

Hg

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2B10a	0.369	1.099	0.051	0.579	Mg	0.130	28.628	28.628	x

2C1	0.005	1.099	0.091	0.579	Mg	0.081	17.769	46.397	x
1A2gviii	0.177	1.099	0.014	0.579	Mg	0.072	15.861	62.258	x
1A2d	0.123	1.099	0.125	0.579	Mg	0.054	11.968	74.226	x
1A1a	0.238	1.099	0.146	0.579	Mg	0.019	4.219	78.445	x
1A2f	0.017	1.099	0.027	0.579	Mg	0.016	3.605	82.050	x
1A4bi	0.021	1.099	0.027	0.579	Mg	0.014	3.184	85.234	
1A1b	0.010	1.099	0.015	0.579	Mg	0.009	2.014	87.248	
1A2a	0.017	1.099	0.0001	0.579	Mg	0.008	1.729	88.977	
1A5a	0.001	1.099	0.008	0.579	Mg	0.007	1.482	90.459	
2C7c	0.028	1.099	0.008	0.579	Mg	0.006	1.379	91.837	
1A3bi	0.017	1.099	0.016	0.579	Mg	0.006	1.280	93.117	
1A4ci	0.005	1.099	0.009	0.579	Mg	0.006	1.244	94.361	
5C1bv	0.023	1.099	0.017	0.579	Mg	0.004	0.974	95.335	
1A3biii	0.005	1.099	0.007	0.579	Mg	0.004	0.915	96.250	
2C7a	0.007	1.099	0.000004	0.579	Mg	0.003	0.685	96.934	
1A2c	0.006	1.099	0.0002	0.579	Mg	0.003	0.622	97.557	
1A2b	0.005	1.099	0.000003	0.579	Mg	0.003	0.562	98.119	
1A2e	0.010	1.099	0.003	0.579	Mg	0.002	0.471	98.590	
2C2	0.0002	1.099	0.002	0.579	Mg	0.002	0.344	98.934	
1A3dii	0.003	1.099	0.003	0.579	Mg	0.001	0.270	99.204	
1A4ai	0.002	1.099	0.002	0.579	Mg	0.001	0.195	99.398	
3F	0.005	1.099	0.004	0.579	Mg	0.001	0.189	99.587	
1A3bii	0.002	1.099	0.002	0.579	Mg	0.001	0.141	99.728	
2C6	NO	1.099	0.001	0.579	Mg	0.001	0.140	99.868	
5E	0.002	1.099	0.001	0.579	Mg	0.0003	0.062	99.929	
1A3biv	0.0001	1.099	0.0003	0.579	Mg	0.0003	0.056	99.986	
2G	0.00002	1.099	0.0001	0.579	Mg	0.0001	0.012	99.998	
1B1b	0.00001	1.099	0.00001	0.579	Mg	0.000004	0.001	99.999	
1A4ciii	0.002	1.099	0.001	0.579	Mg	0.000004	0.001	100	

As

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C7c	28.000	34.805	0.248	2.44	Mg	0.049	47.333	47.333	x
1A1a	2.279	34.805	0.690	2.44	Mg	0.015	14.619	61.953	x
1A1b	0.344	34.805	0.534	2.44	Mg	0.015	14.075	76.027	x
1A2f	0.496	34.805	0.285	2.44	Mg	0.007	6.916	82.944	x
1A4ci	0.052	34.805	0.166	2.44	Mg	0.005	4.475	87.419	
1A2d	0.646	34.805	0.163	2.44	Mg	0.003	3.259	90.678	
2C6	1.700	34.805	0.028	2.44	Mg	0.003	2.504	93.182	
1A4bi	0.141	34.805	0.067	2.44	Mg	0.002	1.573	94.755	
2C7a	0.113	34.805	0.048	2.44	Mg	0.001	1.101	95.856	
1A3bvi	0.032	34.805	0.038	2.44	Mg	0.001	0.984	96.839	
1A2e	0.314	34.805	0.054	2.44	Mg	0.001	0.877	97.716	

1A5a	0.031	34.805	0.021	2.44	Mg	0.001	0.527	98.244	
1A2gviii	0.041	34.805	0.018	2.44	Mg	0.0004	0.429	98.673	
1A4ai	0.033	34.805	0.016	2.44	Mg	0.0004	0.382	99.054	
2C1	0.411	34.805	0.039	2.44	Mg	0.0003	0.293	99.347	
1A3dii	0.028	34.805	0.011	2.44	Mg	0.0002	0.236	99.583	
1A2a	0.105	34.805	0.001	2.44	Mg	0.0002	0.162	99.745	
1B1b	0.004	34.805	0.002	2.44	Mg	0.0001	0.060	99.805	
2G	0.001	34.805	0.002	2.44	Mg	0.00005	0.047	99.852	
1A2c	0.019	34.805	0.003	2.44	Mg	0.00005	0.045	99.897	
1A4ciii	0.002	34.805	0.001	2.44	Mg	0.00003	0.028	99.925	
5E	0.003	34.805	0.001	2.44	Mg	0.00002	0.021	99.946	
2C2	0.002	34.805	0.001	2.44	Mg	0.00001	0.013	99.959	
1A3bi	0.001	34.805	0.0005	2.44	Mg	0.00001	0.012	99.970	
2C3	0.008	34.805	0.001	2.44	Mg	0.00001	0.011	99.981	
5C1bv	0.0001	34.805	0.0004	2.44	Mg	0.00001	0.010	99.992	
1A3biii	0.0001	34.805	0.0001	2.44	Mg	0.000004	0.004	99.996	
3F	0.0002	34.805	0.0001	2.44	Mg	0.000003	0.003	99.999	
1A3bii	0.00005	34.805	0.00003	2.44	Mg	0.000001	0.001	99.999	
1A3biv	0.000004	34.805	0.00001	2.44	Mg	0.0000003	0.0003	100	
1A2b	0.001	34.805	0.0001	2.44	Mg	0.0000002	0.0002	100	

Cr

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C1	19.554	47.142	2.780	16.463	Mg	0.086	27.040	27.040	x
1A1b	2.634	47.142	4.092	16.463	Mg	0.067	21.190	48.230	x
1A4bi	1.733	47.142	1.896	16.463	Mg	0.027	8.624	56.854	x
1A1a	7.925	47.142	1.613	16.463	Mg	0.024	7.713	64.567	x
1A2f	3.368	47.142	2.138	16.463	Mg	0.020	6.425	70.993	x
1A3bvi	0.982	47.142	1.169	16.463	Mg	0.018	5.516	76.509	x
1A2d	2.242	47.142	0.146	16.463	Mg	0.014	4.253	80.762	x
1A2e	1.905	47.142	0.109	16.463	Mg	0.012	3.718	84.480	
1A5a	0.054	47.142	0.537	16.463	Mg	0.011	3.459	87.939	
1A2b	1.855	47.142	0.199	16.463	Mg	0.010	2.998	90.937	
1A4ci	0.331	47.142	0.519	16.463	Mg	0.009	2.696	93.633	
1A2a	0.760	47.142	0.003	16.463	Mg	0.006	1.755	95.388	
1A2gviii	1.037	47.142	0.155	16.463	Mg	0.004	1.387	96.775	
2C7c	0.52	47.142	0.017	16.463	Mg	0.004	1.103	97.877	
2C2	2.000	47.142	0.846	16.463	Mg	0.003	0.986	98.863	
1A4ai	0.097	47.142	0.129	16.463	Mg	0.002	0.635	99.498	
2G	0.006	47.142	0.020	16.463	Mg	0.0004	0.121	99.620	
1A2gvii	0.014	47.142	0.017	16.463	Mg	0.0002	0.078	99.698	
1A3bi	0.014	47.142	0.015	16.463	Mg	0.0002	0.067	99.765	
1A3biii	0.008	47.142	0.012	16.463	Mg	0.0002	0.059	99.824	

1A4cii	0.015	47.142	0.013	16.463	Mg	0.0002	0.051	99.875	
1A2c	0.029	47.142	0.005	16.463	Mg	0.0001	0.033	99.908	
1A4aii	0.008	47.142	0.008	16.463	Mg	0.0001	0.032	99.940	
1B1b	0.003	47.142	0.003	16.463	Mg	0.00004	0.013	99.953	
1A3bii	0.003	47.142	0.003	16.463	Mg	0.00004	0.012	99.965	
3F	0.005	47.142	0.003	16.463	Mg	0.00003	0.010	99.975	
1A3dii	0.03	47.142	0.012	16.463	Mg	0.00002	0.008	99.982	
1A4bii	0.001	47.142	0.001	16.463	Mg	0.00002	0.007	99.989	
2C7a	NO	47.142	0.001	16.463	Mg	0.00001	0.003	99.993	
1A4ciii	0.003	47.142	0.001	16.463	Mg	0.00001	0.003	99.996	
5C1bv	0.0001	47.142	0.0004	16.463	Mg	0.00001	0.002	99.998	
1A3biv	0.0001	47.142	0.0003	16.463	Mg	0.000005	0.002	100	
1A3c	0.003	47.142	0.001	16.463	Mg	0.000001	0.0004	100	
5E	0.003	47.142	0.001	16.463	Mg	0.0000001	0.00002	100	

Cu

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C7c	80.257	149.881	0.441	36.431	Mg	0.127	44.016	44.016	x
1A3bvi	42.326	149.881	26.319	36.431	Mg	0.107	37.009	81.025	x
1A1b	0.923	149.881	1.434	36.431	Mg	0.008	2.793	83.818	
2C7a	4.803	149.881	0.017	36.431	Mg	0.008	2.657	86.475	
2C1	5.540	149.881	0.329	36.431	Mg	0.007	2.350	88.825	
1A5a	0.084	149.881	0.794	36.431	Mg	0.005	1.786	90.611	
1A1a	7.273	149.881	2.435	36.431	Mg	0.004	1.541	92.151	
2G	0.203	149.881	0.596	36.431	Mg	0.004	1.263	93.415	
1A2f	1.287	149.881	0.834	36.431	Mg	0.003	1.204	94.619	
1A2gvii	0.486	149.881	0.568	36.431	Mg	0.003	1.039	95.658	
1A4ci	0.151	149.881	0.471	36.431	Mg	0.003	1.003	96.661	
1A4cii	0.499	149.881	0.434	36.431	Mg	0.002	0.723	97.384	
1A4bi	0.495	149.881	0.356	36.431	Mg	0.002	0.545	97.928	
1A4aii	0.285	149.881	0.263	36.431	Mg	0.001	0.447	98.375	
1A2b	0.503	149.881	0.0002	36.431	Mg	0.001	0.282	98.657	
1A2d	2.130	149.881	0.400	36.431	Mg	0.001	0.271	98.928	
1A2a	0.276	149.881	0.004	36.431	Mg	0.0004	0.146	99.074	
1A2e	0.847	149.881	0.143	36.431	Mg	0.0004	0.145	99.220	
1A3dii	0.100	149.881	0.086	36.431	Mg	0.0004	0.142	99.362	
2B10a	0.270	149.881	0.012	36.431	Mg	0.0004	0.124	99.485	
2C2	0.003	149.881	0.049	36.431	Mg	0.0003	0.112	99.597	
1A4bii	0.033	149.881	0.047	36.431	Mg	0.0003	0.089	99.686	
1A4ai	0.067	149.881	0.050	36.431	Mg	0.0002	0.077	99.763	
1A2gviii	0.823	149.881	0.231	36.431	Mg	0.0002	0.073	99.836	
2C6	NO	149.881	0.016	36.431	Mg	0.0001	0.038	99.874	
1A4ciii	0.049	149.881	0.026	36.431	Mg	0.0001	0.032	99.905	

1B1b	0.004	149.881	0.011	36.431	Mg	0.0001	0.023	99.928	
1A3c	0.103	149.881	0.034	36.431	Mg	0.0001	0.021	99.949	
1A3bi	0.010	149.881	0.010	36.431	Mg	0.0001	0.018	99.968	
1A3biii	0.006	149.881	0.008	36.431	Mg	0.00004	0.015	99.983	
1A2c	0.037	149.881	0.005	36.431	Mg	0.00003	0.009	99.992	
1A3bii	0.002	149.881	0.002	36.431	Mg	0.00001	0.003	99.995	
3F	0.002	149.881	0.001	36.431	Mg	0.00001	0.002	99.997	
5E	0.006	149.881	0.002	36.431	Mg	0.000004	0.002	99.999	
5C1bv	0.0001	149.881	0.0004	36.431	Mg	0.000002	0.001	100	
1A3biv	0.0001	149.881	0.0002	36.431	Mg	0.000001	0.0004	100	

Ni

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C7c	31.000	78.226	0.021	14.752	Mg	0.074	40.537	40.537	x
1A1b	1.879	78.226	1.654	14.752	Mg	0.017	9.041	49.578	x
1A4bi	2.031	78.226	1.661	14.752	Mg	0.016	8.897	58.475	x
1A2f	3.447	78.226	1.794	14.752	Mg	0.015	7.964	66.439	x
1A5a	2.572	78.226	1.323	14.752	Mg	0.011	5.834	72.273	x
2C7b	5.000	78.226	1.720	14.752	Mg	0.010	5.408	77.681	x
2C1	2.002	78.226	0.984	14.752	Mg	0.008	4.219	81.900	x
1A4ci	1.257	78.226	0.589	14.752	Mg	0.004	2.446	84.346	
1A2a	1.918	78.226	0.062	14.752	Mg	0.004	2.089	86.435	
1A2d	4.157	78.226	0.519	14.752	Mg	0.003	1.847	88.282	
1A2e	2.555	78.226	0.221	14.752	Mg	0.003	1.817	90.098	
1A1a	10.211	78.226	2.123	14.752	Mg	0.003	1.372	91.470	
1A2b	1.248	78.226	0.040	14.752	Mg	0.002	1.360	92.830	
1A2c	0.854	78.226	0.346	14.752	Mg	0.002	1.290	94.120	
1A3dii	1.280	78.226	0.423	14.752	Mg	0.002	1.260	95.381	
1A3bvi	0.141	78.226	0.168	14.752	Mg	0.002	0.985	96.366	
2B10a	1.052	78.226	0.059	14.752	Mg	0.002	0.971	97.337	
2C7a	0.508	78.226	0.0003	14.752	Mg	0.001	0.665	98.001	
1A2gviii	1.738	78.226	0.266	14.752	Mg	0.001	0.433	98.435	
2C2	0.017	78.226	0.063	14.752	Mg	0.001	0.416	98.851	
2G	0.025	78.226	0.048	14.752	Mg	0.001	0.301	99.152	
1A4ai	3.210	78.226	0.565	14.752	Mg	0.001	0.282	99.434	
1A2gvii	0.020	78.226	0.023	14.752	Mg	0.0003	0.137	99.570	
1A4ciii	0.056	78.226	0.029	14.752	Mg	0.0002	0.130	99.700	
1B1b	0.002	78.226	0.015	14.752	Mg	0.0002	0.099	99.799	
1A4cii	0.021	78.226	0.018	14.752	Mg	0.0002	0.098	99.896	
1A4aii	0.012	78.226	0.011	14.752	Mg	0.0001	0.060	99.956	
1A3bi	0.004	78.226	0.003	14.752	Mg	0.00003	0.016	99.973	
1A4bii	0.001	78.226	0.002	14.752	Mg	0.00002	0.012	99.984	
3F	0.002	78.226	0.001	14.752	Mg	0.00001	0.006	99.99	

1A3c	0.004	78.226	0.001	14.752	Mg	0.00001	0.004	99.994	
5C1bv	0.0001	78.226	0.0005	14.752	Mg	0.00001	0.003	99.998	
1A3biii	0.0002	78.226	0.0003	14.752	Mg	0.000003	0.002	99.999	
1A3biv	0.00003	78.226	0.0001	14.752	Mg	0.000001	0.001	100	
1A3bii	0.0002	78.226	0.0001	14.752	Mg	0.0000005	0.0003	100	

Se

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C7c	1.400	1.797	0.002	0.869	Mg	0.375	48.516	48.516	x
2C7a	0.050	1.797	0.515	0.869	Mg	0.273	35.303	83.819	x
1A4bi	0.181	1.797	0.267	0.869	Mg	0.100	12.863	96.682	
1A4ci	0.033	1.797	0.035	0.869	Mg	0.011	1.401	98.083	
1A4ai	0.010	1.797	0.016	0.869	Mg	0.006	0.799	98.883	
1A3bvi	0.008	1.797	0.010	0.869	Mg	0.003	0.431	99.314	
1A3dii	0.014	1.797	0.010	0.869	Mg	0.002	0.268	99.582	
1A2gvii	0.003	1.797	0.003	0.869	Mg	0.001	0.141	99.723	
1A4cii	0.003	1.797	0.003	0.869	Mg	0.001	0.082	99.805	
1A4aii	0.002	1.797	0.002	0.869	Mg	0.0004	0.053	99.858	
1A5a	0.001	1.797	0.001	0.869	Mg	0.0003	0.037	99.895	
5C1bv	0.0002	1.797	0.001	0.869	Mg	0.0003	0.035	99.930	
1A4ciii	0.006	1.797	0.003	0.869	Mg	0.0001	0.016	99.946	
3F	0.001	1.797	0.001	0.869	Mg	0.0001	0.016	99.962	
1A4bii	0.0002	1.797	0.0003	0.869	Mg	0.0001	0.013	99.975	
1A3bi	0.0004	1.797	0.0003	0.869	Mg	0.0001	0.011	99.985	
1A3c	0.001	1.797	0.0002	0.869	Mg	0.0001	0.007	99.992	
1A3biii	0.0001	1.797	0.0001	0.869	Mg	0.0001	0.007	99.999	
1A3bii	0.00004	1.797	0.00003	0.869	Mg	0.00001	0.001	100	
1A3biv	0.000003	1.797	0.00001	0.869	Mg	0.000004	0.0005	100	

Zn

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C1	303.559	677.124	1.734	118.741	Mg	0.076	27.867	27.867	x
1A4bi	26.195	677.124	37.388	118.741	Mg	0.048	17.746	45.613	x
2C7c	160.391	677.124	0.567	118.741	Mg	0.041	14.913	60.526	x
1A3bvi	17.150	677.124	18.316	118.741	Mg	0.023	8.284	68.810	x
1A1a	32.291	677.124	19.661	118.741	Mg	0.021	7.575	76.384	x
2C6	90.174	677.124	3.710	118.741	Mg	0.018	6.549	82.933	x
1A5a	0.417	677.124	10.714	118.741	Mg	0.016	5.758	88.691	
1A1b	3.959	677.124	6.151	118.741	Mg	0.008	2.953	91.644	

1A4ci	4.793	677.124	5.581	118.741	Mg	0.007	2.565	94.209	
1A2f	5.827	677.124	4.082	118.741	Mg	0.005	1.656	95.865	
1A2gviii	5.497	677.124	3.300	118.741	Mg	0.003	1.264	97.129	
1A4ai	1.637	677.124	2.261	118.741	Mg	0.003	1.068	98.197	
2C2	0.100	677.124	0.687	118.741	Mg	0.001	0.362	98.559	
2C7a	2.563	677.124	0.007	118.741	Mg	0.001	0.239	98.799	
2G	0.116	677.124	0.348	118.741	Mg	0.0005	0.177	98.976	
1A2gvii	0.286	677.124	0.334	118.741	Mg	0.0004	0.154	99.129	
2B10a	0.010	677.124	0.250	118.741	Mg	0.0004	0.134	99.264	
1A2d	15.22	677.124	2.437	118.741	Mg	0.0003	0.126	99.389	
1A2c	1.491	677.124	0.030	118.741	Mg	0.0003	0.125	99.515	
1A4cii	0.293	677.124	0.255	118.741	Mg	0.0003	0.110	99.625	
1A2a	1.151	677.124	0.014	118.741	Mg	0.0003	0.102	99.727	
1A4aii	0.168	677.124	0.155	118.741	Mg	0.0002	0.068	99.795	
1A2e	3.122	677.124	0.425	118.741	Mg	0.0002	0.066	99.861	
1A3dii	0.117	677.124	0.111	118.741	Mg	0.0001	0.049	99.910	
1A3bi	0.065	677.124	0.057	118.741	Mg	0.0001	0.025	99.935	
1A4bii	0.019	677.124	0.027	118.741	Mg	0.00004	0.013	99.948	
1A4ciii	0.067	677.124	0.035	118.741	Mg	0.00003	0.013	99.960	
1A3biii	0.018	677.124	0.025	118.741	Mg	0.00003	0.012	99.972	
3F	0.024	677.124	0.017	118.741	Mg	0.00002	0.007	99.979	
2C3	0.127	677.124	0.012	118.741	Mg	0.00001	0.005	99.984	
1A3c	0.060	677.124	0.020	118.741	Mg	0.00001	0.005	99.989	
1B1b	0.160	677.124	0.019	118.741	Mg	0.00001	0.005	99.994	
1A3bii	0.007	677.124	0.006	118.741	Mg	0.00001	0.003	99.997	
5C1bv	0.001	677.124	0.005	118.741	Mg	0.00001	0.002	99.999	
1A3biv	0.0005	677.124	0.001	118.741	Mg	0.000002	0.001	100	
1A2b	0.005	677.124	0.0004	118.741	Mg	0.000001	0.0003	100	

PCDD/F

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C1	4.552	18.041	0.557	13.402	g I-Teq	0.157	22.011	22.011	x
1A1a	1.309	18.041	3.391	13.402	g I-Teq	0.134	18.847	40.859	x
2B10a	3.000	18.041	0.031	13.402	g I-Teq	0.122	17.126	57.985	x
1B1b	1.461	18.041	2.592	13.402	g I-Teq	0.084	11.744	69.729	x
5E	3.034	18.041	1.103	13.402	g I-Teq	0.064	8.973	78.702	x
1A4bi	0.795	18.041	1.129	13.402	g I-Teq	0.030	4.202	82.904	x
2C3	0.526	18.041	0.885	13.402	g I-Teq	0.027	3.853	86.757	
1A5a	0.020	18.041	0.331	13.402	g I-Teq	0.017	2.459	89.216	
1A2gviii	0.399	18.041	0.537	13.402	g I-Teq	0.013	1.877	91.093	
2C7c	0.001	18.041	0.227	13.402	g I-Teq	0.013	1.762	92.855	
1A3bii	0.028	18.041	0.221	13.402	g I-Teq	0.011	1.558	94.412	
1A2d	1.032	18.041	0.906	13.402	g I-Teq	0.008	1.084	95.497	

2A2	0.005	18.041	0.129	13.402	g I-Teq	0.007	0.975	96.471	
2A1	0.152	18.041	0.015	13.402	g I-Teq	0.005	0.761	97.232	
1A4ci	0.149	18.041	0.184	13.402	g I-Teq	0.004	0.574	97.806	
1A2f	0.027	18.041	0.071	13.402	g I-Teq	0.003	0.400	98.206	
1A2c	0.061	18.041	0.008	13.402	g I-Teq	0.002	0.294	98.499	
1A3biii	0.217	18.041	0.128	13.402	g I-Teq	0.002	0.259	98.758	
1A4ai	0.057	18.041	0.074	13.402	g I-Teq	0.002	0.247	99.005	
2A3	0.029	18.041	0.0003	13.402	g I-Teq	0.001	0.168	99.174	
1A3bi	0.970	18.041	0.701	13.402	g I-Teq	0.001	0.152	99.325	
1A1b	0.023	18.041	0.036	13.402	g I-Teq	0.001	0.148	99.473	
1A3biv	0.014	18.041	0.029	13.402	g I-Teq	0.001	0.148	99.621	
2C6	0.017	18.041	0.028	13.402	g I-Teq	0.001	0.119	99.739	
1A2a	0.026	18.041	0.008	13.402	g I-Teq	0.001	0.090	99.829	
1A2e	0.043	18.041	0.022	13.402	g I-Teq	0.001	0.078	99.908	
1A3dii	0.026	18.041	0.016	13.402	g I-Teq	0.0002	0.026	99.934	
2L	0.016	18.041	0.009	13.402	g I-Teq	0.0002	0.023	99.956	
1A4ciii	0.007	18.041	0.004	13.402	g I-Teq	0.0001	0.012	99.969	
3F	0.023	18.041	0.016	13.402	g I-Teq	0.0001	0.011	99.980	
2D3b	0.016	18.041	0.011	13.402	g I-Teq	0.0001	0.009	99.988	
5C1bv	0.0002	18.041	0.001	13.402	g I-Teq	0.00003	0.005	99.993	
1A2b	0.002	18.041	0.001	13.402	g I-Teq	0.00003	0.004	99.997	
2G	0.001	18.041	0.00003	13.402	g I-Teq	0.00002	0.003	100	
1A3ei	0.00002	18.041	0.00002	13.402	g I-Teq	0.000001	0.0001	100	

PAH-4

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
1A1a	0.110	7.104	0.540	10.146	Mg	0.054	33.248	33.248	x
2C1	0.122	7.104	0.0005	10.146	Mg	0.024	15.022	48.270	x
1A4bi	5.873	7.104	8.283	10.146	Mg	0.015	9.091	57.361	x
1A2gviii	0.059	7.104	0.181	10.146	Mg	0.014	8.441	65.803	x
1B1b	0.258	7.104	0.458	10.146	Mg	0.013	7.733	73.536	x
1A2d	0.152	7.104	0.135	10.146	Mg	0.011	7.055	80.591	x
1A4ai	0.093	7.104	0.060	10.146	Mg	0.010	6.365	86.956	
1A4ci	0.09	7.104	0.082	10.146	Mg	0.007	4.032	90.987	
1A2e	0.013	7.104	0.003	10.146	Mg	0.002	1.342	92.330	
1A2c	0.013	7.104	0.005	10.146	Mg	0.002	1.168	93.498	
1A4cii	0.023	7.104	0.020	10.146	Mg	0.002	1.132	94.630	
1A3bi	0.072	7.104	0.095	10.146	Mg	0.001	0.727	95.357	
1A4aii	0.013	7.104	0.012	10.146	Mg	0.001	0.589	95.947	
1A2a	0.005	7.104	0.001	10.146	Mg	0.001	0.519	96.466	
1A2gvii	0.023	7.104	0.027	10.146	Mg	0.001	0.515	96.981	
1A2f	0.008	7.104	0.006	10.146	Mg	0.001	0.473	97.455	
1A3c	0.005	7.104	0.002	10.146	Mg	0.001	0.459	97.913	

1A3bii	0.016	7.104	0.018	10.146	Mg	0.001	0.397	98.310	
1A1b	0.006	7.104	0.013	10.146	Mg	0.001	0.387	98.697	
1A5a	0.046	7.104	0.061	10.146	Mg	0.001	0.369	99.066	
2D3i	0.02	7.104	0.026	10.146	Mg	0.0004	0.228	99.294	
1A3biii	0.077	7.104	0.108	10.146	Mg	0.0003	0.214	99.508	
1A2b	0.003	7.104	0.002	10.146	Mg	0.0003	0.184	99.692	
2G	0.001	7.104	0.001	10.146	Mg	0.0002	0.102	99.794	
2A1	0.0001	7.104	0.001	10.146	Mg	0.0002	0.097	99.891	
1A3biv	0.0005	7.104	0.001	10.146	Mg	0.0001	0.054	99.945	
5C1bv	0.0003	7.104	0.001	10.146	Mg	0.0001	0.051	99.996	
1A4bii	0.002	7.104	0.002	10.146	Mg	0.000003	0.002	99.998	
3F	0.00002	7.104	0.00001	10.146	Mg	0.000002	0.001	99.999	
2C2	NO	7.104	0.00001	10.146	Mg	0.000001	0.001	100	

HCB

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C7a	5.514	36.834	6.541	33.556	kg	0.041	35.356	35.356	x
3Df	1.207	36.834	0.015	33.556	kg	0.029	25.279	60.634	x
2B10a	29.000	36.834	25.500	33.556	kg	0.025	21.432	82.066	x
1A1a	0.037	36.834	0.416	33.556	kg	0.010	8.913	90.979	
1A4bi	0.189	36.834	0.267	33.556	kg	0.003	2.211	93.190	
2C1	0.096	36.834	0.013	33.556	kg	0.002	1.723	94.913	
1A2gviii	0.192	36.834	0.228	33.556	kg	0.001	1.239	96.152	
2C7c	0.032	36.834	0.070	33.556	kg	0.001	0.946	97.098	
1A3biii	0.059	36.834	0.083	33.556	kg	0.001	0.674	97.772	
1A2d	0.198	36.834	0.152	33.556	kg	0.001	0.664	98.436	
1A5a	0.001	36.834	0.016	33.556	kg	0.0004	0.359	98.795	
1A3bi	0.127	36.834	0.126	33.556	kg	0.0003	0.227	99.022	
1A4ci	0.033	36.834	0.037	33.556	kg	0.0002	0.170	99.192	
1A4ai	0.010	36.834	0.016	33.556	kg	0.0002	0.164	99.356	
2C3	0.033	36.834	0.035	33.556	kg	0.0001	0.111	99.467	
1A2c	0.005	36.834	0.0002	33.556	kg	0.0001	0.097	99.565	
5C1bv	0.001	36.834	0.004	33.556	kg	0.0001	0.075	99.639	
2D3i	0.004	36.834	0.001	33.556	kg	0.0001	0.061	99.700	
1A2a	0.003	36.834	0.0004	33.556	kg	0.0001	0.052	99.752	
1A4ciii	0.004	36.834	0.002	33.556	kg	0.00005	0.040	99.792	
1A3bii	0.019	36.834	0.019	33.556	kg	0.00005	0.040	99.832	
1A2b	0.002	36.834	0.0001	33.556	kg	0.00005	0.040	99.872	
1A3biv	0.001	36.834	0.002	33.556	kg	0.00005	0.039	99.911	
1A2f	0.004	36.834	0.002	33.556	kg	0.00004	0.035	99.946	
1A2e	0.003	36.834	0.001	33.556	kg	0.00003	0.028	99.974	
1A3dii	0.010	36.834	0.008	33.556	kg	0.00003	0.026	100	

PCB

NFR Code	Base year emission of the NFR category	Base year total emission	Year 2017 emission of the NFR category	Year 2017 total emission	Unit	Trend assessment	Contribution to trend. %	Cumulative total. %	Key source
2C1	13.464	28.550	14.396	25.862	kg	0.077	23.185	23.185	x
1A2d	1.909	28.550	0.037	25.862	kg	0.059	17.845	41.03	x
1B1b	1.753	28.550	3.111	25.862	kg	0.053	16.051	57.081	x
1A4bi	2.181	28.550	3.200	25.862	kg	0.043	12.912	69.993	x
1A2a	0.784	28.550	0.094	25.862	kg	0.022	6.498	76.491	x
1A2f	1.037	28.550	0.374	25.862	kg	0.020	5.954	82.445	x
1A2b	0.551	28.550	0.034	25.862	kg	0.016	4.903	87.348	
1A2c	0.538	28.550	0.026	25.862	kg	0.016	4.860	92.207	
1A1a	0.026	28.550	0.291	25.862	kg	0.009	2.823	95.031	
1A2e	0.298	28.550	0.124	25.862	kg	0.005	1.537	96.568	
1A4ai	0.117	28.550	0.190	25.862	kg	0.003	0.885	97.453	
2A1	3.298	28.550	3.068	25.862	kg	0.003	0.848	98.301	
1A4ci	0.391	28.550	0.423	25.862	kg	0.002	0.726	99.026	
1A2gviii	0.166	28.550	0.122	25.862	kg	0.001	0.296	99.322	
2A2	0.293	28.550	0.248	25.862	kg	0.001	0.176	99.498	
2C3	0.083	28.550	0.090	25.862	kg	0.001	0.160	99.658	
1A3dii	0.024	28.550	0.009	25.862	kg	0.0004	0.132	99.791	
2C7c	0.002	28.550	0.012	25.862	kg	0.0004	0.106	99.896	
5C1bv	0.003	28.550	0.012	25.862	kg	0.0003	0.093	99.989	
1A4ciii	0.002	28.550	0.001	25.862	kg	0.00003	0.009	99.997	
2C7a	0.001	28.550	0.0003	25.862	kg	0.00001	0.002	99.999	
1A3bi	0.0002	28.550	0.0001	25.862	kg	0.000002	0.0005	100	
1A3bii	0.00003	28.550	0.00005	25.862	kg	0.000001	0.0002	100	
1A3biii	0.00004	28.550	0.00003	25.862	kg	0.0000003	0.0001	100	
1A3biv	0.00001	28.550	0.00001	25.862	kg	0.0000001	0.00004	100	

Level assessment 2017

The results of the key category analysis for 2017 data by quantity are presented below.

NOx

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	17.461	17.461	x	3Da3	0.353	98.264	
1A2d	14.314	31.775	x	2B2	0.342	98.606	
1A3biii	11.044	42.818	x	1A2e	0.325	98.931	
1A3bi	10.462	53.281	x	1A4bii	0.243	99.173	
1A3dii	5.011	58.292	x	1A3biv	0.166	99.340	

1A2gvii	4.752	63.044	x	1A2b	0.142	99.482	
3Da1	4.268	67.311	x	1A3aii(i)	0.138	99.620	
1A4bi	4.145	71.457	x	3B1b	0.101	99.722	
1A3bii	3.667	75.124	x	3B4gii	0.061	99.783	
1A4cii	2.665	77.788	x	3F	0.059	99.842	
1A5a	2.510	80.299	x	3B4h	0.044	99.886	
1A2a	2.457	82.756		3B1a	0.031	99.917	
3Da2a	2.267	85.022		3B4gi	0.025	99.943	
1A4aii	1.989	87.011		3B4e	0.023	99.966	
1A1b	1.619	88.630		3B2	0.009	99.975	
1A2f	1.581	90.211		3B4giii	0.007	99.982	
1A2gviii	1.553	91.764		3B3	0.005	99.987	
1A4ciii	1.321	93.086		2G	0.005	99.992	
1A3c	1.086	94.172		3Da2b	0.002	99.994	
1A2c	1.078	95.249		3B4giv	0.002	99.997	
1A4ai	0.903	96.152		1A3ei	0.002	99.999	
1A4ci	0.822	96.973		2B10a	0.001	100	
1A3ai(i)	0.567	97.541		3B4d	0.0003	100	
1A5b	0.370	97.911					

NMVOC

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	24.673	24.673	x	1A2gviii	0.264	97.893	
2D3d	8.979	33.652	x	2C1	0.211	98.104	
3B1a	7.210	40.862	x	3B4gi	0.210	98.314	
2D3a	4.778	45.64	x	2D3c	0.198	98.511	
3B1b	4.479	50.119	x	3B2	0.192	98.703	
1B2aiv	3.427	53.545	x	3F	0.168	98.871	
1A3dii	3.345	56.891	x	1A3ai(i)	0.115	98.986	
1B2av	3.224	60.114	x	1A4ai	0.100	99.086	
1A4aii	3.127	63.241	x	5A	0.094	99.18	
3Da2a	2.863	66.105	x	1A4ciii	0.086	99.265	
2D3g	2.405	68.51	x	1A3c	0.085	99.351	
2B10a	2.361	70.871	x	2B10b	0.079	99.43	
2D3i	2.350	73.222	x	1B1b	0.075	99.505	
1A3bi	2.310	75.531	x	3Da3	0.073	99.578	
2H2	2.024	77.556	x	1A1b	0.070	99.648	
2H1	1.830	79.385	x	1A5b	0.065	99.713	
1A1a	1.807	81.192	x	1A3aii(i)	0.033	99.747	
1A3biv	1.627	82.819		3B4giii	0.033	99.78	
1A4cii	1.614	84.433		2A1	0.033	99.813	
1A3bv	1.597	86.029		1A2e	0.030	99.843	
2I	1.489	87.518		2C7b	0.026	99.869	

3B4h	1.328	88.846		2G	0.023	99.892	
1A2gvii	1.320	90.165		1A2a	0.022	99.913	
1A4bii	1.101	91.267		5D2	0.020	99.933	
3De	1.087	92.353		3B4giv	0.016	99.95	
2D3h	0.684	93.037		1A2f	0.012	99.961	
3B4gii	0.620	93.657		2C7c	0.011	99.973	
2D3e	0.575	94.232		5D1	0.011	99.983	
1A4ci	0.485	94.717		1A2c	0.006	99.989	
1A3biii	0.462	95.179		3B4d	0.005	99.994	
1A3bii	0.450	95.629		2C6	0.002	99.995	
2D3b	0.443	96.072		1A2b	0.001	99.997	
1A2d	0.366	96.438		2L	0.001	99.998	
3B3	0.33	96.769		2C2	0.001	99.999	
1A5a	0.305	97.074		2C7a	0.001	99.999	
3B4e	0.284	97.358		2A3	0.001	100	
1B2b	0.271	97.629		1A3ei	0.0001	100	

SOx

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	34.529	34.529	x	2C7b	0.108	99.743	
1A1b	16.949	51.478	x	1A3bi	0.078	99.821	
1A2b	8.884	60.362	x	1A3biii	0.042	99.863	
1A2d	6.919	67.280	x	1A3aii(i)	0.035	99.899	
2B10a	4.184	71.464	x	3F	0.031	99.929	
1A5a	3.659	75.122	x	2D3i	0.014	99.944	
1A4ai	3.097	78.219	x	1A2gvii	0.011	99.955	
2H1	2.799	81.018	x	2G	0.011	99.966	
1A4bi	2.573	83.591		1A3bii	0.010	99.976	
1A2f	2.307	85.898		1A4cii	0.009	99.985	
1A2c	2.157	88.054		1A4aii	0.005	99.991	
1A4ci	2.089	90.143		2C7c	0.003	99.993	
2C1	2.086	92.229		1A3biv	0.002	99.995	
1A2e	1.987	94.216		2C2	0.001	99.996	
1A2gviii	1.856	96.073		1A4bii	0.001	99.998	
1A2a	1.648	97.721		1A4ciii	0.001	99.999	
1B1b	1.125	98.846		2L	0.001	99.999	
2C7a	0.310	99.156		1A3c	0.001	100	
1A3dii	0.239	99.395		2D3g	0.0001	100	
1A3ai(i)	0.127	99.522		1A3ei	0.00001	100	
1A5b	0.113	99.635					

NH3

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
3Da2a	24.010	24.010	x	2L	0.086	99.682	
3B1a	15.845	39.855	x	1A3biii	0.085	99.768	
3B1b	15.499	55.354	x	2G	0.045	99.812	
3B3	9.162	64.516	x	1A4ci	0.039	99.851	
3B4h	8.321	72.837	x	1A3bii	0.033	99.883	
3Da1	6.005	78.842	x	3B4d	0.018	99.901	
1A4bi	3.784	82.626	x	1A4ai	0.017	99.918	
3Da3	2.978	85.604		2D3g	0.012	99.930	
1A3bi	2.824	88.429		1B1b	0.010	99.941	
3B4gi	2.252	90.680		5D1	0.010	99.951	
3B4e	2.097	92.777		1A2gvii	0.009	99.959	
3B4gii	2.066	94.843		1A1a	0.008	99.968	
5E	1.218	96.062		3Da2b	0.007	99.975	
2B10a	0.950	97.012		1A3biv	0.007	99.981	
2D3i	0.625	97.637		1A4cii	0.006	99.988	
3B2	0.500	98.136		1A2gviii	0.004	99.992	
5B1	0.285	98.421		1A4aii	0.003	99.995	
3F	0.240	98.661		1A3dii	0.003	99.998	
3B4giii	0.232	98.893		1A4ciii	0.001	99.999	
2C7b	0.222	99.115		1A3c	0.0005	99.999	
3B4giv	0.189	99.304		1A4bii	0.0004	100	
2H1	0.155	99.458		1A5a	0.0003	100	
2C1	0.138	99.596		2C7c	0.0001	100	

PM2.5

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	51.946	51.946	x	1A1b	0.142	99.148	
1A2d	7.921	59.867	x	1A5b	0.120	99.268	
1A3bvi	3.459	63.325	x	2L	0.105	99.373	
1B1c	3.230	66.556	x	1A2e	0.083	99.456	
1A3bvii	2.665	69.221	x	3B4h	0.07	99.526	
2H2	2.108	71.329	x	1A4bii	0.068	99.594	
1A1a	2.079	73.408	x	3B4gi	0.053	99.647	
1A2gvii	1.946	75.354	x	3B4gii	0.045	99.693	
1A3dii	1.807	77.161	x	3B4e	0.035	99.728	
1A3bi	1.802	78.963	x	1A2a	0.031	99.759	
1A3bii	1.770	80.733	x	2A3	0.031	99.790	
1A4aii	1.625	82.359		2C7c	0.030	99.820	

2B10a	1.455	83.813		1A3ai(i)	0.030	99.850	
1A4cii	1.379	85.192		2A5b	0.020	99.870	
1A5a	1.334	86.526		1A2b	0.020	99.890	
1A3biii	1.309	87.835		3B4giii	0.016	99.906	
2H1	1.266	89.101		3B3	0.012	99.919	
3Dc	1.095	90.196		1B1b	0.012	99.930	
3F	1.075	91.271		1B2aiv	0.010	99.941	
2C1	1.048	92.319		3B2	0.009	99.949	
1A4ci	0.947	93.266		2B10b	0.008	99.958	
1A4ai	0.762	94.028		2B6	0.008	99.965	
2C2	0.617	94.645		1A3aii(i)	0.007	99.972	
5E	0.600	95.245		5C1bv	0.006	99.978	
1A2gviii	0.53	95.775		3B4giv	0.005	99.982	
2D3i	0.516	96.291		2D3d	0.004	99.987	
2G	0.507	96.797		2D3g	0.004	99.991	
3B1a	0.359	97.156		2A2	0.003	99.993	
2D3b	0.328	97.484		2A5a	0.002	99.996	
1A2f	0.257	97.741		2C7a	0.002	99.998	
1A4ciii	0.228	97.970		1B2av	0.001	99.999	
1A2c	0.209	98.178		5A	0.0004	99.999	
1A3biv	0.199	98.377		3B4d	0.0003	100	
3B1b	0.179	98.556		2D3e	0.0002	100	
2A5c	0.160	98.716		2C3	0.0001	100	
1A3c	0.147	98.863		2I	0.0001	100	
2C7d	0.142	99.006					

PM10

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	32.794	32.794	x	3B1b	0.164	98.677	
1A3bvii	19.152	51.946	x	1A4ciii	0.142	98.819	
1A2d	6.676	58.622	x	1A2e	0.142	98.961	
3Dc	5.551	64.174	x	1A3biv	0.121	99.083	
1A1a	3.972	68.146	x	2L	0.100	99.183	
1A3bvi	3.746	71.892	x	1A3c	0.094	99.277	
1A5a	3.191	75.082	x	3B4h	0.085	99.362	
1B1c	2.806	77.889	x	2I	0.078	99.440	
2H2	1.324	79.213	x	1A5b	0.073	99.513	
2B10a	1.295	80.508	x	2A5b	0.057	99.571	
1A4ci	1.216	81.723		3B4giii	0.055	99.626	
1A2gvii	1.187	82.911		1A2a	0.046	99.672	
1A3dii	1.126	84.037		1A4bii	0.041	99.713	
1A3bi	1.099	85.136		2B10b	0.040	99.754	
1A3bii	1.080	86.216		3B4e	0.034	99.787	

2C7d	1.021	87.237		1B2aiv	0.030	99.817	
1A4aii	0.991	88.228		1A2b	0.022	99.839	
2H1	0.989	89.217		2C7c	0.022	99.861	
2A5c	0.948	90.165		2A3	0.021	99.882	
1A4cii	0.841	91.006		3B4giv	0.020	99.903	
1A2gviii	0.820	91.826		1A3ai(i)	0.018	99.921	
1A3biii	0.799	92.624		1B1b	0.017	99.938	
1A4ai	0.723	93.348		3B2	0.016	99.954	
2C1	0.695	94.043		2A5a	0.012	99.966	
3F	0.688	94.730		2A2	0.008	99.974	
2C2	0.533	95.263		2B6	0.005	99.979	
3B4gi	0.434	95.697		1A3aii(i)	0.004	99.983	
5E	0.366	96.063		2D3d	0.004	99.988	
1A2f	0.350	96.413		2D3g	0.004	99.992	
3B1a	0.337	96.749		5C1bv	0.003	99.995	
2D3i	0.335	97.084		5A	0.002	99.997	
2G	0.309	97.394		2C7a	0.0017	99.998	
3B4gii	0.276	97.669		3B4d	0.0005	99.999	
1A1b	0.263	97.933		1B2av	0.0004	99.999	
2D3b	0.218	98.151		2D3e	0.0004	100	
1A2c	0.198	98.348		2C3	0.0002	100	
3B3	0.165	98.513					

TSP

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A3bvii	25.626	25.626	x	2G	0.207	98.495	
1A4bi	22.885	48.511	x	2D3b	0.194	98.689	
1A5a	7.394	55.904	x	1A2c	0.154	98.843	
1A1a	5.897	61.802	x	3B4h	0.128	98.971	
1A2d	5.179	66.98	x	2A5b	0.116	99.087	
3Dc	3.714	70.694	x	1A4ciii	0.096	99.183	
1A3bvi	3.443	74.138	x	2L	0.089	99.273	
1B1c	2.869	77.007	x	2B10b	0.084	99.357	
1A4ci	2.182	79.189	x	1A3biv	0.081	99.438	
2A5c	1.622	80.811	x	1B2aiv	0.075	99.512	
2C7d	1.453	82.264		1A3c	0.067	99.579	
3B4gi	1.379	83.643		1A2a	0.053	99.632	
1A2gviii	1.234	84.877		3B4e	0.049	99.681	
2B10a	0.998	85.875		1A5b	0.049	99.730	
2H2	0.902	86.776		3B4giii	0.037	99.766	
1A2gvii	0.794	87.571		1A2b	0.03	99.796	
2H1	0.785	88.356		1B1b	0.028	99.824	
1A3dii	0.761	89.117		1A4bii	0.028	99.852	

1A3bi	0.736	89.852		3B2	0.025	99.876	
1A3bii	0.722	90.575		2C7c	0.024	99.900	
3B3	0.708	91.282		3B4giv	0.019	99.920	
1A4ai	0.680	91.962		2A5a	0.017	99.936	
1A4aii	0.663	92.625		2A3	0.016	99.952	
1A4cii	0.563	93.188		2A2	0.014	99.966	
2C1	0.562	93.750		1A3ai(i)	0.012	99.978	
1A3biii	0.534	94.284		2D3d	0.004	99.982	
1A1b	0.511	94.795		2D3g	0.003	99.985	
3B1a	0.493	95.288		2B6	0.003	99.988	
1A2f	0.474	95.762		1A3aii(i)	0.003	99.991	
3F	0.467	96.229		5C1bv	0.003	99.994	
2C2	0.420	96.649		5A	0.002	99.996	
3B4gii	0.369	97.018		2C7a	0.0018	99.998	
2I	0.290	97.308		3B4d	0.0008	99.999	
1A2e	0.256	97.565		2D3e	0.0006	100	
5E	0.245	97.809		1B2av	0.0003	100	
3B1b	0.240	98.049		2C3	0.0002	100	
2D3i	0.239	98.288					

BC

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	64.910	64.910	x	1A3biv	0.119	99.341	
1A2gvii	5.217	70.126	x	1A2f	0.111	99.452	
1A3bii	4.210	74.337	x	2H1	0.101	99.553	
1A3bi	4.070	78.406	x	1A2e	0.083	99.636	
1A3bvi	4.028	82.434	x	2D3b	0.081	99.717	
1A3biii	3.002	85.436		1A3ai(i)	0.064	99.781	
1A4cii	2.891	88.327		1A1b	0.054	99.835	
1A3bvii	2.255	90.582		1A4bii	0.044	99.879	
1A5a	1.660	92.242		2B10a	0.024	99.903	
1A4aii	1.547	93.789		1A2b	0.024	99.927	
1A3dii	1.297	95.086		1A2a	0.019	99.946	
1A4ai	0.656	95.742		2C1	0.016	99.962	
3F	0.579	96.322		1A3aii(i)	0.015	99.977	
1A1a	0.555	96.876		5C1bv	0.012	99.989	
1A3c	0.413	97.290		2G	0.010	99.999	
1A4ciii	0.316	97.606		2B6	0.001	100	
1A4ci	0.268	97.873		2A3	0.0001	100	
2C2	0.267	98.140		2A2	0.0001	100	
1A2d	0.257	98.398		2D3i	0.0001	100	
1A5b	0.248	98.646		1B1b	0.00003	100	
5E	0.226	98.872		2C3	0.00001	100	

1A2c	0.203	99.075		2C7a	0.000002	100	
1A2gviii	0.147	99.222					

CO

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	44.973	44.973	x	1A4ci	0.588	98.058	
1A4aii	9.198	54.171	x	1A5b	0.311	98.368	
1A3bi	8.045	62.217	x	1A2a	0.302	98.670	
1A4bii	7.052	69.269	x	1A1b	0.283	98.953	
1A2d	5.509	74.778	x	1A4ai	0.277	99.23	
1A3dii	5.377	80.156	x	1A3ai(i)	0.206	99.437	
1A1a	3.745	83.901		2C1	0.165	99.601	
1A4cii	2.627	86.528		1A3aii(i)	0.082	99.684	
1A5a	2.357	88.885		1A2c	0.076	99.760	
1A2gvii	2.078	90.963		1A4ciii	0.070	99.830	
1A3biv	1.844	92.807		2G	0.054	99.884	
1A2f	1.345	94.152		1A3c	0.051	99.935	
1A3biii	0.987	95.139		1A2e	0.049	99.983	
1A2gviii	0.891	96.031		1A2b	0.014	99.998	
1A3bii	0.757	96.787		2C7a	0.002	100	
3F	0.682	97.470		1A3ei	0.0003	100	

Pb

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A2d	25.816	25.816	x	1A3dii	0.081	99.804	
1A1b	20.898	46.715	x	1A2a	0.048	99.852	
1A1a	12.997	59.712	x	1B1b	0.024	99.877	
1A2f	11.320	71.031	x	1A4ciii	0.024	99.901	
2G	6.557	77.588	x	2C6	0.023	99.924	
1A5a	4.869	82.457	x	1A3bi	0.016	99.940	
1A4bi	3.651	86.108		3F	0.014	99.954	
2C7c	2.711	88.819		2C7a	0.013	99.967	
1A3bvi	2.703	91.522		2C3	0.008	99.975	
1A4ci	2.631	94.153		2B10a	0.006	99.982	
2C1	2.340	96.493		5C1bv	0.005	99.987	
1A2gviii	1.322	97.815		1A2b	0.005	99.992	
1A2e	0.846	98.661		1A3biii	0.004	99.997	
1A4ai	0.578	99.239		5E	0.002	99.999	
1A2c	0.209	99.448		1A3bii	0.001	100	
1A3aii(i)	0.173	99.621		1A3biv	0.0004	100	

2C2	0.103	99.724					

Cd

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A2d	32.306	32.306	x	1A4aii	0.162	99.457	
1A4bi	16.799	49.104	x	1A3dii	0.108	99.565	
1A1a	15.448	64.553	x	2C3	0.089	99.654	
1A5a	8.072	72.625	x	5E	0.064	99.718	
1A1b	7.752	80.377	x	1A2c	0.052	99.770	
1A2f	4.642	85.018		2C2	0.031	99.801	
1A4ci	2.791	87.810		1A3bi	0.031	99.832	
1A2gviii	2.123	89.933		1A4ciii	0.030	99.863	
2G	2.087	92.019		1A4bii	0.029	99.892	
3F	2.061	94.080		1A2a	0.022	99.914	
2C6	1.387	95.467		1A3c	0.021	99.935	
1A4ai	1.071	96.538		2C7a	0.021	99.956	
2C7c	1.052	97.591		1B1b	0.019	99.974	
2C1	0.571	98.162		5C1bv	0.015	99.989	
1A2gvii	0.350	98.511		1A3biii	0.0072	99.996	
1A2e	0.337	98.849		1A3bii	0.0018	99.998	
1A4cii	0.267	99.116		1A2b	0.001	99.999	
1A3bvi	0.179	99.295		1A3biv	0.001	100	

Hg

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	25.276	25.276	x	1A2e	0.513	98.088	
1A2d	21.545	46.821	x	1A3dii	0.463	98.551	
2C1	15.778	62.599	x	1A4ai	0.335	98.885	
2B10a	8.872	71.471	x	2C2	0.311	99.196	
1A4bi	4.679	76.150	x	1A3bii	0.296	99.493	
1A2f	4.652	80.802	x	1A4ciii	0.151	99.644	
5C1bv	2.888	83.690		2C6	0.121	99.765	
1A3bi	2.680	86.370		5E	0.106	99.870	
1A1b	2.627	88.997		1A3biv	0.060	99.930	
1A2gviii	2.415	91.411		1A2c	0.037	99.967	
1A4ci	1.503	92.915		1A2a	0.017	99.984	
1A5a	1.376	94.291		2G	0.013	99.997	
2C7c	1.358	95.649		1B1b	0.002	99.999	
1A3biii	1.266	96.915		2C7a	0.001	99.999	
3F	0.66	97.575		1A2b	0.001	100	

As

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	28.260	28.260	x	1A2c	0.121	99.568	
1A1b	21.892	50.152	x	1B1b	0.100	99.668	
1A2f	11.697	61.849	x	2G	0.071	99.739	
2C7c	10.147	71.997	x	1A2a	0.059	99.799	
1A4ci	6.795	78.792	x	1A4ciii	0.048	99.846	
1A2d	6.697	85.488	x	5E	0.040	99.886	
1A4bi	2.740	88.229		2C3	0.039	99.925	
1A2e	2.205	90.434		2C2	0.025	99.950	
2C7a	1.959	92.393		1A3bi	0.019	99.969	
2C1	1.616	94.009		5C1bv	0.016	99.985	
1A3bvi	1.553	95.561		1A3biii	0.006	99.991	
2C6	1.165	96.726		3F	0.005	99.996	
1A5a	0.873	97.599		1A2b	0.002	99.998	
1A2gviii	0.756	98.355		1A3bii	0.001	100	
1A4ai	0.661	99.016		1A3biv	0.0005	100	
1A3dii	0.431	99.447					

Cr

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1b	24.859	24.859	x	1A3bi	0.091	99.596	
2C1	16.889	41.747	x	1A4cii	0.078	99.674	
1A2f	12.987	54.734	x	1A3dii	0.071	99.745	
1A4bi	11.519	66.253	x	1A3biii	0.071	99.817	
1A1a	9.797	76.05	x	1A4aii	0.047	99.864	
1A3bvi	7.100	83.150	x	1A2c	0.031	99.894	
2C2	5.139	88.289		3F	0.019	99.914	
1A5a	3.261	91.549		1B1b	0.018	99.932	
1A4ci	3.154	94.703		1A3bii	0.016	99.948	
1A2b	1.208	95.912		1A2a	0.016	99.964	
1A2gviii	0.939	96.850		1A4ciii	0.009	99.973	
1A2d	0.887	97.738		1A4bii	0.008	99.981	
1A4ai	0.783	98.520		1A3c	0.006	99.987	
1A2e	0.660	99.180		5E	0.006	99.993	
2G	0.123	99.304		2C7a	0.003	99.996	
1A2gvii	0.102	99.405		5C1bv	0.002	99.998	
2C7c	0.100	99.506		1A3biv	0.002	100	

Cu

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A3bvi	72.245	72.245	x	2C2	0.135	99.463	
1A1a	6.685	78.930	x	1A4bii	0.128	99.591	
1A1b	3.937	82.867	x	1A3c	0.093	99.685	
1A2f	2.290	85.157		1A4ciii	0.070	99.755	
1A5a	2.180	87.337		2C7a	0.046	99.801	
2G	1.637	88.974		2C6	0.045	99.846	
1A2gvii	1.560	90.534		2B10a	0.033	99.879	
1A4ci	1.293	91.827		1B1b	0.030	99.909	
2C7c	1.210	93.037		1A3bi	0.028	99.937	
1A4cii	1.192	94.229		1A3biii	0.022	99.959	
1A2d	1.099	95.328		1A2c	0.014	99.973	
1A4bi	0.978	96.306		1A2a	0.010	99.983	
2C1	0.902	97.208		5E	0.006	99.989	
1A4aii	0.721	97.930		1A3bii	0.005	99.994	
1A2gviii	0.635	98.565		3F	0.004	99.998	
1A2e	0.392	98.957		5C1bv	0.001	99.999	
1A3dii	0.235	99.192		1A2b	0.001	99.999	
1A4ai	0.136	99.329		1A3biv	0.001	100	

Ni

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	14.390	14.390	x	2G	0.326	98.880	
1A2f	12.165	26.554	x	1A2b	0.271	99.150	
2C7b	11.66	38.214	x	1A4ciii	0.198	99.348	
1A4bi	11.262	49.476	x	1A2gvii	0.159	99.507	
1A1b	11.209	60.685	x	2C7c	0.140	99.647	
1A5a	8.971	69.657	x	1A4cii	0.121	99.768	
2C1	6.670	76.326	x	1B1b	0.099	99.867	
1A4ci	3.990	80.316	x	1A4aii	0.073	99.940	
1A4ai	3.830	84.146		1A3bi	0.021	99.962	
1A2d	3.515	87.661		1A4bii	0.013	99.975	
1A3dii	2.864	90.525		1A3c	0.010	99.984	
1A2c	2.348	92.873		3F	0.008	99.992	
1A2gviii	1.800	94.674		5C1bv	0.003	99.995	
1A2e	1.496	96.170		1A3biii	0.002	99.997	
1A3bvi	1.141	97.310		2C7a	0.002	99.999	
2C2	0.427	97.738		1A3biv	0.001	99.999	
1A2a	0.417	98.155		1A3bii	0.001	100	

2B10a	0.399	98.554					

Se

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
2C7a	59.284	59.284	x	1A4aii	0.178	99.622	
1A4bi	30.681	89.965	x	1A5a	0.102	99.724	
1A4ci	4.051	94.016		3F	0.097	99.821	
1A4ai	1.810	95.826		5C1bv	0.065	99.886	
1A3dii	1.203	97.029		1A3bi	0.039	99.925	
1A3bvi	1.163	98.191		1A4bii	0.032	99.956	
1A2gvii	0.385	98.576		1A3c	0.023	99.979	
1A4ciii	0.335	98.911		1A3biii	0.016	99.995	
1A4cii	0.294	99.205		1A3bii	0.004	99.999	
2C7c	0.239	99.444		1A3biv	0.001	100	

Zn

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	31.487	31.487	x	2B10a	0.211	99.544	
1A1a	16.558	48.045	x	1A4aii	0.130	99.674	
1A3bvi	15.425	63.47	x	1A3dii	0.094	99.768	
1A5a	9.023	72.493	x	1A3bi	0.048	99.816	
1A1b	5.180	77.673	x	1A4ciii	0.029	99.846	
1A4ci	4.700	82.373	x	1A2c	0.025	99.871	
1A2f	3.438	85.810		1A4bii	0.023	99.894	
2C6	3.124	88.935		1A3biii	0.021	99.915	
1A2gviii	2.779	91.714		1A3c	0.017	99.932	
1A2d	2.052	93.766		1B1b	0.016	99.948	
1A4ai	1.904	95.670		3F	0.014	99.962	
2C1	1.460	97.130		1A2a	0.012	99.974	
2C2	0.579	97.708		2C3	0.010	99.984	
2C7c	0.477	98.186		2C7a	0.006	99.990	
1A2e	0.358	98.544		1A3bii	0.005	99.995	
2G	0.293	98.837		5C1bv	0.004	99.999	
1A2gvii	0.282	99.118		1A3biv	0.001	100	
1A4cii	0.215	99.334		1A2b	0.0003	100	

PCDD/F

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	25.302	25.302	x	2B10a	0.231	98.751	
1B1b	19.342	44.644	x	1A3biv	0.220	98.970	
1A4bi	8.428	53.072	x	2C6	0.209	99.179	
5E	8.228	61.300	x	1A2e	0.165	99.344	
1A2d	6.761	68.06	x	1A3dii	0.117	99.461	
2C3	6.607	74.667	x	3F	0.116	99.577	
1A3bi	5.233	79.900	x	2A1	0.115	99.692	
2C1	4.156	84.056	x	2D3b	0.079	99.771	
1A2gviii	4.009	88.065		2L	0.066	99.836	
1A5a	2.468	90.532		1A2a	0.060	99.897	
2C7c	1.692	92.224		1A2c	0.058	99.955	
1A3bii	1.650	93.874		1A4ciii	0.028	99.983	
1A4ci	1.373	95.247		1A2b	0.009	99.992	
2A2	0.963	96.210		5C1bv	0.006	99.997	
1A3biii	0.953	97.163		2A3	0.002	100	
1A4ai	0.551	97.715		2G	0.0003	100	
1A2f	0.533	98.248		1A3ei	0.0002	100	
1A1b	0.272	98.519					

PAH-4

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	81.639	81.639	x	1A4aii	0.122	99.748	
1A1a	5.326	86.965		1A2f	0.062	99.810	
1B1b	4.514	91.479		1A2c	0.048	99.858	
1A2gviii	1.789	93.268		1A2e	0.029	99.887	
1A2d	1.332	94.599		1A4bii	0.022	99.909	
1A3biii	1.066	95.665		1A2b	0.019	99.928	
1A3bi	0.934	96.599		1A3c	0.016	99.944	
1A4ci	0.812	97.411		1A3biv	0.013	99.957	
1A5a	0.606	98.017		2A1	0.013	99.970	
1A4ai	0.587	98.603		5C1bv	0.009	99.979	
1A2gvii	0.264	98.867		2G	0.008	99.987	
2D3i	0.253	99.120		1A2a	0.008	99.995	
1A4cii	0.201	99.321		2C1	0.004	100	
1A3bii	0.178	99.499		3F	0.0001	100	
1A1b	0.127	99.626		2C2	0.0001	100	

HCB

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
2B10a	76.147	76.147	x	1A4ai	0.047	99.848	
2C7a	19.531	95.679	x	3Df	0.045	99.893	
1A1a	1.243	96.922		2C1	0.040	99.933	
1A4bi	0.797	97.718		1A3dii	0.024	99.957	
1A2gviii	0.477	98.196		5C1bv	0.013	99.970	
1A2d	0.455	98.650		1A3biv	0.007	99.977	
1A3bi	0.375	99.026		1A4ciii	0.007	99.984	
1A3biii	0.248	99.274		1A2f	0.006	99.99	
2C7c	0.209	99.483		2D3i	0.004	99.994	
1A4ci	0.110	99.593		1A2e	0.004	99.998	
2C3	0.103	99.696		1A2a	0.001	99.999	
1A3bii	0.058	99.753		1A2c	0.001	100	
1A5a	0.048	99.801		1A2b	0.0004	100	

PCB

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
2C1	55.664	55.664	x	1A2d	0.142	99.637	
1A4bi	12.374	68.039	x	1A2b	0.130	99.767	
1B1b	12.028	80.066	x	1A2c	0.101	99.868	
2A1	11.864	91.930		5C1bv	0.045	99.913	
1A4ci	1.634	93.565		2C7c	0.045	99.958	
1A2f	1.447	95.012		1A3dii	0.036	99.994	
1A1a	1.126	96.138		1A4ciii	0.004	99.998	
2A2	0.960	97.098		2C7a	0.001	99.999	
1A4ai	0.733	97.831		1A3bi	0.001	100	
1A2e	0.479	98.311		1A3bii	0.0002	100	
1A2gviii	0.471	98.782		1A3biii	0.0001	100	
1A2a	0.363	99.145		1A3biv	0.00003	100	
2C3	0.350	99.495					

1.6 QA/QC, verification and treatment of confidentiality issues

Changes in chapter	
Update of text	May 2018 KS, JM

1.6.1 Quality system

A quality management system is used to support the preparation of the air pollutant emissions inventory. QA/QC procedures have been implemented in the inventory work since the inventory of the year 2003 emissions carried out in 2005 they follow the principles carried out in the Finnish greenhouse gas emission inventory http://tilastokeskus.fi/tup/khkinv/khkaasut_laadunhallinta_en.html.

Due to the pending recalculation of energy sector emissions, there are currently constrains in following the QA/QC practices in many quality checks, e.g. where data for the previous years would need to be corrected due to the fact that it is impossible to track the data where the desired corrections should be made. After the finalization of the recalculation of energy sector emissions, these corrections will be carried out.

1.6.2 Quality plan and QA/QC procedures

Quality plan

The QA/QC plan covers quality objectives and the planned general quality control and quality assurance procedures regarding all sectors. The checklist in Table 1.6 specifies the actions, schedules and responsibilities in order to attain the quality objectives and to provide confidence in the preparation of high-quality inventories.

The QC procedures comply with those set in the EMEP/EEA Emission Inventory Guidebook 2009. General inventory QC procedures include routine checks of the integrity, correctness and completeness of the data, identification of errors and deficiencies, documentation and archiving of the inventory data as well as quality control actions.

Table 1.6 Quality objectives (* means restricted applications due to availability of resources)

Inventory principle	Quality objectives
1.Continuous improvement	1.1. Treatment of review feedback is systematic 1.2. Improvements are indicated in Informative Inventory Report and carried out* 1.3. Improvement of the inventory is systematic * 1.4. Inventory quality control procedures meet the requirements * 1.5. Inventory quality assurance is appropriate and sufficient*
2. Transparency	2.1. Archiving of the inventory is systematic and complete 2.2. Internal documentation of calculations supports emission and removal estimates 2.3. NFR tables and Informative Inventory Report include transparent and appropriate descriptions of emission estimates and of their preparation
3. Consistency	3.1. The time series are consistent * 3.2. Data have been used in a consistent manner in the inventory *
4. Comparability	4.1. The methodologies and formats used in the inventory meet comparability requirements

5. Completeness	5.1. The inventory covers all emission sources, pollutants and geographic areas
6. Accuracy	6.1. Estimates are systematically neither higher nor lower than the true emissions or removals 6.2. Calculations are performed correctly 6.3. Inventory uncertainties are estimated
7. Timeliness	7.1. Inventory reports submitted within the set time

Applied QA/QC procedures

Internal review

Normal statistical quality checks and comparisons to the previous years' data are implemented in the preparation of the inventory.

For the energy and industrial processes sectors compliance data reported by the plants have been used where applicable. The quality checks performed to the compliance data are explained in Chapter 2.4. The corrections made to the year 2014 compliance data are documented in Annex 4 of Part 2 of the IIR.

Category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

QA reviews performed after the implementation of QC procedures concerning the finalised inventory comprise comparisons and checks to assess procedures already taken and to identify areas where improvements could be made. Specific QA actions include basic reviews of the draft report, data verification with other available datasets and information sources. The data and documentation are cross-checked by several experts not involved in the area where they do the checks.

QA/QC tools

In 2017-2018 a series of tools was developed to manage the data in the IPTJ and to compile, analyse and correct the NFR output data. The tools were applied in the recalculation of the time series 1990-2016 reported on 13th April 2018.

The tools consist of a variation of solutions, techniques and manual routines to manage the content of over two million rows or air emission data. The tools connect directly to the IPTJ and allow the latest information to be always available in a comprehensive format. The embedded check-ups find inconsistent notation keys, strongly deviating values, gaps in emission data and trend progression analysis (remark on sudden decrease or increase) and general value validity. Also notation key management tools are included.

The tools enable comparisons between datasets by highlighting emission rates that increase or decrease over a selected tolerance. It also highlights cells to which IPTJ contains updated values. In such cases, the changes can be exported to the NFR reporting sheet instantaneously for the selected year, range of years or all years. This enables agile and adjustable control over the whole time series.

The time series for national totals or individual NFR-categories can be evaluated with an index value that is constructed by analysing the standard deviation of the series and the count of points of discontinuity. The indexing helps in directing focus into the most relevant subjects. All values are also visually enhanced to create a visual overview of series consistency. A more detailed description of the tools is presented in Annex 6.

Inter-comparisons

Close cooperation is carried out with the Finnish Greenhouse Gas Inventory Unit at Statistics Finland, to maintain comparability and to discuss improvements and their impacts on both air pollutant and greenhouse gas inventories. Annual inventories are compared and possible differences discussed and corrective actions made in both inventories where relevant.

External review

CLRTAP S1 and S2 review results by the review conducted by the CEIP are used to identify deficiencies and errors in the data. Due to resource constraints, this part will be re-introduced to the quality checks only when the time series has been recalculated

CLRTAP 2009 and 2018 S3 review results as well as NECD Technical Reviews' results 2017 and 2018 have been addressed in Chapter Recalculations

1.6.3 Implementation of the QA/QC plan in the preparation of the 2016 data

The leading principle has been that certain source categories or certain types of quality measures to solve systematic errors are taken under work during one inventory year.

Implementation of quality control and assurance measures has seriously been restricted the last years due to the lack of time between the finalization of the inventory and the reporting date, which should preferably cover one month or at the minimum two weeks, instead of the current few days.

QA/QC measures are carried out separately for each of the boxes illustrated in Figure 1.14 as follows:

1. dark blue boxes cover calculation in MSExcel sheets where data checking and comparison is mostly visual but rather straight forward, and the data used comes from statistics, industrial organizations or research
2. light blue boxes cover database tables within the IPTJ data system with inbuilt check operations; these data are also compared, where possible, against environmental reports by plants and E-PRTR data, both of which are also used in the inventory, as well as statistics and expert institutes
3. light red boxes include data, which is cross-checked between Statistics Finland data sets for fuels and emissions at CRF classification level, as well as comparisons to EU ETS data, which is also used in the inventory
4. the final results are manually compiled for 1980-19889 into the NFR table; for 1990-2016 the IPTJ QA/QC tool is use both to compile the NFR tables and to check the data.
5. Manual comparison against CRF data is carried out before the reporting, Deviations larger than 5% are explained in the IIR Chapter x.

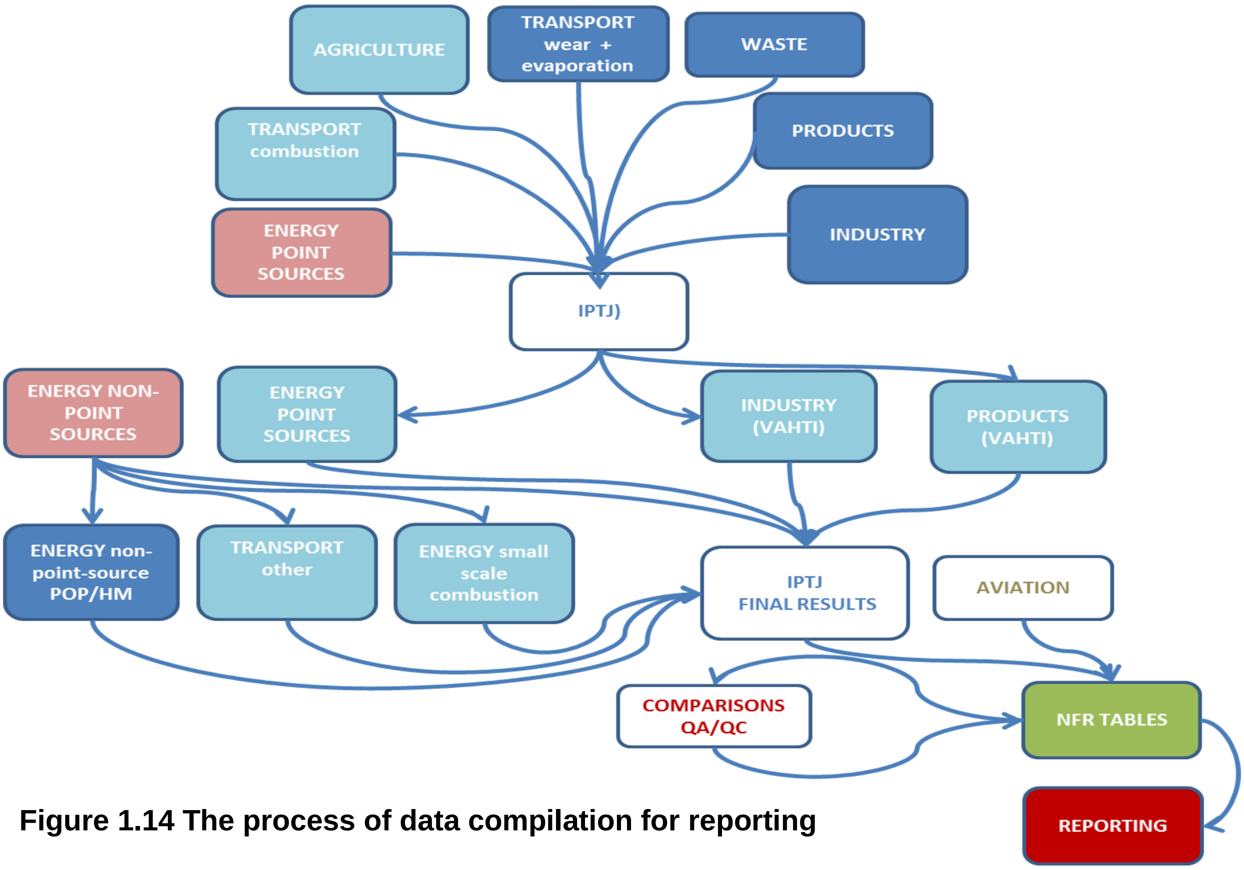


Figure 1.14 The process of data compilation for reporting

1.6.4 Documentation

Documentation of the calculation methods is updated whenever there are changes in the methods or new sources are included in the inventory. The documentation is carried out in the working guidelines available for each source sector (in Finnish). Notes and explanations for deviating values are recorded in the calculation sheets.

A summary of improvements made in the inventory submitted in February 2019 is presented in Chapter 14.

1.6.5 Archiving of the inventory

The annually reported NFR tables, calculation sheets and documentation of the methods together with the records of the original data are archived at the Finnish Environment Institute. The original data sets and calculation results are stored in databases on a SQL server.

1.6.6 Verification

The inter-comparison explained in Chapter 1.4 is carried out annually. The inventory has not yet been verified by a third party.

1.6.7 Treatment of confidential issues

When confidential information is used for the preparation of the inventory, this data is handled and stored in a way that ensures the confidentiality to remain. When confidential data is included in the reported emissions, the emissions are aggregated so that disclosure of confidential information is not possible.

1.7 Uncertainties

Changes in chapter	
May 2018	TF KS

1.7.1 Methodology

The uncertainty analysis for emission data is carried out at NFR subcategory 3 level for the actual emission sources. The method is Monte Carlo simulation (Tier 2) using @Risk software. The uncertainties of the input parameters are estimated by experts compiling the inventories and those of the measured emissions by the competent authorities that supervise emission monitoring carried out at the individual plants. The emissions of some pollutants from certain sources are poorly understood, for instance some POP compounds from fuel combustion and industrial processes, and therefore estimation of their uncertainty is found to be very challenging at the moment.

The uncertainty analysis covers all emission sources included in the inventory and represents thus the uncertainty of the reported emission data. The possible lack of completeness of emission sources is, however, not reflected in the uncertainty analysis. Information of the completeness of the inventory is presented in Chapter 2.8.

The uncertainty analysis is carried out at the country-level, i.e. uncertainties in emissions by region are not assessed.

Uncertainties are expressed as bounds of 95% confidence interval as percent relative to the mean value as recommended in the GPG.

In this uncertainty analysis, two different types of distributions are used. These are

- Normal distribution, which is used in case uncertainties are symmetrical and <±100%.
- Beta distribution, which are used in case uncertainty is asymmetric, because the upper boundary exceeded 100% (positively skewed Beta distribution)

In cases where positively skewed Beta distribution was used, the uncertainty was high the upper boundary (>100% and up to 1000%) lower boundary close to 0 (-100%) and mean significantly closer to the lower boundary than the higher one. The distribution function that fitted all these conditions was found to be Beta distribution (@Risk function RiskBetaGeneral) with parameters as specified below:

Alpha1=1 (this shape parameter was kept constant)
Alpha2 defined using mean, Alpha1 and min and max
Min=0
Max=upper boundary.

This distribution type was used for all positively skewed uncertainties. Examples of a RiskBetaGeneral functions are presented below in Figures 1.15 for a cases where the upper bound of uncertainty is +1000% and +120%, respectively. The distribution function is inside Excel's If-function (the user language is Finnish; JOS means IF).

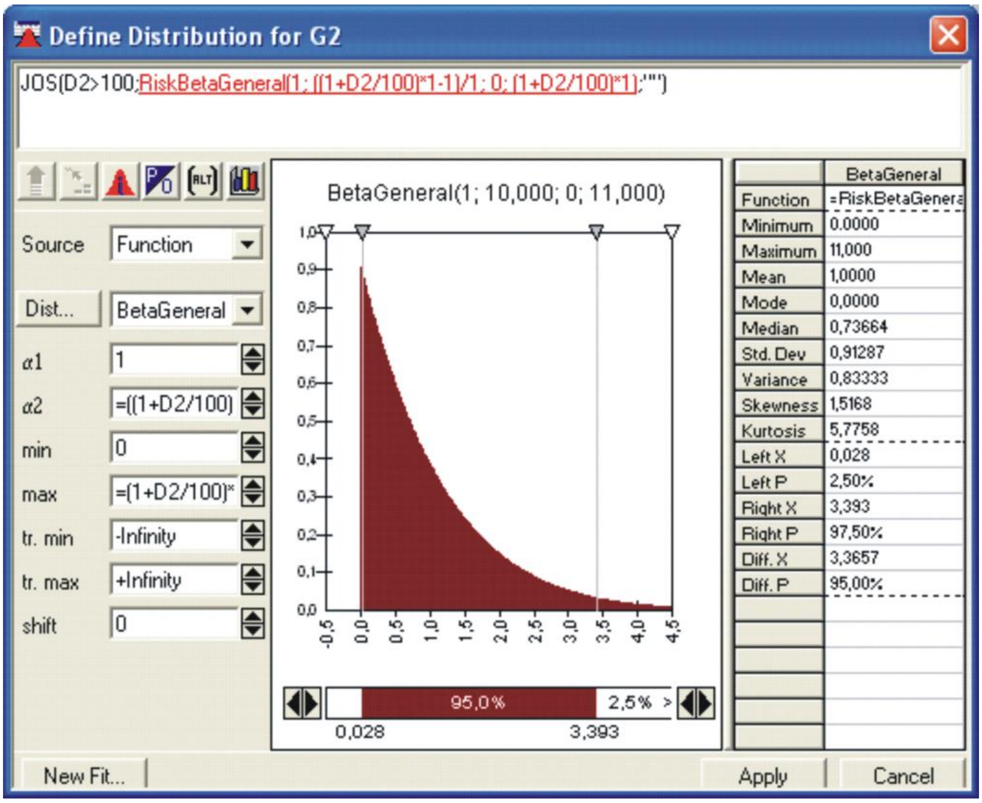


Figure 1.15. An example of the applied beta distribution. The function used can be seen on the top of the picture (JOS = IF in Finnish and cell D2 contains the uncertainty percentage).

Appropriate aggregation of data for the uncertainty analysis is important to avoid over- or underestimation of uncertainty due to correlations. The following assumptions are used in the aggregation level:

- Point source data reported by the plants: emission estimates reported by the operators are considered to be independent. Therefore, uncertainties have been applied separately to the emission estimates of each plant.
- Calculated emissions: Before calculation of uncertainty, those emission sources (e.g. point sources) having the same emission factor were grouped together, and the same uncertainty applied to the whole group. This reflects the situation that the emission factor uncertainties are correlated across, for instance, different plants. This may overestimate uncertainty when the same emission factor is used for different plants and the real emissions vary notably between these plants (uncertainties potentially cancelling each other) because there are also other factors than technology and fuel affecting the emissions (such as plant operation).
- Emission factors are considered independent across the different sectors, technologies and fuels. This may underestimate uncertainties in the case the emission factors for different

technologies are derived from the same data. It can roughly be assumed that this underestimation cancels potential overestimation presented in previous bullet.

- Emission estimates of different pollutants are considered to be independent.
- Activity data are considered to be as independent.
- The fuel use uncertainties are the same Statistics Finland uses in the UC analysis for the Finnish greenhouse gas inventory. Thus the fuels are grouped - and the fuel consumption summed up - using the same grouping as Statistics Finland: Solid, Liquid, Gaseous, Biomass and Other fuels.

1.7.2 Uncertainty of the trend

Finland has not yet carried out a trend UC assessment due to inconsistency of methods used throughout the time series. However, the principles for such an analysis for the Finnish data are presented below.

For the purposes of the trend uncertainty analysis, uncertainty of the base year emissions and the current year are needed. The base year depends on the emission compound as presented in the Table 1.7 below. In addition, to ensure comparability between compounds, the uncertainties were also estimated for the year 1990 for all the compounds.

Table 1.7 Base years for Finland for the pollutants regulated under the UNECE Convention of Long-Range Transboundary Air Pollution.

Compound	Base year
SO_2	1980
NO_x	1987
CO	1980 *
NH_3	1980 *

Compound	Base year
NMVOC	1988
HM	1990
TSP	2000 *
POP	1994

* For CO, NH_3 and TSP there is no Protocol base

The methodology to be used for calculating the trend uncertainty will follow, when implemented, the assumptions listed below:

- activity data were estimated independent between years
- emission data reported by the plants were estimated independent between years
- emission factors were assumed to correlate between years in case the same emission factors were used, and uncertainties for both years were estimated equal
- emissions which were estimated using completely different system (e.g. emissions for the year 1980) were assumed independent from the latest year estimate
- to simplify the calculation and also due to lack of detailed data, partial correlations were not used

Detailed information of the uncertainty analysis as well as the results of the analysis carried out for the 2014 emission data are presented in Annex 7 to this IIR. The annex will be published in May 2016 and uploaded to the EIONET CDR together with the LPS data and gridded emissions.

1.7.3 Point source data reported by the plants

Emissions of SO_2, NO_x and particulate matter (TSP) are generally included in the emission monitoring programmes of the plants. As this emission monitoring data is being supervised by competent authorities, they can be considered highly reliable.

Those plants that fall under the IPPC installation categories (Integrated Pollution Prevention and Control Directive) report also emissions included in the EPER (European Pollutant Release and Transfer Register) pollutant list. Uncertainty of the EPER pollutant data depend on the estimation method used (measured, calculated by national default emission factors or estimated by plant specific engineering calculations). The methods used in quantifying emissions and their uncertainties are not always known.

Sulphur dioxide, nitrogen oxide and particle emissions

SO_2 NO_X and TSP emissions reported by the operators are produced according to the reporting obligations determined in their environmental permit, which also stipulates the emission data production methods for these pollutants. The emission data reports are checked and approved by the supervising authorities and can therefore be considered to be the best known data in the inventory. Under NFR 1 around 95%, under NFR 2 and 3 100% and under NFR 6 around 20% of the emissions are reported by the plants.

For small particles, PM_{10} and $PM_{2,5}$, an additional uncertainty is caused by the uncertainty of coefficients used for deriving the small particle fractions from TSP values. This uncertainty is taken into account in the Monte Carlo analysis by adding a separate uncertainty percentage into the calculation: for PM_{10} 30% and for $PM_{2,5}$ 100%.

1.7.4 QC and planned improvements in uncertainty estimation

For the majority of the calculated data, the activity data uncertainty and emission factor uncertainty have been defined separately. However, for some emissions, the uncertainty has been already combined before importing it to the uncertainty calculation system.

The following improvements should be carried out every 5 years:

- Uncertainty percentages need to be re-evaluated for activity data and emission factors.
- Uncertainty percentages need to be re-evaluated for emission data reported by the plants

The following QA/QC procedures were carried out for the uncertainty analysis in 2011:

- All uncertainty estimates used in the previous submission were evaluated by an external consultant[17], and many of the estimates were revised in collaboration with the inventory agency.
- The uncertainty estimates were compared with the uncertainty estimates presented the Good Practice Guidance for CLRTAP Inventories.
- Order-of-magnitude comparisons were carried out with other data sources and uncertainty analysis documentations provided by other parties to the CLRTAP conventions.
- Results of these QA/QC procedures lead to notable changes in some of the inventory uncertainty estimates when compared with the previous submission.

The following QA/QC procedures were carried in the UC analysis carried out in 2016 for 2014 data:

- Uncertainty percentages for activity data and emission factors were re-evaluated.
- Uncertainty percentages for emission data reported by the plants were re-evaluated

1.8 General assessment of completeness

Changes in chapter	
Update of text	February 2018 JMP, ks

The completeness by emission sources and the geographical and timely coverage of the inventory is explained in this chapter.

The annual submissions of LPS data are presented in Chapter 11 and of projected emissions in Chapter 13.

The figures in the NFR tables are given with an accuracy of three decimals from the inventory calculations.

1.8.1 Completeness by emission sources

The inventory is almost complete regarding the emission sources and substances and it can be estimated that the total emission levels are representative to the actual emissions. However, there are still a few cases where either the lack of methodology or activity data has prevented quantifying the emissions, for instance, in the product use sector.

Sources that are reported as not estimated (NE) are listed in Table 1.8

[17] Suvi Monni from Benviroc Ltd

Table 1.8a Explanation of the use of the Notation key NE in NFR Tables submitted in 2019.

NFR14	Substance	Reason for not estimated
All	Se	
5 C a1	Se	A comprehensive inventory of all sources of Se is not yet available, however, bottom-up data reported by the plants is included in the inventory
5 C 1bi	Se	

Allocation of emissions reported as included elsewhere (IE) is provided in Table x and explanation of sources reported under categories Other in Table x**Error! Reference source not found.**

Table 1.8b Explanation of the use of the Notation key IE in NFR tables submitted in 2019.

NFR14	Substance	Included in
Several	benzo (a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene	Included in PAH-4 of the same NFR
1A1c	NOx, NMVOC, Sox, PCDD/PCDF, HCB	IE depending on the year reported (use of NA/IE will be checked when the recalculation is finalized)
1A2f	NH3	USE of notation keys and allocation will be checked when the
1B1a	Particles	2A5c
1B1b	PM2.5, PM10, TSP, Hg	USE of notation keys and allocation will be checked when the
1B1c	All (wood pellets)	1A2gviii
1B2aiv, aiv	CO	USE of notation keys and allocation will be checked when the
2A1	NOx,SOx, PM2.5, PM10, TSP,	USE of notation keys and allocation will be checked when the recalculation is finalized
2A2	NOx, Sox, Cd	
2A3	NOx	USE of notation keys and allocation will be checked when the recalculation is finalized
2A5a	CO	
2B6	all (except PM2.5, PM10, TSP)	1A2c
2B10a	CO	1A2c
2C5	PM2.5, PM10, TSP	1A2a
2C6	Zn	1A2a
2C7b	PM2.5, PM10, TSP	1A2a
2D3e	CO	1A2gviii- NK will be checked during recalculation
2D3f	NMVOC	2D3e
2D3g	CO	1A2gviii - NK will be checked during recalculation
2H1	CO	1A2d
2H2	all	1A2gviii - NK will be checked during recalculation
2I	SOx	1A2gviii - NK will be checked during recalculation
5B1	all except NMVOC, NH3	NK will be checked during recalculation
5B2	all	? NK will be checked during recalculation
5C1bii	all	1A1a
5C1biii	all	1A1a
5C1biv	all	1A1a
5D1	all except NMVOC, NH3	NK will be checked during recalculation
5D2	all except NMVOC	NK will be checked during recalculation
5E	NMVOC	NK will be checked during recalculation

Table 1.8c Sub-categories reported under “Other” in 2017 for the year 2019 (updated every 5 yrs).

NFR14	Substance	SNAP	Sub-source description
1 A 2 g viii	all	030101 030102 030103a 030103b	Combustion plants in - manufacturing of fishing equipment - dry cleaners - rock wool manufacturing - concrete production - limestone production - car production - testing of engines - shipyards - quarrying and crushing - manufacturing of textiles - reparation of railway vehicles - starch modification - pellet production - manufacturing of zip production machines - light gravel manufacturing - manufacturing of gypsium products - manufacturing of tiles - glass production - talc manufacturing
1 A 2 g viii	all	030105	Stationary engines in - crushing
1 A 2 g viii	all	030204	Gas turbines in - manufacturing of gypsium products
1 A 2 gviii	all	030205	Other furnaces - crushing
		030326	Other - boiler plants in food industry, mines tc
2C1		040210	Other metal production -foundries
2C7c		040306 040307	allied metal manufacturing galvanizing
2C7c		040309z	smelteries, surface treatment plants
2C7d		040211	ferrous metals storage and handling
2 B10 a	all	040401	Sulfuric acid
2 B 10 a	all	040406	Ammonium phosphate
2 B 10 a	all	040407	NPK fertilisers
2 B 10 a	all	040413	Chlorine production
2 B 10 a	all	040414	Phosphate fertilizers
2 B 10 a	all	040416	Calcium Carbonate manufacturing
2 B 10 a	all	040416	Silicon wafer manufacturing
2 B 10 a	all	040416	Production of oxygen, nitrogen and hydrogen
2 B 10 a	all	040416	Al- and Fe-chemicals manufacturing
2 B 10 a	all	040416	Manufacturing of ion exchange and chromatographic resins and special
2 B 10 a	all	040416	Pigments manufacturing
2 B 10 a	all	040416	Manufacturing of explosives
2 B 10 a	all	040416	Fertilizer manufacturing
2 B 10 a	all	040416	Manufacturing of cobolt based special chemicals
2 B 10 a	all	040416	Hydrogen peroxide plant
2 B 10 a	all	040416	Manufacturing of natrium silicate
2 B 10 a	all	040416	Potassium sulphate manufacturing
2 B 10 a	all	040416	Formic acid and hydrogen peroxide manufacturing

NFR14	Substance	SNAP	Sub-source description
2 B 10 a	all	040416	Manufacturing of viscose staple fibres and by-products
2 B 10 a	all	040501	Ethylene
2 B 10 a	all	040506	Polyethylene Low Density
2 B 10 a	all	040507	Polyethylene High Density
2 B 10 a	all	040509	Polypropylene
2 B 10 a	all	040511	Polystyrene
2 B 10 a	all	040512	Styrene butadiene
2 B 10 a	all	040513	Styrene-butadiene latex
2 B 10 a	all	040527	Enzyme production
2 B 10 a	all	040527	Manufacturing of techno-chemical products
2 B 10 a	all	040527	Manufacturing of benzene, cumene and phenols
2 B 10 a	all	040527	Drag reducing additive production
2 B 10 a	all	040527	Manufacturing of prganic base chemicals
2 B 10 a	all	040527	Manufacturing of tall oil
2 B 10 a	all	040527	Manufacturing of organic fine chemicals
2 B 10 a	all	040527	Manufacturing of pharmaceuticals
2 B 10 a	all	040527	Manufacturing of titanium dioxide pigments
2 B 10 a	all	040527	Manufacturing of lignosulphonate products
2 B 10 a	all	040527	Cleaning of solvents and manufacturing of solvent mixtures
2 B 10 a	all	040527	Manufacturing of biocides and other 95gricultural chemicals
2 B 10 a	all	040527	Manufacturing of carboxymethylcellulose
2 A 6		040618	Limestone and Dolomite use
2 B 10 b	all	040522	Storage and handling of organic products
2 B 10 b	all	040415	Storage and handling of inorganic chemical products
2 L	all	040617	Light gravel manufacturing
2 L	all	040617	Talc manufacturing
2 L	all	040617	Ceramic household and decorative products manufacturing
2 L	all	040617	Tile manufacturing
2 L	all	040617	Gypsium product manufacturing
2 L	all	040617	Quarrying and crushing
2 L	all	040617	Manufacturing of electricity distribution and monitoring devices
2 L	all	040617	Starch modification
3 B 4 h	all	100510	Fur animals and reindeer
3 B 4 g iv	all	100509z	other poultry
5 E	all	091101	Unintentional house fires
5 E	all	091102	Unintentional car fires
5 E	all	091103	Unintentional landfill fires
5 E	all	091007	Latrines

1.8.2 Completeness by geographical coverage

The inventory includes emissions from the autonomic territory of Åland (Ahvenanmaa). Information on national emissions allocated for the territory of Åland is underway and will be available later at the website *http://www.environment.fi > Maps and statistics Air pollutant emissions in Finland >.*

The gridded emissions data over the national territory are illustrated by maps for each substance in Chapter 3.2.

As a result from the project to prepare geographical presentation of emission data in 1 km *1 km resolution, Finland reported in May 2015 gridded data in the new 0.1^{O} * 0.1^{O} EMEP grid. The new EMEP grid equals approximately 7 km * 7 km resolution in Finland. The submission of gridded data is available in the EIONET CDR.

Table 1.9 Finnish submissions of gridded data.

Pollutants	For the year	Comments

SO_X	1999 - 2015	
NO_X	1999 - 2015	
NH_3	1999 - 2015	
CO	1999 - 2015	
NMVOC	1999 - 2015	Gridded data for earlier years has been submitted year by year by their due dates. Updated gridded data will be sent when recalculation of time-series is finalized
PCDD/F	1999 - 2015	
PAH-4	1999 - 2015	
HCB	1999 - 2015	
PCB	1999 - 2015	
PCP	1999 – 2007*	
SCCP	-*	
TSP	1999 - 2015	*excluded from NFR tables in 2009
PM10	1999 - 2015	
PM2.5	1999 - 2015	** inventory not complete, Se not one of the obligatory heavy metals
As	1999 - 2015	
BC	2015	
Cd	1999 - 2015	
Cr	1999 - 2015	
Cu	1999 - 2015	
Hg	1999 - 2015	
Pb	1999 - 2015	
Ni	1999 - 2015	
Se	-**	
Zn	1999 - 2015	

1.8.3. Completeness by coverage of years

The annual inventory submissions under the UNECE CLRTAP include emission estimates since 1980 as presented in Tables 1.9 and 1.10.

Complete emission data sets for all substances have been reported for the years 1980-2017 with the following exceptions:

Sox, NOx and CO: Emission data has been reported for the years 1980-2016.

Heavy metals: Emission data has been reported for the years 1990 –-2016. The reporting requirement for particles starts from the year 1990.

NMVOC: Emission data has been reported for the years 1988 –-2016. The reporting requirement for particles starts from the base year for Finland 1988.

Particles: Emission data has been reported for the years 1990 –-2016. The reporting requirement for particles starts from the year 2000..

Table 1.11 presents Finland's official submissions.

Table 1.10 Finnish official submissions of emission data – the years indicate the year of emissions (not the submission).

Pollutants	Data per sector	National Totals	Comments
SO_X	1990-2017	1980-2017	National totals available for only those pollutants and tears for which reporting requirements existed
NO_X	1990-2017	1980-2017	
NH_3	1990-2017	1980-2017	The reporting requirement starts from 1990
CO	1990-2017	1980-2017	
NMVOCs	1988-2017	1988-2017	The reporting requirement starts from the base year for Finland 1988
PCDD/F	1990-2017	1990-2017	The reporting requirement starts from 1990
PAH-4	1990-2017	1990-2017	The reporting requirement starts from 1990
HCB	1990-2017	1990-2017	The reporting requirement starts from 1990
PCB	1990-2017	1990-2017	The reporting requirement starts from 1990
PCP	1990-2015	1990-2017	Available separately and in the old submissions
SCCP	1990-2015	1990-2017	Available separately and in the old submissions
As	1990-2017	1980 – 2017	The reporting requirement starts from 1990
Cd			
Cr			
Cu			
Hg			
Ni			
Pb			
Zn			
Se	1990-2017	(inventory is not complete)	

Table 1.11 Finnish projected data (submitted annually).

Pollutants	Per sector for years	National totals for years	Based on
SO_X	2020, 2025, 2030	2020, 2025, 2030	WM
NO_X	2020, 2025, 2030	2020, 2025, 2030	WM
NH_3	2020, 2025, 2030, 2050	2020, 2025, 2030, 2050	WM
NMVOCs	2020, 2025, 2030	2020, 2025, 2030	WM
PM2.5	2020, 2025, 2030	2020, 2025, 2030	WM
PM10	2020, 2025, 2030	2020, 2025, 2030	WM

1.8.4 Completeness of information reported

In addition to emissions and projections data presented in Chapter 2.13.4. Finland reports gridded data as presented in Table 1.12 and data for large point sources (LPSs) as presented in Table 1.13.

Table 1.12 Finnish submissions of gridded data – the years indicate the year of emissions (not the submission.

LPS data submitted	Format
1999-2015, 2018	EMEP Grid 50 km * 50 km
2012-2014. 2016 (not in 2015-2018 submissions due to resource restrictions)	EMEP Grid 0.1 ° * 0.1 °

Table 1.13 Finnish submissions of LPS data. - the years indicate the year of emissions (not the submission.

Main Pollutants	LPS data submitted
SO_X	1999 – 2015, 2018
NO_X	1999 – 2015, 2018
NH_3	1999 – 2015, 2018
CO	1999 – 2015, 2018
NMVOCs	1999 – 2015, 2018
PCDD/F	1999 – 2015, 2018
PAHs	1999 – 2015, 2018
HCB	1999 – 2015, 2018
PCBs	1999 – 2015, 2018
HCH	1999 – 2015, 2018
Cd	1999 – 2015, 2018
Pb	1999 – 2015, 2018
Hg	1999 – 2015, 2018
Additional heavy metals	1999 – 2015, 2018
TSP, PM10, PM2.5	1999 – 2015, 2018

1.8.5 Use of Notation Keys

Changes in chapter	
Update of text	March 2018 ks, jmp

The application of notation keys is reported on Reporting Table IV extension sheet. Notation keys are used and understood in the Finnish inventory as follows:

IE Included elsewhere – Emissions for this source are estimated and included in the inventory but not presented separately for this source (the source where included is indicated in 0).

In the Finnish inventory IE is used when it is not possible to give disaggregated values.

NA Not applicable – The source exists but relevant emissions are considered never to occur.

In certain cases, mainly in the Energy and Industrial Processes sectors, ***instead of using NA, the actual emissions*** are presented for categories where both the sources and their emissions are well-known due to availability of bottom-up data. When pointing the value "0.000" with the cursor, the actual emissions can be seen. The value "0.000" is shown in the NFR table due to the rounding of data to three significant decimals. Summing up of these below 0.000 values often results in emissions of > 1 reporting unit and would thus cause inaccuracies in the sums as well as when compared to e.g. gridded or LPS data.

NE Not estimated – Emissions occur, but have not been estimated or reported.

In the Finnish inventory NE is used when the source exists and it can be assumed that emissions occur, but the emissions have not been estimated.

NO Not occurring – A source or process does not exist within the country.

The source does not exist in Finland

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.

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.

NR is not in use in the Finnish inventory report.

1.8.6 Basis for estimating emissions from mobile sources

The basis for estimating emissions from mobile sources is presented in Table 1.14 Fuel statistics for mobile sources is providing in the NRF reporting tables.

Table 1.14 Basis for estimating emissions from mobile sources.

NFR09	Description	Fuel sold	Fuel used
1 A 3 a i (i)	International aviation (LTO)	*x*	
1 A 3 a i (ii)	International aviation (Cruise)	*x*	
1 A 3 a ii (i)	1 A 3 a ii Civil aviation (Domestic, LTO)	x	
1 A 3 a ii (ii)	1 A 3 a ii Civil Aviation (Domestic, Cruise)	x	
1A3b	Road transport	x	
1A3c	Railways	*x*	
1A3di (i)	International maritime navigation	*x*	
1A3di (ii)	International inland waterways	*x*	
1A3dii	National navigation	*x*	
1A4ci	Agriculture	x	
1A4cii	Off-road vehicles and other machinery	x	
1A4ciii	National fishing	x	
1 A 5 b	Other mobile (Including military)	*x*	

2 KEY EMISSION TRENDS

Changes in chapter	
Update of text and figures	March 2019 KS

2.1 Description and interpretation of emission trends for air pollutants emissions

2.1.1 Overview of factors having impact on the emission trends

Fluctuations in the economic and climatic conditions are reflected in the different emission source sectors. For instance, changes in electricity imports and production of fossil fuel based condensing power cause annual variation in the energy sector emissions and emissions from industrial processes are influenced each by the economic situation. The main industrial sectors in Finland are energy intensive. In addition, weather conditions and the volumes of energy produced with renewable energy sources vary annually.

Information by individual air pollutants is provided under Chapter 3.2 and by emission sources under Chapter 3.

2.1.2 Air pollutant emission time-series

The air pollutant emission inventory includes estimates of the so called main pollutants, i.e. sulphur dioxide, nitrogen oxides, carbon monoxide and ammonia since year 1980 and non-methane volatile organic compounds (NMVOC) since 1988.

Heavy metal emissions have been estimated since 1990 for lead, cadmium, mercury, arsenic, chromium, copper, nickel, vanadium and zinc. There is not yet a comprehensive emission inventory covering all sources of selene. Vanadium is not included in the international reporting obligations, but an annual inventory is prepared for domestic purposes. Information on cobolt emissions from point sources is collected annually but a comprehensive inventory has not been established.

Persistent organic pollutants (POPs) are estimated since 1990 and include PCDD/F, PAH-4, HCB, HCH, PCB. In addition, PCP and SCCP which no more are included in the reporting obligations are covered by annual inventories for domestic purposes. In addition, studies were carried out in 1990-2006 on emissions of the following POP compounds: HBCD, HBCDD, HCBD, DeBDE, OBDE, PeBDE PeCB, PCN, PFAS/PFOS.

Particulate matter emissions have been estimated since year 2000 for total particles and particle sizes smaller than 10 μm and 2.5 μm as well as for black carbon (BC).

The time series has not yet been completely recalculated for any substances. Recalculations are already finished for several subcategories, but the completion of the work is waiting for the energy sector recalculations to be finalized.

Air pollutant emission trends by pollutant are discussed in Chapter 3.1.5 and illustrated in Figures 1.16 and 1.17. Although the time series have not fully been recalculated[18], it is obvious that the emission levels are generally decreasing. The annual variations mainly depend on economic trends for the energy intensive sectors, the production level of hydropower, the level of imported electricity and the availability of alternative non-carbon energy sources. In Finland, the level of imported electricity is highly affected by the annual rainfall situation in the neighboring countries, Sweden and Norway, which have significant hydropower capacities.

Future emissions of air pollutants have been estimated by using national integrated models and scenarios as explained in details in Chapter 12.

2.1.3 Reduction targets

Changes in chapter	
Update of text and figures	March 2019 KS

2010 Ceilings

According to the National Air Pollution Control Programme 2010 (Ministry of the Environment, 2002) the reduction targets adopted in the EU Directive on national emission ceilings as well as in the Gothenburg Protocol were anticipated to be met by 2010 by applying already adopted national and international measures to reduce emissions from both stationary and mobile sources. However, when approaching the year 2010 it become clear that the national emission ceiling for ammonia (31 kt in 2010) would not be met as explained in Chapter 3.1.4.

To meet the best science practise inventories and to show more compliance towards the reduction targets of ammonia emissions, Finland applied for adjustments for (1) manure management, (2) small scale combustion and (3) transport sector emissions. The adjustment application is presented as Appendix 3 to the Finnish IIR 2015.

The Adjustments Expert Review Team in 2015 accepted two of the applied adjustments (small scale combustion and transport) but rejected the application for manure management. Finland disagrees with the conclusions of the ERT and continues to discuss the reasons for the current level of ammonia emissions from manure management. The ERT Review Report is presented in Appendix 3D of the IIR.

Finland changed the calculation in the national agriculture emissions calculation model in 2015-2016 closer to follow the method presented in the Guidebook. As a result from that, ammonia emissions decreased to a level which enabled Finland to meet the 2010 ceiling with the help of the granted adjustments already in 2015.

2020 ceilings

The 2020 reduction targets are expected to be achieved without additional measures bearing in mind some uncertainties (Suoheimo et al. 2015, update of NH3 scenarios in the agriculture emissions calculation model).

The reduction target for sulphur dioxide seems possible to be reached in all the different scenarios.

The reduction target for nitrogen oxides would be narrowly achieved in all scenarios. NOx emissions are generated in all combustion processes, which means that changes in the use of different fuels

[18] Recalculations have been carried out for several subcategories in the latest years but the complete recalculation and reporting of the full the time-series is waiting for the finalization of the energy sector emission recalculations.

partly compensate each other while the use of solid fuels and a decrease of plant size increase the average emissions. The renewal rate of the car fleet also contributes to the NOx target.

Measures defined in the action plan for reduction of atmospheric emissions of ammonia from agriculture are needed to meet ammonia reduction targets.

The achievement of the target set for fine particulate matter depends on the development of peat use and residential wood combustion. According to the preliminary assessment of the impacts of the proposed new emission limits set for the medium combustion plants additional investments to flue gas cleaning technologies would be necessary especially in small combustion plants burning solid fuel. Combustion and traffic are the central activities releasing fine particles to air and consequently causing harmful human health effects in Finland. The emission reduction measures need to be focused on these sectors.

Further information on the preparation of national emission projections is presented in Chapter 12.

2.1.4 Progress in meeting the reduction targets set in the CLRTAP Protocols, especially in the Gothenburg Protocol

Changes in chapter	
Update of text and figures	February 2019 KS

Follow up of meeting the reduction targets set in Gothenburg Protocol and the respective emission levels in 2010 are presented in Table 1.15. Note that for some pollutants progress in decreasing emissions is not straightforward due to the pending recalculation of time series as the years are not calculated with consistent methodologies. However, the only pollutant, where Finland currently does not comply with the reduction targets is ammonia, and the time series of ammonia emissions has been recalculated as for this pollutant there is no interdependency in emissions from the energy sector, where the pending recalculation creates challenges for the other pollutants.

Sulphur dioxide

The reduction target of 80 per cent for sulphur dioxide from the 1980 level (584 kt), as well as the Gothenburg emission ceiling of 116 kt, were achieved already in 1995, when the emissions were 104 kt.

Nitrogen oxides

The Sophia Protocol target was to reduce nitrogen oxides below the 1987 level, when the Finnish NO_x emissions were 297 kt including emissions from agriculture. Without NOx emissions from agriculture the emissions in 1987 were 285 kt, which target has been met in since 1995.

The emission ceiling in the Gothenburg protocol is 170 kt, and has been met since 2012.

Non-methane volatile organic compounds

For NMVOC emissions the reduction target of 30 per cent from the year 1988 emissions of 221 kt, without agricultural emissions, to 1999 (to 155 kt) was achieved in 2005, when the emissions were 144 kt.

The emission ceiling in the Gothenburg protocol is 130 kt, which was met since 2008.

Due to the recent introduction of the results of a new calculation model for small scale wood combustion, the level of NMVOC emissions dropped by 10%. New sources have been added to the NMVOC emissions inventory since the 1980's.

Ammonia

Ammonia emissions have been reduced since 1990 but not as rapidly as expected.

Finland carried out a profound recalculation of the agriculture sector emissions in 2015-2016 to more closely follow the guidance provided in the EMEP EEA Guidebook. As a result of the revised calculations, ammonia emissions in 2016 were 31.027 kt, which is slightly above the 2010 national emission ceiling of NH3 for Finland (31 kt), both under the UNECE CLRTAP Gothenburg Protocol and the EU NEC Directive.

The adjustments review team under the CLRTAP accepted adjustments for the Finnish inventory for the years after 2010 regarding ammonia emissions from small scale combustion and road transport as indicated in Appendix I of the IIR. Taking into account the granted Finnish ammonia emissions are currently below the ceiling of 31 kt. A detailed presentation of the adjustments reporting is presented in Annex x.

The projections show that emissions in 2020-2030 will be near the -20% reduction obligation of 29.223 kt.
.

Heavy metals

Reduction targets set for the three priority heavy metals lead, cadmium and mercury, to reduce the emissions below 1990 level have been achieved since 1991.

POP emissions

The PCDD/F reduction target to decrease the emission level below the 1994 level was met in 1996.

The PAH-4 reduction target to decrease the emission level below the 1994 level (7.5 t) has not yet been met. During the time of setting the reduction target, PAH-4 emissions were calculated in a different method than currently and the increase of wood use in combustion was not foreseen at that time.

The target to reduce HCB emissions below the level in 1994 (37 kt) has been met in 1995, 2001-2006, 2008-2015 and in 2017.

The target to reduce PCB emissions below the level in 1994 (28 kt) has been met in 1996 and since 2009.

Table 1.15 Emission ceilings, reduction targets and emissions. Substances in bold have specified reduction targets. The values in red italics are currently above the reduction targets. Note that the pending recalculation of the time series introduces certain uncertainties in the current emission levels. ***NOx and NMVOC emissions are presented without agricultural emissions***

	Air pollutant (pollutants with reduction requirements in **bold**)	CLRTAP base year	Emissions (kt) **In the base year**	1980	1990	2005	2010	**2017**	**Change %** 1980-1990	1990-2017	2005-2017	1980-2017	Since base yr (7	**Targets** **2020 Gothenburg Protocol targets**		Year when reached	Old Gothenburg Targets kt / %	Old Gothenburg Year when reached	CLRTAP Reduction obligation	CLRTAP Year when reached
Main pollutants	**SO_2**	1980	**584**	584	249	70	66	**35**	-57	-86	-50	-94	**-94**	49 kt	-30%	2013	116 / -55	1995	-30% by 1993 and 116 kt by 2010	1983 & 1994
Main pollutants	**NO_x**	1987	***285***	*292*	*292*	*198*	*177*	***120***	0	-59	-44	-59	**-58**	129 kt	-35%	2015	170 / -43	2008-	Freeze on 1987	since
Main pollutants	**NMVOC**	1988	***222***	*NE*	*213*	*128*	*97*	***71***	NE	-67	-45	NE	**-68**	83 kt	-35%	2013	130 / -38	since	-30% by 1999	2001
Main pollutants	**NH_3**	1990	**34**	35	34	37	***35/33***	***31*/30**	-3	-9	-16	-11	**-9**	30 kt	-20%	2017	31 / -11	2015	31 kt in 2010	2015
Main pollutants	CO			NE	721	470	400	**312**	NE	-57	-34	NE	NA							
Partic-les	TSP	2000	**55**	NE	NE	55	54	**44**	NE	NE	-20	NE	-20							
Partic-les	PM_{10}	2000	**40**	NE	NE	39	38	**29**	NE	NE	-25	NE	-27							
Partic-les	$PM_{2,5}$	2000	**26**	NE	NE	25	24	**18**	NE	NE	-30	NE	-31	18 kt	-30%	2014				
	BC		**6**	NE	NE	6	6	**4**	NE	NE	-27	NE	-36							
Heavy metals	Pb	1990	314	NE	314	21	21	**16**	NE	-95	-27	NE	-95						Below 1990 level	1995
Heavy metals	Cd	1990	13	NE	13	2	2	**1**	NE	-89	-27	NE	-89						Below 1990 level	1991
Heavy metals	Hg	1990	1	NE	3	1	1	**1**	NE	-41	20	NE	-41						Below 1990 level	1991
Heavy metals	As		35	NE	35	3	3	**2**	NE	-93	-18	NE	-93							
Heavy metals	Cr		47	NE	47	20	26	**17**	NE	-65	-16	NE	-65							
Heavy metals	Cu		150	NE	150	52	38	**36**	NE	-76	-30	NE	-76							
Heavy metals	Ni		78	NE	78	36	23	**15**	NE	-81	-59	NE	-81							
Heavy metals	Zn		677	NE	677	114	129	**119**	NE	-82	4	NE	-82							

Table 3.1. Emission ceilings, reduction targets and emissions. Substances in bold have specified reduction targets (continued)
Note that the pending recalculation of the time series introduces certain uncertainties in the current emission levels.

Air pollutant (pollutants with reduction requirements in **bold**)		CLRTAP base year	Emissions (kt)							Change %					Targets					
			In the base year		1980	1990	2005	2010	**2016**	1980-1990	1990-2016	2005-2016	1980-2016	Since base yr (2015)	New Gothenburg Protocol		Old Gothenburg		CLRTAP	
			Original	Recalc 2019													Targets	Year when reached*	Reduction obligation	Year when reached
Persistent organic compounds	PCDD/F	1994	33	18	NE	18	13	16	**13**	NE	-23	0	NE	-26			Below 1994 level		Below 1994 level	1996
	PAH-4	1994	17	7	NE	7	9	11	**11**	NE	49	22	NE	42			Below 1994 level		Below 1994 level	Not yet
	HCB	1994	41	36	NE	37	32	9	**26**	NE	-30	-21	NE	-29			Below 1994 level		Below 1994 level	1995, 2001-2005, 2008-2015, 2017
	PCB		292	28	NE	29	31	28	**26**	NE	-9	-17	NE	-8						

***New sources were not in the original inventories but have been included in the inventory due to the development of the Guidebook for whole time series.**

2.1.5 National emission ceilings 2020 (EU NECD)

National emission ceilings set in the EU Directive 2001/81/EC and the respective emission levels are presented in Table 1.16 for SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$. Annual variations in the emission levels occur depending on economic and climatic conditions.

Finland is currently meeting all its emission ceilings as presented in Table 1.16

Table 1.16 Development of emissions related to the 2020 ceilings
The values in red italics are currently above the reduction targets. Note that the pending recalculation of the time series introduces certain uncertainties in the current emission levels.

Air pollutant	Emission Ceiling 2020		Emissions in kt					Reductions %		
	Kt	%	1980	1990	2005	2010	2017	2005-2017	1990-2010	1990-2017
SO_2	49	-30	584	249	70	66	35	-50	-73	-86
NO_x	129	-35	285	292	214	177	120	-44	-39	-59
NMVOC	83	-35	NA	222	128	97	71	-45	-54	-67
NH_3	29	-20	*34*	*35*	***37***	***35/33***	***31***/30	-16	3	-11
$PM_{2.5}$	18	-30	NA	NA	26	24	18	-30	NA	NA

Sulphur dioxide The SO_x emission ceiling of the old NECD directive of 110 kilotonnes for the year 2010 was met in 1995, when the emissions were 95 kt. In 2010 the emissions were 68 kt. The emissions have also been under the emission ceiling of 49 kt of the revised NECD for 2020 since 2013.

Nitrogen oxides The NO_x emission emission ceiling of 170 kilotonnes in the old NECD for the year 2010 has been met since 2008. New sources have recently been added to the Inventory for the whole time series and annual variations in emissions are common due to variations in both economic and climatic conditions. The emission ceiling of 131 kt of the revised NECD for 2020 was met in 2016.

Non-methane volatile organic compounds NMVOC emission ceiling of 130 kilotonnes for the year 2010 was met in 2007, when the emissions were 129 kt. In 2010 the emissions were 117 kt. Slight variations in the emissions are possible depending on economic and climatic conditions. Finland has implemented and fulfilled the requirements on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (EU Solvents Emissions Directive (1999/13/EC) and Paint Directive (2004/42/EC) and reports regularly on the environmental permits and registrations under this directive.

Due to the revised calculation of small scale wood combustion the level of emissions decreased by 10%. New sources have been added to the NMVOC emissions inventory since the 1980's, and slight variations in emissions are possible depending on the climatic conditions. The emission ceiling of 98 kt of the revised NECD has been met since 2013.

Ammonia Ammonia emissions have been reduced since 1990 but not as rapidly as expected. Finland revised the agriculture sector emissions calculation model in 2015-2016 to more closely follow the guidance provided in the EMEP EEA Guidebook. As a result of the revised calculations, ammonia emissions in 2016 were 31.0275 kt, which is above the 2020 national emission ceiling of NH3 for Finland (30 kt).

The adjustments review team under the CLRTAP accepted adjustments for the Finnish inventory for the years after 2010 regarding ammonia emissions from small scale combustion and road transport as indicated in Appendix I of the IIR. Taking into account the granted adjustments for 2016 (-1.3095kt), Finnish ammonia emissions in 2016 are below the ceiling of 30 kt, being 29.7180.

The projections also show that emissions in 2020-2030 will be close to the -20% reduction obligation .

Table 1.17 Ammonia emissions and projections reported in 2017

NH3 Inventory	2005 (kt)	2017 (kt)	Reduction from 2005 (kt)	Projections (kt) without adjustments		
				2020	2025	2030
INVENTORY 13.4.2018	37.006	30.740	-16%	29.454	28.478	27.963
GRANTED ADJUSTMENTS	NA	-1.235				
TOTAL EMISSIONS WITH ADJUSTMENTS	NA	29.504				

$PM_{2.5}$ PM2.5 emissions have been reduced since the base year of 2000 and have been under the emission ceiling of 20 kt of the revised NECD since 2015.

2.3 Description and interpretation of emission in 2017 and the trends by pollutant

Changes in chapter	
March 2019	KS

This section describes the sources of air pollutants, emission trends and their spatial distribution[19].

The emission levels of the gridded air pollutants are indicated with the colour scales presented in Figure 1.16. The emissions of sulphur dioxide, nitrogen oxides, carbon monoxide and NMVOC are presented in kilotonnes (kt). Ammonia and particle emissions are presented in tonnes (t). The emissions of heavy metals are presented in kilogrammes (kg). Out of POP emissions PAH-4, HCB and PCB are presented in kilogrammes (kg), PCP in grammes (g) and PCDD/F emissions in toxicity equivalents (mg I-Teq).

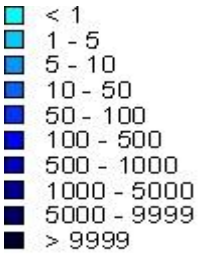


Figure 1.16. Colour scale to indicate emission levels in the figures for spatial distribution of emissions in Chapter 3.1. ***(note: the maps are currently in greyshade)***

[19] Finland has reported gridded emissions data in the new EMEP 0.1o* 0.1o grid since May 2015. However, the mapping tool for the new grid is still in progress and new maps are expected to be included in the IIR 2018. The spatial distribution of the pollutants in 2012 in the EMEP 50 km * 50 km grid are presented therefore instead of the 0.1o * 0.1o grid. The maps are produced according to the method provided in Posch (2006).

2.3.1 Main pollutants

The time series of the main pollutants SO_x, NO_x, NH_3, NMVOC and CO for 1980-2013 are presented in Figure 1.17.

- *Sulphur oxides* trend since 1980 is strongly declining.
- *Nitrogen oxides* trend since 1980 is declining. New sources have been included in the inventory over the years..
- *NMVOC* emissions have been continuously decreasing since the base year of 1988. New sources have been included in the inventory over the years.
- *Ammonia* emissions have been slightly decreasing since 1980. There was an unexpected change in the emission levels regarding especially dairy cows when the animal-specific emissions started gradually grow in the 1990's with the increased animal size and productivity while the number of animals decreased drastically. New sources have been included in the inventory over the years.
- The annual fluctuations in the *carbon monoxide* emissions are related to fluctuations in the energy use in fuel combustion and transport sectors, but the trend is generally declining. Full emission inventories have been carried out since 1990.

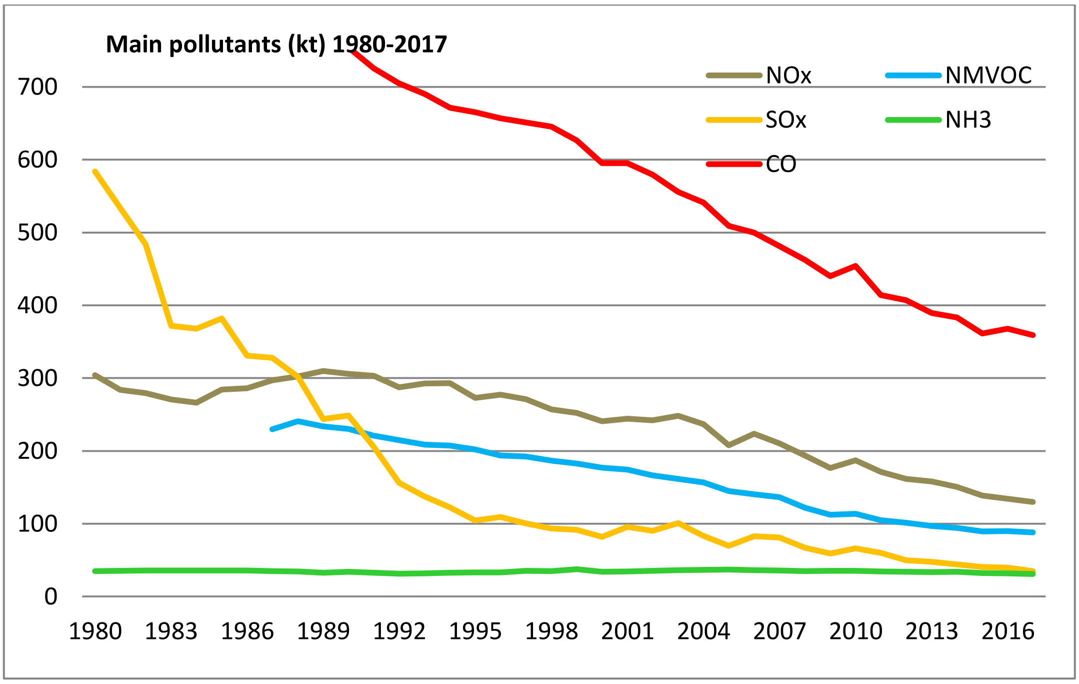


Figure 1.17. Emissions of main pollutants SO_2, NO_2, NH_3, NMVOC and CO in 1990–2017.

2.3.2 Nitrogen oxide emissions reported as nitrogen dioxide NO_2

Emission trend

In 2017 emissions of nitrogen oxides have been reduced by 56% since the year 1987 emissions to which level the emissions should be freezed.

The Finnish inventory covers all nitrogen oxide emissions converted into nitrogen dioxide (NO_2). Other nitrogen compounds include, for instance, nitric acid (HNO_3), nitrogen oxide (NO) and nitrogen trioxide (NO_3). The main sources of NO_2 in Finland are energy production and transport.

Nitrogen oxide emissions have decreased since the 1980's. In 1991 the government issued general guidelines restricting emissions from boilers and gas turbines, and, in 1988 a resolution on the reduction of emissions from road transport. New petrol-engine vehicles were required to be equipped with three-way catalytic converters since 1991 and emissions from diesel-engine vehicles were to be reduced through new engine construction and after-treatment equipment. Follow-up of how Finland has met the reduction targets under the UN and EU legislation is presented in Chapters 3.1.4 – 3.1.5.

The NOx emissions trend 1980-2015 is presented in Figure 1.18. Fluctuations in the time series are mainly driven by changes in fuel combustion. Emission data reported by the plants according to their monitoring programmes in their environmental permits is used in the inventory, so energy and industry sector emissions are considered to be quite accurate.

A major recalculation regarding the transport sector was finalized in the 2015-2016 submissions. Information of the revision of the national transport sector calculation model LIPASTO is presented in Chapter x.

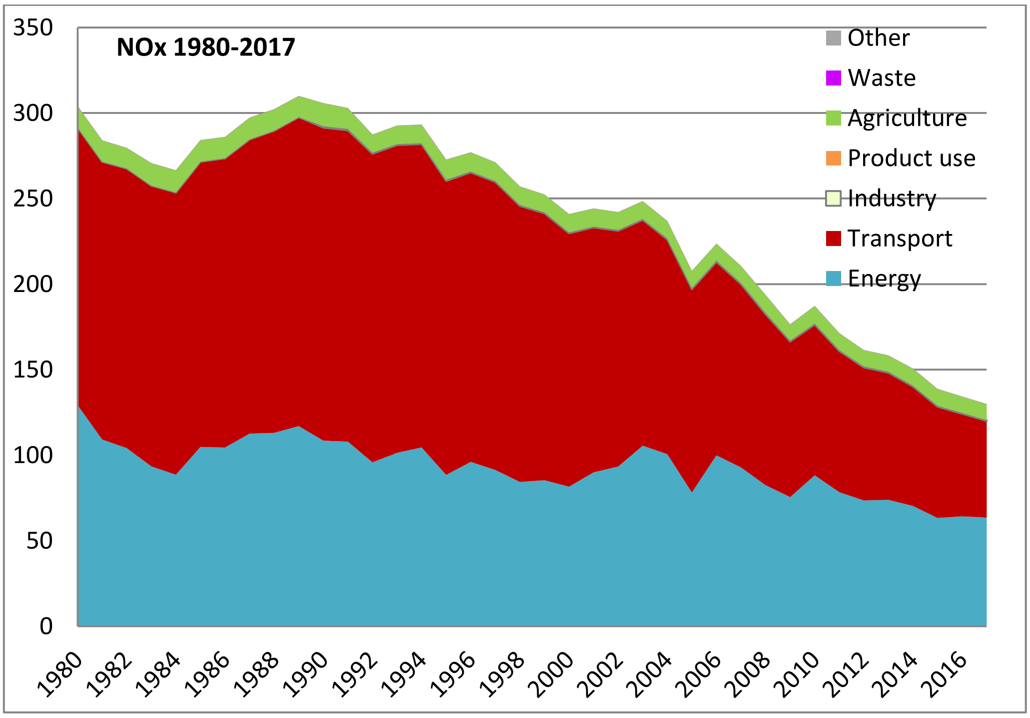
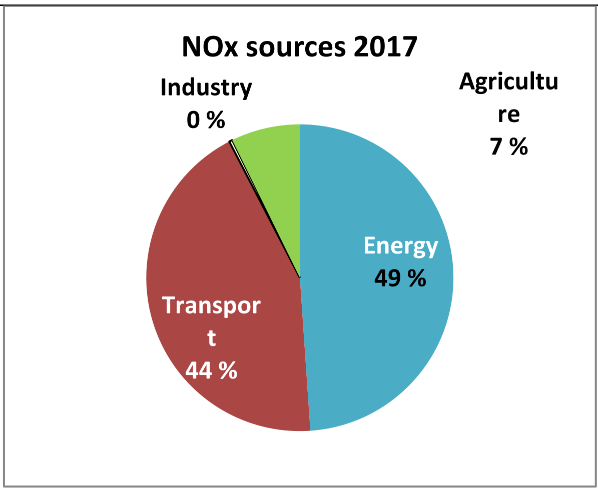


Figure 1.19 Emissions of nitrogen oxide (Gg) in 1980-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.20.



Shares of data reported by the plants of total NOx emissions in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	17.5	22.673	90.6	1A4cii	2.7	3.460	0
1A1b	1.6	2.102	98.2	1A4ciii	1.3	1.715	0
1A2a	2.5	3.191	99.8	1A5a	2.5	3.260	0
1A2b	0.1	0.184	90.8	1A5b	0.4	0.481	0
1A2c	1.1	1.399	90.1	2B10a	<0.1	0.001	100
1A2d	14.3	18.586	98.9	2B2	0.3	0.444	100
1A2e	0.3	0.422	74.0	2G	<0.1	0.006	0
1A2f	1.6	2.053	93.2	3B1a	<0.1	0.041	0
1A2gvii	4.8	6.170	0	3B1b	0.1	0.132	0
1A2gviii	1.6	2.017	83.1	3B2	<0.1	0.011	0
1A3ai(i)	0.6	0.736	0	3B3	<0.1	0.007	0
1A3aii(i)	0.1	0.180	0	3B4d	<0.1	<0.001	0
1A3bi	10.5	13.585	0	3B4e	<0.1	0.030	0
1A3bii	3.7	4.762	0	3B4gi	<0.1	0.033	0
1A3biii	11	14.34	0	3B4gii	<0.1	0.080	0
1A3biv	0.2	0.216	0	3B4giii	<0.1	0.009	0
1A3c	1.1	1.410	0	3B4giv	<0.1	0.003	0
1A3dii	5.0	6.507	0	3B4h	<0.1	0.057	0
1A3ei	<0.1	0.003	100	3Da1	4.3	5.542	0
1A4ai	0.9	1.172	1.2	3Da2a	2.3	2.943	0
1A4aii	2.0	2.583	0	3Da2b	<0.1	0.003	0
1A4bi	4.1	5.383	0	3Da3	0.4	0.459	0
1A4bii	0.2	0.315	0	3F	<0.1	0.076	0
1A4ci	**0.8**	**1.067**	**0**	**Total**	**100**	**129.850**	**38.5**

Figure 1,20 **The contribution of different sources and data reported by the plants in the 2017 emissions.**

2.3.3 Non-methane organic compounds emissions (NMVOC)

Emission trend

Non-methane organic compounds emissions have been reduced by 63% since the base year 1988.

NMVOC emissions originate in energy production, transport and product use and have been decreased since the 1990s. In its time, the CLRTAP VOC protocol requirement to reduce emissions by 30% from the 1988 level by 1999 proved to be difficult, because emissions in the transport sector did not decrease as expected, particularly concerning non-road machinery and equipment, as vehicles had not been replaced at the rate that was earlier foreseen. Strict emission limits have been applied to new vehicles since 1990 and their impact on emissions can be seen through the gradual renewal of the passenger car fleet. With the aid of differential taxes, there was a transition in the 1990s toward reformulated traffic fuels, which helped reduce evaporative emissions from petrol engine vehicles as well as CO and VOC emissions from vehicle flue gases.

Finland has implemented EU Directives on the control of volatile organic compound emissions from storage and distribution of petrol and from industrial solvents. Decreased NMVOC content in paints and the introduction of better abatement techniques in several industrial processes have contributed emission reductions in addition to the economic depression resulting in lower production volumes. The most important emission sources for the decreased NMVOC emissions after 2007 are paint application and printing industry. Low-NMVOC containing and waterborne paint products were introduced during the 1990's and their market-share rapidly increased, typically in indoor paints and road marking paints, leading to source specific emission reductions of 20- 50%. At the same time, also the sales of thinners for paint products decreased, printing processes were improved and new abatement technologies as well as substitution and recovery of NMVOC containing substances took place.

Follow-up of how Finland has met the reduction targets under the UN and EU legislation is presented in Chapters 3.1.4 – 3.1.5.

The NMVOC emission trend presented in Figure 1.21 shows decreasing emissions since 1990. The time series is not consistent: especially for the years 1980-1987 for which not all sources are included. A revised time series is under work. The small scale combustion calculation was revised in 2016 resulting in a sharp drop of NMVOC emissions and transport sector emissions have been updated according to the revision of the national transport sector calculation model LIPASTO.

The uncertainties of emission data in 2017 are included in Annex 7 of the IIR.

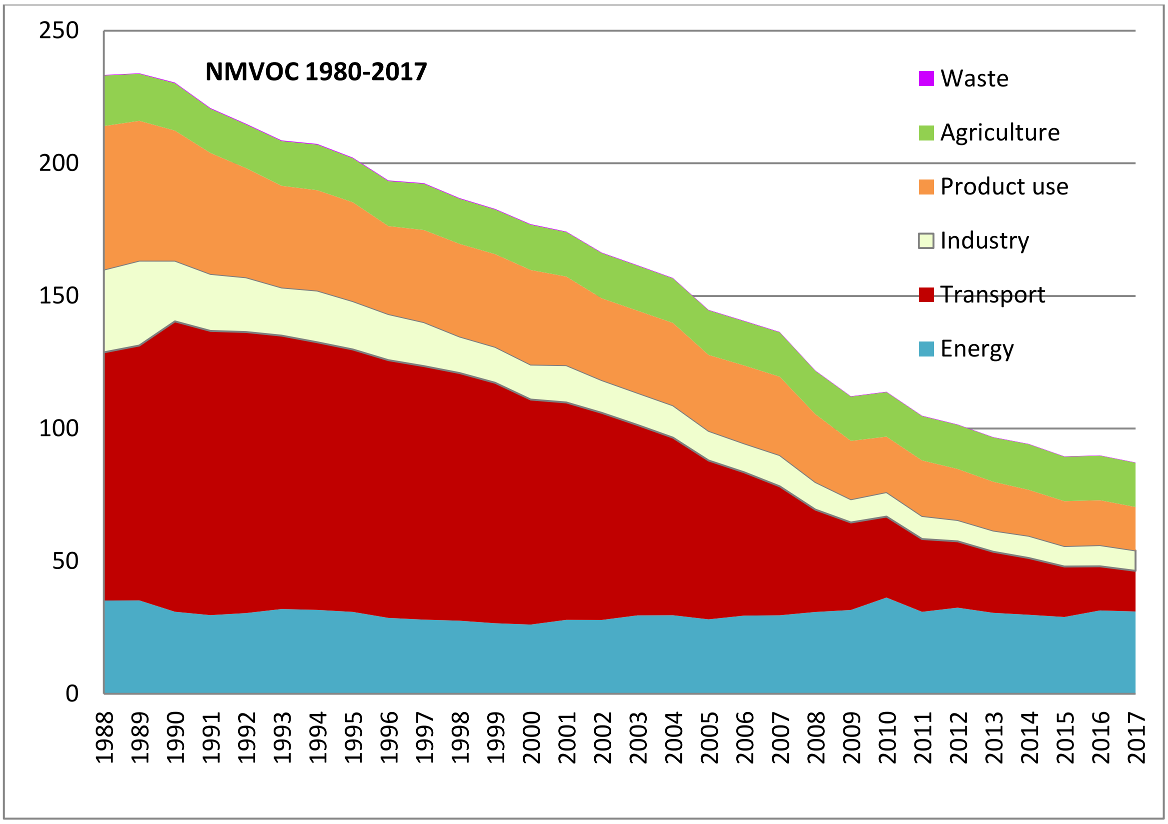
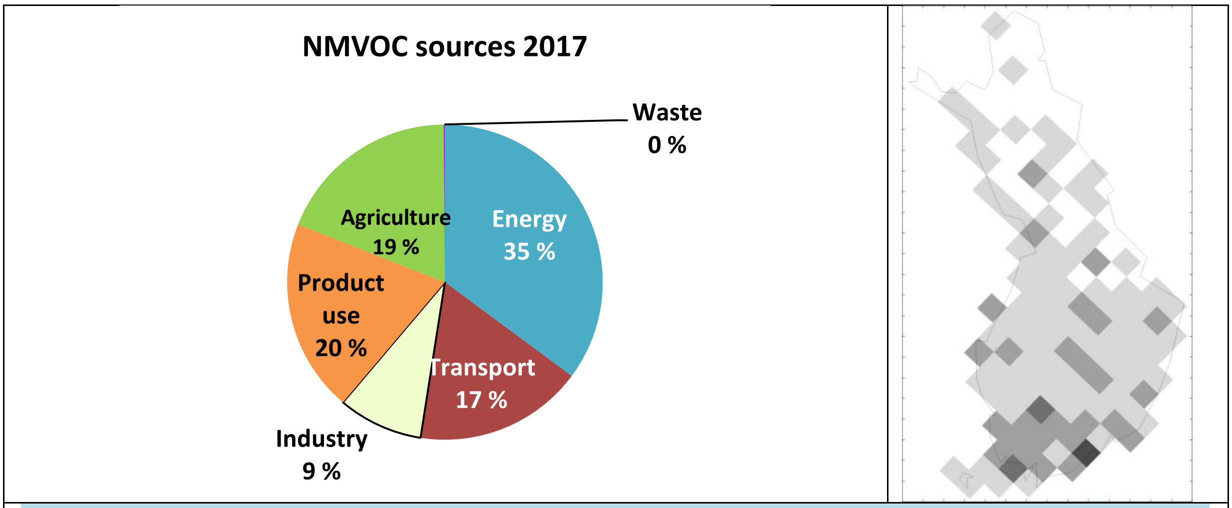


Figure 1.21. NMVOC emissions (Gg) in 1988-2017

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.22.



Shares of data reported by the plants of total NMVOC emissions in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	1.8	1.596	31.6	2C1	0.2	0.186	100
1A1b	<0.1	0.062	32.5	2C2	<0.1	<0.001	100
1A2a	<0.1	0.019	0	2C6	<0.1	0.001	0

1A2b	<0.1	0.001	0	2C7a	<0.1	<0.001	100
1A2c	<0.1	0.005	0	2C7b	<0.1	0.023	100
1A2d	0.4	0.323	4.9	2C7c	<0.1	0.010	100
1A2e	<0.1	0.027	0	2D3a	4.8	4.220	0
1A2f	<0.1	0.010	0	2D3b	0.4	0.391	0
1A2gvii	1.3	1.166	0	2D3c	0.2	0.174	0
1A2gviii	0.3	0.233	17.0	2D3d	9.0	7.931	14.5
1A3ai(i)	0.1	0.102	0	2D3e	0.6	0.508	1.8
1A3aii(i)	<0.1	0.029	0	2D3g	2.4	2.124	67.2
1A3bi	2.3	2.040	0	2D3h	0.7	0.604	82.0
1A3bii	0.5	0.398	0	2D3i	2.4	2.076	4.3
1A3biii	0.5	0.408	0	2G	<0.1	0.020	0
1A3biv	1.6	1.437	0	2H1	1.8	1.616	16.2
1A3bv	1.6	1.410	0	2H2	2.0	1.788	0.2
1A3c	<0.1	0.075	0	2I	1.5	1.315	32.5
1A3dii	3.3	2.955	0	2L	<0.1	0.001	100
1A3ei	<0.1	<0.001	0	3B1a	7.2	6.368	0
1A4ai	<0.1	0.088	0	3B1b	4.5	3.956	0
1A4aii	3.1	2.762	0	3B2	0.2	0.169	0
1A4bi	24.7	21.792	0	3B3	0.3	0.292	0
1A4bii	1.1	0.973	0	3B4d	<0.1	0.004	0
1A4ci	0.5	0.429	0	3B4e	0.3	0.251	0
1A4cii	1.6	1.425	0	3B4gi	0.2	0.185	0
1A4ciii	<0.1	0.076	0	3B4gii	0.6	0.547	0
1A5a	0.3	0.270	0	3B4giii	<0.1	0.029	0
1A5b	<0.1	0.058	0	3B4giv	<0.1	0.014	0
1B1b	<0.1	0.067	0	3B4h	1.3	1.173	0
1B2aiv	3.4	3.026	100	3Da2a	2.9	2.529	0
1B2av	3.2	2.847	6.8	3Da3	<0.1	0.064	0
1B2b	0.3	0.239	0	3De	1.1	0.960	0
2A1	<0.1	0.029	32.3	3F	0.2	0.149	0
2A3	<0.1	<0.001	96.2	5A	<0.1	0.083	0
2B10a	2.4	2.086	100	5D1	<0.1	0.009	0
2B10b	<0.1	0.070	100	5D2	<0.1	0.018	0
				Total	**100**	**88.323**	**11.4**

Figure 1.22 **The contribution of different sources and data reported by the plants in the 2017 emissions.**

2.3.4 Sulphur emissions as sulphur dioxide SO_2

Emission trend

Emissions of sulphur have been reduced by 94% since the base year 1980.

The main sources of sulphur emissions in Finland are energy production and industrial processes. All sulphur compounds converted into sulphur dioxide (SO_2) are included in the inventory, such as sulphur trioxide (SO_3), sulphuric acid (H_2SO4), and reduced sulphur compounds, e.g. hydrogen sulphide (H_2S), mercaptans and dimethyl sulphides. Emissions of sulphur compounds other than SO_2 originate, for instance, from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, kraft pulp and paper plants and animal feedlots.

Sulphur emissions have been dramatically decreased since the beginning of1980's due to successful national programmes to reduce emissions. A Government resolution was issued in 1986 for a 50% reduction of emissions from the 1980 level, and in 1990, the aim was set at an 80% reduction over the next ten years. Emissions from energy production, pulp mills, sulphur acid plants and refineries were limited as was the sulphur content of coal and oil products. The industry branch specific reduction targets were regularly followed and re-examined. Investments, including desulphurization units for existing coal-fired power stations, were made in the beginning of the 1990's to implement these decisions. Follow-up on how Finland meets the reduction targets under the UN and EU legislation is presented in Chapters 3.1.4 – 5.

SOx emissions are regarded rather accurate as emission data reported by the plants according to their monitoring programmes in environmental permits is used in the inventory. Fluctuations in annual emission levels are related to economic conditions and changes in energy production (Figure 1.23)

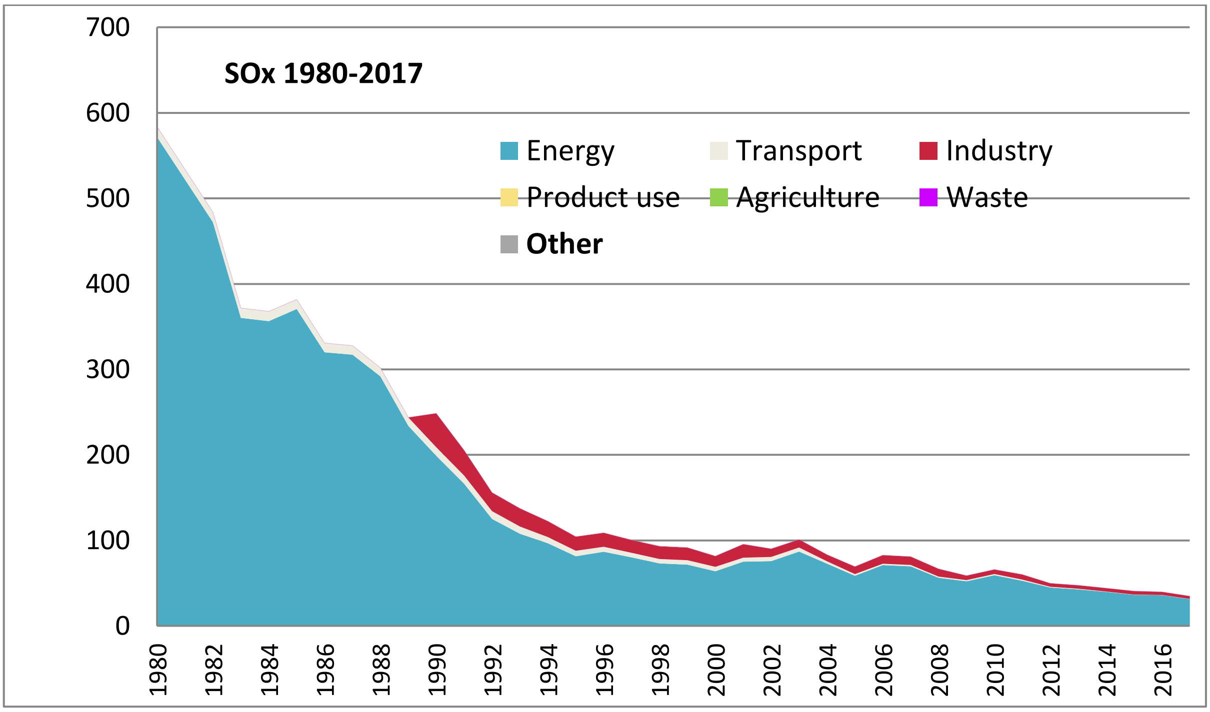
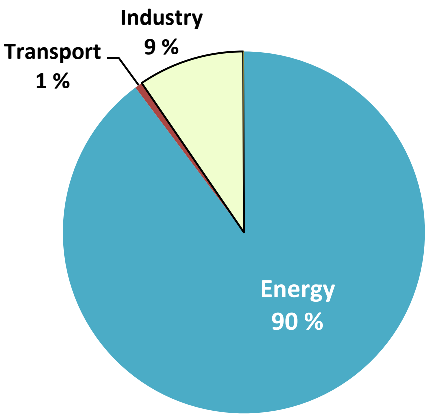


Figure 1.23. Emissions of sulphur dioxide (Gg) in 1980-2017.

The uncertainties of emission data in 2016 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.24.



Shares of data reported by the plants of total SOx emissions in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	34.5	12.092	89.1	1A4bi	2.6	0.901	0
1A1b	16.9	5.936	99.9	1A4bii	<0.1	<0.001	0
1A2a	1.6	0.577	99.8	1A4ci	2.1	0.731	0
1A2b	8.9	3.111	99.6	1A4cii	<0.1	0.003	0
1A2c	2.2	0.755	95.0	1A4ciii	<0.1	<0.001	0
1A2d	6.9	2.423	92.8	1A5a	3.7	1.281	0
1A2e	2.0	0.696	50.4	1A5b	0.1	0.039	0
1A2f	2.3	0.808	51.1	1B1b	1.1	0.394	100
1A2gvii	<0.1	0.004	0	2B10a	4.2	1.465	100
1A2gviii	1.9	0.650	58.7	2C1	2.1	0.730	100
1A3ai(i)	0.1	0.045	0	2C2	<0.1	<0.001	100
1A3aii(i)	<0.1	0.012	0	2C7a	0.3	0.109	1
1A3bi	<0.1	0.027	0	2C7b	0.1	0.038	100
1A3bii	<0.1	0.003	0	2C7c	<0.1	<0.001	100
1A3biii	<0.1	0.015	0	2D3g	<0.1	<0.001	100
1A3biv	<0.1	<0.001	0	2D3i	<0.1	0.005	100
1A3c	<0.1	<0.001	0	2G	<0.1	0.004	0
1A3dii	0.2	0.084	0	2H1	2.8	0.980	100
1A3ei	<0.1	<0.001	0	2L	<0.1	<0.001	100
1A4ai	3.1	1.085	0.9	3F	<0.1	0.011	0
1A4aii	**<0.1**	**0.002**	**0**	**Total**	**100**	**35.020**	**80.3**

Figure 1.24 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.5 Ammonia emissions

Emission trend

Ammonia emissions have been reduced by 9% from 1990. The main ammonia source is agriculture, while transport and industrial processes contribute to 10% of emissions. The emissions decreased from early 1980's by 1990, however, after that the emission trend has been rather consistent. Ammonia emission trend is presented in Figure 1.25.

According to the current understanding, the emissions are expected to stay at the present level, or even slightly increase. Follow-up of how Finland has met the reduction targets under the UN and EU legislation is presented in Chapters 3.1.4 – 3.1.5. A project to closer study manure management practices and present options to reduce emissions from this source is underway.

Understanding of ammonia emission sources and levels has gradually been improved during the 2000's. Still in 2002 not all sources of ammonia emissions were identified and the emissions from the major source, agriculture, were underestimated. While the Gothenburg protocol which limits NH3 emissions had not yet entered into force, it was understood that further assessment of the inventory was necessary. A new calculation model to improve the agriculture sector inventory was developed in 2006-2008. Based on the results of this work, it was concluded that the earlier estimates, especially for dairy cows, did not take into account the increased specific emissions following the growth of the animals while the number of the animals had significantly decreased. The time series has been revised several times since, while the latest comprehensive recalculation was carried out in 2013. After that, minor corrections and inclusion of minor new sources have been carried out. A detailed description of ammonia emissions is presented in Appendix 1.

During the year 2014 new sources were identified (residential combustion, leather tanning, coke production and use of latrines) and ammonia emissions from the new sources were included in the inventories from the year 1990 onward.

Ammonia emissions had earlier been estimated as national totals only for 1980, 1985-1988, 1990, 1995 and 1997-1999 and in NFR format only from 2000 onwards. At the moment, the recalculated time series is available in NFR format since 1980.

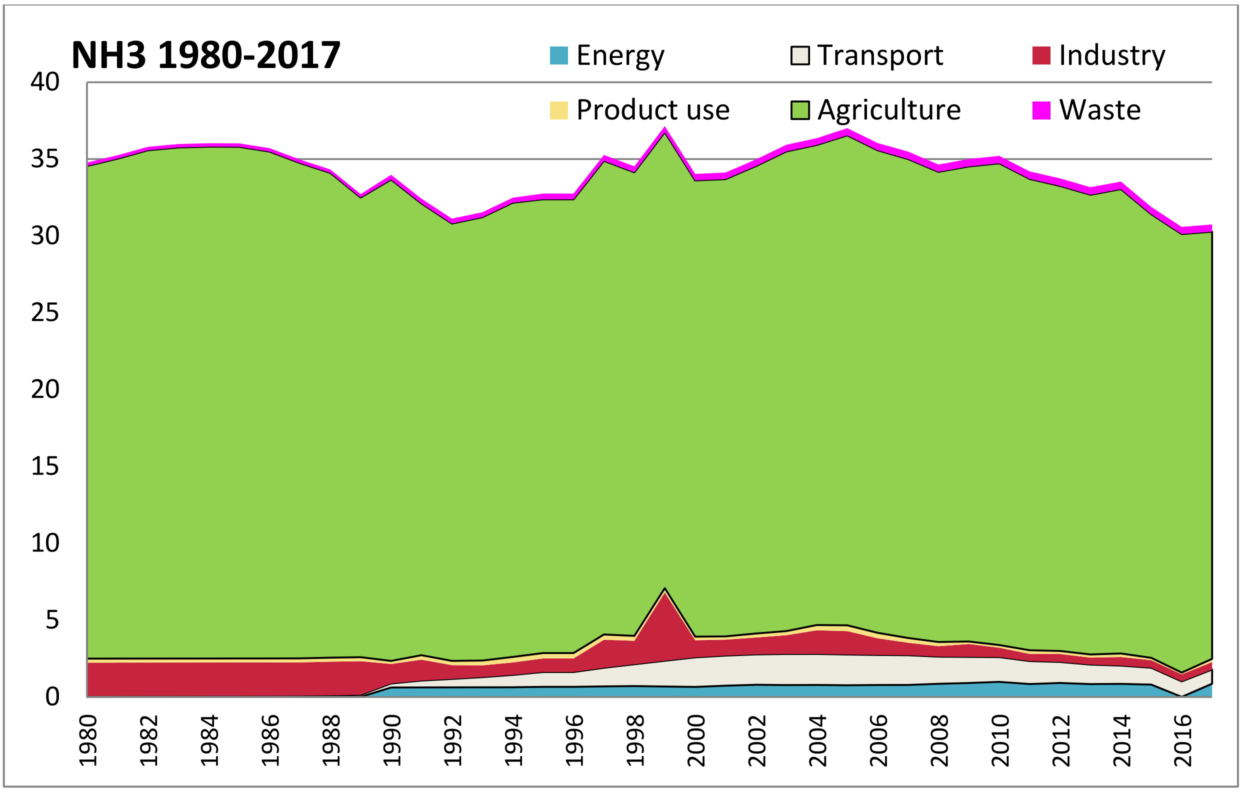
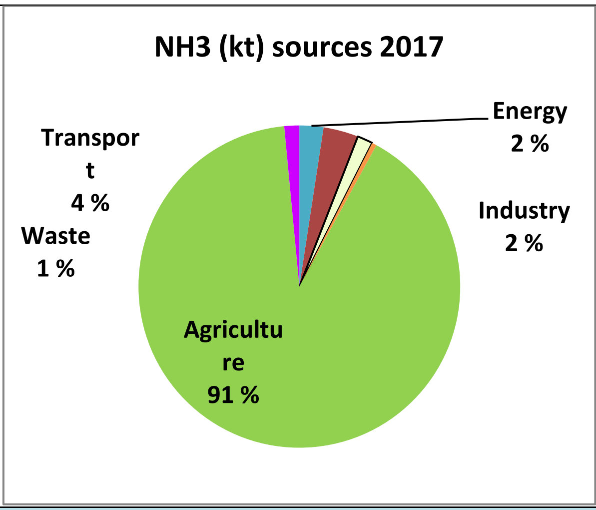
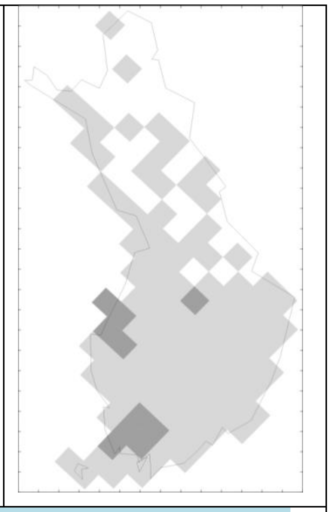


Figure 1.25. Ammonia emissions (Gg) in 1980-2017. Note, The peak NFR2 (Industry) in 1999 is due to an accidental emission reported by the plant to the environmental authorities.

The uncertainties of emission data in 2016 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.26.





NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
Shares of data reported by the plants of total SOx emissions in 2017							
1A1a	<0.1	0.003	100	2D3i	0.6	0.194	100
1A2gvii	<0.1	0.003	0	2G	<0.1	0.014	0
1A2gviii	<0.1	0.001	100	2H1	0.2	0.048	100

1A3bi	2.8	0.878	0	2L	<0.1	0.027	100
1A3bii	<0.1	0.010	0	3B1a	15.8	4.925	0
1A3biii	<0.1	0.027	0	3B1b	15.5	4.818	0
1A3biv	<0.1	0.002	0	3B2	0.5	0.155	0
1A3c	<0.1	<0.001	0	3B3	9.2	2.848	0
1A3dii	<0.1	<0.001	0	3B4d	<0.1	0.006	0
1A4ai	<0.1	0.005	0	3B4e	2.1	0.652	0
1A4aii	<0.1	0.001	0	3B4gi	2.3	0.700	0
1A4bi	3.8	1.176	0	3B4gii	2.1	0.642	0
1A4bii	<0.1	<0.001	0	3B4giii	0.2	0.072	0
1A4ci	<0.1	0.012	0	3B4giv	0.2	0.059	0
1A4cii	<0.1	0.002	0	3B4h	8.3	2.586	0
1A4ciii	<0.1	<0.001	0	3Da1	6.0	1.867	0
1A5a	<0.1	<0.001	0	3Da2a	24	7.463	0
1B1b	<0.1	0.003	0	3Da2b	<0.1	0.002	0
2B10a	0.9	0.295	100	3Da3	3.0	0.926	0
2C1	0.1	0.043	100	3F	0.2	0.074	0
2C7b	0.2	0.069	100	5B1	0.3	0.089	0
2C7c	<0.1	<0.001	100	5D1	<0.1	0.003	100
2D3g	<0.1	0.004	23.0	5E	1.2	0.379	0
				Total	**100**	**31.083**	**2.2**

Figure 1.26 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.6 Carbon monoxide emissions

Emission trend

Carbon monoxide emissions have been reduced by 55% since 1990. The carbon monoxide emission trend is presented in Figure 1.27. The trend is declining and the main sources are fuel combustion in the energy production and transport sectors. CO emission data reported by the plants is used in the inventory. CO emission levels are well known due to the use of CO as process parameter.

CO emission data is available as national totals since the year 1980 and in NFR format since the year 2000. However, the earlier reported CO emissions are not consistent with those data after 1990, e.g. emissions from off-road machinery are not included in them. A revised time series for the 1980's is under work.

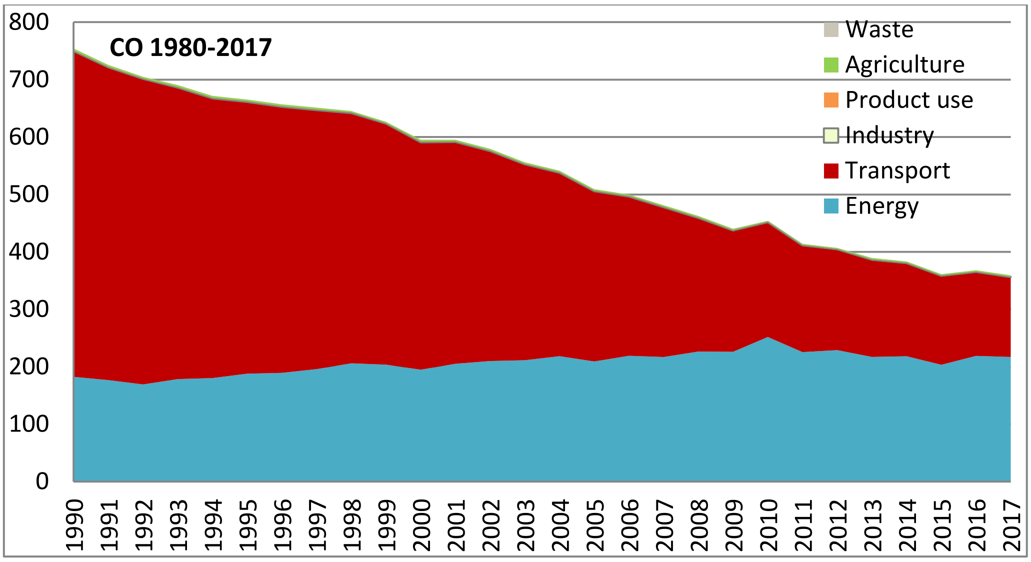
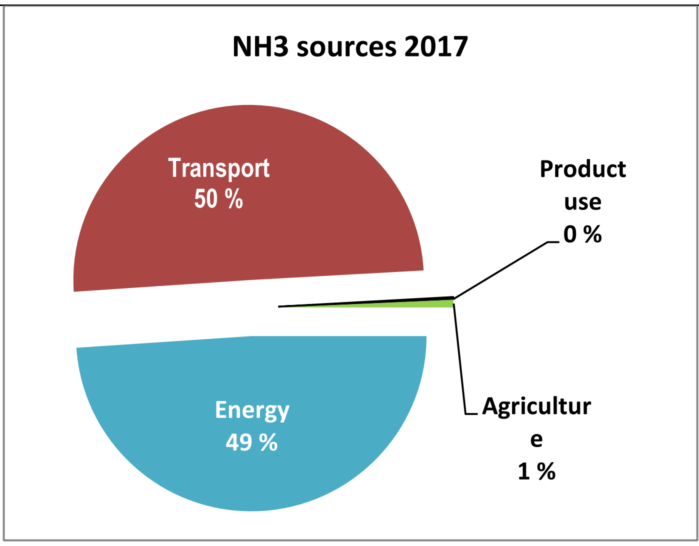


Figure 1.27. Emissions of carbon monoxide (Gg) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.28.



Shares of data reported by the plants of total NH3 emissions in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	4.1	13.124	24.2	1A3c	<0.1	0.186	0
1A1b	0.4	1.134	20.4	1A3dii	5.9	19.127	0
1A2a	0.3	1.074	0	1A3ei	<0.1	0.003	0
1A2b	<0.1	0.076	70.1	1A4ai	0.2	0.725	0.4
1A2c	0.1	0.335	9.0	1A4aii	10.7	34.749	0
1A2d	5.6	18.278	10.5	1A4bi	35.6	115.317	0
1A2e	<0.1	0.180	0.2	1A4bii	8.1	26.257	0
1A2f	1.7	5.574	24.7	1A4ci	0.4	1.325	0

1A2gvii	2.2	6.993	0	1A4cii	2.9	9.290	0
1A2gviii	1.0	3.110	9.3	1A4ciii	<0.1	0.267	0
1A3ai(i)	0.2	0.682	0	1A5a	2.6	8.311	0
1A3aii(i)	<0.1	0.295	0	1A5b	0.3	0.964	0
1A3bi	10.8	35.127	0	2C1	0.2	0.537	100
1A3bii	1.0	3.117	0	2C7a	<0.1	0.008	100
1A3biii	1.9	6.168	0	2G	<0.1	0.214	0
1A3biv	2.8	8.965	0	3F	0.7	2.261	0
				Total	**100**	**323.774**	**2.4**
				1A3c	<0.1	0.186	0

Figure 1.28 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.7 Particulate matter emissions

Particulate matter emissions have been estimated since 2000 and the trend is slightly decreasing. The main sources for particle emissions in Finland are energy, road transport and industrial processes sectors. The emission trend is presented in Figure 1.29.

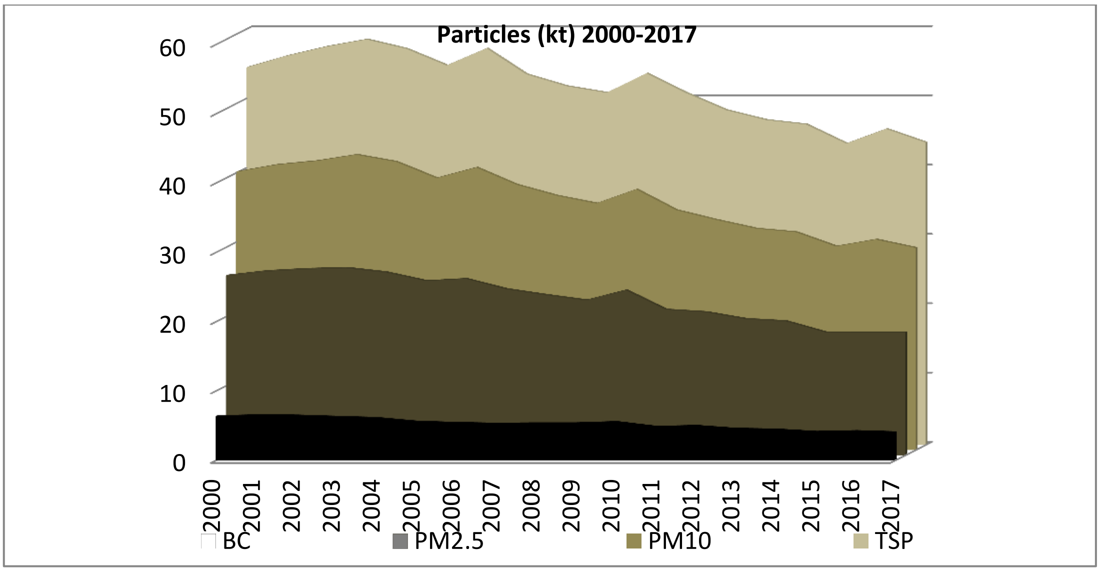


Figure 1.29Particle emissions (TSP, PM10, PM2.5 and BC) in 2000-2017.

TSP emissions have been reduced by 36%, PM10 emissions by 42%, PM2.5 emissions by 44% and BC emissions by 31% since 1990.

Particulate matter emissions fluctuate largely from year to year due to changes in energy consumption, which is affected by the level of annually imported electricity and fossil fuel based condensing power in annual energy production. Energy consumption reflects the energy intensity of the Finnish industry (forest industry, chemical industry and manufacture of basic metals), extensive consumption during the long heating period, as well as energy consumption in the transport sector due to long distances in the sparsely inhabited country. During the last decades large decreases in specific emissions have been achieved through implementation of abatement techniques especially in peat and oil combustion.

The especially high peat production volumes in summer 2006 can be seen as a peak in the emission trend. The drop in emissions in 2014 is due to introduction of small scale combustion calculation model, the results of which have not been possible to integrate over the whole time series due to pending recalculation of the energy sector emissions. The recalculation of emissions from small scale combustion sources decreased significantly particle emissions as the new inventory system more accurately defines the wood amounts used in small scale combustion equipment and larger boilers.

Reporting of TSP emissions is traditionally included in the monitoring programmes of environmental permits and emission data for LCPs can therefore be regarded quite accurate. This data as well as PM10 emission data reported under the ETS and the E-PRTR are used in the inventory. Particle emissions from energy production are efficiently abated in the centralized electricity and power production using electrostatic precipitators and scrubbers.

However, the current particle emissions time series are strongly affected by smaller boilers, where the inventory does not reflect implemented abatement technology. These emissions are calculated as unabated due to the fact that information is not available of the implemented abatement technology in smaller district heating plants.

Note: the sources for $PM_{2.5}$ and BC are not equal: peat production (NFR 1B3) is a significant source for $PM_{2.5}$ but is not a source of BC. In the black carbon emission inventory, the main sources are transport (road transport and off-road machinery) and energy production, mainly residential combustion. The preliminary BC time series for 2000-2012, reported on a separate sheet in the NFR table submission in February 2014, the technology-specific calculation method was already used.

The new calculation model for small scale wood combustion that has been implemented since the 2016 submission decreased the level of particle emissions substantially. Detailed information on the model and methods are presented under the Chapter for NFR 1A4bi.

2.3.7.1 Particles TSP

Emission trend

The trend of TSP emissions is presented in Figure 1.30.

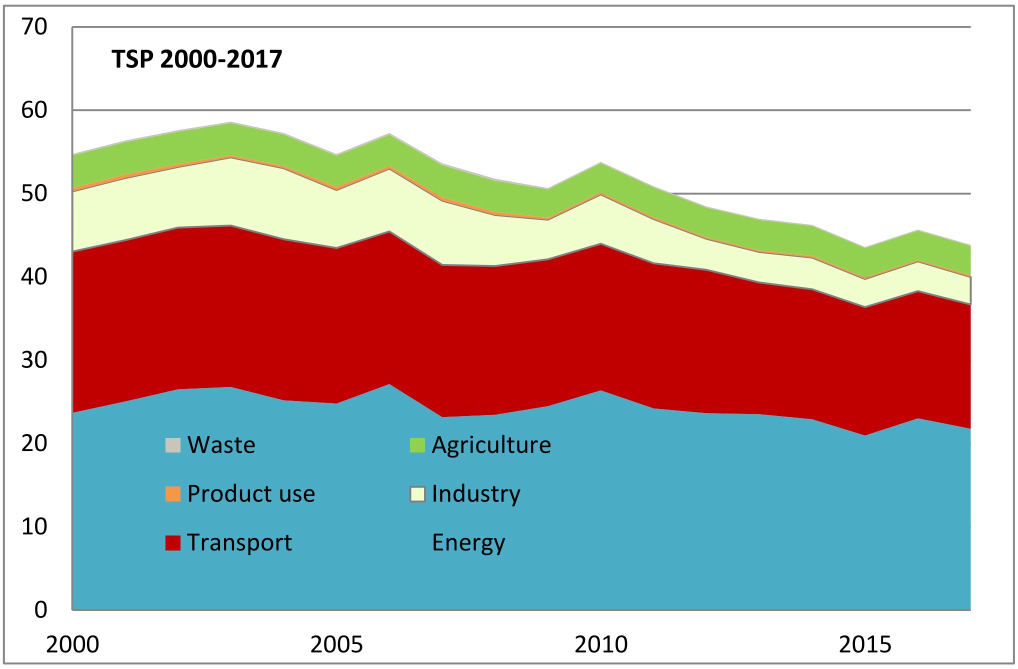
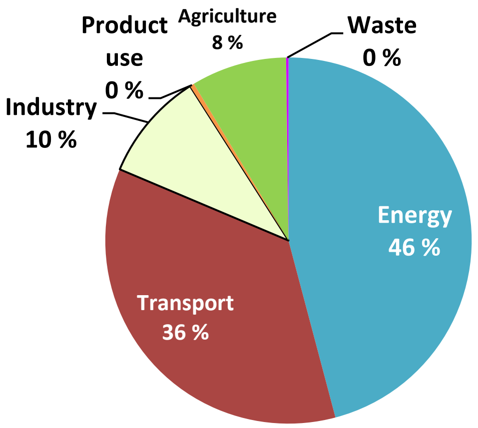


Figure 1.20. TSP emissions (kt) 2000-2017

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.31.



Shares of total TSP emissions reported by the plants in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	5.9	2.572	71.8	2A5c	1.6	0.707	0
1A1b	0.5	0.223	100	2B10a	1	0.435	100
1A2a	<0.1	0.023	100	2B10b	<0.1	0.037	0
1A2b	<0.1	0.013	100	2B6	<0.1	0.001	100
1A2c	0.2	0.067	100	2C1	0.6	0.245	100
1A2d	5.2	2.259	100	2C2	0.4	0.183	100
1A2e	0.3	0.112	100	2C3	<0.1	<0.001	74.1
1A2f	0.5	0.207	100	2C7a	<0.1	<0.001	18.5
1A2gvii	0.8	0.346	0	2C7c	<0.1	0.011	100
1A2gviii	1.2	0.538	100	2C7d	1.5	0.634	0
1A3ai(i)	<0.1	0.005	0	2D3b	0.2	0.085	0
1A3aii(i)	<0.1	0.001	0	2D3d	<0.1	0.002	100
1A3bi	0.7	0.321	0	2D3e	<0.1	<0.001	100
1A3bii	0.7	0.315	0	2D3g	<0.1	0.001	100
1A3biii	0.5	0.233	0	2D3i	0.2	0.104	100
1A3biv	<0.1	0.035	0	2G	0.2	0.090	0
1A3bvi	3.4	1.502	0	2H1	0.8	0.342	100
1A3bvii	25.6	11.176	0	2H2	0.9	0.393	10.5
1A3c	<0.1	0.029	0	2I	0.3	0.127	100
1A3dii	0.8	0.332	0	2L	<0.1	0.039	100
1A4ai	0.7	0.296	2.3	3B1a	0.5	0.215	0
1A4aii	0.7	0.289	0	3B1b	0.2	0.105	0
1A4bi	22.9	9.981	0	3B2	<0.1	0.011	0
1A4bii	<0.1	0.012	0	3B3	0.7	0.309	0
1A4ci	2.2	0.952	0	3B4d	<0.1	<0.001	0
1A4cii	0.6	0.245	0	3B4e	<0.1	0.021	0
1A4ciii	<0.1	0.042	0	3B4gi	1.4	0.601	0
1A5a	7.4	3.225	0	3B4gii	0.4	0.161	0
1A5b	<0.1	0.021	0	3B4giii	<0.1	0.016	0

1B1b	<0.1	0.012	100	3B4giv	<0.1	0.008	0
1B1c	2.9	1.251	0	3B4h	0.1	0.056	0
1B2aiv	<0.1	0.033	100	3Dc	3.7	1.620	0
1B2av	<0.1	<0.001	100	3F	0.5	0.204	0
2A2	<0.1	0.006	100	5A	<0.1	0.001	0
2A3	<0.1	0.007	100	5C1bv	<0.1	0.001	0
2A5a	<0.1	0.007	78.5	5E	0.2	0.107	0
2A5b	**0.1**	**0.051**	**4.8**	**Total**	**100**	**43.614**	**15.8**

Figure 1.31 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.7.2 Particles PM10

Emission Trend

For introduction to drivers behind the emission trend, please see the beginning of Chapter 3.1.12. The trend of PM10 emissions is presented in Figure 1.32.

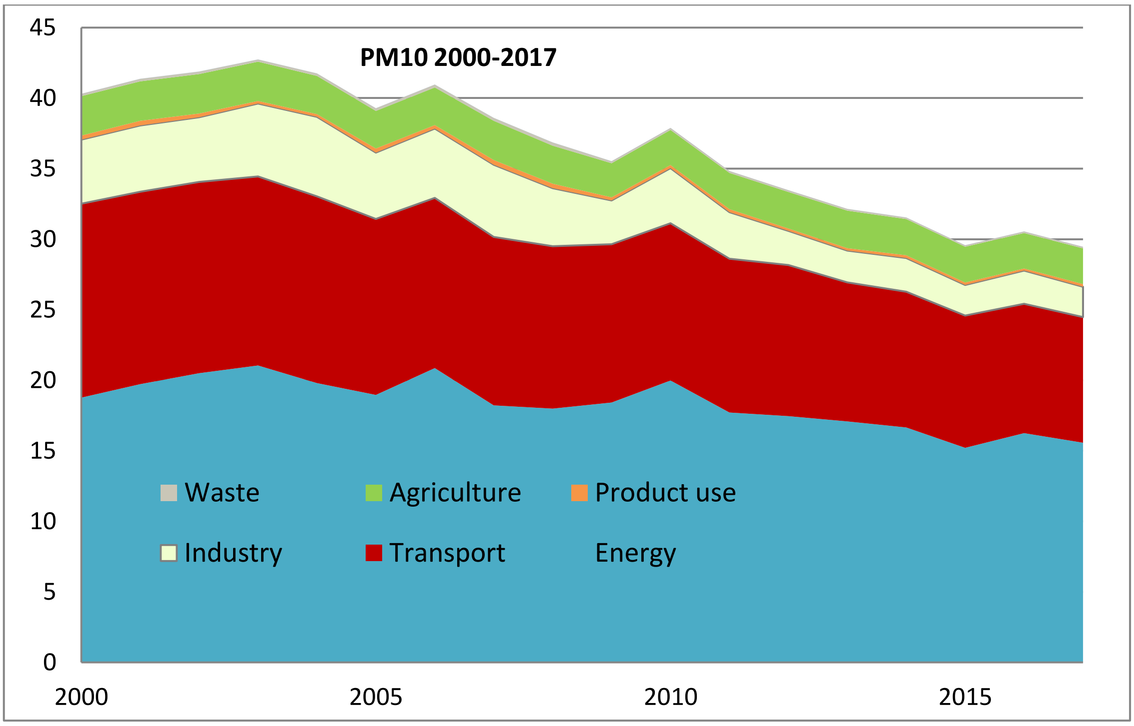
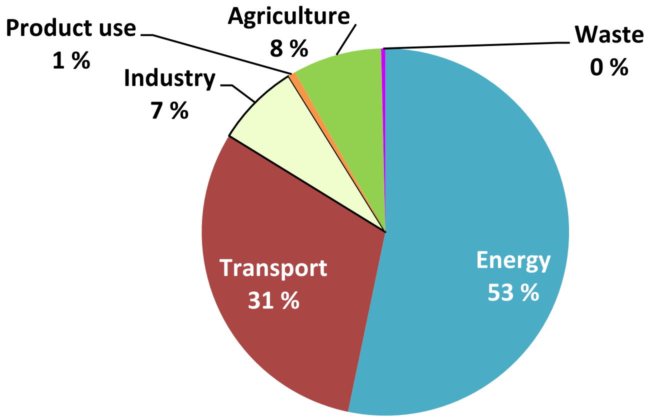


Figure 1.32. PM10 emissions (kt) in 2000-2017

The uncertainties of emission data in 2016 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.33



Shares of total PM10 emissions reported by the plants in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	4.0	1.159	0	2A5c	0.9	0.277	0
1A1b	0.3	0.077	0	2B10a	1.3	0.378	0
1A2a	<0.1	0.014	0	2B10b	<0.1	0.012	0
1A2b	<0.1	0.006	0	2B6	<0.1	0.001	0
1A2c	0.2	0.058	0	2C1	0.7	0.203	0
1A2d	6.7	1.948	0	2C2	0.5	0.156	0
1A2e	0.1	0.041	0	2C3	<0.1	<0.001	0
1A2f	0.3	0.102	0	2C7a	<0.1	<0.001	0
1A2gvii	1.2	0.346	0	2C7c	<0.1	0.006	0
1A2gviii	0.8	0.239	0	2C7d	1.0	0.298	0
1A3ai(i)	<0.1	0.005	0	2D3b	0.2	0.064	0
1A3aii(i)	<0.1	0.001	0	2D3d	<0.1	0.001	0
1A3bi	1.1	0.321	0	2D3e	<0.1	<0.001	0
1A3bii	1.1	0.315	0	2D3g	<0.1	0.001	0
1A3biii	0.8	0.233	0	2D3i	0.3	0.098	0
1A3biv	0.1	0.035	0	2G	0.3	0.090	0
1A3bvi	3.7	1.093	0	2H1	1.0	0.288	0
1A3bvii	19.2	5.588	0	2H2	1.3	0.386	0
1A3c	<0.1	0.027	0	2I	<0.1	0.023	0
1A3dii	1.1	0.329	0	2L	0.1	0.029	0
1A4ai	0.7	0.211	0	3B1a	0.3	0.098	0
1A4aii	1.0	0.289	0	3B1b	0.2	0.048	0
1A4bi	32.8	9.569	0	3B2	<0.1	0.005	0
1A4bii	<0.1	0.012	0	3B3	0.2	0.048	0
1A4ci	1.2	0.355	0	3B4d	<0.1	<0.001	0
1A4cii	0.8	0.245	0	3B4e	<0.1	0.010	0
1A4ciii	0.1	0.042	0	3B4gi	0.4	0.127	0
1A5a	3.2	0.931	0	3B4gii	0.3	0.080	0
1A5b	<0.1	0.021	0	3B4giii	<0.1	0.016	0
1B1b	<0.1	0.005	0	3B4giv	<0.1	0.006	0

1B1c	2.8	0.819	0	3B4h	<0.1	0.025	0
1B2aiv	<0.1	0.009	0	3Dc	5.6	1.620	0
1B2av	<0.1	<0.001	0	3F	0.7	0.201	0
2A2	<0.1	0.002	0	5A	<0.1	<0.001	0
2A3	<0.1	0.006	0	5C1bv	<0.1	<0.001	0
2A5a	<0.1	0.004	0	5E	0.4	0.107	0
2A5b	**<0.1**	**0.017**	**0**	**Total**	**100**	**29.179**	**0**

Figure 1.33 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.7.3 Particles PM2.5

Emission trend

The trend of PM2.5 emissions is presented in Figure 1.34.

For introduction to drivers behind the emission trend, please see the beginning of Chapter 3.1.12.

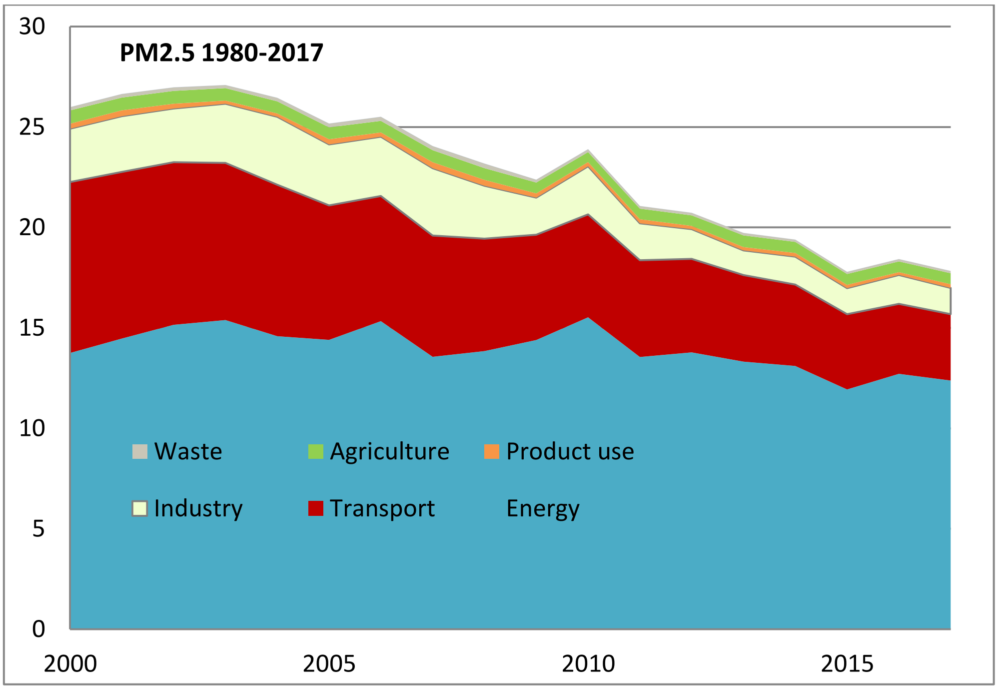
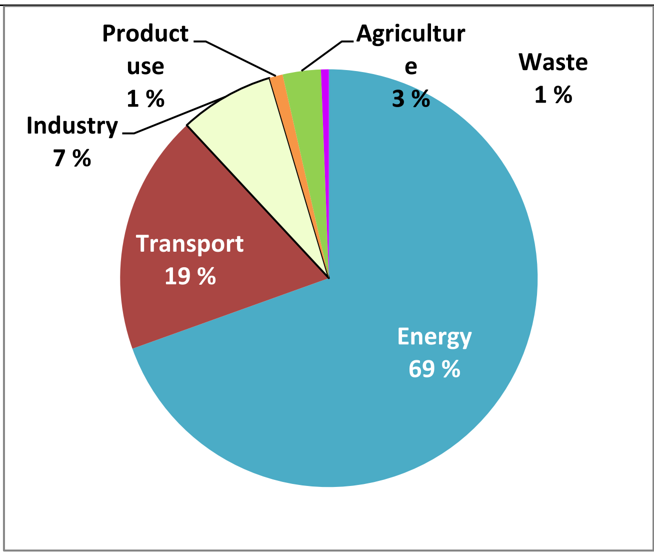


Figure 1.34. PM2.5 emissions in 2000-2017

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to PM2.5 emissions in 2015, the spatial distribution of emi The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in ssions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 1.35.



Shares of total PM2.5 emissions reported by the plants in 2017							
NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	2.1	0.370	0	2A5c	0.2	0.029	0
1A1b	0.1	0.025	0	2B10a	1.5	0.259	0
1A2a	<0.1	0.006	0	2B10b	<0.1	0.001	0
1A2b	<0.1	0.004	0	2B6	<0.1	0.001	0
1A2c	0.2	0.037	0	2C1	1.0	0.186	0
1A2d	7.9	1.410	0	2C2	0.6	0.110	0
1A2e	<0.1	0.015	0	2C3	<0.1	<0.001	0
1A2f	0.3	0.046	0	2C7a	<0.1	<0.001	0
1A2gvii	1.9	0.346	0	2C7c	<0.1	0.005	0
1A2gviii	0.5	0.094	0	2C7d	0.1	0.025	0
1A3ai(i)	<0.1	0.005	0	2D3b	0.3	0.058	0
1A3aii(i)	<0.1	0.001	0	2D3d	<0.1	<0.001	0
1A3bi	1.8	0.321	0	2D3e	<0.1	<0.001	0
1A3bii	1.8	0.315	0	2D3g	<0.1	<0.001	0
1A3biii	1.3	0.233	0	2D3i	0.5	0.092	0
1A3biv	0.2	0.035	0	2G	0.5	0.090	0
1A3bvi	3.5	0.616	0	2H1	1.3	0.225	0
1A3bvii	2.7	0.474	0	2H2	2.1	0.375	0
1A3c	0.1	0.026	0	2I	<0.1	<0.001	0
1A3dii	1.8	0.322	0	2L	0.1	0.019	0
1A4ai	0.8	0.136	0	3B1a	0.4	0.064	0
1A4aii	1.6	0.289	0	3B1b	0.2	0.032	0
1A4bi	51.9	9.246	0	3B2	<0.1	0.002	0
1A4bii	<0.1	0.012	0	3B3	<0.1	0.002	0
1A4ci	0.9	0.169	0	3B4d	<0.1	<0.001	0
1A4cii	1.4	0.245	0	3B4e	<0.1	0.006	0
1A4ciii	0.2	0.041	0	3B4gi	<0.1	0.009	0

1A5a	1.3	0.237	0	3B4gii	<0.1	0.008	0
1A5b	0.1	0.021	0	3B4giii	<0.1	0.003	0
1B1b	<0.1	0.002	0	3B4giv	<0.1	<0.001	0
1B1c	3.2	0.575	0	3B4h	<0.1	0.012	0
1B2aiv	<0.1	0.002	0	3Dc	1.1	0.195	0
1B2av	<0.1	<0.001	0	3F	1.1	0.191	0
2A2	<0.1	<0.001	0	5A	<0.1	<0.001	0
2A3	<0.1	0.006	0	5C1bv	<0.1	<0.001	0
2A5a	<0.1	<0.001	0	5E	0.6	0.107	0
2A5b	**<0.1**	**0.004**	**0**	**Total**	**100**	**17.800**	**0**

Figure 1.36 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.7.4 Black carbon (BC)

Emission trend

The trend of black carbon emissions is presented in Figure 1.37.

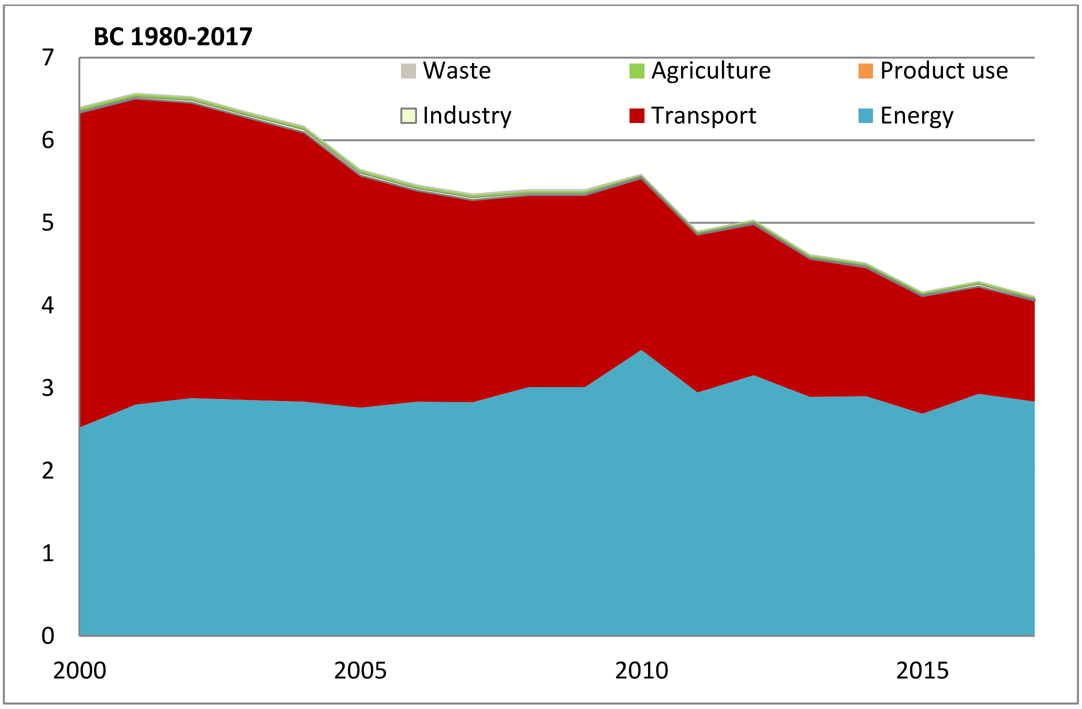
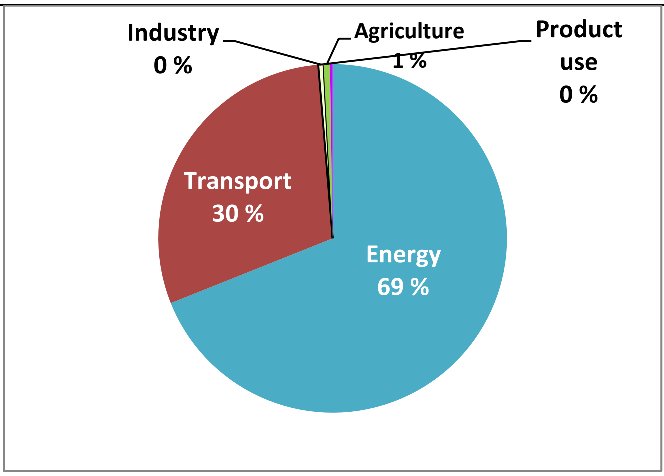
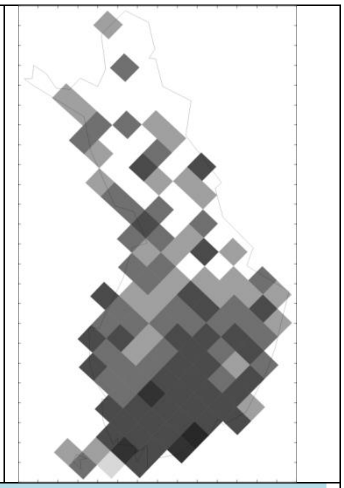


Figure 1.37. BC emissions (kt) in 2000-2017

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.38.





Shares of total BC emissions reported by the plants in 2017							
NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	0.6	0.023	0	1A4bii	<0.1	0.002	0
1A1b	<0.1	0.002	0	1A4ci	0.3	0.011	0
1A2a	<0.1	<0.001	0	1A4cii	2.9	0.119	0
1A2b	<0.1	<0.001	0	1A4ciii	0.3	0.013	0
1A2c	0.2	0.008	0	1A5a	1.7	0.068	0
1A2d	0.3	0.011	0	1A5b	0.2	0.010	0
1A2e	<0.1	0.003	0	1B1b	<0.1	<0.001	0
1A2f	0.1	0.005	0	2A2	<0.1	<0.001	0
1A2gvii	5.2	0.215	0	2A3	<0.1	<0.001	0
1A2gviii	0.1	0.006	0	2B10a	<0.1	<0.001	0
1A3ai(i)	<0.1	0.003	0	2B6	<0.1	<0.001	0
1A3aii(i)	<0.1	<0.001	0	2C1	<0.1	<0.001	0
1A3bi	4.1	0.167	0	2C2	0.3	0.011	0
1A3bii	4.2	0.173	0	2C3	<0.1	<0.001	0
1A3biii	3.0	0.123	0	2C7a	<0.1	<0.001	0
1A3biv	0.1	0.005	0	2D3b	<0.1	0.003	0
1A3bvi	4.0	0.166	0	2D3i	<0.1	<0.001	0
1A3bvii	2.3	0.093	0	2G	<0.1	<0.001	0
1A3c	0.4	0.017	0	2H1	0.1	0.004	0
1A3dii	1.3	0.053	0	3F	0.6	0.024	0
1A4ai	0.7	0.027	0	5C1bv	<0.1	<0.001	0
1A4aii	1.5	0.064	0	5E	0.2	0.009	0
1A4bi	**64.9**	**2.67**	**0**	**Total**	**100**	**4.113**	**0**

Figure 1.38 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8 Heavy metals

The following heavy metals are included in the Finnish inventory: primary heavy metals, lead, cadmium and mercury, and in addition, arsenic, chromium, copper, nickel and zinc. The time series 1990-2015 are presented in Figure 1.39.

Selene is one of the non-obligatory heavy metals for reporting and as a full inventory has not yet been performed for selene, the national total is reported as NE although sector specific values exist and are reported. The same applies also to all other heavy metals prior to the year 1990 when the obligation for inventories starts.

The inventory includes bottom-up data, i.e. data reported by the plants on basis of reporting obligations in their environmental permits. However, as the inventory time-series has not been updated, it has not been possible to check possible errors. Also, the emission factors used in the old time-series may not reflect the actual emission trends and emissions from small combustion plants may be highly overestimated as, in lack of information for the applied abatement techniques, these emissions are calculated as unabated. Due to lack of resources in calculation of the energy sector emissions, an update of the time series is still pending but anticipated to be finalized for the submission in 2018. The time series fluctuation is also impacted by different allocation of sources under NFR codes between the years, for the above mentioned reasons.

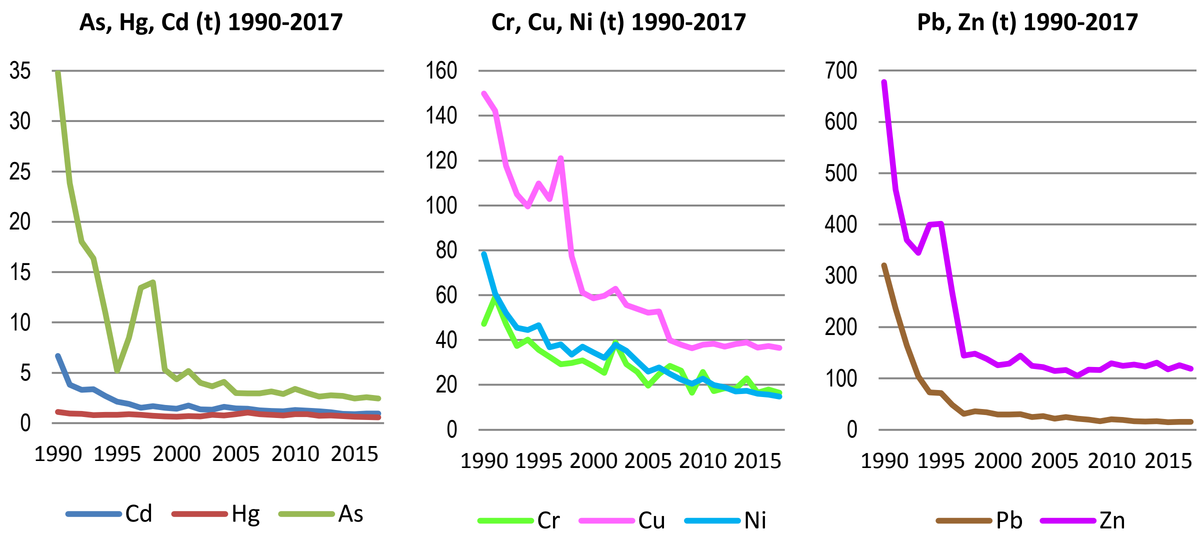


Figure 1.39. Heavy metal emission trends

The emission trends have been strongly decreasing (Figure 1.40) after the first reporting year 1990. Lead emissions have decreased by 95%, cadmium by 81%, mercury by 41%, arsenic by 91%, chromium by 38%, copper by 64%, nickel by 74% and zinc emissions by 77%.

The main sources of heavy metal emissions in Finland are industrial processes and energy production. In both sources there can be large annual variations. For industrial processes the variations are due to changes in the production capacities and in the energy sector, the energy supply structure causes fluctuations. In the integrated Nordic electricity market the annual rainfall and accordingly the availability of cheap hydropower decreased the Finnish emissions in the early 1990's as well as in the turn of the millennium. After that, in years with limited availability of Nordic hydropower, coal and peat fuelled condensing power generation has increased and impacted emission levels.

Annual variations in the emissions are mainly due to fluctuations in the production of non-ferrous metals. In the energy sector, emissions are more stable though affected by the variations in energy production. Heavy metal emissions may be overestimated for small combustion plants as these emissions are calculated as unabated because no information of abatement technique is available.

Heavy metal emissions are likely overestimated due to rather high emission factors compared to e.g. other Nordic countries, and due to the fact that for the small combustion plants from which no information of abatement technique is available, the emissions are calculated as unabated. A project funded by the Nordic Council of Ministers is running in 2016-2018 to study emissions in the Nordic countries and to develop methodologies that better reflect the real emission levels.

2.3.8.1 Arsenic emissions

Arsenic emissions have been reduced by 91% since the base year 1990. The main source in the beginning of the 1990's was industrial processes (mainly non-ferrous metals), where the emissions have dropped considerably. The largest source at the moment is energy production where the energy supply structure causes fluctuations. The main source currently is combustion of wood in the residential sector (Figure 1.41).

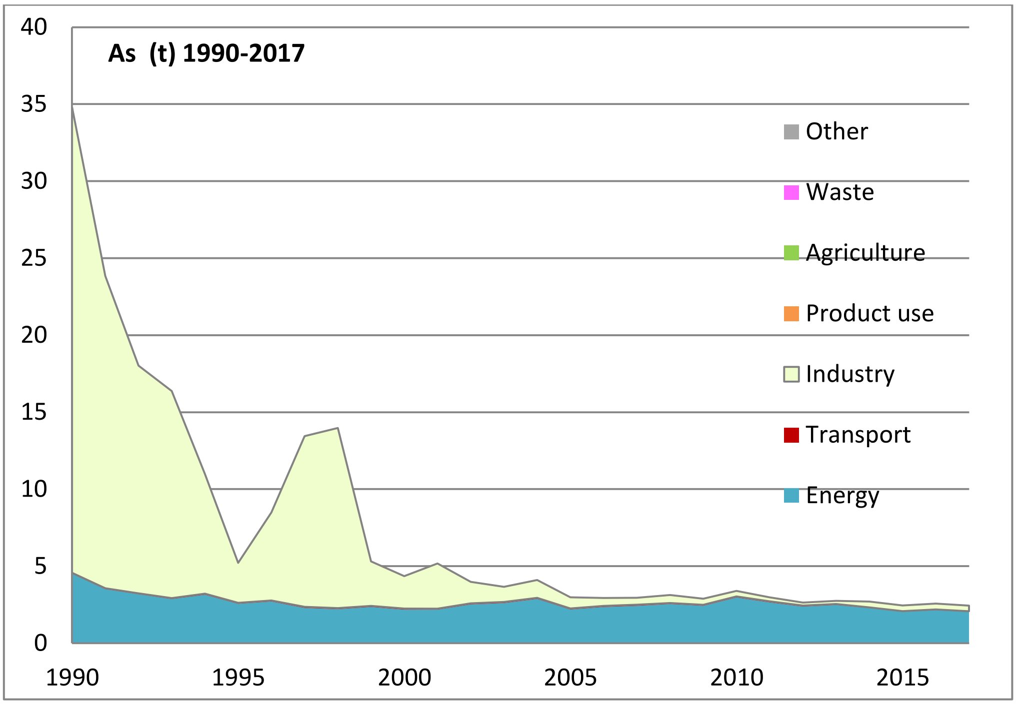
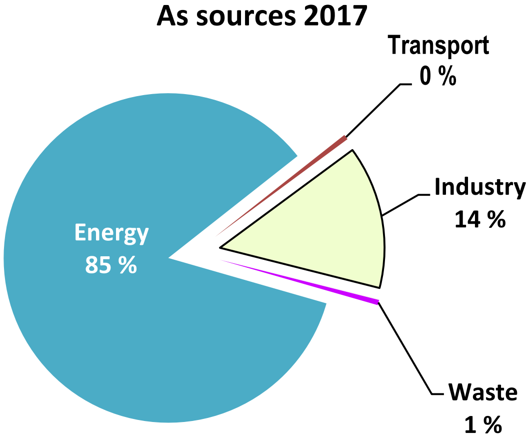
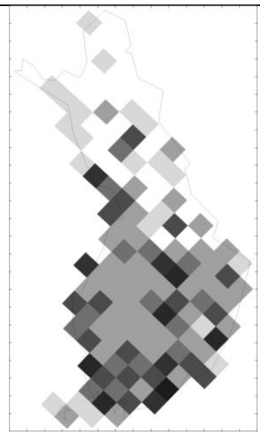


Figure 1.41. Arsenic emissions (t) in 1990-2017

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.42.





Shares of total As emissions reported by the plants in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	28.3	0.690	16.0	1A4bi	2.7	0.067	0
1A1b	21.9	0.534	0	1A4ci	6.8	0.166	0
1A2a	<0.1	0.001	27.5	1A4ciii	<0.1	0.001	0
1A2b	<0.1	<0.001	0	1A5a	0.9	0.021	0
1A2c	0.1	0.003	6.1	1B1b	0.1	0.002	100
1A2d	6.7	0.163	8.6	2C1	1.6	0.039	100
1A2e	2.2	0.054	10.8	2C2	<0.1	<0.001	100
1A2f	11.7	0.285	2.3	2C3	<0.1	<0.001	100
1A2gviii	0.8	0.018	9.2	2C6	1.2	0.028	100
1A3bi	<0.1	<0.001	0	2C7a	2	0.048	77.4
1A3bii	<0.1	<0.001	0	2C7c	10.1	0.248	100
1A3biii	<0.1	<0.001	0	2G	<0.1	0.002	0
1A3biv	<0.1	<0.001	0	3F	<0.1	<0.001	0
1A3bvi	1.6	0.038	0	5C1bv	<0.1	<0.001	0
1A3dii	0.4	0.011	0	5E	<0.1	<0.001	0
1A4ai	**0.7**	**0.016**	**0**	**Total**	**100**	**2.440**	**20.3**

Figure 1.42(a) The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.2 *Cadmium emissions*

Emission trend

Cadmium emissions have been reduced by 79% since the base year 1990. The main sources of cadmium are industrial processes and energy production. The emissions fluctuate annually depending on the consumption of fossil fuels and production rates in manufacturing industries. (Figure 1.43). There is an incorrect value for the IPPU sector in 1999 in the NFR table as can be seen in the figure below, this will be corrected to the next submission.

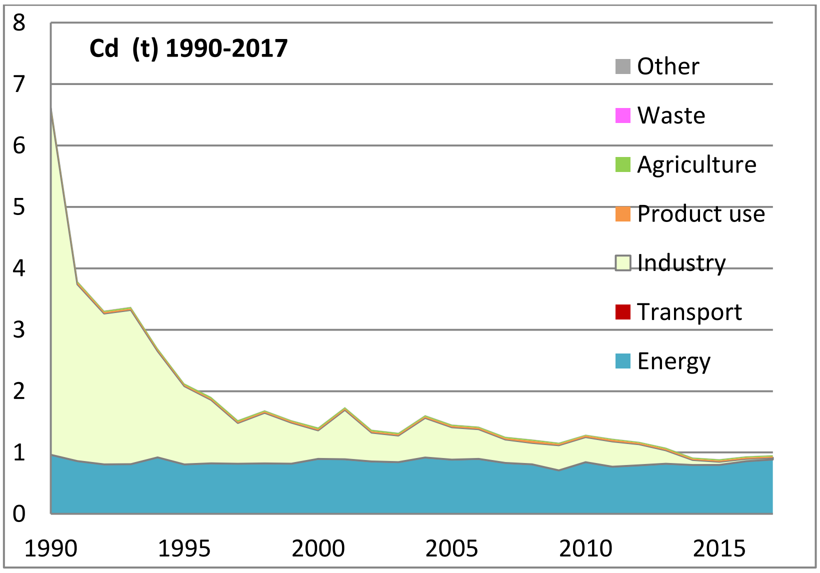
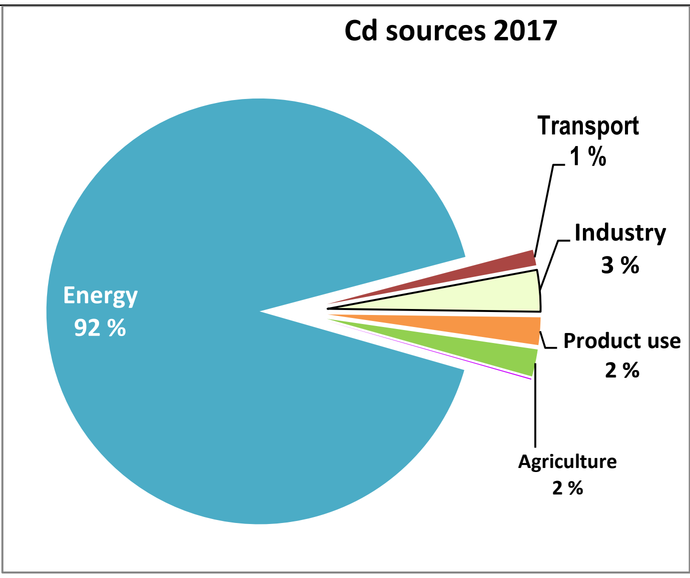


Figure 1.43. Emissions of cadmium (t) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.44.



NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	15.4	0.148	18.2	1A4aii	0.2	0.002	0
1A1b	7.8	0.074	0	1A4bi	16.8	0.161	0
1A2a	<0.1	<0.001	62.5	1A4bii	<0.1	<0.001	0
1A2b	<0.1	<0.001	0	1A4ci	2.8	0.027	0
1A2c	<0.1	<0.001	4.1	1A4cii	0.3	0.003	0
1A2d	32.3	0.309	2.4	1A4ciii	<0.1	<0.001	0
1A2e	0.3	0.003	5.8	1A5a	8.1	0.077	0
1A2f	4.6	0.044	2.3	1B1b	<0.1	<0.001	100
1A2gvii	0.3	0.003	0	2C1	0.6	0.005	100
1A2gviii	2.1	0.020	1.2	2C2	<0.1	<0.001	100
1A3bi	<0.1	<0.001	0	2C3	<0.1	<0.001	100
1A3bii	<0.1	<0.001	0	2C6	1.4	0.013	100
1A3biii	<0.1	<0.001	0	2C7a	<0.1	<0.001	100
1A3biv	<0.1	<0.001	0	2C7c	1.1	0.010	100
1A3bvi	0.2	0.002	0	2G	2.1	0.020	0
1A3c	<0.1	<0.001	0	3F	2.1	0.020	0
1A3dii	0.1	0.001	0	5C1bv	<0.1	<0.001	0
1A4ai	1.1	0.010	0	5E	<0.1	<0.001	0
				Total	**100**	**0.956**	**6.9**

Shares of total Cd emissions reported by the plants in 2017

Figure 1.44 (a) The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.3 Chromium emissions

Emission trend

Chromium emissions have been reduced by 38% since the base year 1990. Both energy production and industrial processes contribute the annual releases. Emissions from industrial processes have large annual variations due to variations in the production volumes, also the energy supply structure causes fluctuations. (Figure 1.45).

Emissions from industry fluctuate according to fluctuating production volumes.

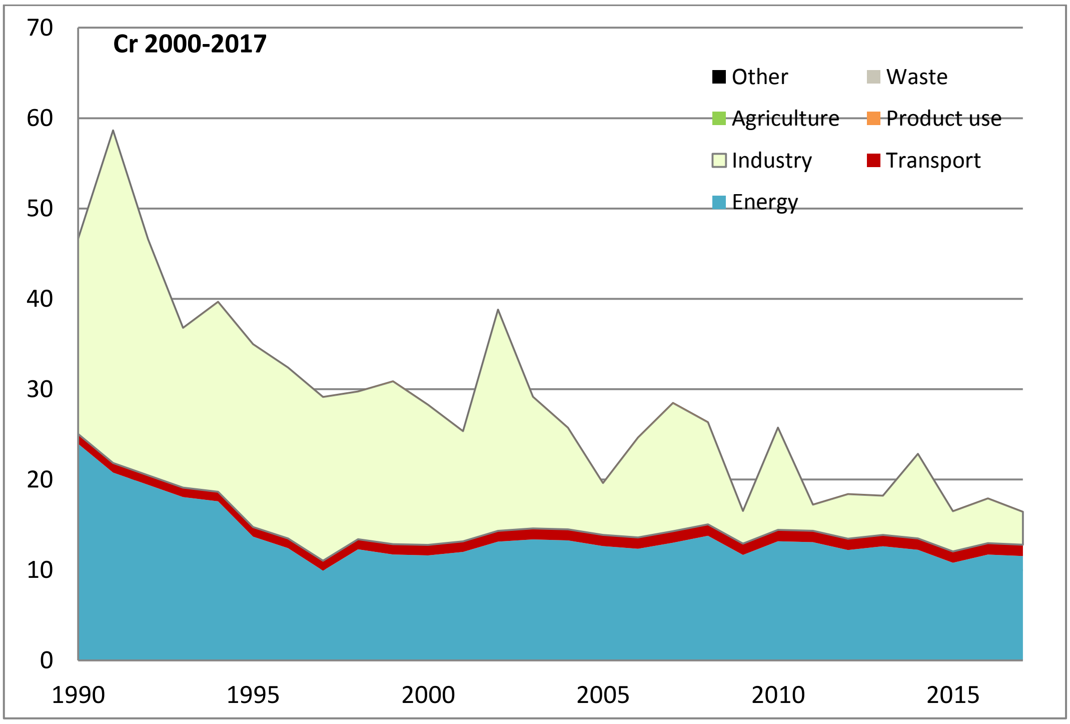
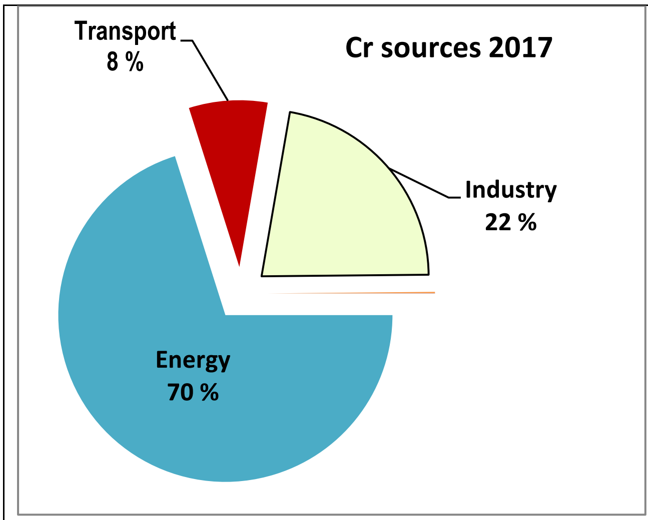
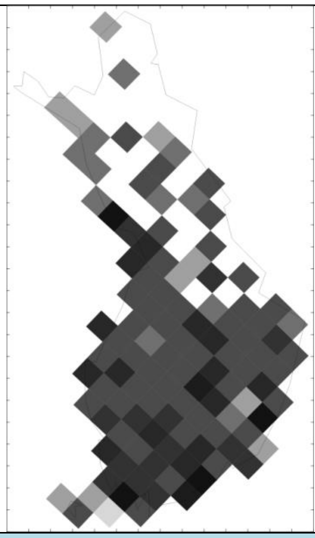


Figure 1.45. Emissions of chromium (t) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.46.





Shares of total Cr emissions reported by the plants in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	9.8	1.613	17.1	1A4ai	0.8	0.129	0
1A1b	24.9	4.092	0	1A4aii	<0.1	0.008	0
1A2a	<0.1	0.003	19.5	1A4bi	11.5	1.896	0
1A2b	1.2	0.199	0	1A4bii	<0.1	0.001	0
1A2c	<0.1	0.005	5.1	1A4ci	3.2	0.519	0
1A2d	0.9	0.146	27.4	1A4cii	<0.1	0.013	0
1A2e	0.7	0.109	3.4	1A4ciii	<0.1	0.001	0
1A2f	13	2.138	0.5	1A5a	3.3	0.537	0
1A2gvii	0.1	0.017	0	1B1b	<0.1	0.003	100
1A2gviii	0.9	0.155	3.8	2C1	16.9	2.780	100
1A3bi	<0.1	0.015	0	2C2	5.1	0.846	100
1A3bii	<0.1	0.003	0	2C7a	<0.1	<0.001	100
1A3biii	<0.1	0.012	0	2C7c	0.1	0.017	100
1A3biv	<0.1	<0.001	0	2G	0.1	0.020	0
1A3bvi	7.1	1.169	0	3F	<0.1	0.003	0
1A3c	<0.1	0.001	0	5C1bv	<0.1	<0.001	0
1A3dii	<0.1	0.012	0	5E	<0.1	<0.001	0
				Total	**100**	**16.463**	**24.2**

Figure 1.46 (a) The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.4 Copper emissions

Emission trend

Copper emissions have been reduced by 63% since the base year 1990 (Figure 1.47)

The main sources of copper emissions are industrial processes and transport. In the industrial processes sector emissions from metal industry have the largest contribution and the emissions vary depending on the annual production rates. Also, the national energy supply structure causes fluctuations to emissions (see Chapter x).

Emissions from the industry sector have been decreased due to improvements in processes and abatement technology. Since 2000 emissions from small scale combustion have been included in the inventory and in 2014 the emission factor for copper was revised, however, only for 2014. Recalculation of the time series has not yet been carried out.

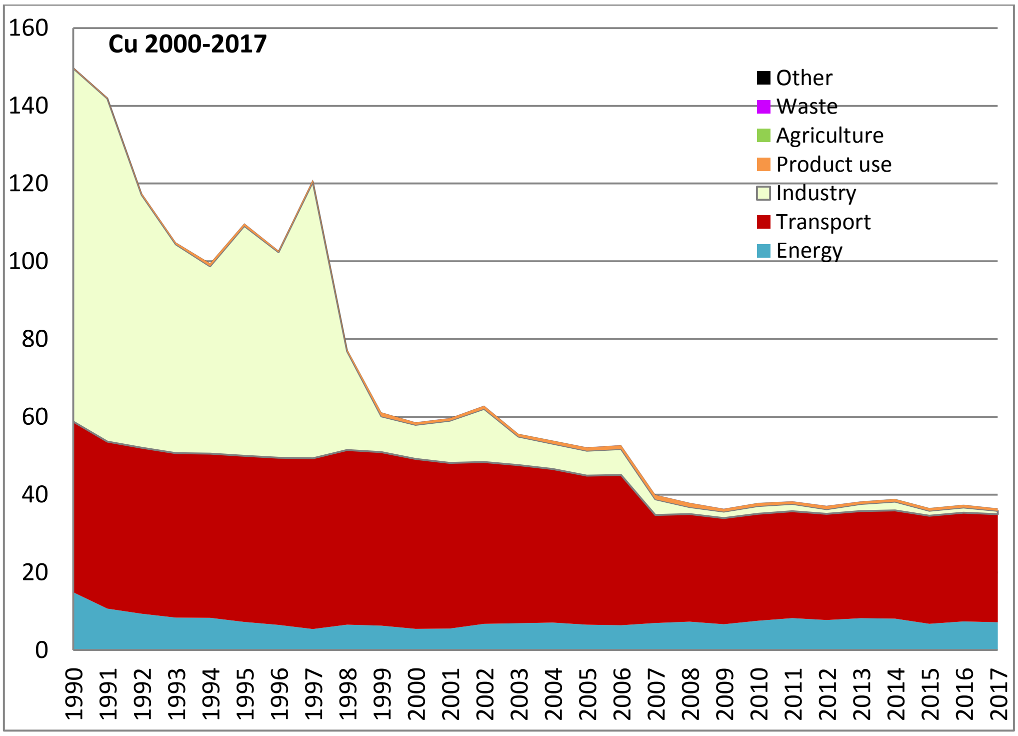
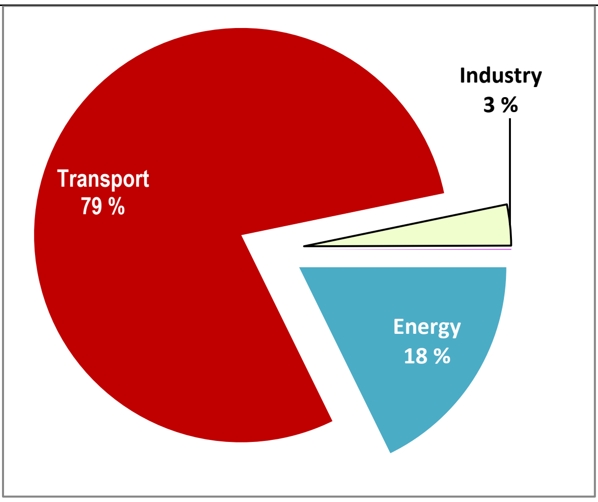
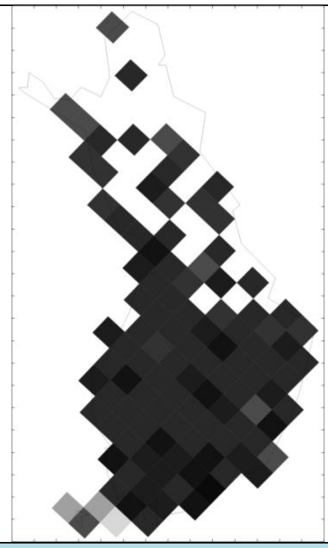


Figure 1.47. Emissions of copper (t) 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.48.





Shares of total Cu emissions reported by the plants in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	6.7	2.435	12.2	1A4aii	0.7	0.263	0
1A1b	3.9	1.434	0	1A4bi	1.0	0.356	0
1A2a	<0.1	0.004	13.4	1A4bii	0.1	0.047	0
1A2b	<0.1	<0.001	0	1A4ci	1.3	0.471	0
1A2c	<0.1	0.005	6	1A4cii	1.2	0.434	0
1A2d	1.1	0.400	63.6	1A4ciii	<0.1	0.026	0
1A2e	0.4	0.143	2.2	1A5a	2.2	0.794	0
1A2f	2.3	0.834	4.5	1B1b	<0.1	0.011	100
1A2gvii	1.6	0.568	0	2B10a	<0.1	0.012	100
1A2gviii	0.6	0.231	1.9	2C1	0.9	0.329	100
1A3bi	<0.1	0.010	0	2C2	0.1	0.049	100
1A3bii	<0.1	0.002	0	2C6	<0.1	0.016	100
1A3biii	<0.1	0.008	0	2C7a	<0.1	0.017	100
1A3biv	<0.1	<0.001	0	2C7c	1.2	0.441	100
1A3bvi	72.2	26.319	0	2G	1.6	0.596	0
1A3c	<0.1	0.034	0	3F	<0.1	0.001	0
1A3dii	0.2	0.086	0	5C1bv	<0.1	<0.001	0
1A4ai	0.1	0.050	0	5E	<0.1	0.002	0
				Total	**100**	**36.431**	**4.0**

Figure 1.48(a) The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.5 Lead emissions

Emission trend

Lead emissions have been reduced by 94% since the base year 1990.

The main source of lead in the beginning of the 1990's was the use of lead added to gasoline being 1211 tonnes in 1980 and 192 tonnes in 1990 and coming down to 0 tonnes in 1994. Lead is still emitted from lubricant use in vehicles. Lead emissions from industrial processes (metal industry) have been significantly decreased since the mid-1990's. The largest source of lead at the moment is combustion of fuels and the emissions vary annually depending on changes in the annual energy supply structure.

The time series is presented in Figure 1.49

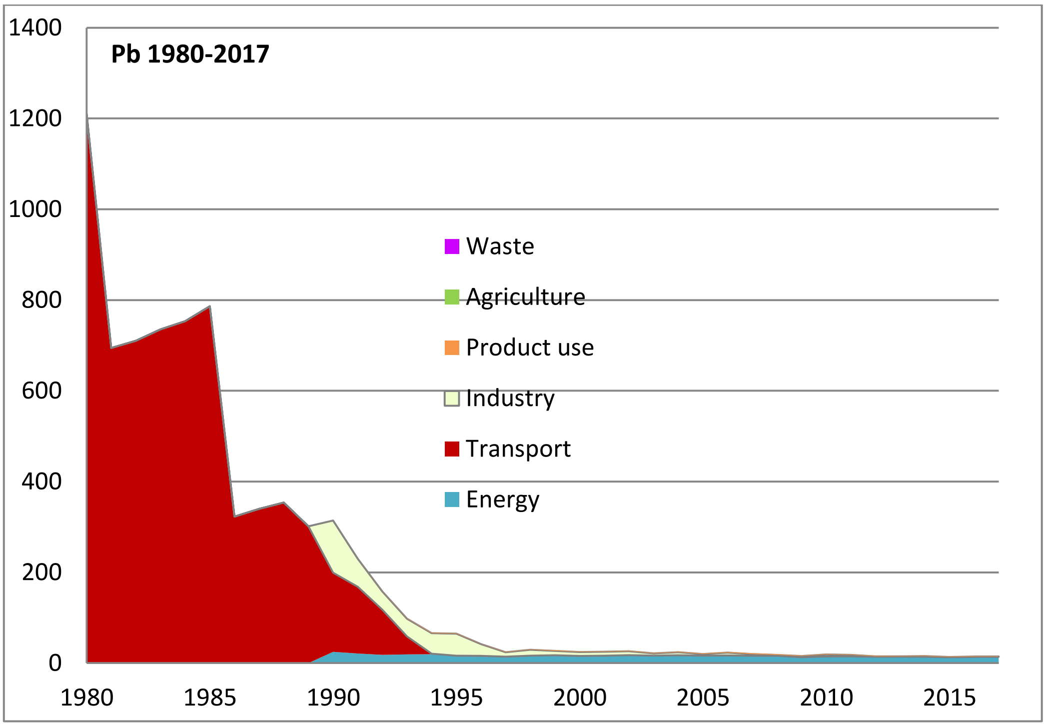
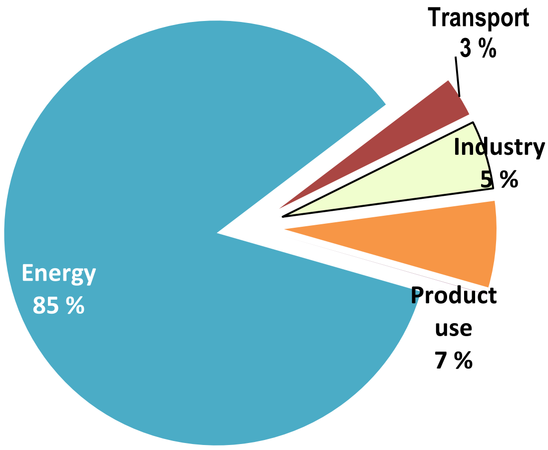
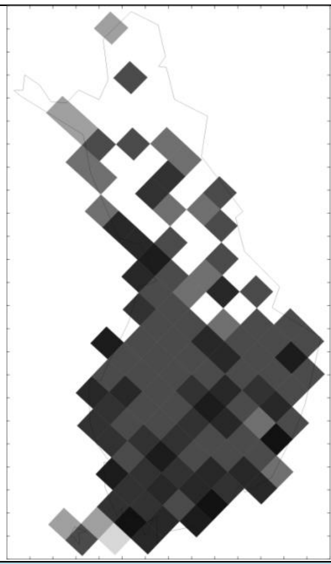


Figure 1.49. Pb emissions (Mg) in 1980-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.50.





Shares of total Pb emissions reported by the plants in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	13.0	2.024	15.9	1A4bi	3.7	0.569	0
1A1b	20.9	3.255	0	1A4ci	2.6	0.410	0
1A2a	<0.1	0.007	59.9	1A4ciii	<0.1	0.004	0
1A2b	<0.1	<0.001	0	1A5a	4.9	0.758	0
1A2c	0.2	0.033	1	1B1b	<0.1	0.004	100
1A2d	25.8	4.021	4.2	2B10a	<0.1	0.001	0
1A2e	0.8	0.132	4.8	2C1	2.3	0.365	100
1A2f	11.3	1.763	1.6	2C2	0.1	0.016	100
1A2gviii	1.3	0.206	2.9	2C3	<0.1	0.001	100
1A3aii(i)	0.2	0.027	0	2C6	<0.1	0.004	100
1A3bi	<0.1	0.002	0	2C7a	<0.1	0.002	33.3
1A3bii	<0.1	<0.001	0	2C7c	2.7	0.422	100
1A3biii	<0.1	<0.001	0	2G	6.6	1.021	0
1A3biv	<0.1	<0.001	0	3F	<0.1	0.002	0
1A3bvi	2.7	0.421	0	5C1bv	<0.1	<0.001	0
1A3dii	<0.1	0.013	0	5E	<0.1	<0.001	0
1A4ai	**0.6**	**0.09**	**0.4**	**Total**	**100**	**15.576**	**8.7**

Figure 1.50 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.6 Mercury emissions

Emission trend

The emissions are fluctuating annually depending on changes in the annual energy production structure and fluctuations in the industrial production volumes. Mercury emissions have been reduced by 33% since the base year 1990 (Figure 1.51).

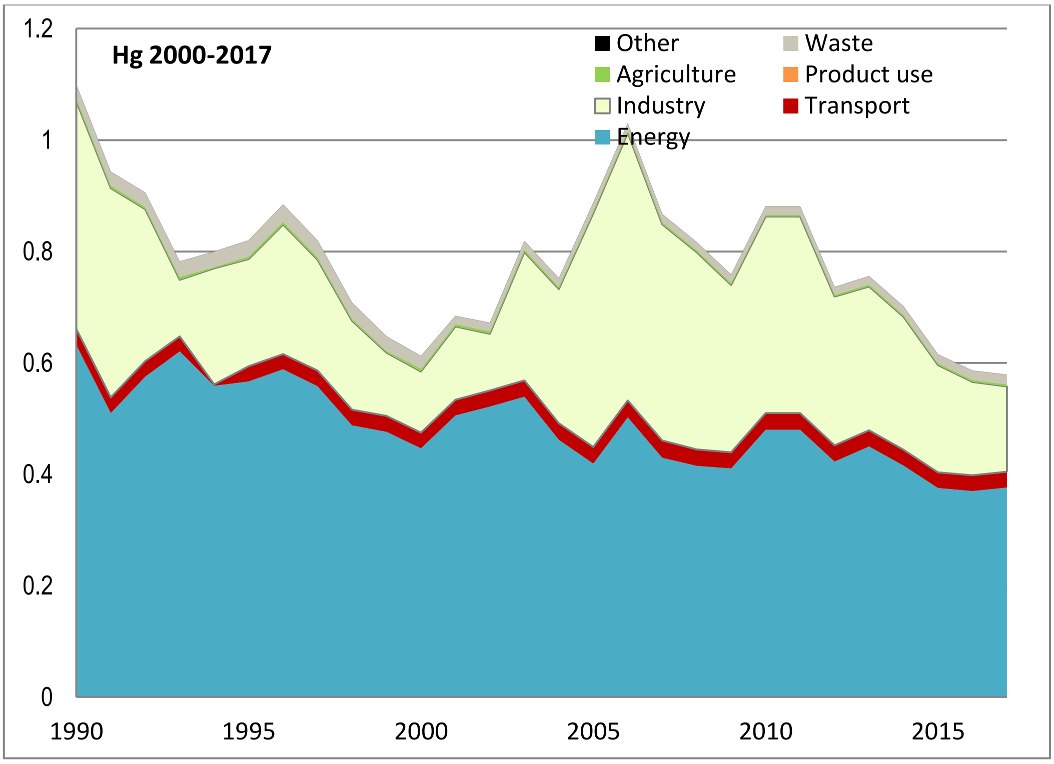
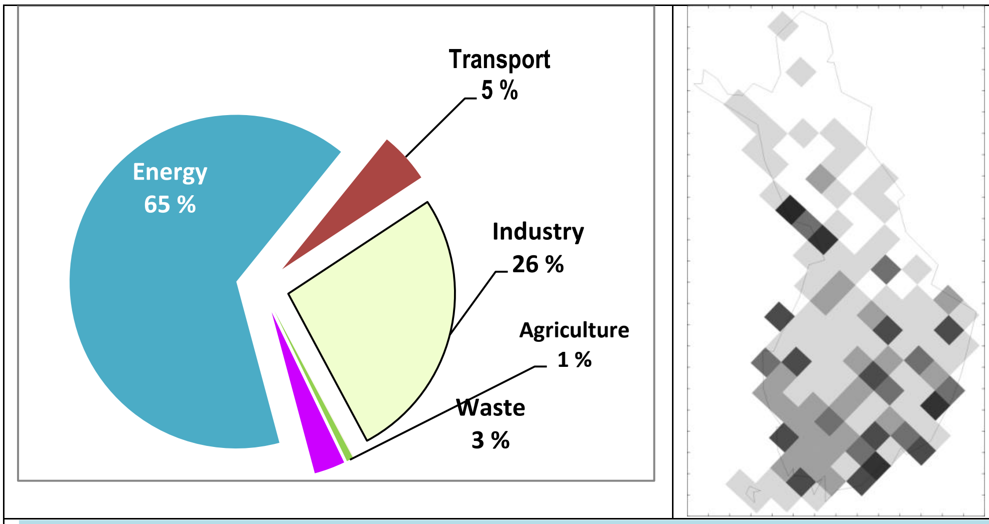


Figure 1.51. The emissions of mercury (t) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.52.



Shares of total Hg emissions reported by the plants in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	25.3	0.146	58.5	1A4bi	4.7	0.027	0
1A1b	2.6	0.015	0	1A4ci	1.5	0.009	0
1A2a	<0.1	<0.001	2	1A4ciii	0.2	<0.001	0
1A2b	<0.1	<0.001	0	1A5a	1.4	0.008	0

1A2c	<0.1	<0.001	74.9	1B1b	<0.1	<0.001	0
1A2d	21.5	0.125	18.8	2B10a	8.9	0.051	100
1A2e	0.5	0.003	33.6	2C1	15.8	0.091	100
1A2f	4.7	0.027	68.8	2C2	0.3	0.002	100
1A2gviii	2.4	0.014	68.5	2C6	0.1	<0.001	100
1A3bi	2.7	0.016	0	2C7a	<0.1	<0.001	0
1A3bii	0.3	0.002	0	2C7c	1.4	0.008	100
1A3biii	1.3	0.007	0	2G	<0.1	<0.001	0
1A3biv	<0.1	<0.001	0	3F	0.7	0.004	0
1A3dii	0.5	0.003	0	5C1bv	2.9	0.017	0
1A4ai	0.3	0.002	0	5E	0.1	<0.001	0
				Total	**100**	**0.579**	**50.3**

Figure 1.52 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.7 Nickel emissions

Emission trend

The emission trend is decreasing (Figure 1.53) and the emissions are fluctuating annually depending on the consumption of fossil fuels and production rates in the manufacturing industries (mainly non-ferrous metals). Nickel emissions have been reduced by 69% since the base year 1990.

It is not possible to indicate the current reduction level from the base year emissions due to the pending recalculation of the time series.

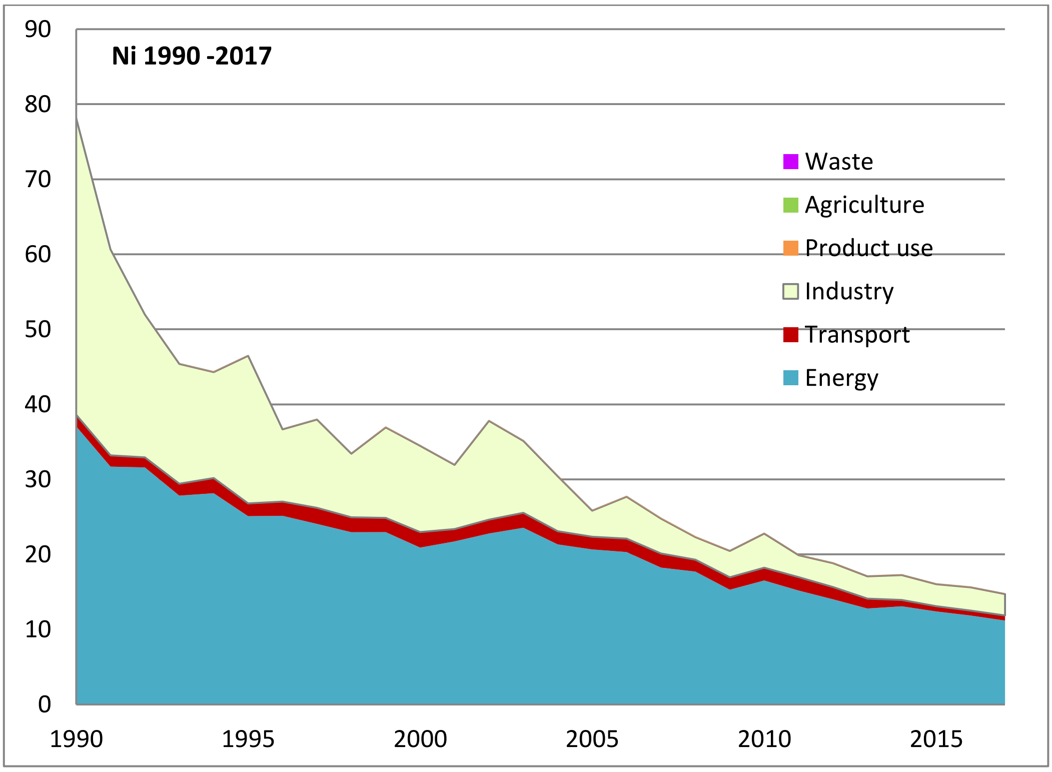
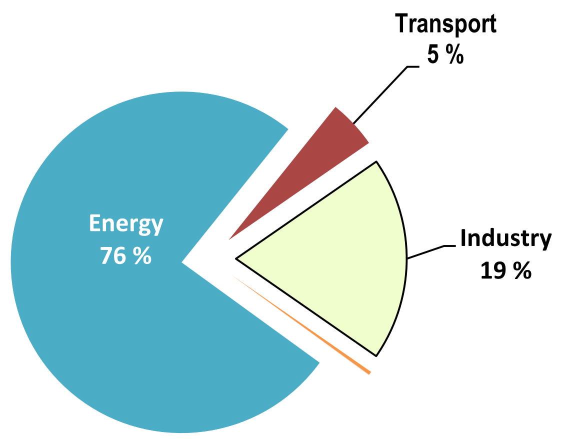
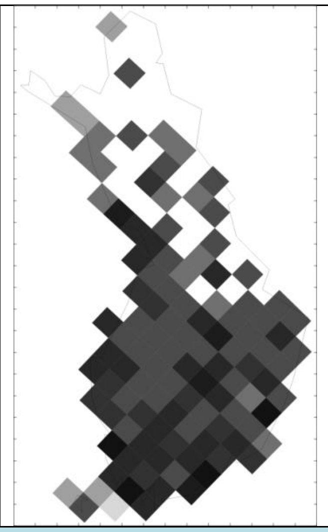


Figure 1.53. Nickel emissions (t) in 1990-2017.

The uncertainties of emission data in 2016 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.54.





NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
Shares of total Ni emissions reported by the plants in 2017							
1A1a	14.4	2.123	20.0	1A4aii	<0.1	0.011	0
1A1b	11.2	1.654	68.7	1A4bi	11.3	1.661	0
1A2a	0.4	0.062	96.2	1A4bii	<0.1	0.002	0
1A2b	0.3	0.040	0	1A4ci	4.0	0.589	0
1A2c	2.3	0.346	0.4	1A4cii	0.1	0.018	0
1A2d	3.5	0.519	53.8	1A4ciii	0.2	0.029	0
1A2e	1.5	0.221	20.7	1A5a	9.0	1.323	0
1A2f	12.2	1.794	1.2	1B1b	<0.1	0.015	100
1A2gvii	0.2	0.023	0	2B10a	0.4	0.059	100
1A2gviii	1.8	0.266	13.0	2C1	6.7	0.984	100
1A3bi	<0.1	0.003	0	2C2	0.4	0.063	100
1A3bii	<0.1	<0.001	0	2C7a	<0.1	<0.001	0
1A3biii	<0.1	<0.001	0	2C7b	11.7	1.720	100
1A3biv	<0.1	<0.001	0	2C7c	0.1	0.021	100
1A3bvi	1.1	0.168	0	2G	0.3	0.048	0
1A3c	<0.1	0.001	0	3F	<0.1	0.001	0
1A3dii	2.9	0.423	0	5C1bv	<0.1	<0.001	0
1A4ai	**3.8**	**0.565**	**1.1**	**Total**	**100**	**14.752**	**33.0**

Figure 1.54 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.8.8 Zinc emissions

Emission trend

The emissions have been significantly reduced since the base year 1990 (Figure 1.55). The main source until 1998 was industrial processes (metal industry), where significant reductions occurred annually after 1990. Emissions from energy production have been fluctuating due to changes in the annual energy supply structure. However, the time series in the energy production sector has not been recalculated and emissions before 2000 may be underestimated

Emissions from tyre and brake wear have been recalculated for the whole time series since 1990.

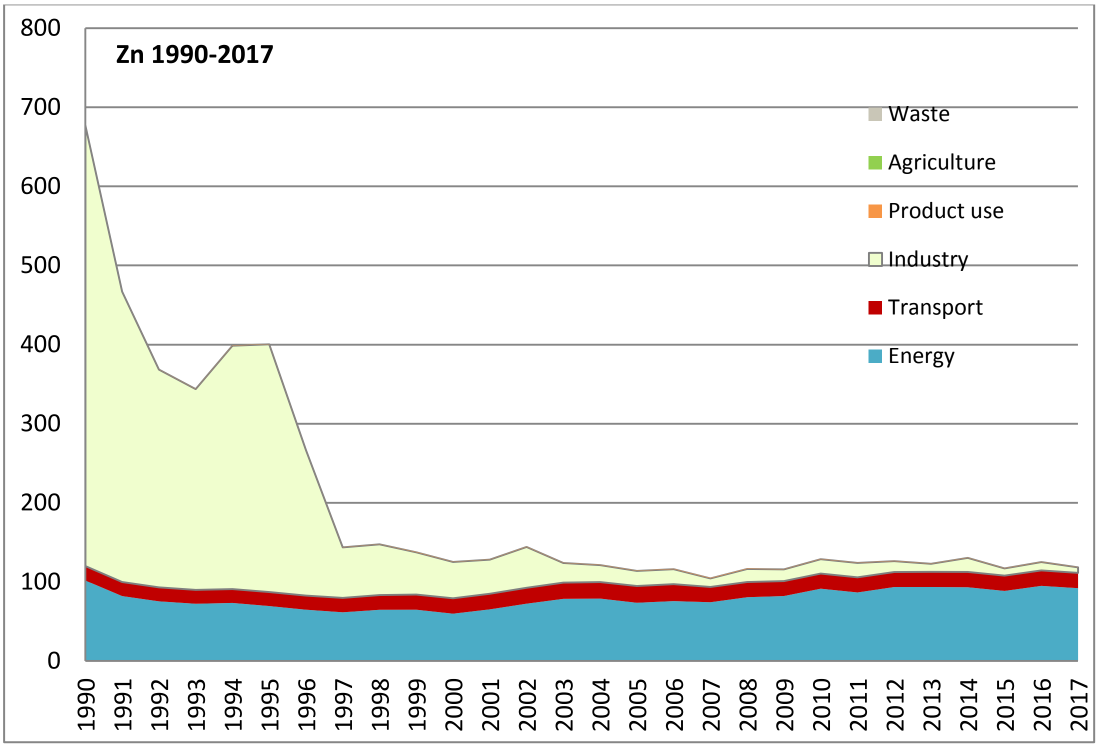
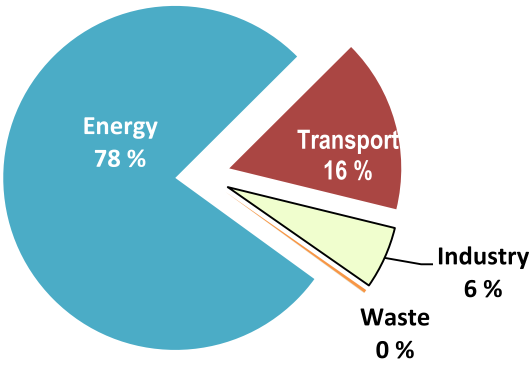
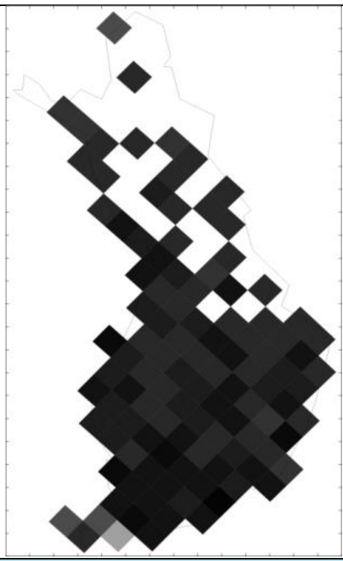


Figure 1.55. Emissions of zinc (t) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.56





NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
Shares of total Zn emissions reported by the plants in 2017							
1A1a	16.6	19.661	13.4	1A4aii	0.1	0.155	0
1A1b	5.2	6.151	0	1A4bi	31.5	37.388	0
1A2a	<0.1	0.014	26.0	1A4bii	<0.1	0.027	0
1A2b	<0.1	<0.001	0	1A4ci	4.7	5.581	0
1A2c	<0.1	0.03	6.9	1A4cii	0.2	0.255	0
1A2d	2.1	2.437	27.3	1A4ciii	<0.1	0.035	0
1A2e	0.4	0.425	14.4	1A5a	9.0	10.714	0
1A2f	3.4	4.082	0	1B1b	<0.1	0.019	100
1A2gvii	0.3	0.334	0	2B10a	0.2	0.250	0
1A2gviii	2.8	3.300	0.1	2C1	1.5	1.734	100
1A3bi	<0.1	0.057	0	2C2	0.6	0.687	100
1A3bii	<0.1	0.006	0	2C3	<0.1	0.012	100
1A3biii	<0.1	0.025	0	2C6	3.1	3.710	100
1A3biv	<0.1	0.001	0	2C7a	<0.1	0.007	100
1A3bvi	15.4	18.316	0	2C7c	0.5	0.567	100
1A3c	<0.1	0.020	0	2G	0.3	0.348	0
1A3dii	<0.1	0.111	0	3F	<0.1	0.017	0
1A4ai	1.9	2.261	0	5C1bv	<0.1	0.005	0
				Total	**100**	**118.741**	**8.5**

Figure 1.56 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.9 Persistent organic pollutants

The time series 1990-2015 of PCDD/F, PAH-4, HCB and PCBs are presented in Figure 1.57.

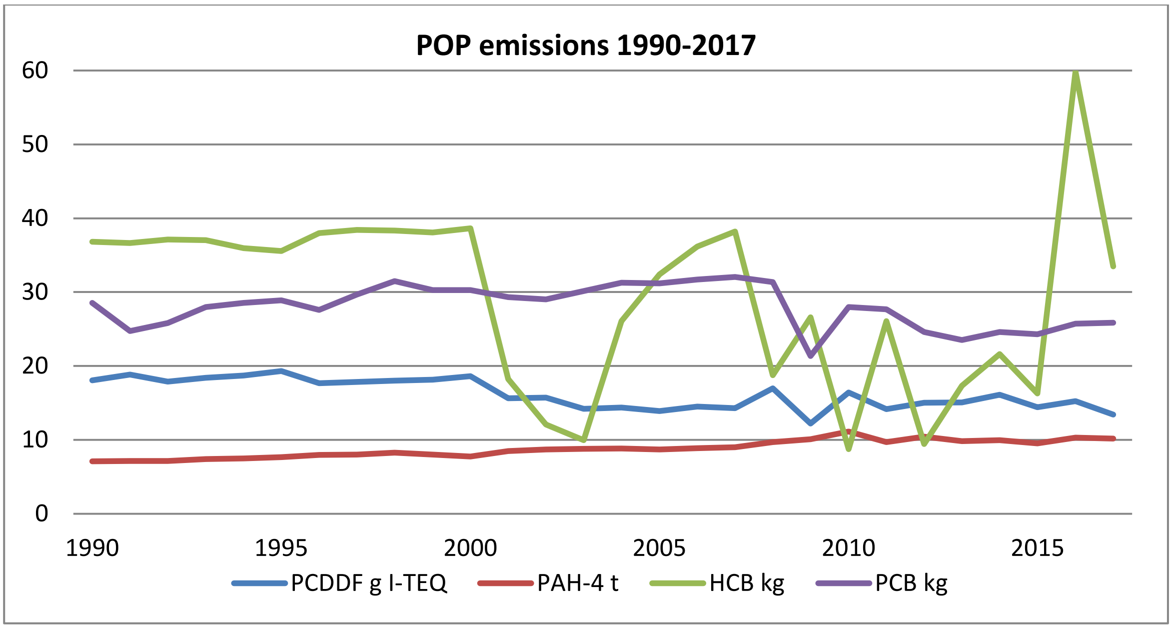


Figure 1.57 POP emissions (PCDD/F (gI-Teq), PAH-4 (t), HCB (kg) and PCB (kg)) emissions 1990–2017.

2.3.9.1 Polychlorinated dioxins and furanes, PCDD/F

Emission trend

The time series since 1990 is inconsistent (Figure 1.58) due to changes of methodologies in several sectors where understanding of the generation of emissions has increased during the years. The recalculation has not yet been possible but is scheduled for the submission in 2018.

In 2005 and 2014 the emission factors for small scale combustion were revised and used since for the annual inventories. Recalculation of the earlier years emissions has not yet been carried out. which can be seen in the change of the emission levels, especially in 1995.

For the IPPU sector emissions from the year 2005 onwards are not comparable with the earlier years due to the changes in the methodologies: the emission estimates for the earlier years are calculated on basis of activity data and emission factors, while emissions after 2005 are based on data reported by the plants.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.59.

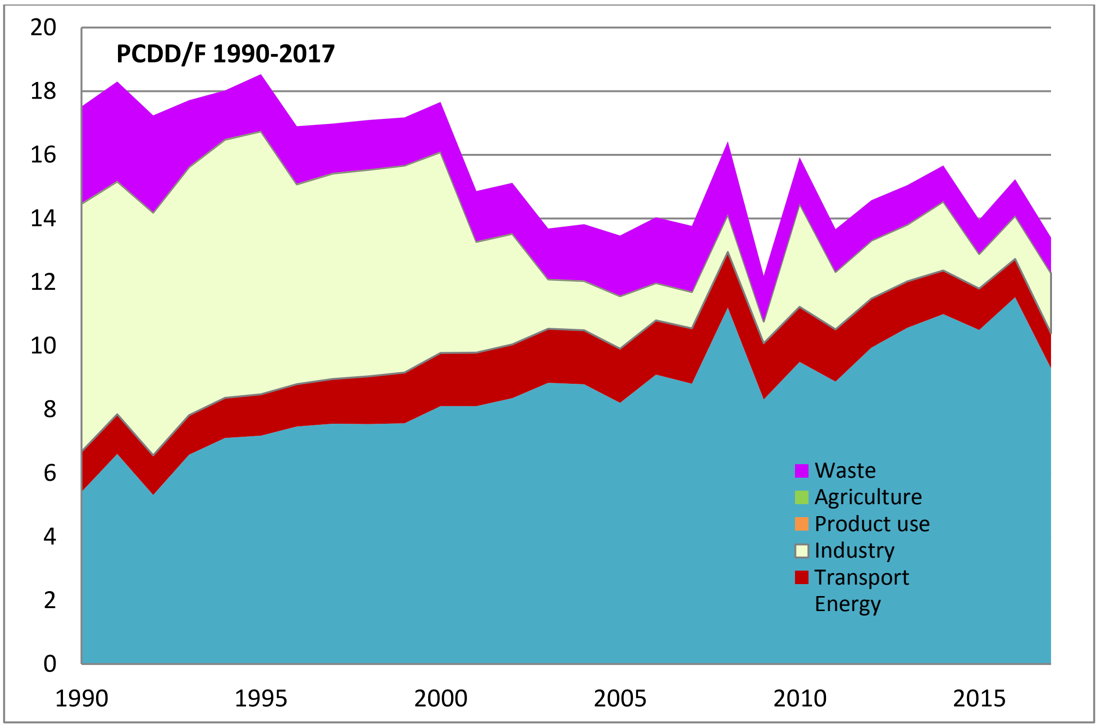


Figure 1.59. Emissions of PCDD/F (g I-Teq) in 1990-2017.

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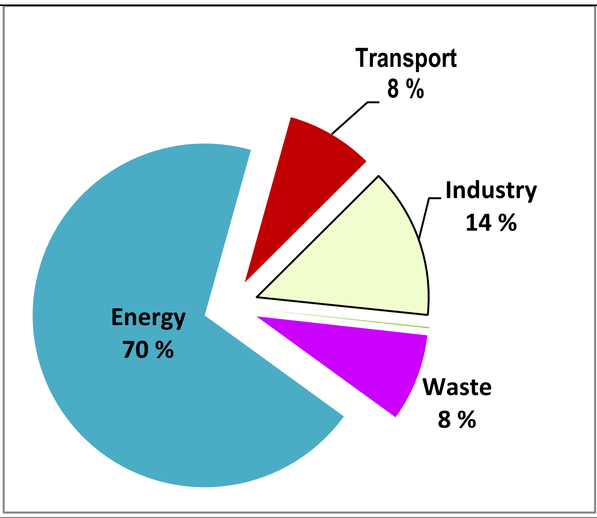


Shares of total PCDD/F emissions reported by the plants in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	25.3	3.391	15.6	1A4ciii	<0.1	0.004	0
1A1b	0.3	0.036	0	1A5a	2.5	0.331	0
1A2a	<0.1	0.008	0	1B1b	19.3	2.592	0
1A2b	<0.1	0.001	0	2A1	0.1	0.015	0
1A2c	<0.1	0.008	0	2A2	1.0	0.129	0
1A2d	6.8	0.906	14.9	2A3	<0.1	<0.001	0
1A2e	0.2	0.022	0	2B10a	0.2	0.031	100
1A2f	0.5	0.071	28.0	2C1	4.2	0.557	100
1A2gviii	4.0	0.537	1.2	2C3	6.6	0.885	0
1A3bi	5.2	0.701	0	2C6	0.2	0.028	0
1A3bii	1.6	0.221	0	2C7c	1.7	0.227	0.4
1A3biii	1.0	0.128	0	2D3b	<0.1	0.011	0
1A3biv	0.2	0.029	0	2G	<0.1	<0.001	0
1A3dii	0.1	0.016	0	2L	<0.1	0.009	0
1A3ei	<0.1	<0.001	0	3F	0.1	0.016	0

1A4ai	0.6	0.074	0	5C1bv	<0.1	<0.001	0
1A4bi	8.4	1.129	0	5E	8.2	1.103	0
1A4ci	**1.4**	**0.184**	**0**	**Total**	**100**	**13.402**	**9.5**

Figure 1.60 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.9.2 Polyaromatic hydrocarbons, PAH

Polyaromatic hydrocarbons under the CLRTAP convention are reported as the sum of four indicator substances (PAH-4), i.e. benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3_cd)pyrene.

Emission trend

PAH-4 emissions are increasing, however there are uncertainties included in the time series. PAH-4 emissions time-series is presented in Figure 1.61.

In 2005 and 2014 emission factors for small scale combustion were revised. Also the transport sector emissions were calculated with the new emissions factors from Guidebook.

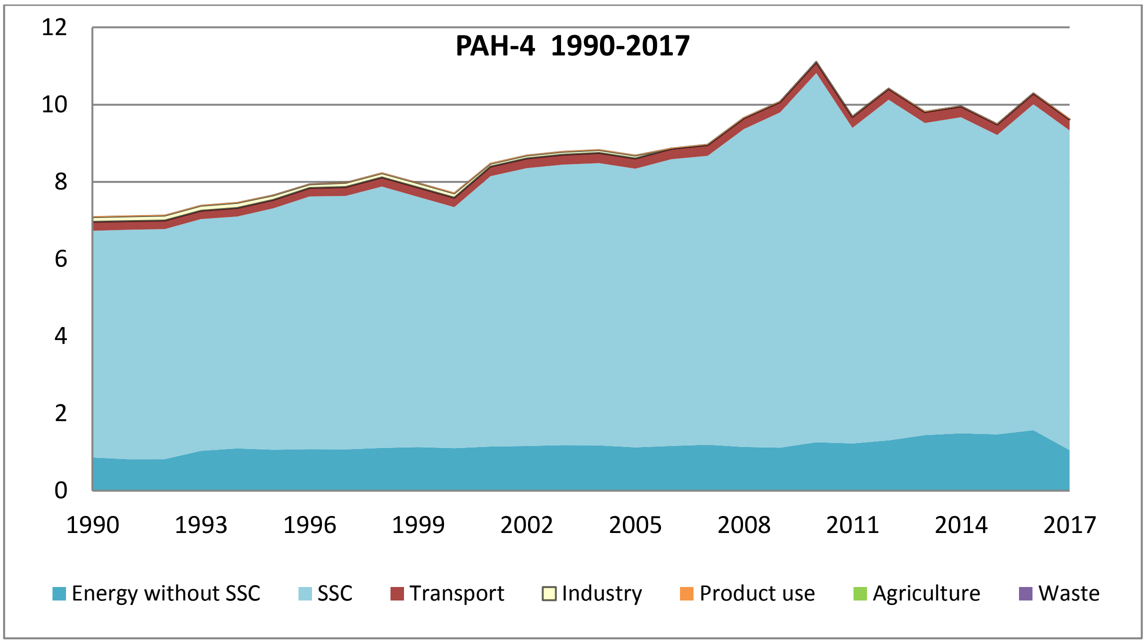
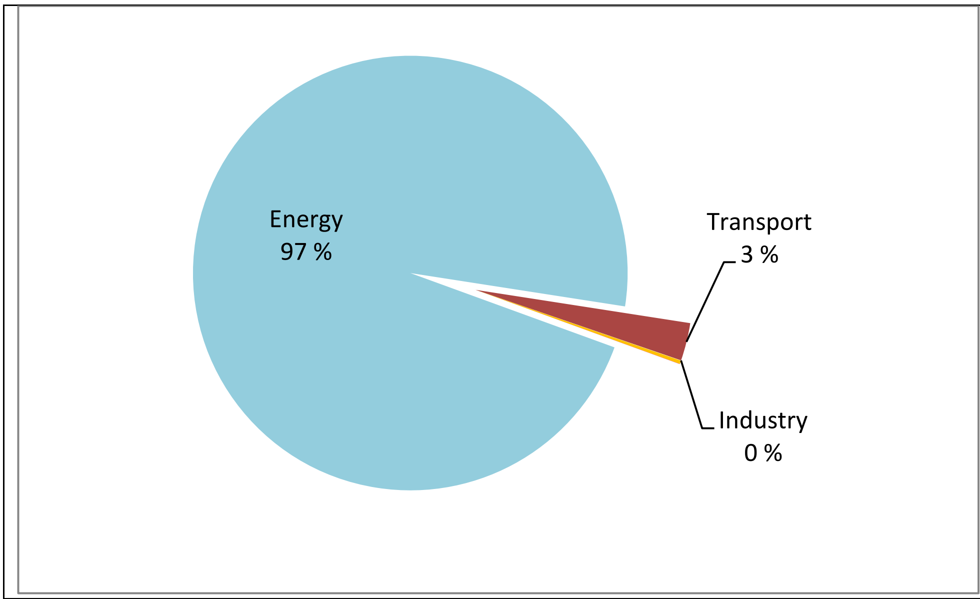
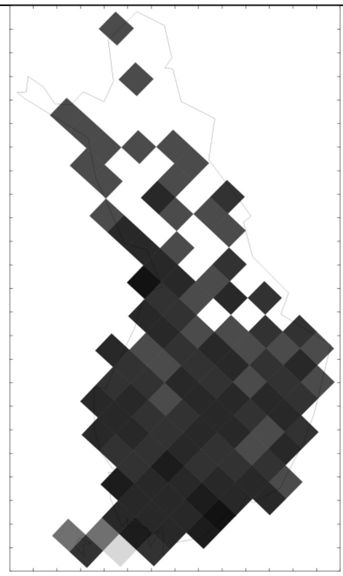


Figure 1.61. The emissions of PAH-4 (Mg) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.62.





Shares of total PAH-4 emissions reported by the plants in 2017							
NFR	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**	**NFR**	**Percentage of national total**	**Total release [Gg]**	**Percentage reported by the plants**
1A1a	5.3	0.540	35.1	1A4ai	0.6	0.060	0
1A1b	0.1	0.013	0	1A4aii	0.1	0.012	0
1A2a	<0.1	<0.001	0	1A4bi	81.6	8.283	0
1A2b	<0.1	0.002	0	1A4bii	<0.1	0.002	0
1A2c	<0.1	0.005	1.0	1A4ci	0.8	0.082	0
1A2d	1.3	0.135	18.8	1A4cii	0.2	0.020	0
1A2e	<0.1	0.003	0	1A5a	0.6	0.061	0
1A2f	<0.1	0.006	0	1B1b	4.5	0.458	0
1A2gvii	0.3	0.027	0	2A1	<0.1	0.001	0
1A2gviii	1.8	0.181	0	2C1	<0.1	<0.001	31.1
1A3bi	0.9	0.095	0	2C2	<0.1	<0.001	0
1A3bii	0.2	0.018	0	2D3i	0.3	0.026	0
1A3biii	1.1	0.108	0	2G	<0.1	<0.001	0
1A3biv	<0.1	0.001	0	3F	<0.1	<0.001	0
1A3c	<0.1	0.002	0	5C1bv	<0.1	<0.001	0
				Total	**100**	**10.146**	**2.1**

Figure 1.62 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.9.3 Hexachlorobenzene, HCB

HCB emissions were reported for the first time in the 2007 submission.

Emission trend

HCB emissions have been reduced by 60% from the base year 1994. The emission trend is dominated by the fluctuations in the industrial processes sector and may be overestimated for the other sources due to the highly uncertain methods. (Figure 1.63).

Emissions in the other sectors may be overestimated due to the fact that many estimation methods are highly uncertain.

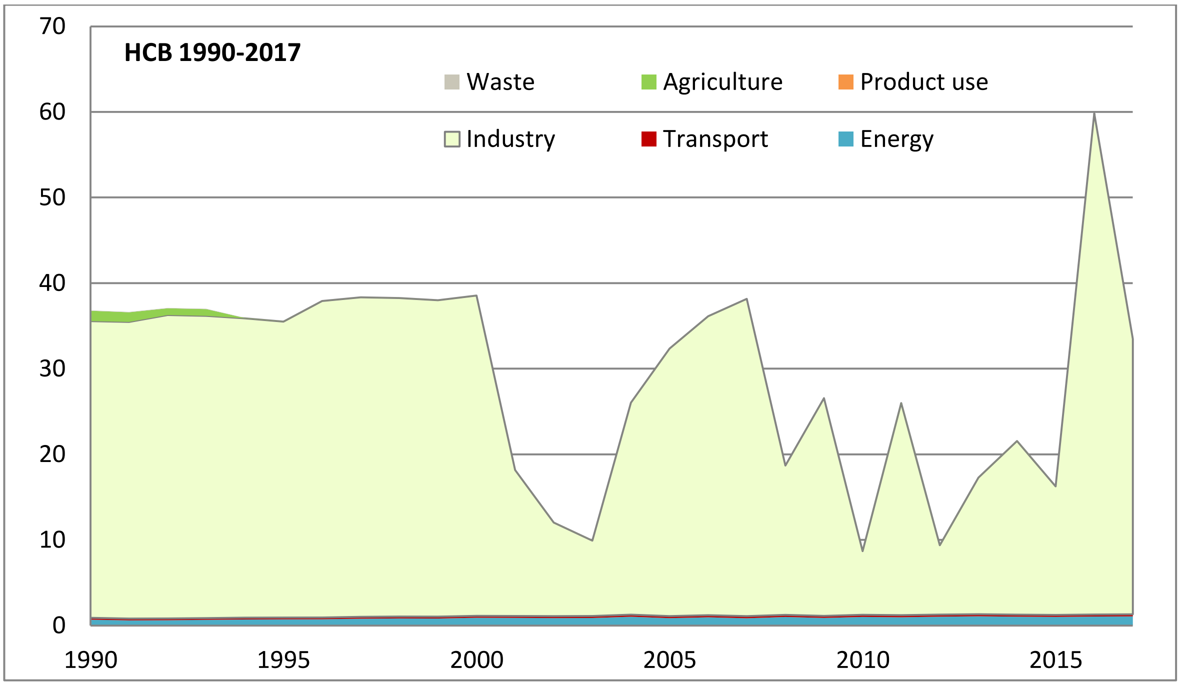
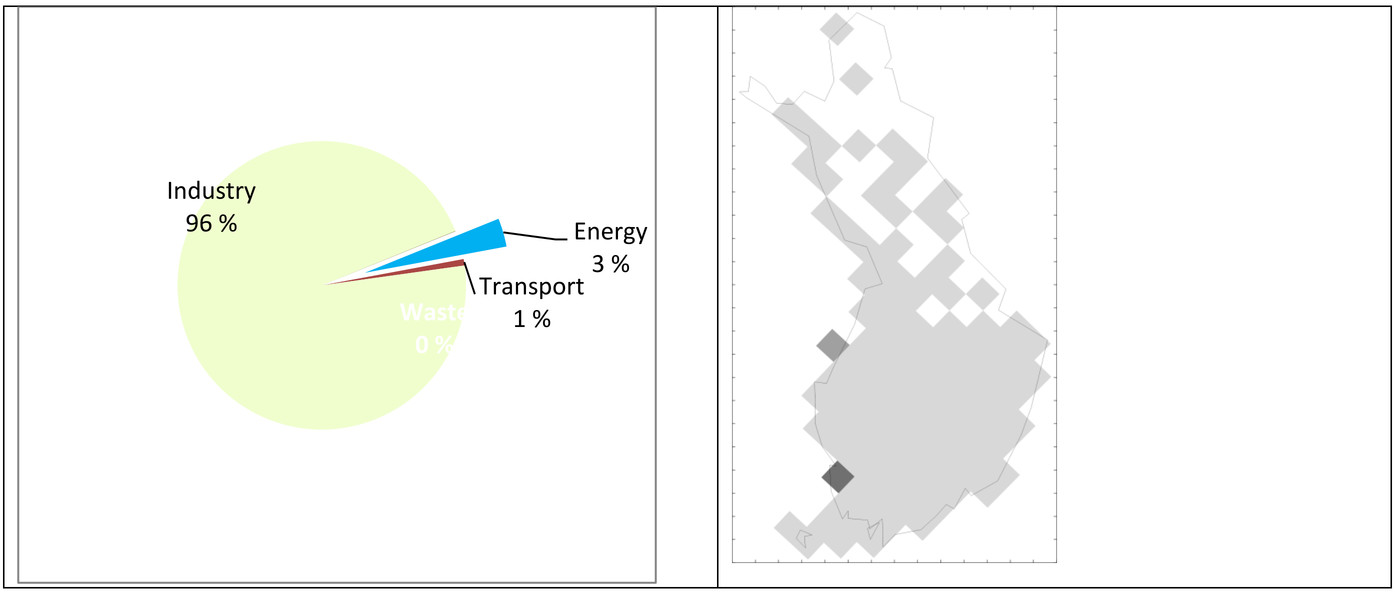


Figure 1.63. Emissions of HCB (kg) in 1990-2017

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.64.



Shares of total HCB emissions reported by the plants in 2017							
NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	1.2	0.416	0	1A4ai	<0.1	0.016	0
1A2a	<0.1	<0.001	0	1A4bi	0.8	0.267	0
1A2b	<0.1	<0.001	0	1A4ci	0.1	0.037	0
1A2c	<0.1	<0.001	0	1A4ciii	<0.1	0.002	0
1A2d	0.5	0.152	0	1A5a	<0.1	0.016	0
1A2e	<0.1	0.001	0	2B10a	76.1	25.500	100
1A2f	<0.1	0.002	0	2C1	<0.1	0.013	0
1A2gviii	0.5	0.160	0	2C3	0.1	0.035	0
1A3bi	0.4	0.126	0	2C7a	19.5	6.541	0
1A3bii	<0.1	0.019	0	2C7c	0.2	0.070	0
1A3biii	0.2	0.083	0	2D3i	<0.1	0.001	0
1A3biv	<0.1	0.002	0	3Df	<0.1	0.015	0
1A3dii	<0.1	0.008	0	5C1bv	<0.1	0.004	0
				Total	**100**	**33.488**	**76.1**

Figure 1.64 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.9.4 Polychlorinated biphenyls, PCBs

PCB emissions have been included in the inventory since 2008.

Emission trend

The PCB emission trend (Figure 1.65) is fluctuating mainly due to changes in the IPPU sector but not decreasing at the moment.

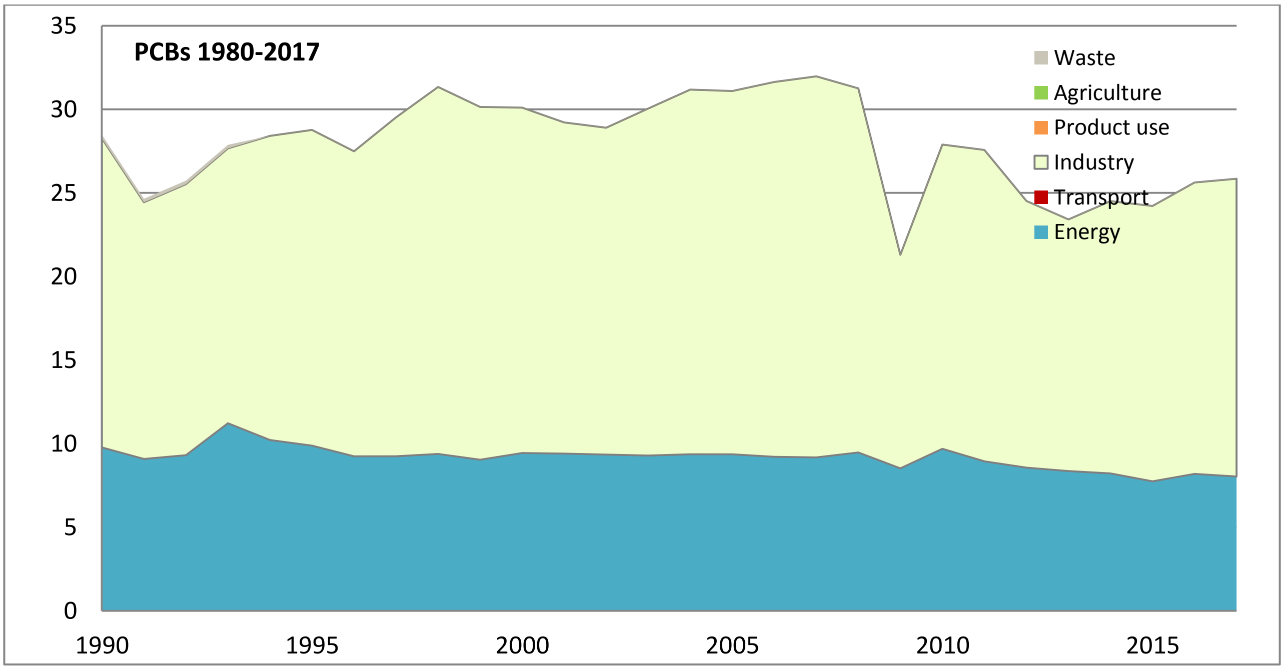
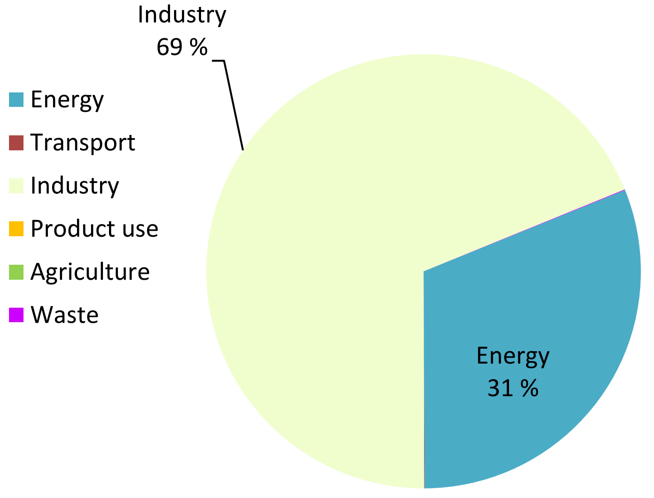


Figure 3.43. Emissions of PCB (kg) in 1990-2017.

The uncertainties of emission data in 2017 are presented in Annex 7 of the IIR.

The contribution of different sources to emissions, the spatial distribution of emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Figure 1.66.



Shares of total PCB emissions reported by the plants in 2017

NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [Gg]	Percentage reported by the plants
1A1a	1.1	0.291	0	1A4ai	0.7	0.19	0
1A2a	0.4	0.094	0	1A4bi	12.4	3.200	0
1A2b	0.1	0.034	0	1A4ci	1.6	0.423	0
1A2c	0.1	0.026	3	1A4ciii	<0.1	0.001	0
1A2d	0.1	0.037	0	1B1b	12	3.111	0
1A2e	0.5	0.124	0	2A1	11.9	3.068	0
1A2f	1.4	0.374	0	2A2	1.0	0.248	0
1A2gviii	0.5	0.122	0	2C1	55.7	14.396	34.7
1A3bi	<0.1	<0.001	0	2C3	0.3	0.090	0
1A3bii	<0.1	<0.001	0	2C7a	<0.1	<0.001	0
1A3biii	<0.1	<0.001	0	2C7c	<0.1	0.012	0
1A3biv	<0.1	<0.001	0	5C1bv	<0.1	0.012	0
1A3dii	**<0.1**	**0.009**	**0**	**Total**	**100**	**25.862**	**19.3**

Figure 1.66 The contribution of different sources and data reported by the plants in the 2017 emissions.

2.3.9.5 Polychlorinated biphenols PCP

Emission trend

PCP emissions were earlier, but not currently requested to be reported under the CLRTAP. Emissions of PCP originate mainly in the waste sector (Figure 1.67).

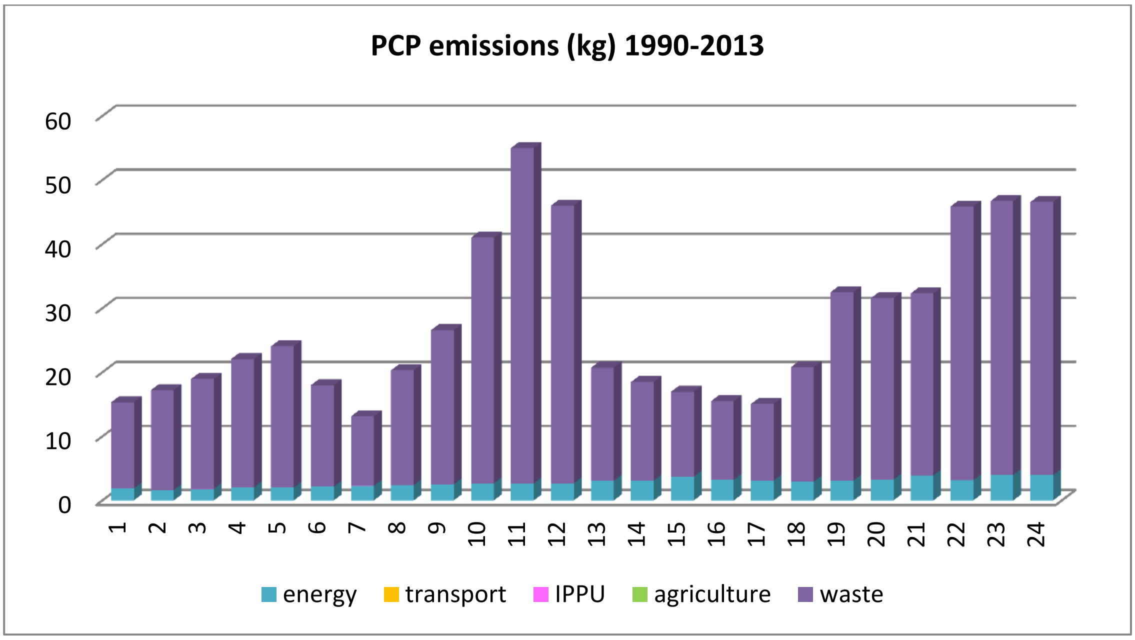


Figure 1.67. Emissions of PCP (kg) in 1990-2007.

Emissions in 2007

PCP emissions in 2013 emissions were 46.6 kg. The contribution of different sources to emissions and the shares of data reported by operators of industrial plants of total emissions are presented in Table 1.19 (The information for PCP will be updated to the next submission)

Table 1.19. PCP emissions, the share of emissions reported by the plants of the total emissions by NFR categories in 2007.

NFR	Percentage of national total	Total release [kg]	Percentage reported by the plants	NFR	Percentage of national total	Total release [kg]	Percentage reported by the plants
1A1a	4.3	2.025	0	1A4ci	0.4	0.170	0
1A2gviii	1.3	0.590	0	2C7c	<0.1	0.003	0
1A4ai	<0.1	0.004	0	5C1a	91.5	42.595	0
1A4bi	2.4	1.140	0	5C1bi	<0.1	0.040	0
				Total	**100**	**152.046**	**2.6**

2.3.9.6 Short chain chlorinated paraffins, SCCP

According to studies carried out at the Finnish Environment Institute SCCP emissions from the industrial processes sector deceased after 1995 totalling around 0.02 kilogrammes during 1990-1995. SCCP emissions from the use of products were not included in the inventory because no methodology exists at the moment. Further work to develop estimation methods and quantify emissions will be carried out when resources allow.

2.4 Description and interpretation of emissions by source

The sources of the air pollutant emissions are reported in the NFR (Nomenclature for Reporting) classification: energy (NFR 1), industrial processes (NFR 2), solvent and other product use (NFR 3), agriculture (NFR 4) and waste (NFR 6).

More detailed information of the contribution of different sources to the emissions of the specific air pollutants is provided in Chapter 3.2 Description and interpretation of emission trends by pollutants.

NFR 1 Sulphur dioxide (SO_2) emissions are mainly due to fuel combustion in the energy industries. Nitrogen oxides (NO_2) and carbon monoxide (CO) are generated both in the energy industries and in the traffic sector. NMVOC and POP emissions are released mainly from small combustion processes in the energy sector.

The emissions in the energy sector have varied considerably throughout the 1990's with an overall slightly increasing trend being visible.

NFR 2 Industrial processes release mainly heavy metals and POP compounds from production of iron, steel and non-ferrous metals as well as SO_2 from wood processing industries and NMVOC from the chemical industry.

The trends are in general decreasing but variations due to fluctuations in production occur annually.

Solvent and other product use emit mainly NMVOC compounds. Paint application and printing are the most significant NMVOC sources. Small amounts of particles are generated in spray painting, barbeques, meat frying, tobacco smoking, fires and fire works. The trends of both NMVOC and particulate matter emissions are decreasing.

NFR 3 Agriculture is the main source of ammonia emissions in Finland. The main sources of NH_3 are manure management and application of fertilizers. The annual emissions have been reduced compered to emissions level in 1990 due to strong decreases in the number of livestock, and in nitrogen fertilisation. The decreasing emission trend will be safeguarded in the EU common agricultural policy by adopting support measures encouraging production that minimises the burden on the greenhouse gas balance.

NFR 5 The emissions from the waste sector include NMVOC emissions from solid waste disposal on land, from wastewater treatment and composting. Particulate matter emissions from waste incineration are included. Emissions from waste incineration (reported by the operators) are included (NO_x, CO, NMVOC, SO_2, particles, heavy metals, PCB, PCDD/F, and PAH-4).

Detailed information of the emissions under the NFR categories is presented in Sections 4-10 as well as information of the source sector specific emissions and the calculation methodologies.