FINLAND's INFORMATIVE INVENTORY REPORT 2017

Air Pollutant Emissions 1980-2015

under the UNECE CLRTAP and the EU NECD

Part I

General A

Revised 28.4.2017 FINNISH ENVIRONMENT INSTITUTE

Centre for Sustainable Consumption and Production

Environmental Management in Industry – Air Emissions Team

PART 1

EMISSION INVENTORIES

The IIR resubmitted by 1st May 2017

is completed from the first submission on 15th March 2017

with information that was not possible to include

due to the late finalization of the 2017 submission.

IMPORTANT NOTES FOR THE 2017 SUBMISSION

Pending recalculation impacts energy, IPPU and waste sector emissions

The time series has not been fully recalculated but the data included in the NFR tables is mainly the same as reported on year-by-year basis in the year of its initial reporting. Recalculations and inclusion of new sources have, however, been included in the time series for such sources which are not interconnected with data reported by the plants[1] (NFR 1, 2 and 5). Only NH3 emissions have been recalculated for 1990-2015.

The main inconsistencies in the time series include:

- Data in NFR tables for 1980-2007 are not calculated in a consistent way compared to the later years.
- Data for 1980-1989 have not been recalculated and do not cover all sources that are reported after 1990.
- Data for 1990-2014 have not been recalculated for sources that are interconnected to data reported by the plants.
- New sources identified after the initial reporting year are included since 1990, and in some cases since 1980 for sources which are not interconnected with data reported by the plants. The same applies also to revised methods, e.g. updates in the Guidebook.

Schedule of recalculations

The full recalculation has been pending for more than a decade due to ongoing work to recalculate the energy sector emissions, which have interconnections to other source categories due to inclusion of data reported by the plants. The reason for the pending full recalculation of the time series is prioritization of other tasks to the inventory work.

Recalculation of the time series of fuel use 1990-2014 is ongoing in 2016-2017. Finalization of the allocations and recalculation of emissions is foreseen during 2017 to be submitted by 2018. When the recalculations have been fully completed, the differences between the data reported earlier, and the recalculated emissions, will be explained in the IIR for that submission.

Allocation of emissions under the NFR codes

- The data has originally been reported under NFR 2014 codes since the reporting in 2015 (2013 data).
- The allocation of 1980-2012 data under the NFR2014 codes is not fully consistent with the data from 2013 onwards.
- Only 2008 - 2015 data have been originally reported in NFR09/NRF14 format.
- Data for the years 1980-2007 are converted into NFR09/NFR14 by forcing from old NFRs or SNAPs.

Requests to postpone reviews

The Finnish air pollutant inventory was reviewed in 2009. As the schedule for reviews is every 5th year the second review should have taken place in 2014. Finland applied postponing of reviews under the CLRTAP in 2014 to 2016 and again in 2016 to 2018. The reason was the inconsistent time series which do not allow a full review of the inventory.

[1] See Chapter 2.3.4 “Use of bottom-up data in the emission inventories”

PREFACE

Finland's Informative Inventory Report (IIR) 2017 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 the year 2015 emissions and changes to methodologies compared to the previous inventories.

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). The structure of the report follows the template for the CLRTAP Informative Inventory Report and the United Nations Framework Convention on Climate Change new reporting guidelines (FCCC/SBSTA/2002/L.5/Add.1), when applicable, to enable comparison between the two inventory reports.

The report is reviewed and completed annually to include updated information.

- Preparation of emission data for 2015 is presented in Chapters 2 and 4-15 of this report.
- Emission trends and Finland's progress in meeting national emission ceilings is discussed in Chapter 3.
- Emission data for the years 1980-2015 are summarised in Tables 1.1 - 1.3 and emission data for 2015 presented in the NFR (Nomenclature for Reporting) format in Annex 1 of Part 2 to this report.

Finland applied adjustment to the NH_3 emission inventory in 2015 regarding small combustion, road transport and manure management. Out of these the Adjustments Review Team accepted the adjustments for small combustion and road transport. The adjusted emissions are included in the NFR tables for the years 2010-2015 and reported separately in the annual adjustments reporting NFR table.

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, from which the following experts have participated the work with total 2.8 man years: 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). 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, website: http://www.environment.fi.

Helsinki 28th April 2017

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International maritime navigation
Multilateral operations
Transport (fuel used)
Other not included in national total of the entire territory
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Forest fires
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Cover: "We are prisoners of the pending recalculation", Original photo "Snow/covered wire-netting fence" by Raili Malinen, 2010, Image bank of the Environmental Administration

Page 15 Sources: Finnish Tourist Board 2017 Image bank of the Environmental Administration 2017, Riku Lumiaho 2014, Lieksan Luonnonsuojeluyhdistys E. Lappi 2013, K. Saarinen 2016

Page 187: Source: Image bank of the Environmental Administration 2012, Photos by Aarno Torvinen and Kalervo Ojutkangas

Page 351 Agricultural practices, I.K. Inha 1899, the Finnish Museum of Photography

Page 360 Agricultural practices, I.K. Inha 1899, the Finnish Museum of Photography

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 2017 KS

1.1 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 2.1.

1.1.1 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[2] 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[3], Swedish[4] and English[5].

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

1.1.2 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[6], Swedish[7] and English[8]

1.2 Summary of national emissions related to trends

Changes in chapter	
Update of text or emission figures	November 2017 KS
Other (e.g. language, layout)	November 2017 KS

Summaries of air pollutant emissions in Finland for the years 1980-2015 are presented in Tables 1.1, 1.2 and 1.3.

At present, only years 2008-2015 are available in the new NFR format (NFR14), while the years 2000 – 2007 are in the older NFR format and the years 1990 – 1999. Emission data for the years 1980 - 1989 are mainly available only as national totals. Emission data from 1990 to 1999 has been calculated with the old inventory calculation system at SYKE and is therefore currently available only in the SNAP format and not possible to fully convert into NFR format regarding sources where data reported by the plants is used. Recalculation of emission data 1990 – 2013 is anticipated to be finalized in the next years. Due to the ongoing work, the time series 1980 – 2013 is not yet consistent, except for the ammonia emission inventory.

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. The latest 2016 version of the Guidebook has been used in almost all sectors except for energy and particles from agriculture, except for NFR 3F, where 2016 methods are used.

[4] http://www.ymparisto.fi/default.asp?contentid=371537&lan=fi&clan=sv
[5] http://www.ymparisto.fi/default.asp?node=13255&lan=en
[6] http://www.ymparisto.fi/default.asp?node=6323&lan=fi
[7] http://www.ymparisto.fi/default.asp?contentid=371537&lan=fi&clan=sv
[8] http://www.ymparisto.fi/default.asp?node=13255&lan=en

Table 1.1. Summary of main air pollutant emissions in Finland for 1980–2015[9].

kt/a	SO_x (as SO_2)	NO_x (as NO_2)	NH_3	NMVOC	CO	TSP	PM_{10}	$PM_{2,5}$	BC
1980	584	313	34	NE	NE				
1981	534	295	36	NE	NE				
1982	484	289	35	NE	NE				
1983	372	281	35	NE	NE		No estimates for total national emissions of particulate matter are available for 1980-1989		
1984	368	277	35	NE	NE				
1985	382	294	36	NE	NE				
1986	331	296	35	NE	NE				
1987	328	307	34	230	NE				
1988	302	312	34	264	NE				
1989	244	320	33	258	NE				
1990	263	285	34	270	724				
1991	198	274	32	255	693		The time series 1990-1999 for particulate matter emissions have been recalculated only for certain subsectors but not for all sources.		
1992	144	277	31	250	666				
1993	126	275	31	243	636				
1994	119	277	32	245	621				
1995	100	255	33	234	607				
1996	110	263	34	229	631				
1997	105	257	35	226	625				
1998	95	251	35	222	616			NE[10]	
1999	92	221	37	217	571				
2000	80	229	34	183	570	78	55	39	7.2
2001	86	240	34	181	565	79	54	40	7.4
2002	81	231	35	175	554	79	58	40	7.3
2003	98	243	36	168	524	79	54	40	7.1
2004	84	229	36	164	509	80	55	40	6.9
2005	70	202	37	151	477	74	49	39	6.6
2006	85	219	36	147	458	74	50	35	6.4
2007	83	216	36	141	445	73	46	33	6.2
2008	70	196	35	131	428	70	46	34	6.1
2009	59	176	35	123	397	69	46	34	5.9
2010	67	189	35/33*	128	412	74	49	37	6.3
2011	61	175	34/33*	117	384	71	46	34	6.3
2012	51	167	34/32*	116	381	71	47	36	6.3
2013	47	159	33/32*	111	368	68	45	34	5.8
2014	43	153	33/32*	93	343	52	34	24	4.8
2015	42	140	32/31*	88	325	50	32	22	4.6

Remark 1: Due to rounding the sum of subtotals does not equal to total figure
Remark 2: Values changed from the previous reporting are indicated in red.
*NH_3 including accepted adjustments under the UNECE CLRTAP for the years 2010-2015

[9] 2000-2010 emissions are available in NFR09 format, 1990-1999 emissions will be recalculated into NFR format in the next years.
10 In the NFR tables submitted in February 2015 PM2.5 emissions should be NE (instead of the erroneous data).

Table 1.2. Summary of heavy metal emissions in Finland for the years 1990–2015.

	Heavy Metals (t/a)								
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Zn**	**Se**
1990	321	6.4	1.1	33	29	159	64	598	
1991	236	3.6	0.9	22	44	153	49	408	
1992	165	3.1	0.9	18	34	128	33	312	
1993	98	2.9	0.6	14	21	117	23	286	
1994	67	2.3	0.6	11	20	112	36	343	
1995	66	1.7	0.8	3.5	22	90	36	349	
1996	45	1.5	0.8	7.2	22	120	27	219	
1997	28	0.9	0.6	12	21	140	27	99	
1998	32	1.3	0.6	12	19	100	23	99	
1999	NE[4]	NE[4]	NE[4]	NE[4]	NE[4]	NE[4]	NE[4]	NE[4]	NE
2000	44	1.4	0.6	4.4	28	80	36	98	
2001	45	1.7	0.8	5.2	26	80	33	98	
2002	45	1.3	0.7	3.8	38	85	38	117	
2003	38	1.3	0.8	3.2	28	74	36	92	
2004	28	1.6	0.8	3.8	26	70	46	158	
2005	22	1.4	0.9	2.8	18	62	28	142	
2006	26	1.3	1.0	2.8	23	64	26	142	
2007	22	1.0	0.9	2.8	27	63	24	134	
2008	20	1.3	0.8	3.0	25	61	22	139[5]	
2009	18	1.3	0.8	2.7	15	60	20	141[5]	
2010	23	1.5	0.9	3.7	22	50	24	165	
2011	21	1.4	0.7	3.4	18	45	21	138	
2012	19	1.4	0.8	2.9	19	45	20	145	
2013	18	1.3	0.7	2.9	18	45	17	139	
2014	17	0.9	1.0	3.0	24	43	19	141	
2015	14	0.9	0.6	2.4	16	40	17	129	

Remark 1: Due to rounding the sum of subtotals does not equal to total figures
Remark 2: Values changed from the previous reporting are indicated in red.

[4] Heavy metal emission estimates for 1999 are at the moment inconsistent with the later years, recalculations are under way. The erroneous emission data were accidently included in the NFR tables submitted in February 2015.
[6]The time series for Se emissions is not yet completed.

Table 1.3. Summary of persistent organic pollutant emissions in Finland for the years 1990–2015.

Year	Persistent Organic Pollutants			
	PCDD/F (g I-TEQ)	PAH-4 (Mg)	HCB (kg)	PCB (kg)
1990	34	16	41	321
1991	34	13	41	318
1992	30	13	42	319
1993	31	13	42	302
1994	37	17	41	300
1995	37	17	41	293
1996	33	17	43	278
1997	33	16	44	267
1998	33	16	44	265
1999	34	17	43	234
2000	34	14	44	228
2001	32	16	24	216
2002	33	17	17	199
2003	31	17	15	198
2004	30	17	32	187
2005	12	13	39	181
2006	12	13	43	184
2007	12	13	45	174
2008	14	15	26	162
2009	11	16	34	150
2010	15	18	16	156
2011	13	16	33	157
2012	14	17	17	154
2013	12	17	25	152
2014	12	10	26	157
2015	14	9	21	152

Remark 1: Due to rounding the sum of subtotals do not equal to total figures
Remark 2: Values changed from the previous reporting are indicated in red.

1.3 Overview of source category 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.

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.3.5 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.

2 INTRODUCTION

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

Changes in chapter	
Update of text	October 2017 KS
Other (e.g. language, layout)	October 2017 KS

2.1.1 National circumstances relevant to air pollutant emissions

Population and geography

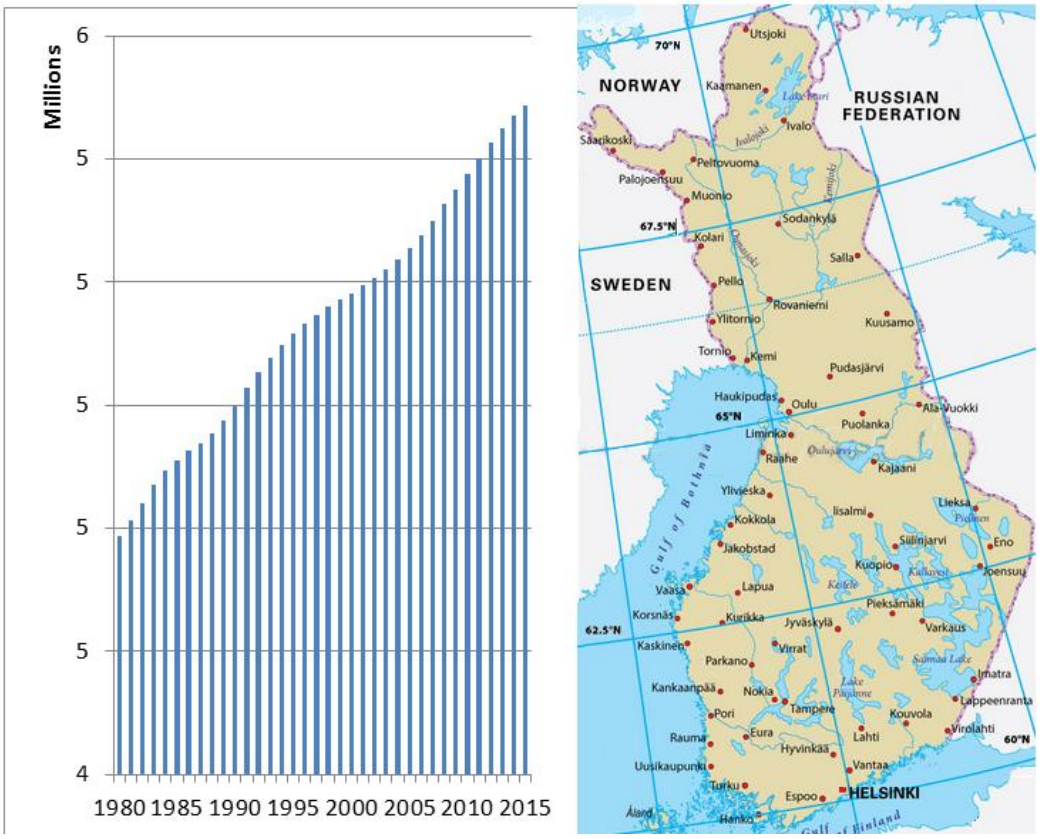


Figure 2.1 Population and geographical location of Finland

The population of Finland was 5 487 308 at the end of 2015 (Figure x). 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.

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.

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

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).

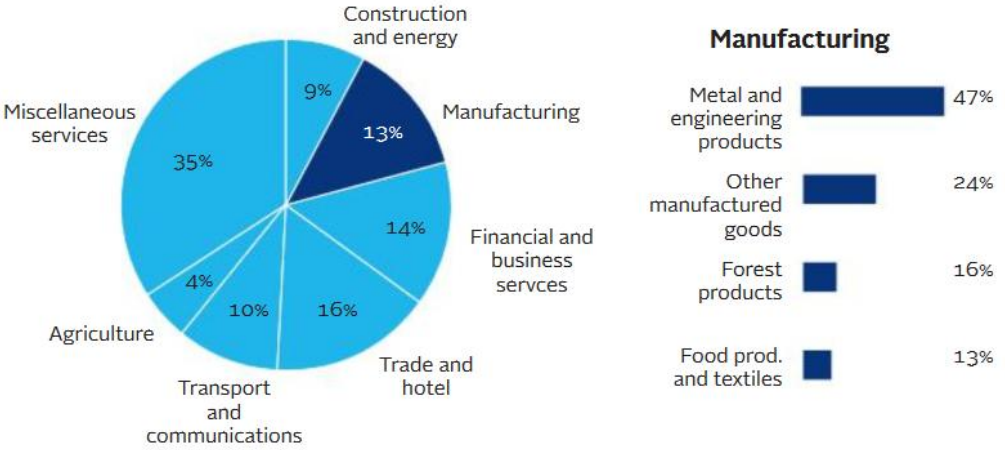


Figure 2.2 Economic Structure Finland (Blue Wings 1/2016)

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.

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.
(Finland's 6th National Communication to the UNFCCC, Population Statistics, Statistics Finland)

2.1.2 Environmental Protection

Figure 2.3. 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 Programme 2010

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.

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.

2.1.3 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)

2.2 Institutional arrangements for inventory preparation

Changes in chapter	
Update of text	November 2017 KS
Other (e.g. language, layout)	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.

Sharing of responsibilities between the different emission reportings is illustrated in Figure 2.1.

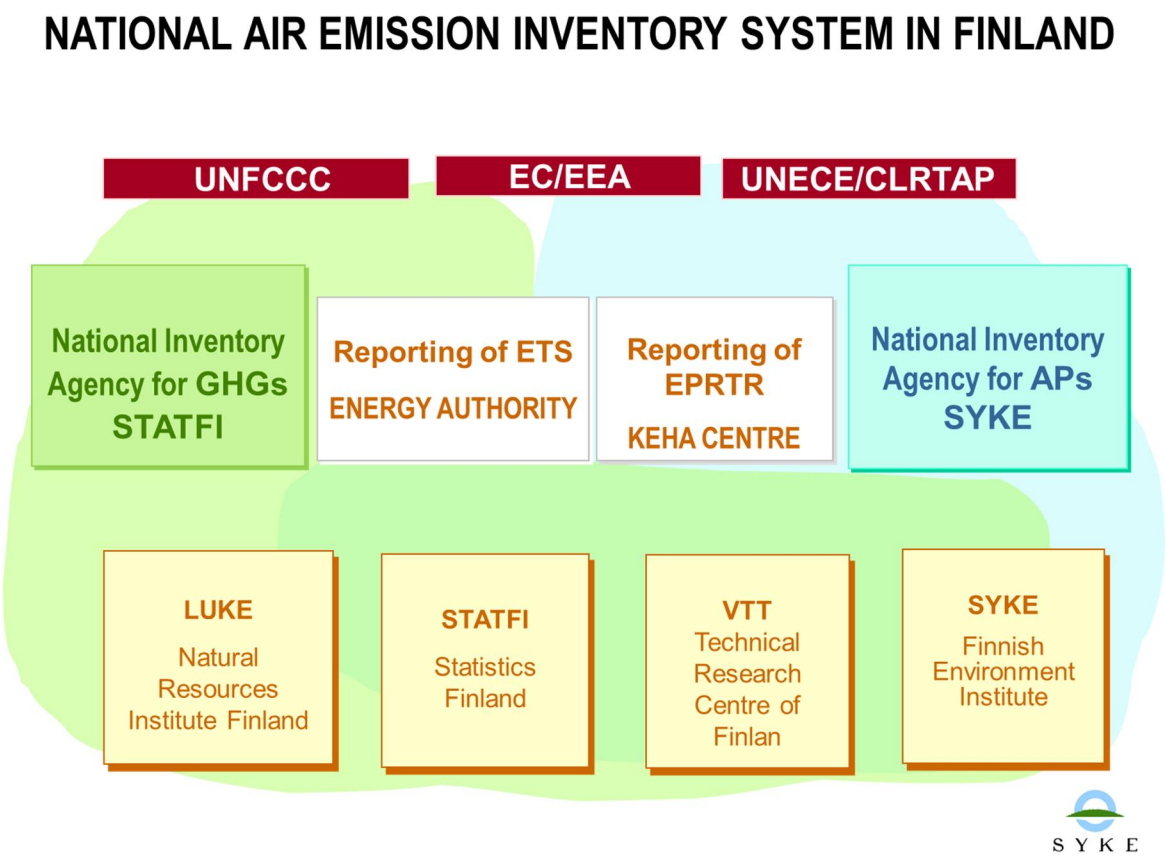


Figure 2.4. National systems for air emission inventories in Finland.

2.3 Brief description of the process of inventory preparation

2.3.1 Organization of the air pollutant inventory

Changes in chapter	
Update of text	February 2017 KS, JMP
Other (e.g. language, layout)	February 2017 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 2.2).

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.

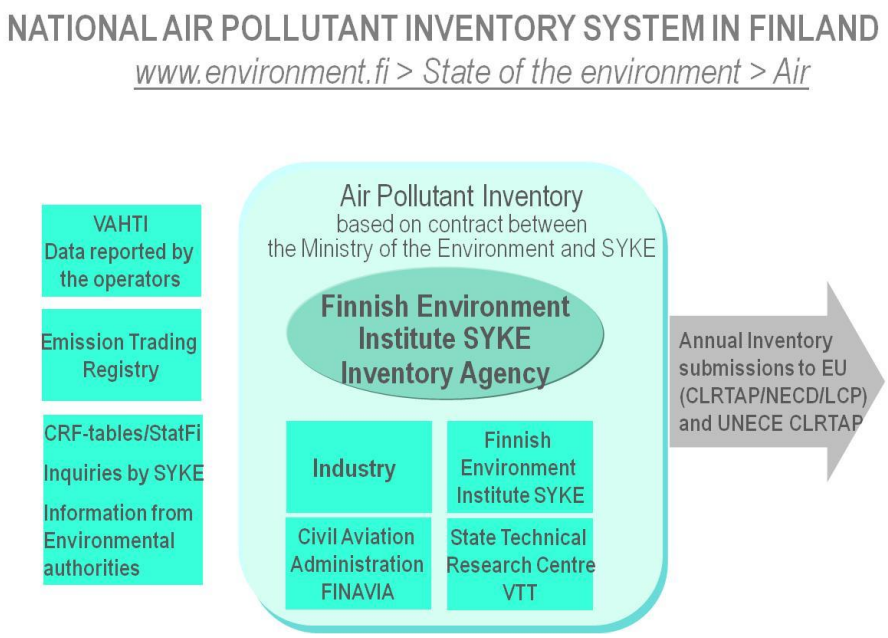


Figure 2.5 Organization of the air pollutant emission inventory in Finland.

2.3.2 Preparation of the inventory

Changes in chapter	
Update of text	March 2016 KS
Other (e.g. language, layout)	November 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 2.3.

Supporting tasks

*D*evelopment and maintaining national release estimation techniques for air pollutants and providing information[11] 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 2.3.

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

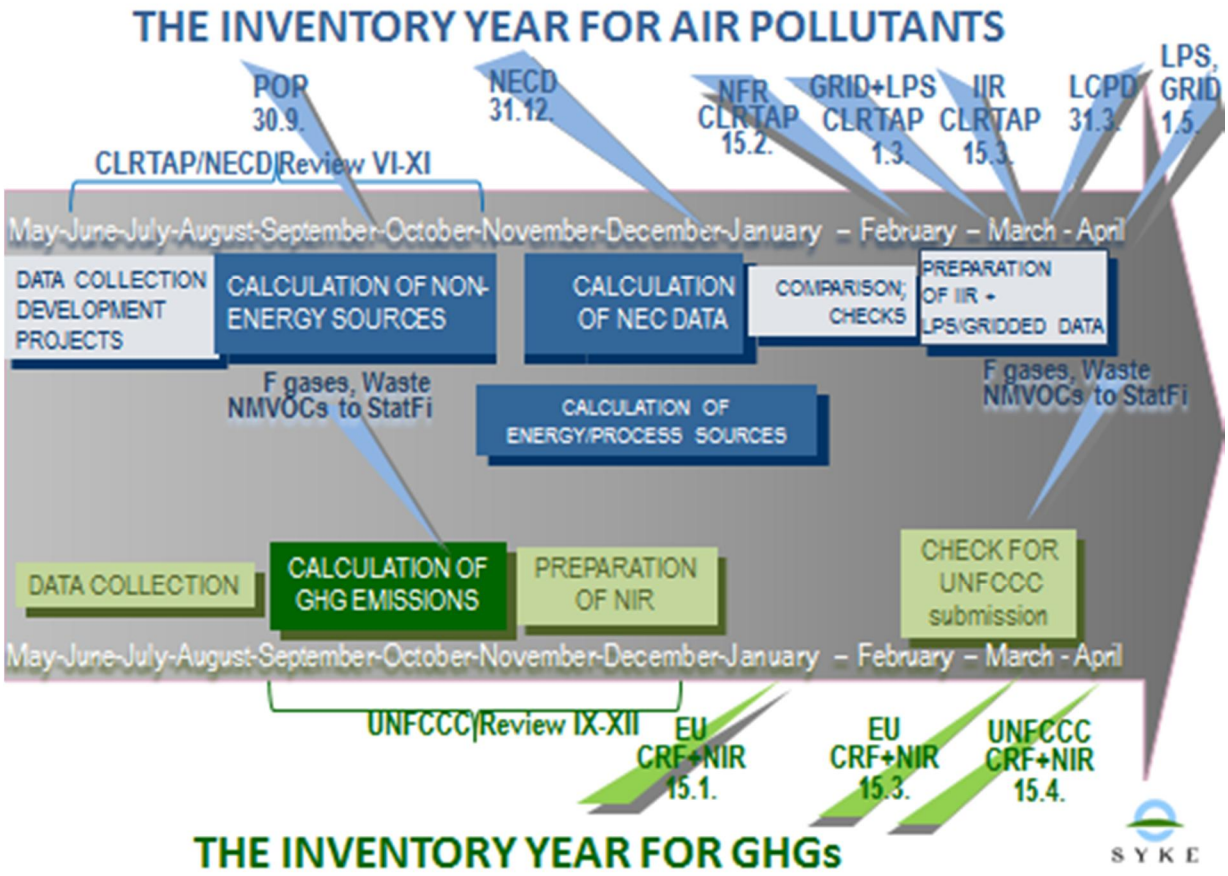


Figure 2.6. Annual schedule of inventory work at SYKE.

2.3.3 Reporting tool IPTJ

Changes in chapter	
Update of text	March 2016 ks
Other (e.g. language, layout)	December 2016 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[12]. 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 2.4.

Spatial emission data calculated at the level of EMEP grids (0.1° * 0.1° 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).

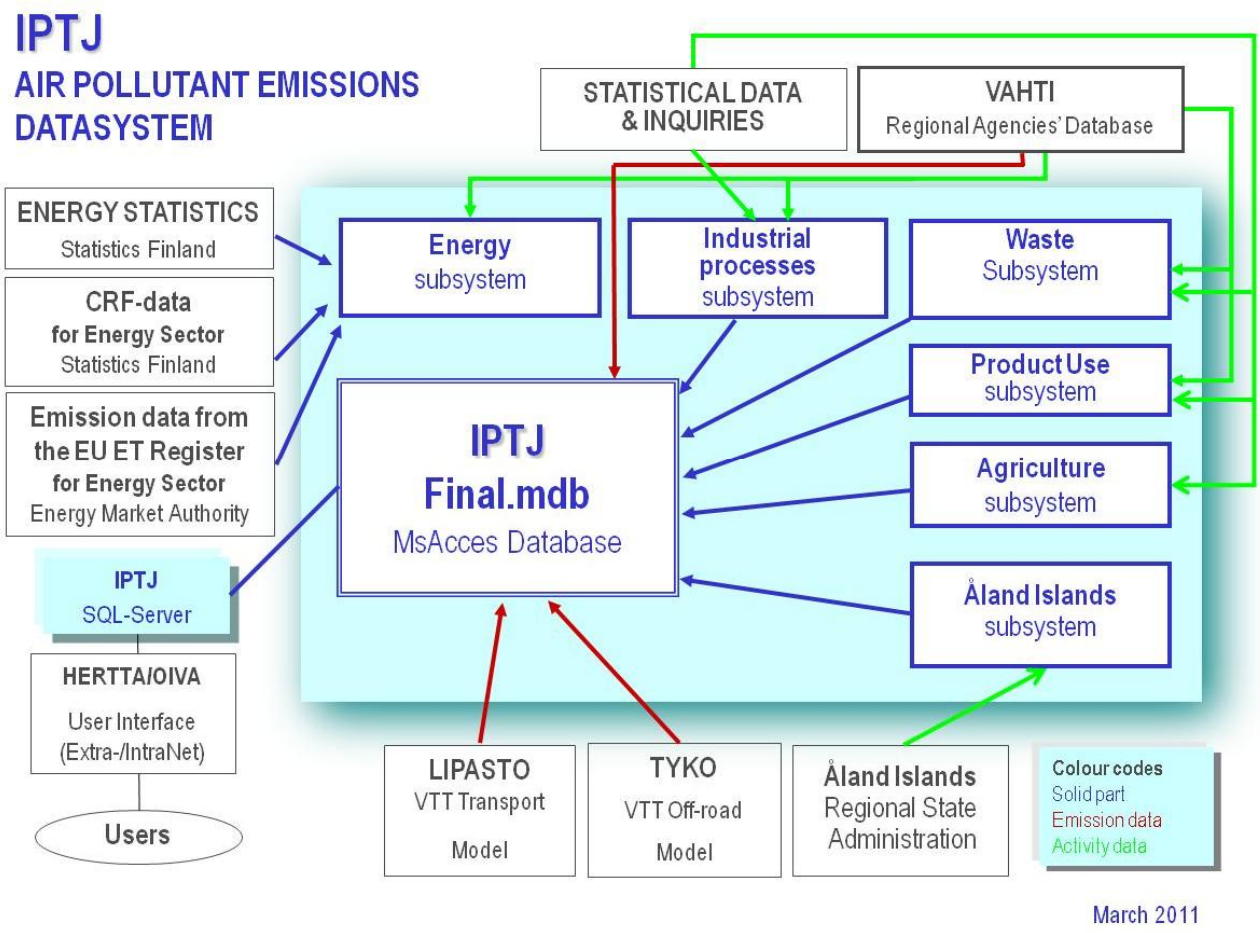


Figure 2.7. Structure of the air pollutant emission data system IPTJ at the Finnish Environment Institute SYKE.

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

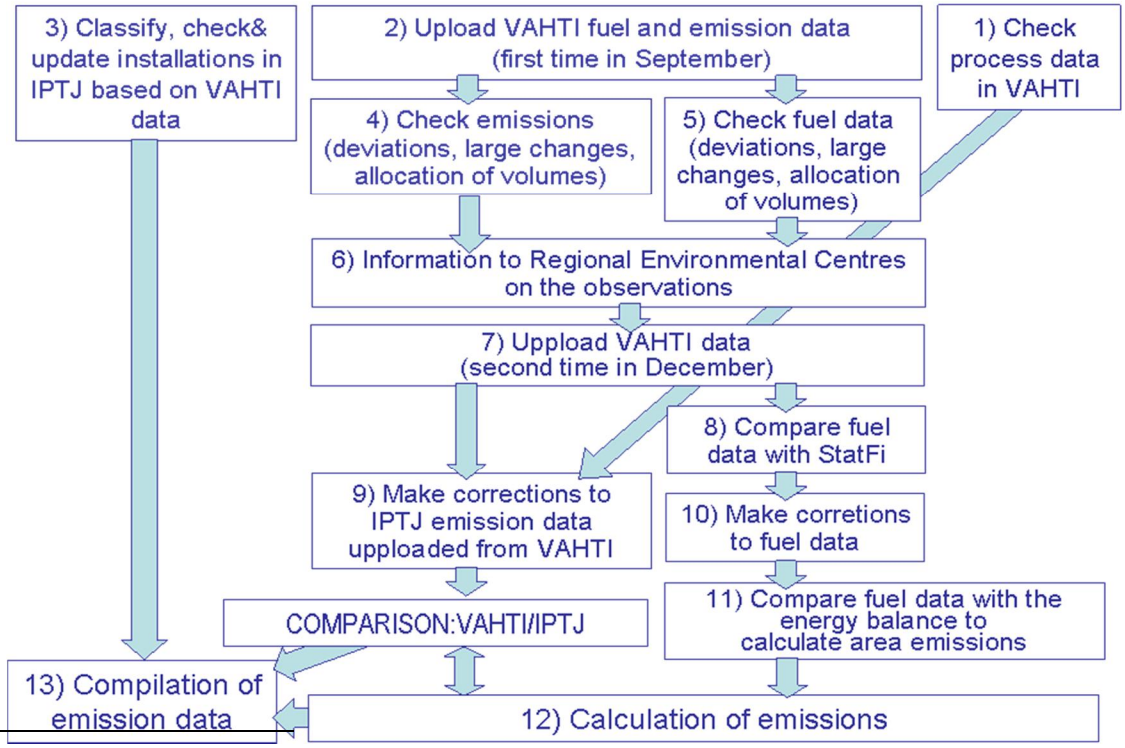
2.3.4 Use of bottom-Up Data in the Emission Inventories

Changes in chapter	
Update of text	February 2017 JMP
Other (e.g. language, layout)	February 2017 KS

The approach

A specific feature of the Finnish emission inventories is the use of data reported by the industrial installations[13]. 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 (VAHTI)[14] 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[15], which otherwise would not easily be captured (Figures 2.5 and 2.6).. 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.



[13] 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.
[14] Database for the supervising authority
[15] Such as malfunctioning of abatement technique, accidental releases due to process failures etc.

Figure 2.8. Processing of emission data reported by the plants for use in the air pollutant emission inventory, Part 1.

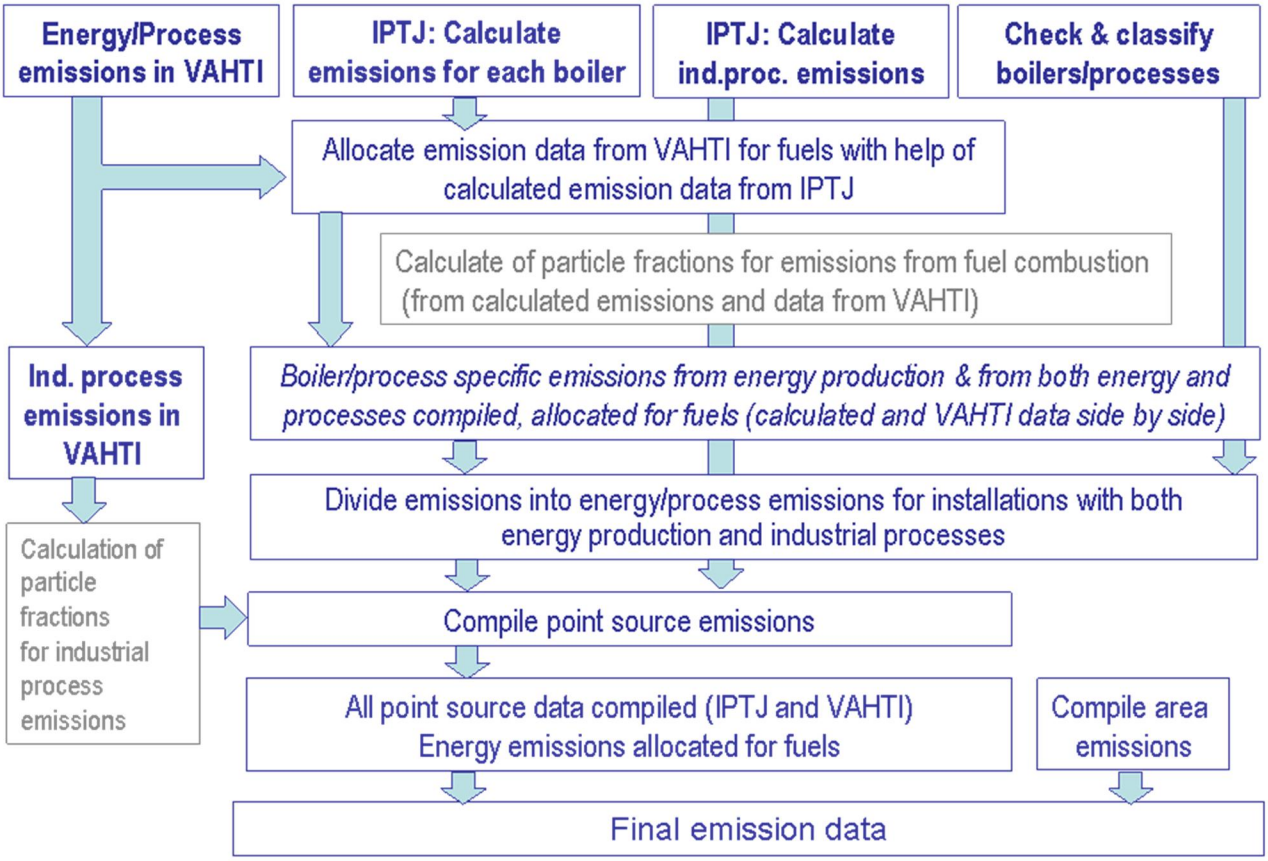


Figure 2.9. Processing of emission data reported by the plants for use in the air pollutant emission inventory, Part 2.

VAHTI database

The Centres for Economic Development, Transport and the Environment (ELY Centres[16]) 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 VAHTI database of the ELY Centres (Figure 2.7).

VAHTI 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.

VAHTI 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

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

new customers, change or add customer data, retrieve reports from database and write inspection 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.

VAHTI 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

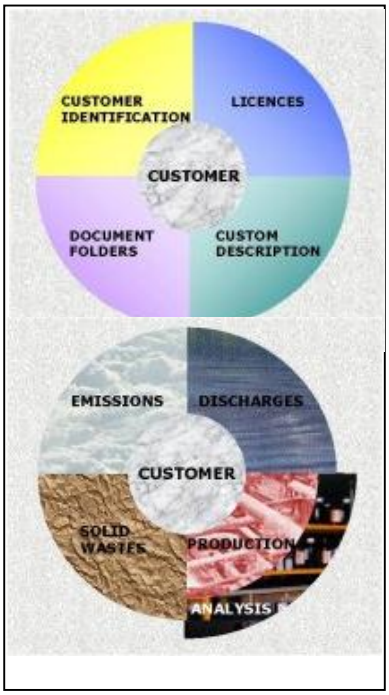


Figure 2.10. Structure of the VAHTI database.

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 2.8). After checking and approving the data the supervising authorities record the data into the VAHTI 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. The VAHTI 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 2.1.

Table 2.1. Facilities reporting information to VAHTI in 2015.

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)[17] 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 VAHTI.

The operators may submit emission reports to the supervising authorities as hard copies, electronically by email or through the Internet (Figure 2.8). 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 VAHTI.

When the operator chooses to send the data over the Internet using the national authorities' centralized data collection system (TYVI)[18] the data is automatically checked for completeness and only the completed data set will be sent to the authorities for further checking.

[17] 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.

[18] 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.

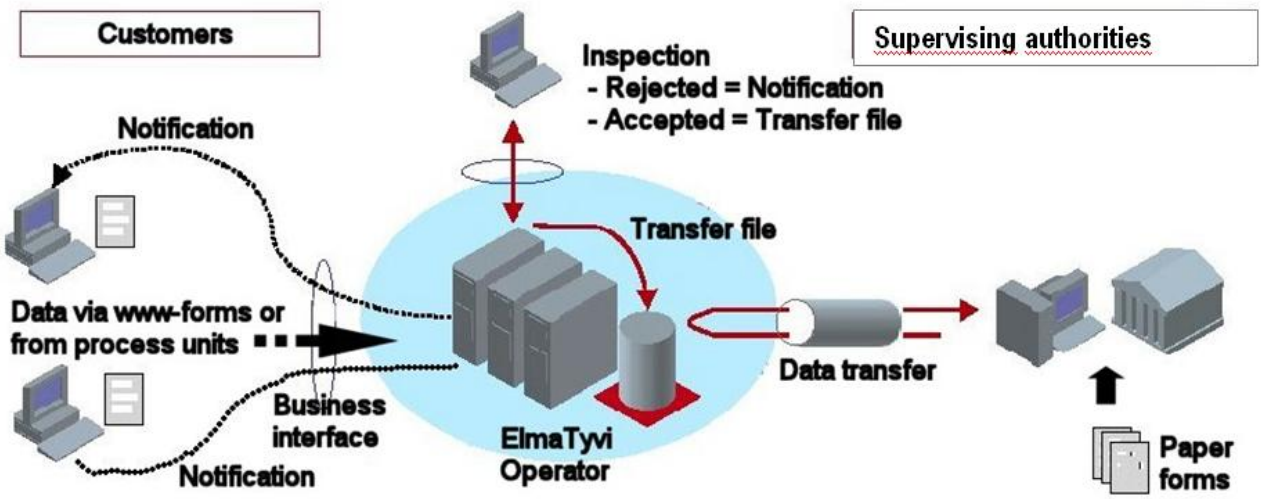


Figure 2.11. Reporting options for the operators.

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 VAHTI 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 data in the EU ETS system

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 in stead 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).

2.3.5 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 2.9. 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.

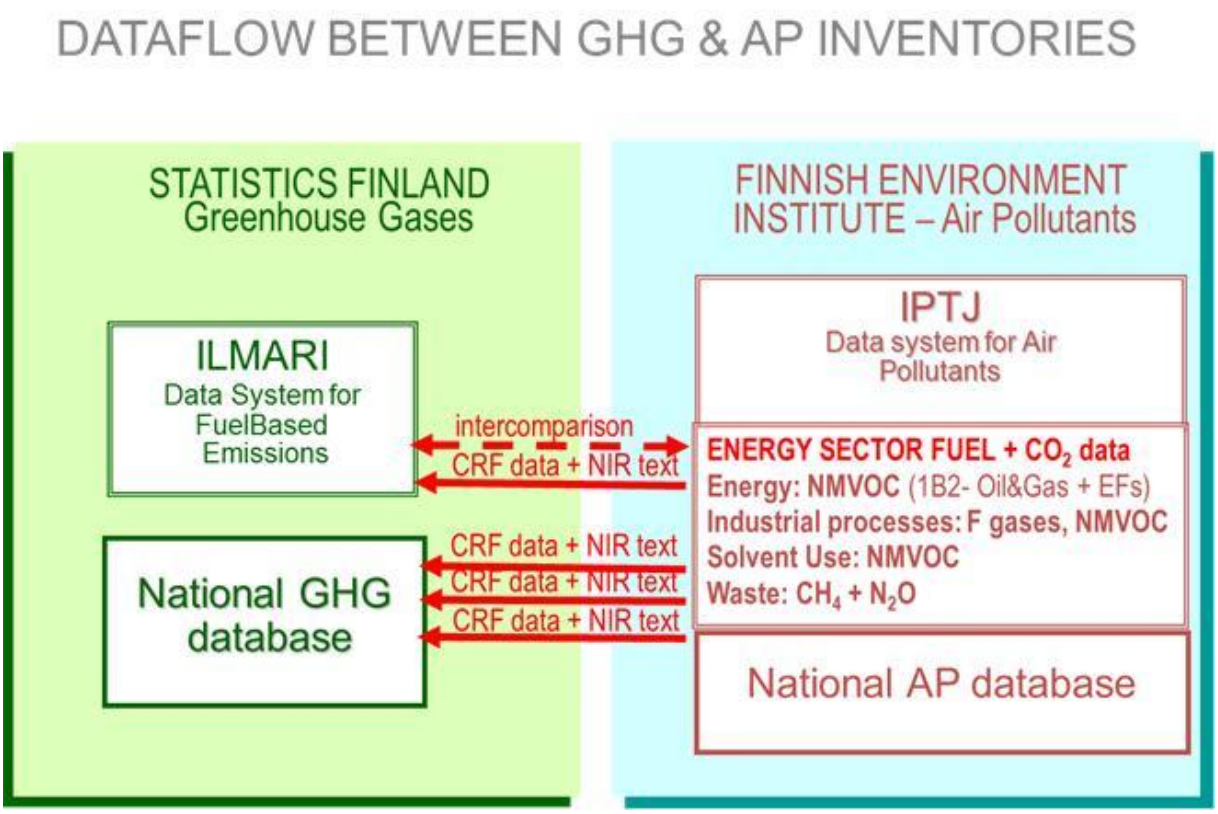


Figure 2.12. Inter-comparison of air emissions inventory data between Statistics Finland and SYKE.

2.4 General description of methodologies and data sources

2.4.1 Methodology

Changes in chapter	
Update of text	March 2016 KS
Other (e.g. language, layout)	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 2014 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.

2.4.2 Differences in the methods between data for the years 2014 and 2015

Changes in chapter	
Update of text	March 2016 KS
Other (e.g. language, layout)	April 2017 KS

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. However, at the moment, recalculations have been carried out in specific subcategories as explained in Chapter 14, but not for the whole inventory. A complete recalculation of the inventory is still pending due to lack of resources in finalizing the recalculation in the energy sector. Due to the structure of the inventory (see chapter 2.3.2.) this also prevents 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 2016 are presented in Chapters 4 – 9, and summarised in Chapter 14.

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

Changes in chapter	
Update of text	January 2017 KS
Other (e.g. language, layout)	February 2017 KS

This chapter explains differences between the emission report to the UNECE CLRTAP Secretariat and the emission reports to the UNFCCC Secretariat and to the Commission under the European Union CO2 and other greenhouse gas Monitoring Mechanism. Differences in NMVOC and CO emissions, as well as smaller differences in NO_x and SO_x emissions are due to inclusion of the results of the new small scale combustion calculation method into the CLRTAP emissions inventory.

While the above mentioned differences remain between the data reported under the CLRTAP 15 February 2017 and UNFCCC 15 April 2017, the differences will be cancelled during the next reporting round in 2018 when the results of the model for small scale combustion sources is implemented also in the calculation system of Statistic Finland.

The analysis of differences for 2015 data is presented in Appendix 2 of the IIR (to be published by 1st May 2017)..

In addition, some minor differences generally exist in the emission data submitted to the UNECE CLRTAP Secretariat, to the UNFCCC Secretariat and to the EU Commission, concerning 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 has not been practical in the earlier years due to the inherent and different purposes of these reporting formats. For instance, it is not always possible to report the same point sources under the corresponding CRF/NFR source categories because certain point sources fall under NFR 2A4 Soda Ash Production and Use when reporting greenhouse gas emissions from the activity, while air pollutants generated from the same activity are not related to soda ash production or use and 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 2017-2018 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 VAHTI 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 VAHTI 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. The recalculation of inventory time-series is currently underway at Finnish Environment Institute, and 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.

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

Changes in chapter	
Update of text	February 2017 KS
Other (e.g. language, layout)	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.

2.5 Brief description of key category categories

Changes in chapter	
Update of text	March 2016 KS
Other (e.g. language, layout)	February 2017 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 2017 inventory, two of these methods were 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 2017.

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 2017 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.

Trend analysis

The key category assessment by trend is planned to be carried out when the whole time series has been recalculated and is available for further analysis.

Table 2.2. Key category categories for NO_x emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	17.635	17.635	x	1A4bii	0.227	98.677	
1A3biii	14.029	31.663	x	5C1bi	0.212	98.889	
1A2d	12.007	43.67	x	1A2e	0.205	99.094	
1A3bi	7.680	51.35	x	1A2b	0.173	99.267	
3Da1	6.304	57.654	x	5C1a	0.160	99.427	
1A2gvii	4.987	62.641	x	1A3aii(i)	0.129	99.555	
1A3dii	4.053	66.694	x	3B1b	0.098	99.654	
1A4bi	3.696	70.390	x	2B10a	0.097	99.751	
1A3bii	3.666	74.056	x	3F	0.051	99.802	
1A2gviii	3.284	77.341	x	3B4gii	0.050	99.852	
3Da2a	3.133	80.473	x	3B4h	0.042	99.894	
1A4cii	3.069	83.542		3B1a	0.034	99.927	
1A2a	2.308	85.851		3B4gi	0.023	99.950	
1A4aii	2.113	87.964		3B4e	0.022	99.972	
1A1b	1.570	89.534		3B2	0.008	99.980	
1A2f	1.489	91.023		3B3	0.007	99.987	
1A4ciii	1.455	92.478		3B4giii	0.005	99.992	
1A3c	1.091	93.568		1A3ei	0.003	99.996	
1A2c	1.035	94.603		3B4giv	0.002	99.998	
1A4ai	0.871	95.475		2L	0.0008	99.999	
1A4ci	0.688	96.163		1B2av	0.00046	100	
3Da3	0.606	96.769		3B4d	0.00026	100	
1A3ai(i)	0.463	97.232		2C1	0.00007	100	
1A5a	0.408	97.640		2C7c	0.00004	100	
2B2	0.311	97.951		2B10b	0.00004	100	
1A5b	0.271	98.222		2G	0.00001	100	
1A3biv	0.228	98.449					

Table 2.3. Key category categories for NMVOC emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	19.691	19.691	x	3B2	0.192	98.132	
2D3d	7.714	27.405	x	5D2	0.177	98.310	
3B1a	7.364	34.769	x	5D1	0.161	98.470	
2D3a	4.808	39.577	x	3F	0.147	98.617	
1A4aii	4.645	44.222	x	2B10b	0.125	98.742	
3B1b	4.498	48.72	x	5A	0.109	98.850	

1A3bi	4.456	53.176	x	1A4ai	0.104	98.955
1A3dii	3.885	57.061	x	1A3ai(i)	0.102	99.057
1A3bv	3.708	60.770	x	1A4ciii	0.100	99.156
1B2aiv	3.427	64.197	x	1A3c	0.093	99.250
1B2av	3.384	67.581	x	1A1b	0.090	99.340
3Da2a	2.908	70.489	x	1B1b	0.077	99.417
2B10a	2.634	73.123	x	3Da3	0.075	99.491
1A3biv	2.321	75.444	x	5B1	0.057	99.548
2D3g	2.317	77.761	x	2C7b	0.052	99.601
2H1	1.743	79.505	x	1A5b	0.049	99.650
2D3i	1.723	81.227	x	5C1bi	0.043	99.693
1A4cii	1.700	82.928		1A2c	0.042	99.735
1A2gvii	1.493	84.420		1A3aii(i)	0.037	99.772
3B4h	1.373	85.793		1A2a	0.032	99.804
2I	1.358	87.151		3B4giii	0.028	99.833
2H2	1.308	88.459		1A5a	0.027	99.859
1A4bii	1.213	89.672		2A1	0.026	99.885
1A1a	1.102	90.774		1A2e	0.024	99.909
3De	1.011	91.785		3B4giv	0.019	99.928
2D3h	0.985	92.770		5C1a	0.015	99.942
1A3bii	0.743	93.513		2C7c	0.013	99.955
1A3biii	0.564	94.077		1A2f	0.013	99.968
3B4gii	0.550	94.627		2C7a	0.010	99.978
2D3e	0.482	95.109		1A2b	0.005	99.983
1A2d	0.427	95.536		2L	0.004	99.987
2D3b	0.384	95.920		5B2	0.004	99.991
1A2gviii	0.382	96.302		3B4d	0.004	99.996
3B3	0.382	96.684		2A3	0.002	99.997
1A4ci	0.348	97.032		2C6	0.002	99.999
3B4e	0.285	97.317		2C2	0.001	100
2D3c	0.224	97.541		1A3ei	0.0001	100
2C1	0.201	97.742		2G	0.00002	100
3B4gi	0.198	97.940				

Table 2.4. Key category categories for SO_2 emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	35.265	35.265	x	5C1bi	0.031	99.859	
1A1b	18.414	53.679	x	1A3aii(i)	0.029	99.889	
1A2gviii	8.686	62.365	x	1A3biii	0.028	99.917	
1A2d	7.584	69.949	x	3F	0.025	99.942	
1A2b	7.222	77.171	x	2G	0.019	99.961	
1A2c	7.064	84.235	x	1A3bii	0.008	99.969	
1A2a	3.990	88.225		1A2gvii	0.007	99.976	
1A4ai	2.523	90.748		2C1	0.006	99.983	
2H1	2.467	93.215		1A4cii	0.006	99.989	

1A4bi	2.370	95.585	1A4aii	0.004	99.993
1A4ci	1.325	96.910	1A3biv	0.002	99.995
1A2f	0.904	97.814	2C7b	0.001	99.996
2B10a	0.893	98.707	1A3c	0.001	99.997
1A2e	0.604	99.311	1A4bii	0.001	99.998
1A3dii	0.152	99.464	1A4ciii	0.001	99.999
1A3ai(i)	0.095	99.559	2C7a	0.0004	99.999
1A5b	0.074	99.633	2L	0.0003	100
1A3bi	0.065	99.697	2C7c	0.0001	100
1A5a	0.062	99.760	2B10b	0.0001	100
5C1a	0.034	99.794	1A3ei	0.00001	100
2D3i	0.034	99.828			

Table 1.4. Key category categories for NH_3 emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
3Da2a	23.611	23.611	x	1A3bii	0.030	99.892	
3B1a	15.875	39.487	x	3B4d	0.015	99.907	
3B1b	15.195	54.681	x	1A4ci	0.01462	99.922	
3B3	10.388	65.069	x	2D3g	0.01141	99.933	
3B4h	8.145	73.214	x	1B1b	0.010	99.944	
3Da1	7.265	80.479	x	1A3biv	0.008	99.952	
1A3bi	3.350	83.829		1A2gvii	0.008	99.960	
3Da3	2.970	86.799		3Da2b	0.007	99.967	
1A4bi	2.359	89.158		1A1a	0.007	99.974	
3B4gi	2.133	91.291		1A4cii	0.006	99.980	
3B4e	2.099	93.390		1A4ai	0.006	99.986	
3B4gii	1.781	95.171		2L	0.004	99.991	
2B10a	1.267	96.438		1A4aii	0.003	99.994	
5E	1.177	97.615		1A3dii	0.003	99.997	
3B2	0.486	98.101		1A4ciii	0.001	99.997	
2D3i	0.461	98.561		5D1	0.001	99.998	
5B1	0.317	98.878		5C1a	0.001	99.999	
3B4giv	0.220	99.098		1A3c	0.0005	99.999	
2C7b	0.220	99.318		1A4bii	0.0004	100	
3F	0.219	99.537		1A5a	0.0002	100	
3B4giii	0.188	99.726		2C7c	0.0001	100	
1A3biii	0.080	99.805		2G	0.0001	100	
2H1	0.057	99.862					

Table 2.5. Key category categories for CO emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	32.615	32.615	x	1A4ai	0.260	98.818	
1A3bi	12.245	44.860	x	1A3aii(i)	0.249	99.067	
1A4aii	11.143	56.003	x	1A3ai(i)	0.210	99.277	
1A4bii	8.162	64.165	x	1A5b	0.209	99.486	
1A3dii	6.099	70.264	x	2C1	0.158	99.644	
1A2d	5.979	76.243	x	1A2c	0.093	99.737	
1A1a	3.983	80.226	x	1A4ciii	0.09	99.827	
1A3biv	3.196	83.422		1A3c	0.061	99.888	
1A2gviii	3.099	86.521		1A2e	0.039	99.926	
1A4cii	2.957	89.478		1A5a	0.032	99.959	
1A2gvii	2.423	91.902		1A2b	0.020	99.979	
1A3biii	1.936	93.838		2I	0.011	99.989	
1A2f	1.844	95.682		2G	0.003	99.993	
1A3bii	1.205	96.886		5C1bi	0.003	99.996	
3F	0.698	97.584		5C1a	0.002	99.998	
1A4ci	0.387	97.971		2C7a	0.002	100	
1A1b	0.303	98.274		1A3ei	0.0005	100	
1A2a	0.284	98.558					

Table 2.6. Key category categories for TSP emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A3bvii	27.152	27.152	x	5E	0.204	97.937	
1A4bi	21.012	48.164	x	1A2a	0.201	98.139	
1A2gviii	9.457	57.621	x	2C2	0.190	98.329	
1A2d	5.297	62.918	x	3B4gi	0.189	98.518	
3Da1	3.884	66.801	x	2G	0.189	98.707	
1A1a	3.505	70.306	x	2D3i	0.179	98.885	
1A3bvi	3.057	73.363	x	2A5a	0.176	99.062	
2A5b	3.028	76.391	x	2D3b	0.170	99.231	
1B1c	2.849	79.240	x	1A3biv	0.120	99.351	
1A4ci	1.387	80.627	x	1A4ciii	0.097	99.448	
2C7d	1.371	81.998		2B10b	0.065	99.513	
3B3	1.257	83.256		1A2e	0.063	99.576	
2A5c	1.244	84.499		1A3c	0.063	99.639	
1A1b	1.016	85.515		1A2b	0.049	99.688	
2H1	0.938	86.453		1A5a	0.038	99.725	
2H2	0.836	87.289		3B4e	0.037	99.762	
1A2gvii	0.821	88.110		1A5b	0.034	99.796	
2B10a	0.788	88.899		2L	0.031	99.827	
3Dc	0.769	89.667		2B6	0.031	99.858	
1A3bii	0.760	90.427		2C7c	0.027	99.884	
1A4aii	0.752	91.180		1A4bii	0.025	99.910	

1A3biii	0.721	91.901	2C6	0.018	99.927
3B4gii	0.711	92.612	2A3	0.016	99.944
1A3dii	0.659	93.270	3B4giii	0.016	99.959
1A3bi	0.649	93.919	2D3d	0.014	99.974
1A4cii	0.565	94.484	1A3ai(i)	0.010	99.984
1A4ai	0.535	95.019	2A2	0.005	99.989
3B1a	0.489	95.508	2D3g	0.003	99.993
2C1	0.418	95.926	1A3aii(i)	0.003	99.995
3B4giv	0.389	96.315	5C1bi	0.002	99.997
3F	0.378	96.693	2D3e	0.001	99.999
3B1b	0.321	97.013	5C1a	0.001	100
2I	0.257	97.271	2C7a	0.0003	100
1A2f	0.248	97.518	1B2av	0.0002	100
1A2c	0.215	97.733	5C1bv	0.000001	100

Table 2.7. Key category categories for PM_{10} emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	31.330	31.330	x	2C2	0.272	97.848	
1A3bvii	21.118	52.448	x	2D3i	0.257	98.105	
1A2d	6.692	59.140	x	3B1b	0.231	98.336	
1A2gviii	4.736	63.876	x	2D3b	0.198	98.533	
1A3bvi	3.563	67.439	x	1A3biv	0.181	98.715	
1A1a	3.314	70.752	x	1A2f	0.178	98.892	
1B1c	2.898	73.650	x	1A2a	0.170	99.063	
2A5b	2.377	76.027	x	1A4ciii	0.150	99.212	
2H1	1.287	77.314	x	2A5a	0.135	99.347	
3Da1	1.280	78.593	x	1A3c	0.096	99.443	
2H2	1.265	79.858	x	2I	0.081	99.524	
1A2gvii	1.233	81.091	x	1A2e	0.060	99.584	
1A3bii	1.153	82.244		1A5a	0.055	99.638	
1A4aii	1.130	83.374		1A5b	0.052	99.691	
3B4gii	1.106	84.480		1A4bii	0.038	99.728	
1A3biii	1.094	85.574		1A2b	0.037	99.765	
1A3dii	1.014	86.589		2B10b	0.032	99.798	
2B10a	1.008	87.597		2L	0.029	99.827	
2C7d	1.003	88.599		3B4e	0.026	99.853	
1A3bi	0.985	89.584		2C7c	0.026	99.879	
3B3	0.961	90.545		3B4giii	0.025	99.904	
1A4ci	0.869	91.414		2B6	0.024	99.927	
1A4cii	0.849	92.263		2A3	0.023	99.950	
2A5c	0.753	93.015		1A3ai(i)	0.016	99.966	
3B4giv	0.605	93.620		2D3d	0.012	99.978	
1A4ai	0.592	94.212		2C6	0.008	99.985	
3F	0.579	94.791		1A3aii(i)	0.004	99.990	
1A1b	0.498	95.288		2A2	0.004	99.993	
2C1	0.447	95.735		2D3g	0.004	99.997	

3B1a	0.352	96.088	2D3e	0.001	99.998
5E	0.318	96.406	5C1bi	0.001	99.999
3Dc	0.302	96.708	5C1a	0.0004	100
3B4gi	0.295	97.002	2C7a	0.0002	100
2G	0.293	97.296	1B2av	0.0002	100
1A2c	0.280	97.576	5C1bv	0.000002	100

Table 2.8. Key category categories for $PM_{2.5}$ emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	44.241	44.241	x	3B4gii	0.212	98.647	
1A3bvii	16.711	60.952	x	1A2a	0.142	98.789	
1A2d	6.531	67.483	x	1A2f	0.129	98.918	
1B1c	2.976	70.459	x	2C7d	0.125	99.043	
1A3bvi	2.848	73.306	x	1A3c	0.123	99.165	
1A2gviii	2.165	75.471	x	3B4giv	0.114	99.280	
1A1a	1.795	77.266	x	2A5c	0.113	99.393	
2H2	1.763	79.029	x	1A5b	0.076	99.469	
1A2gvii	1.668	80.697	x	3Dc	0.070	99.539	
2H1	1.616	82.314		3B4gi	0.067	99.606	
1A4aii	1.529	83.843		1A5a	0.061	99.667	
1A3bii	1.477	85.320		1A4bii	0.051	99.718	
1A3dii	1.452	86.772		1A2e	0.049	99.767	
1A3biii	1.401	88.173		2A5a	0.033	99.801	
1A3bi	1.261	89.434		2C7c	0.032	99.833	
1A4cii	1.148	90.582		2A3	0.029	99.862	
2B10a	0.924	91.506		1A2b	0.026	99.889	
3F	0.807	92.313		3B4e	0.026	99.914	
1A4ci	0.668	92.980		1A3ai(i)	0.023	99.938	
2C1	0.560	93.540		2L	0.018	99.956	
1A4ai	0.554	94.094		2B6	0.008	99.964	
5E	0.465	94.559		1A3aii(i)	0.006	99.970	
2G	0.429	94.988		2B10b	0.006	99.976	
2A5b	0.389	95.377		2I	0.006	99.982	
3Da1	0.378	95.755		2D3d	0.005	99.987	
2C2	0.354	96.110		3B4giii	0.005	99.991	
2D3i	0.346	96.456		2D3g	0.003	99.995	
3B1a	0.331	96.787		2C6	0.002	99.997	
2D3b	0.265	97.052		2A2	0.002	99.999	
1A2c	0.263	97.315		2D3e	0.0003	99.999	
1A3biv	0.232	97.547		2C7a	0.0003	99.999	
3B3	0.229	97.776		5C1bi	0.0003	100	
1A1b	0.223	97.999		1B2av	0.0002	100	
3B1b	0.222	98.221		5C1a	0.0001	100	
1A4ciii	0.214	98.435		5C1bv	0.000003	100	

Table 2.9. Key category categories for BC emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	63.525	63.525	x	1A1b	0.187	99.049	
1A2gvii	5.529	69.054	x	2H1	0.181	99.230	
1A3bii	4.543	73.597	x	1A5b	0.175	99.405	
1A3biii	4.153	77.75	x	2C2	0.169	99.574	
1A3bi	3.667	81.418	x	1A5a	0.077	99.651	
1A4cii	3.089	84.506		2D3b	0.072	99.724	
1A2gviii	2.750	87.256		1A2e	0.066	99.790	
1A3bvi	2.676	89.933		1A2f	0.057	99.847	
1A3bvii	2.450	92.383		1A2a	0.054	99.901	
1A4aii	1.688	94.070		1A4bii	0.042	99.942	
1A3dii	1.078	95.148		1A2b	0.034	99.977	
1A1a	0.617	95.765		2G	0.009	99.986	
1A4ai	0.534	96.299		2C1	0.009	99.995	
3F	0.471	96.770		2B10a	0.005	100	
1A2d	0.439	97.209		2D3i	0.0002	100	
1A3c	0.381	97.589		5C1bi	0.0001	100	
1A4ciii	0.327	97.917		2A3	0.0001	100	
1A2c	0.316	98.232		2A2	0.00002	100	
1A3biv	0.223	98.455		5C1a	0.00001	100	
1A4ci	0.213	98.668		5C1bv	0.00001	100	
5E	0.193	98.862		2C7a	0.000001	100	

Table 2.10. Key category categories for Cd emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A2d	30.618	30.618	x	1A2b	0.221	98.811	
1A4bi	16.315	46.933	x	1A2a	0.183	98.995	
1A1a	12.199	59.132	x	1A4aii	0.177	99.172	
1A2gviii	10.731	69.864	x	5C1bi	0.131	99.303	
1A1b	8.423	78.287	x	2A5a	0.108	99.411	
1A2f	4.053	82.340	x	1A3dii	0.092	99.503	
2C6	2.608	84.948		2C7a	0.065	99.567	
1A4ci	2.506	87.454		5E	0.063	99.631	
1A3bi	2.306	89.759		1A2c	0.062	99.692	
2C1	2.196	91.955		5C1a	0.061	99.754	
3F	2.058	94.013		1A3biv	0.059	99.813	
1A3biii	1.192	95.205		1B1b	0.055	99.868	
1A4ai	1.018	96.223		1A4ciii	0.036	99.903	
1A3bvi	0.414	96.637		1A4bii	0.030	99.934	
2A5b	0.388	97.025		1A3c	0.024	99.957	
1A2gvii	0.348	97.372		1A5a	0.020	99.977	

2C2	0.335	97.708		5C1bv	0.014	99.991	
1A3bii	0.327	98.034		2C7c	0.009	100	
1A2e	0.278	98.313		2G	0.00004	100	
1A4cii	0.278	98.590					

Table 2.11. Key category categories for Pb emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A2d	25.791	25.791	x	1B1b	0.168	99.510	
1A1b	22.510	48.301	x	1A3bii	0.128	99.638	
1A2gviii	11.373	59.674	x	2C2	0.093	99.732	
1A2f	10.991	70.666	x	1A3dii	0.073	99.805	
1A1a	10.779	81.445	x	2A5b	0.053	99.858	
1A4bi	3.909	85.354		1A4ciii	0.031	99.889	
1A3bvi	3.802	89.156		5C1bi	0.025	99.914	
1A4ci	2.144	91.300		5C1a	0.019	99.933	
2C7c	1.934	93.233		1A5a	0.016	99.950	
2C1	1.759	94.992		3F	0.015	99.965	
1A2b	1.300	96.292		1A3biv	0.013	99.978	
1A2e	0.817	97.109		2A5a	0.007	99.985	
1A4ai	0.643	97.752		5C1bv	0.006	99.990	
1A3bi	0.617	98.369		2C7a	0.004	99.995	
1A3biii	0.474	98.843		2A2	0.003	99.998	
1A2c	0.286	99.129		5E	0.002	100	
1A2a	0.213	99.342		2G	0.000001	100	

Table 2.12. Key category categories for Hg emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	26.037	26.037	x	1A4ai	0.294	98.250	
2C1	18.975	45.012	x	1A3bii	0.291	98.541	
1A2d	17.600	62.611	x	1A2e	0.286	98.827	
2B10a	10.821	73.432	x	5C1a	0.203	99.029	
1A4bi	4.001	77.434	x	1A4ciii	0.156	99.185	
1A2gviii	3.138	80.571	x	2C6	0.131	99.316	
1A3bvi	3.138	83.709		1A2b	0.130	99.446	
1A3bi	2.480	86.189		2A5b	0.119	99.565	
5C1bv	2.375	88.564		2C2	0.094	99.660	
1A1b	2.371	90.935		5E	0.092	99.751	
2A1	1.952	92.888		1A2a	0.090	99.841	
1A2f	1.513	94.401		1A3biv	0.068	99.909	

1A3biii	1.055	95.455		1A5a	0.061	99.970	
1A4ci	1.051	96.507		1A2c	0.029	99.999	
3F	0.568	97.075		2C7c	0.001	100	
5C1bi	0.551	97.626		2G	0.00005	100	
1A3dii	0.330	97.956					

Table 2.13. Key category categories for As emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	22.145	22.145	x	2A5a	0.247	99.262	
1A1b	20.688	42.833	x	2C6	0.219	99.481	
1A2gviii	14.048	56.881	x	1A2a	0.166	99.647	
1A2f	10.151	67.032	x	1A2c	0.146	99.793	
2C7c	6.343	73.375	x	1A4ciii	0.054	99.847	
1A2d	6.074	79.450	x	5E	0.038	99.885	
1A4ci	4.727	84.176	x	2C2	0.029	99.914	
2C1	4.725	88.902		1A5a	0.028	99.942	
1A4bi	2.668	91.569		1A3bi	0.020	99.962	
2C7a	2.069	93.639		5C1bv	0.014	99.977	
1A2e	1.843	95.481		1A3bvi	0.010	99.986	
1A2b	1.202	96.683		1A3biii	0.005	99.992	
1A4ai	0.694	97.378		3F	0.005	99.997	
5C1bi	0.459	97.836		1A3bii	0.001	99.998	
1A3dii	0.413	98.249		5C1a	0.001	99.999	
2A5b	0.408	98.658		1A3biv	0.0006	100	
1B1b	0.357	99.015		2G	0.00002	100	

Table 2.14. Key category categories for Cr emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
2C1	25.292	25.292	x	1A3dii	0.071	99.682	
1A1b	24.863	50.156	x	1A3bii	0.066	99.747	
1A2f	11.597	61.753	x	1A4aii	0.052	99.800	
1A4bi	11.423	73.175	x	1A2c	0.038	99.838	
1A1a	7.605	80.780	x	5C1bi	0.025	99.864	
1A2gviii	7.368	88.148		1B1b	0.025	99.889	
1A4ci	2.638	90.786		2A5b	0.021	99.909	
2C2	2.374	93.160		3F	0.019	99.928	
1A2d	1.594	94.754		2A5a	0.013	99.941	
1A2b	1.403	96.157		1A4ciii	0.011	99.951	
1A4ai	0.763	96.920		5C1a	0.010	99.961	
1A2e	0.592	97.512		1A4bii	0.009	99.970	
1A3bvi	0.560	98.073		1A5a	0.009	99.979	

1A2a	0.557	98.630		1A3c	0.007	99.986	
1A3bi	0.290	98.920		5E	0.006	99.991	
2C7c	0.263	99.182		1A3biv	0.006	99.997	
1A3biii	0.243	99.425		5C1bv	0.002	99.999	
1A2gvii	0.103	99.528		2A2	0.0008	100	
1A4cii	0.082	99.610		2G	0.00001	100	

Table 2.15. Key category categories for Cu emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A3bvi	75.080	75.080	x	2A5a	0.099	99.530	
1A1a	4.526	79.606	x	1A3c	0.094	99.624	
1A2gviii	4.403	84.008	x	1A4ciii	0.074	99.698	
1A1b	3.607	87.615		1A3biii	0.068	99.765	
2C1	1.991	89.606		2A5b	0.053	99.819	
1A2f	1.790	91.396		5C1bi	0.029	99.847	
1A2gvii	1.381	92.777		1A5a	0.028	99.875	
1A4cii	1.104	93.881		1B1b	0.023	99.898	
1A2d	0.989	94.871		1A3bii	0.019	99.917	
1A4bi	0.858	95.728		2B10a	0.015	99.932	
1A4ci	0.840	96.568		1A2c	0.015	99.947	
1A4aii	0.704	97.273		5C1a	0.014	99.962	
2C7c	0.680	97.952		1A2a	0.010	99.971	
1A2e	0.324	98.276		2A2	0.008	99.980	
1A2b	0.198	98.474		2C7a	0.005	99.985	
1A3bi	0.184	98.658		1A3biv	0.005	99.990	
2C2	0.177	98.835		5E	0.005	99.996	
1A3dii	0.174	99.009		3F	0.004	99.999	
2C6	0.167	99.176		5C1bv	0.0008	100	
1A4ai	0.135	99.311		2G	0.000001	100	
1A4bii	0.121	99.432					

Table 2.16. Key category categories for Ni emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1b	18.578	18.578	x	1A4cii	0.1063	99.642	
1A2gviii	16.936	35.513	x	1A4aii	0.0678	99.709	
1A1a	12.313	47.827	x	1A3biii	0.0659	99.775	
2C7b	9.997	57.824	x	1A5a	0.0571	99.832	
1A4bi	9.632	67.456	x	5C1bi	0.0298	99.862	
1A2f	8.944	76.400	x	2A5b	0.023	99.885	
2C1	6.078	82.478	x	1B1b	0.021	99.907	
1A4ai	3.201	85.680		1A3bii	0.018	99.925	

1A2d	2.924	88.604		1A3bvi	0.017	99.942	
1A4ci	2.796	91.400		2A5a	0.012	99.954	
1A3dii	2.465	93.864		1A4bii	0.012	99.965	
1A2c	2.350	96.214		1A3c	0.009	99.974	
1A2e	1.048	97.263		5C1a	0.008	99.982	
1A2a	0.571	97.834		3F	0.006	99.988	
2C2	0.526	98.360		1A3biv	0.004	99.992	
1A2b	0.479	98.839		5C1bv	0.003	99.995	
2B10a	0.225	99.063		2C7c	0.002	99.997	
1A4ciii	0.195	99.259		2C7a	0.002	99.999	
1A3bi	0.144	99.402		2A2	0.001	100	
1A2gvii	0.133	99.535					

Table 2.17. Key category categories for Zn emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	27.195	27.195	x	1A4cii	0.199	99.396	
1A3bvi	16.287	43.482	x	1A4aii	0.127	99.523	
1A1a	14.377	57.859	x	1A2b	0.089	99.612	
1A2gviii	10.432	68.291	x	1A3biv	0.085	99.697	
1A1b	5.361	73.652	x	1A3dii	0.069	99.765	
2C6	3.870	77.522	x	1B1b	0.037	99.802	
1A4ci	3.841	81.363	x	1A4ciii	0.031	99.833	
1A3bi	3.305	84.669		2A5a	0.026	99.858	
1A2d	2.935	87.603		1A2c	0.025	99.883	
1A2f	2.659	90.263		1A2a	0.025	99.908	
2C1	2.171	92.434		1A4bii	0.022	99.930	
5C1bi	1.762	94.196		1A3c	0.017	99.947	
1A3biii	1.706	95.902		1A5a	0.016	99.963	
1A4ai	1.574	97.476		5C1a	0.015	99.978	
2C2	0.507	97.984		3F	0.012	99.990	
1A3bii	0.468	98.452		2A2	0.004	99.994	
2C7c	0.260	98.712		5C1bv	0.003	99.997	
1A2gvii	0.249	98.961		2C7a	0.003	100	
1A2e	0.237	99.197		2H2	0.0001	100	

Table 2.18. Key category categories for PCDD/F emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A1a	26.203	26.203	x	1A4ai	0.495	98.544	
1A3biii	15.030	41.233	x	1A2f	0.457	99.001	
2C7a	8.117	49.350	x	2C6	0.211	99.212	
5E	7.567	56.917	x	1A2e	0.120	99.332	
1A4bi	7.305	64.222	x	1A2a	0.105	99.437	

1A2d	5.809	70.031	x	3F	0.102	99.539
2H1	5.066	75.097	x	1A3dii	0.094	99.633
1A3bii	4.102	79.200	x	2D3b	0.074	99.708
2C1	3.767	82.967	x	2A1	0.071	99.779
1A2gviii	3.307	86.274		2L	0.062	99.840
5C1bi	2.567	88.841		1A2c	0.056	99.896
5C1a	2.345	91.185		1A3biv	0.030	99.926
1B1b	1.413	92.599		1A4ciii	0.030	99.957
1A4ci	1.128	93.727		1A5a	0.025	99.981
1A3bi	1.121	94.848		1A2b	0.017	99.998
2B10a	1.051	95.899		2A3	0.002	100
2A2	0.906	96.805		1A3ei	0.0003	100
1A1b	0.704	97.509		2G	0.00004	100
5C1bv	0.540	98.049				

Table 2.19. Key category categories for PAH-4 emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
1A4bi	80.904	80.904	x	1A4aii	0.139	99.651	
1B1b	4.933	85.838		2C1	0.127	99.777	
1A1a	4.515	90.353		1A2c	0.054	99.831	
1A2d	2.082	92.435		1A2f	0.029	99.860	
1A3biii	1.053	93.488		1A2e	0.025	99.885	
1A3bi	1.025	94.514		1A4bii	0.024	99.909	
5C1bi	0.956	95.469		1A2b	0.020	99.929	
1A2gviii	0.942	96.412		1A3c	0.019	99.947	
1A4ci	0.792	97.204		1A3biv	0.018	99.965	
5C1a	0.600	97.804		1A2a	0.011	99.976	
1A4ai	0.578	98.382		5C1bv	0.009	99.985	
2D3i	0.275	98.657		2G	0.009	99.995	
1A2gvii	0.273	98.930		1A5a	0.002	99.997	
1A4cii	0.219	99.149		2B10a	0.002	99.999	
1A3bii	0.207	99.356		2C2	0.001	100	
1A1b	0.156	99.511		3F	0.0001	100	

Table 2.20. Key category categories for HCB emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
2B10a	42.645	42.645	x	3Df	0.066	99.913	
2C7a	28.701	71.345	x	1A3dii	0.031	99.945	
5C1bi	18.774	90.120	x	5C1bv	0.018	99.963	
5C1a	6.284	96.403		1A3biv	0.015	99.978	
1A4bi	1.196	97.599		1A4ciii	0.013	99.99	
1A3bi	0.610	98.210		2D3i	0.006	99.996	
1A3biii	0.408	98.617		1A5a	0.004	100	

2C7c	0.393	99.010	1A2f	0.0001	100
1A1a	0.268	99.278	1A2a	0.0001	100
1A4ci	0.154	99.432	1A2e	0.0001	100
1A2d	0.146	99.578	1A2b	0.0001	100
1A2gviii	0.104	99.682	1A1b	0.0001	100
1A3bii	0.099	99.781	1A2c	0.00003	100
1A4ai	0.067	99.847			

Table 2.21. Key category categories for PCB emissions in 2015 by quantity.

NFR Code	contribution percentage	cumul percentage	key source	NFR Code	contribution percentage	cumul percentage	key source
5E	35.277	35.277	x	1A4ai	0.637	98.742	
5C1bi	22.707	57.983	x	1A4ci	0.530	99.271	
2C1	9.093	67.076	x	1A3biv	0.169	99.440	
1B2aiv	8.013	75.089	x	2A2	0.163	99.603	
1A3bi	7.013	82.102	x	1A2d	0.155	99.758	
5C1a	4.331	86.433		2C7a	0.116	99.874	
1A3biii	4.177	90.610		2C7c	0.063	99.937	
1A4bi	2.735	93.345		1A3dii	0.047	99.984	
1B1b	2.075	95.421		1A4ciii	0.013	99.997	
2A1	1.546	96.966		2B10a	0.002	100	
1A3bii	1.139	98.105		5C1bv	0.0005	100	

Table 2.22. Key category categories for PCP emissions in 2013 by quantity.

NFR	Contribution %	Cumulative sum %	Key category	NFR	Contribution %	Cumulative sum %	Key category
5C1a	91.472	91.472	x	1A4ci	0.365	99.900	
1A1a	4.348	95.820		5C1bi	0.086	99.986	
1A4bi	2.448	98.268		1A4ai	0.009	99.994	
1A2gviii	1.267	99.535		2C7c	0.006	100	

2.6 Information on the QA/QC plan including verification and treatment of confidentiality issues

Changes in chapter	
Update of text	March 2016 KS
Other (e.g. language, layout)	December 2017 KS

2.6.1 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.

2.6.2 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 1.4 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 2.23. 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

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.

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

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.

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.

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.

2.6.3 Implementation of the QA/QC plan in the preparation of the 2015 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 2.7 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 into the NFR table and compared against CRF data

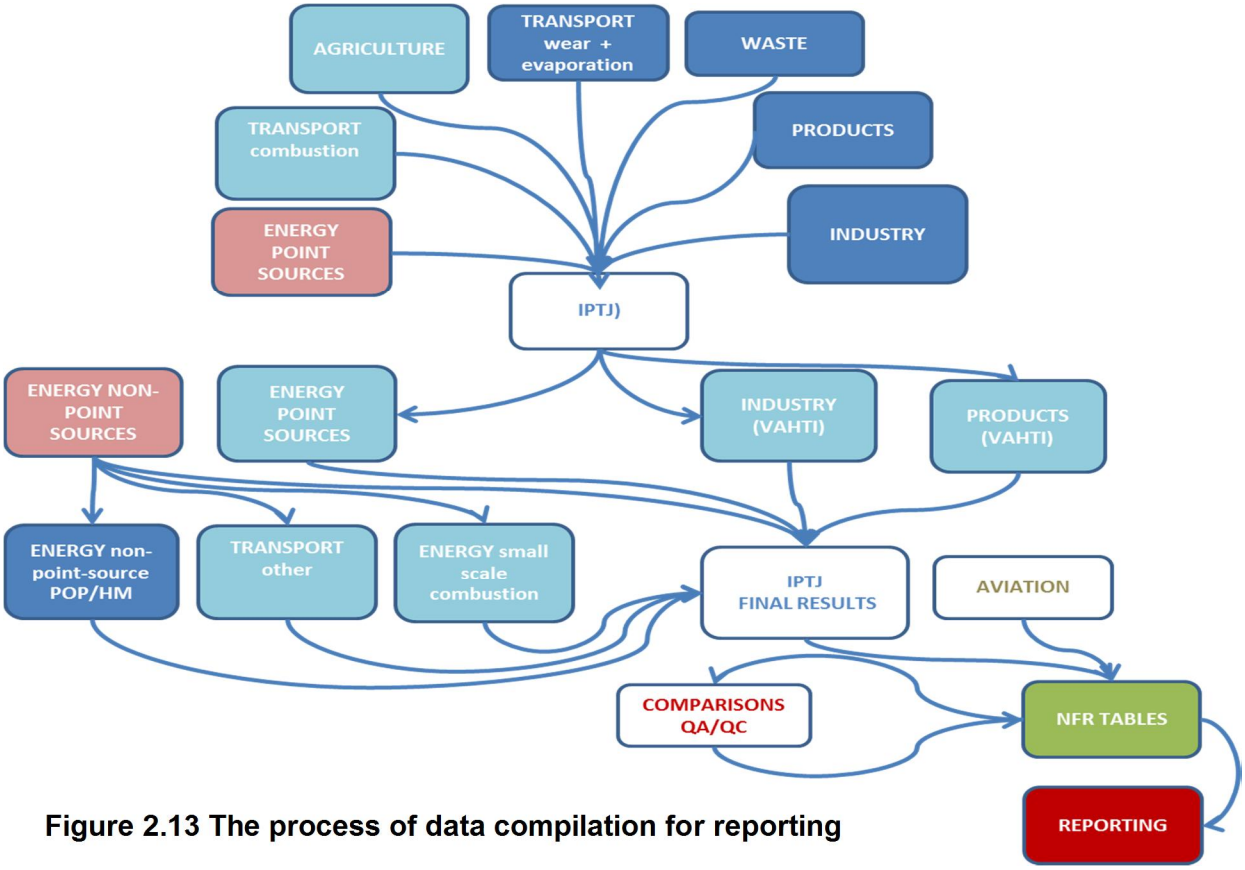


Figure 2.13 The process of data compilation for reporting

2.6.4 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 2017 is presented in Chapter 14.

2.6.5 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.

2.6.6 Verification

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

2.7 Inventory improvement programme at Finnish Environment Institute

Changes in chapter	
Update of text	February 2017 KS
Other (e.g. language, layout)	February 2017 KS

Identification of further development needs in the Finnish UNECE CLRTAP inventory is carried out on a continuous basis although larger scale improvements are possible only when the necessary resources for the improvement projects are available.

The inventory improvement programme is strongly linked with the national emission data production methods provided to the operators in their reporting to emission registers such as the E-PRTR.

National emission factors are derived from data reported by the plants when these are based on site-specific measurements and other site-specific data.

Finnish Environment Institute maintains information on emission estimation methodologies and emission factors on a website (http://www.ymparisto.fi/fi-FI/Asiointi_luvat_ja_ymparistovaikutusten_arviointi/Luvat_ilmoitukset_ja_rekisterointi/Paastotiedon_ilmoittaminen__paastorekistereihin_PRTR) (in Finnish). These methods should be applied in the E-PRTR reporting by the plant operators whenever no plant specific data is available. This procedure has been developed to ensure consistency between the data reported by the plants and the emission inventory.

The programme has thus far included studies in the energy production sector (boilers >50 MW), industrial processes (pulp and paper, iron and steel), agriculture and waste sectors and resulted in updating or developing of several emission factors. The studies involve also examination of the applicability of the default methods presented in the Guidebook for the national conditions.

The results of the uncertainty analysis are used to prioritise the improvements.

The overall scheme of the inventory improvement programme is presented in Chapter 14 in Table 14.1.

2.8 Improvement and Harmonization of the Nordic Air Emission Inventories in the Nordic Air Emission Inventory Group

Changes in chapter	
Update of text	February 2017 KS
Other (e.g. language, layout)	February 2017 KS

A Nordic programme resourced by the Nordic Council of Ministers, has been more or less active since 2004 between Denmark, Iceland, Finland, Norway and Sweden. The programme includes information exchange by comparing the completeness of emission sources and the levels of emissions and emission factors. Several improvements to the national inventories have been made over the in all Nordic countries due to the results of the work, for instance in NMVOC and particle emission inventories.

A programme is running in 2015-2017 to improve understanding of short lived climate pollutant emissions and from 2016 another programme to improve POP and heavy metal emissions in Nordic cooperation.

Smaller projects funded by the NMR on improving emission estimates of POP and heavy metal emissions and further developing activity data collection on small scale wood combustion are under work in 2016-2018.

2.9 Identified improvements needs

Changes in chapter	
Update of text	2016 KS
Other (e.g. language, layout)	2016 KS

A summary of identified improvement needs and implemented improvements are presented in Chapter 14.

2.10 General uncertainty evaluation

Changes in chapter	
Update of text	2016 KS
Other (e.g. language, layout)	February 2017 KS

2.10.1 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 2.10 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).

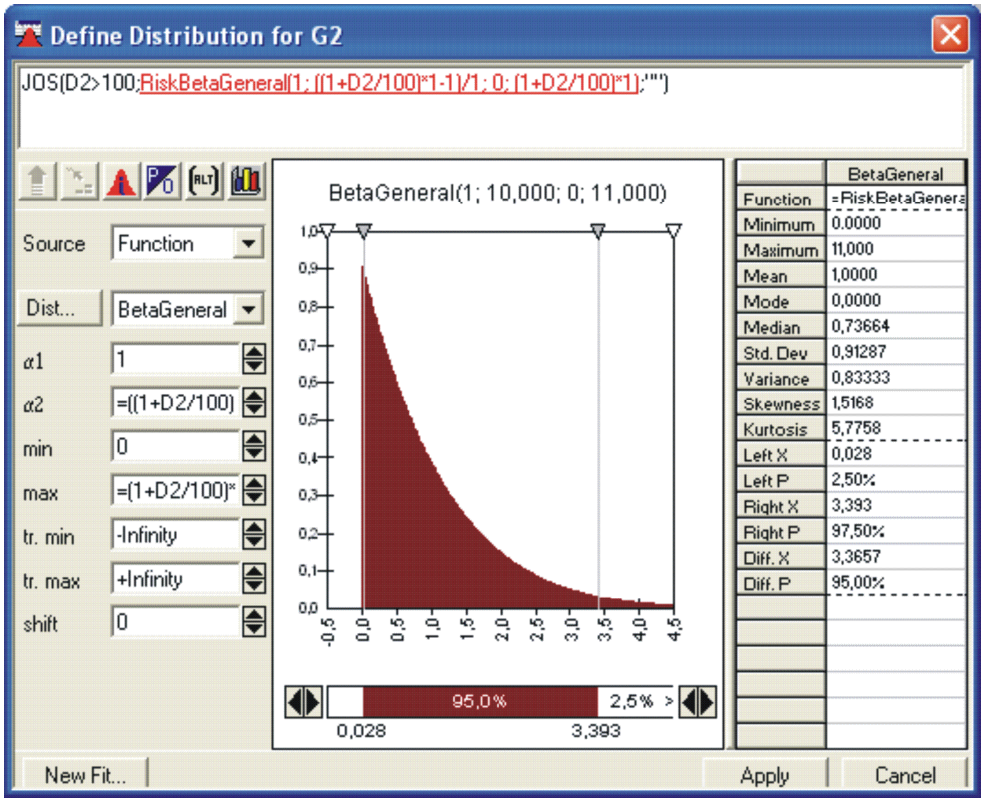


Figure 2.14. An example of the applied beta distribution. The function used can be seen on the top of the picture (JOS = IF in Finnish and cell D2 contains the uncertainty percentage).

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.

2.10.2 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 2.23 below. In addition, to ensure comparability between compounds, the uncertainties were also estimated for the year 1990 for all the compounds.

Table 2.24. 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.

2.10.3 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%.

2.10.4 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 2017 (2011 data):

- All uncertainty estimates used in the previous submission were evaluated by an external consultant[19], 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

[19] Suvi Monni from Benviroc Ltd

2.11 Use of Notation Keys and basis for estimating emissions from mobile sources

Changes in chapter	
Update of text	March 2016 ks
Other (e.g. language, layout)	March 2016 ks

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 Table 2.27).

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.

2.12 Basis for estimating emissions from mobile sources

The basis for estimating emissions from mobile sources is presented in Table 2.25. Fuel statistics for mobile sources is providing in the NRF reporting tables.

Table 2.25. 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*	

2.13 General assessment of completeness

Changes in chapter	
Update of text	February 2017 JMP
Other (e.g. language, layout)	February 2017 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.

2.13.1 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 2.26.

Table 2.26. Explanation of the use of the Notation key NE in NFR Tables submitted in 2017.

NFR09	Substance	Reason for not estimated
All	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 a1	Se	
5 C 1bi	Se	

The inventory for the year 2015 emissions is regarded complete in coverage of emission sources with the following exceptions:

NFR 3 PCB emissions from old electrical equipment containing PCBs could not be estimated due to lack of activity data. PCP and SCCP emissions from products could not be estimated due to insufficient activity data. PCB emissions from recycling of ferrous scrap could not be estimated due to lack of estimation method.

Allocation of emissions reported as included elsewhere (IE) is provided in Table 2.27 and explanation of sources reported under categories Other in Table 2.28.

Table 2.27. Explanation of the use of the Notation key IE in NFR tables submitted in 2017.

NFR09	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 recalculation is finalized
1B1b	PM2.5, PM10, TSP, Hg	
1B2aiv, aiv	CO	
2A1	NOx,SOx, PM2.5, PM10, TSP,	
2A2	NOx, Sox, Cd	
2A3	NOx	
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 except NMVOC,	? 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 2.28. Sub-categories reported under "Other" in 2017 for the year 2015.

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

NFR14	Substance	SNAP	Sub-source description
2 B 10 a	all	040416	Formic acid and hydrogen peroxide manufacturing
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 agriultural 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

2.13.2 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 2.29. Finnish submissions of gridded data.

Pollutants	For the year	Comments
SO_X	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 *excluded from NFR tables in 2009 ** inventory not complete, Se not one of the obligatory heavy metals
NO_X	1999 - 2015	
NH_3	1999 - 2015	
CO	1999 - 2015	
NMVOC	1999 - 2015	
PCDD/F	1999 - 2015	
PAH-4	1999 - 2015	
HCB	1999 - 2015	
PCB	1999 - 2015	
PCP	1999 – 2007*	
SCCP	-*	
TSP	1999 - 2015	
PM10	1999 - 2015	
PM2.5	1999 - 2015	
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	

2.13.3. Completeness by coverage of years

The annual inventory submissions under the UNECE CLRTAP include emission estimates since 1980 as presented in Tables 2.30 and 2.31.

Complete emission data sets for all substances have been reported for the years 1980-2015 with the following exceptions:

Heavy metals: The previously reported estimates for the year 1999 were found to be highly inconsistent with the earlier calculations and the recalculation is under way.

NMVOC: The time-series from landfills and wastewater treatment for 1990-2015 has been calculated with a model which was developed in 2006 as presented in Chapter 8. The recalculated time series will be reported officially when recalculation of the whole time-series has been finalized.

Particles: Only the years 2000 –-2015 have been reported. Although the reporting obligation for particles starts from the year 2000, it is anticipated to include these emissions in the inventory when the recalculation of the time-series has been finalized.

The inventory reporting system IPTJ includes at the moment data in various NFR formats only for the years 2001 – 2015. The older NFR formats as well as data for the years 1980-2001 forced from earlier formats (SNAP and NFR) into NFR14. In the 2012 submission data for all years 1980-2010 were allocated for the first time into NFR09 reporting tables and again forced to the NFR14 format during the introduction of that format. Note that although the emission data are now in the required

reporting format of NFR 2014 tables emission inventories have each year been carried out independently from the previous years and the allocation of data into the NFR categories is not consistent over the years. The recalculation of the time series from 1990 onwards is foreseen by the next submission in 2018.

Table 2.30. 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	1990-2015	1980-2015	1980-1989 national total NFR08 1990-1999 NFR08 (forced from SNAP) 2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
NO_X	1990-2015	1980-2015	1980-1989 national total NFR08 1990-1999 NFR08 (forced from SNAP) 2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
NH_3	1990-2015	1980, 1985-1987 1990-2015	1980, 1985-1987 national total NFR08 1990-1999 NFR08 (forced from SNAP) 2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
CO	1990-2015	1980-2015	1980-1989 national total NFR08 1990-1999 NFR08 (forced from SNAP) 2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
NMVOCs	1988-2013	1988-2015	1988-1999 NFR08 (forced from SNAP) 2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
PCDD/F	1990-2015	1990-2015	2000-2006 NFR08 2007-2012 NFR09 1980-2015 NFR2014
PAH-4	1990-2015	1990-2015	2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
HCB	1990-2015	1990-2015	2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
PCB	1990-2015	1990-2015	2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
PCP	1990-2015	1990-2015	2000-2006 NFR08 2007-2012 NFR09

			1980-2013 NFR2009 1980-2015 NFR2014
SCCP	1990-2015	1990-2015	2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR2014
As	1990-2015	1990-2015	1990-1999 SNAP in the original submissions by their due date, in this submission forced to NFR08 2000-2006 NFR08 2007-2012 NFR09 1980-2013 NFR2009 1980-2015 NFR20149
Cd	1990-2015	1990-2015	
Cr	1990-2015	1990-2015	
Cu	1990-2015	1990-2015	
Hg	1990-2015	1990-2015	
Ni	1990-2015	1990-2015	
Pb	1990-2015	1990-2015	
Se	1990-2015	(inventory is not complete)	
Zn	1990-2015	1990-2015	

Table 2.31. 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

2.13.4 Completeness of information reported

In addition to emissions and projections data presented in Chapter 2.13.4. Finland reports gridded data as presented in 0 and data for large point sources (LPSs) as presented in Table 2.33.

Table 2.32. Finnish submissions of gridded data - the years indicate the year of emissions (not the submission.

LPS data submitted	Format
1999-2012	EMEP Grid 50 km * 50 km
2012-2014 (not for 2015 due to resource restrictions)	EMEP Grid 0.1 ^{o} * 0.1 ^{o}

Table 2.33. Finnish submissions of LPS data. - the years indicate the year of emissions (not the submission.

Main Pollutants	LPS data submitted
SO_X	1999 - 2015
NO_X	1999 - 2015
NH_3	1999 - 2015
CO	1999 - 2015
NMVOCs	1999 - 2015
PCDD/F	1999 - 2015
PAHs	1999 - 2015

HCB	1999 - 2015
PCBs	1999 - 2015
HCH	1999 - 2015
Cd	1999 - 2015
Pb	1999 - 2015
Hg	1999 - 2015
Additional heavy metals	1999 - 2015
TSP, PM10, PM2.5	1999 - 2015

3 AIR POLLUTANT EMISSION TRENDS

Changes in chapter	
Update of text and figures	February 2017 KS
Other (e.g. language, layout)	February 2017 KS

3.1 Description and interpretation of emission trends for air pollutants emissions

3.1.1 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.

3.1.2 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. The ammonia emissions inventory does not yet cover all years in the 1980's.

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.

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 3.1 and 3.2. Although the time series have not fully been recalculated[20], 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.

3.1.3 Reduction targets

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).

[20] 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.

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 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.

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

Follow up of meeting the reduction targets set in Gothenburg Protocol and the respective emission levels in 2010 are presented in Table 3.1. 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 1994, when the emissions were 114 kt.

Nitrogen oxides

The Sophia Protocol target was to reduce nitrogen oxides below the 1987 level, when the Finnish NO_x emissions were 288 kt. The target was met in 1992 with emissions of 284 kt. The emission ceiling in the Gothenburg protocol is 170 kt, and has been met since 2008. In 2010 it seemed that the ceiling of 170 kt would have been slightly exceeded as the calculations resulted in a total of 172 kt of NO_x. However, this was not certain at the time the NFR tables and the IIR was submitted (February-March 2012) because it was not possible to make sufficient data checks before the deadlines of the reporting. The emission inventory was cross-checked and reported as final in December 2012under the EU NECD to verify the situation. In this final inventory NOx emissions totalled 166 kt and did thus not exceed the emission ceiling.

Non-methane volatile organic compounds

For NMVOC emissions the reduction target of 30 per cent from the year 1988 emissions of 228 kt

to 1999 was achieved first in 2001, when the emissions were 155 kt. The emission ceiling in the Gothenburg protocol is 130 kt, which was met in 2007.

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, however, their impact in the time series is currently not seen due to the pending recalculation of energy sector emissions, which has hindered updating the time series.

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 2015 were 31.824 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 adjustments for 2015 (-1.245 kt), Finnish ammonia emissions in 2015 (30.579 kt) are below the ceiling of 31 kt.

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

A detailed description of the development of ammonia emission inventories presented in Appendix 1 of the IIR will be complemented with information of the revised agriculture sector inventory and uploaded in the EIONET CDR by 1st May 2017. The inclusion of this information in the IIR submitted on 15th March was unfortunately not possible due to the late finalization of the inventory.
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Heavy metals

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

POP emissions

The targets to reduce emissions of PCDD/F and PAH-4 below the emission level in 1994 have been met in 1995. The target to reduce HCB emissions below the level in 1994 has been met in 2001-2005 and since 2008.

Table 3.1. 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.

Air pollutant (pollutants with reduction requirements in bold)		CLRTAP base year	Emissions (kt)						Change %					Targets						
			In the base year	1980	1990	2005	2010	2015	1980-1990	1990-2015	2005-2015	1980-2015	Since base yr (2015)	2012 Gothenburg Protocol targets		Year when reached	Old Gothenburg		CLRTAP	
																	Targets kt / %	Year when reached	Reduction obligation	Year when reached
Main pollutants	SO_2	1980	584	584	263	70	67	42	-55	-84	-40	-93	-93	49 kt	-30%	2013	116 / -55	1995	-30% by 1993 and 116 kt by 2010	1983 & 1994
	NO_x	1987	291	314	285	202	189	140	-9	-51	-31	-55	-52	131 kt	-35%	Not yet	170 / -43	2008-	Freeze on 1987	since
	NMVOC	1988	265	NE	270	151	128	88	NE	-67	-42	NE	-67	98 kt	-35%	2014	130 / -38	since	-30% by 1999	2001
	NH_3	1990	34	34	34	37	*35/33*	*32*/31	0	-9	-16	-9	-9	30 kt	-20%	Not yet	31 / -11	2015	31 kt in 2010	2015
	CO			NE	724	478	412	325	NE	-55	-32	NE	NA							
Partic-les	TSP	2000	78	NE	NE	74	74	50	NE	NE	-32	NE	-36							
	PM_{10}	2000	55	NE	NE	49	50	32	NE	NE	-35	NE	-42							
	$PM_{2,5}$	2000	39	NE	NE	36	37	22	NE	NE	-39	NE	-44	25 kt	-30%	2014				
	BC		7	NE	NE	7	6	5	NE	NE	-29	NE	NA							
Heavy metals	Pb	1990	332	NE	322	22	23	14	NE	-95	-50	NE	-95			Below 1990 level			since 1991	
	Cd	1990	8	NE	8	1	1	1	NE	-81	-6	NE	-81			Below 1990 level			since 1991	
	Hg	1990	3	NE	3	1	1	1	NE	-41	20	NE	-41			Below 1990 level			since 1991	
	As		36	NE	36	3	4	2	NE	-91	-33	NE	-91							
	Cr		32	NE	32	18	22	16	NE	-38	-36	NE	-38							
	Cu		165	NE	165	62	50	40	NE	-64	-27	NE	-64							
	Ni		64	NE	64	28	24	17	NE	-74	-52	NE	-74							
	Zn		598	NE	598	142	165	129	NE	-77	48	NE	-77							

Table 3.2. 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	2015	1980-1990	1990-2015	2005-2015	1980-2015	Since base yr (2015)	New Gothenburg Protocol		Old Gothenburg		CLRTAP	
																Targets kt / %	Year when reached*	Reduction obligation	Year when reached
Main pollutants	SO_2	1980	584	584	263	70	67	42	-55	-84	-40	-93	-93	49 kt	-30%	116 / -55	1995	-30% by 1993 and 116 kt by 2010	1983 & 1994
	NO_x	1987	291	314	285	202	189	140	-9	-51	-31	-55	-52	131 kt	-35%	170 / -43	2008-2009, with new sources since 2011	Freeze on 1987 level	since 1987
	NMVOC	1988	265	NE	270	151	128	88	NE	-67	-42	NE	-67	98 kt	-35%	130 / -38	since 2007, with new sources since 2009	-30% by 1999	2001
	NH_3	1990	34	34	34	37	*35/33*	*32*/31	0	-9	-16	-9	-9	30 kt	-20%	31 / -11	2015	31 kt in 2010	2015
	CO			NE	724	478	412	325	NE	-55	-32	NE	NA						
Partic-les	TSP	2000	78	NE	NE	74	74	50	NE	NE	-32	NE	-36						
	PM_{10}	2000	55	NE	NE	49	50	32	NE	NE	-35	NE	-42						
	$PM_{2,5}$	2000	39	NE	NE	36	37	22	NE	NE	-39	NE	-44	25 kt	-30%				
	BC		7	NE	NE	7	6	5	NE	NE	-29	NE	NA						
Heavy metals	Pb	1990	332	NE	322	22	23	14	NE	-95	-50	NE	-95			Below 1990 level		since 1991	
	Cd	1990	8	NE	8	1	1	1	NE	-81	-6	NE	-81			Below 1990 level		since 1991	
	Hg	1990	3	NE	3	1	1	1	NE	-41	20	NE	-41			Below 1990 level		since 1991	
	As		36	NE	36	3	4	2	NE	-91	-33	NE	-91						
	Cr		32	NE	32	18	22	16	NE	-38	-36	NE	-38						
	Cu		165	NE	165	62	50	40	NE	-64	-27	NE	-64						
	Ni		64	NE	64	28	24	17	NE	-74	-52	NE	-74						
	Zn		598	NE	598	142	165	129	NE	-77	48	NE	-77						

***New sources not in the original inventories but identified according to the latest Guidebook versions and added to the whole time series.**

3.1.5 National emission ceilings (EU NECD)

National emission ceilings set in the EU Directive 2001/81/EC and the respective emission levels in 2011 are presented in Table 3.3 for SO_2, NO_x, NMVOC and NH_3. Annual variations in the emission levels occur depending on economic and climatic conditions.

Finland has met emission ceilings for SO_x, NO_x and NMVOC. The ceiling of 31 kt for NH_3 was met in 2015 when using the granted adjustments.

Table 3.3. Development of emissions related to the 2010 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 2010 (kt)	Emissions in kt				Reductions %			
		1980	1990	2010	2015	1980-1990	1990-2010	1980-2015	1990-2015
SO_2	110	584	263	67	42	-55	-75	-93	-84
NO_x	170	314	284	189	140	-9	-34	-55	-51
NMVOC	130	NE	271	128	88	NE	-53	NE	-67
NH_3	31	34	34	***35/33***	***32***/31	0	-3	-9	-9

Table 3.4. Development of emissions related to 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	Reduction % from 2005 emissions to 2020	Target in 2020 (kt)	Emissions in kt		Reductions
			2005	2015	2005-2015
SO_2	-30	49	70	42	-40
NO_x	-35	131	202	140	-31
NMVOC	-35	98	151	88	-42
NH_3	-20	30	37	32/31	-16
$PM_{2.5}$	-30	25	36	22	-38

Sulphur dioxide The SO_x emission ceiling 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 are estimated to stay around this level, though slight variations are possible depending on economic and climatic conditions.

Nitrogen oxides The NO_x emission ceiling of 170 kilotonnes for the year 2010 has been met since 2008. New sources have recently been added to the inventory, however, their full impact in the time series is currently not seen due to the pending recalculation of energy sector emissions, which has hindered updating the time series. Annual variations in emissions are common due to variations in both economic and climatic conditions.

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, however, their full impact in the time series is currently not seen due to the pending recalculation of energy sector emissions, which has hindered updating the time series.

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 2015 were 31.824 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 adjustments for 2015 (-1.245 kt), Finnish ammonia emissions in 2015 (30.579 kt) are below the ceiling of 31 kt.

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

Table 3.5. Ammonia emissions and projections

NH3 Inventory	2005 (kt)	2015 (kt)	Current reduction (%)	-20% reduction from 2005 (kt)	Projections (kt) without adjustments		
					2020	2025	2030
OLD INVENTORY	39.155	35.052	10.5	31.324			
REVISED INVENTORY 15.3.2017	36.529	31.824	12.9	29.223	32.331	31.885	31.319
GRANTED ADJUSTMENTS	NA	-1.245					
TOTAL EMISSIONS WITH ADJUSTMENTS	NA	30.579					

A detailed description of the development of ammonia emission inventories presented in Appendix 1 of the IIR will be complemented with information of the revised agriculture sector inventory and uploaded in the EIONET CDR by 1st May 2017.

3.3 Description and interpretation of emission in 2015 and the trends by pollutant

Changes in chapter	
Update of text and figures	March 2017 KS
Other (e.g. language, layout)	March 2017 KS

This section describes the sources of air pollutants, emission trends and their spatial distribution[21].

The emission levels of the gridded air pollutants are indicated with the colour scales presented in Figure 3.1. 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).

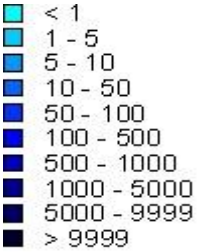


Figure 3.1. Colour scale to indicate emission levels in the figures for spatial distribution of emissions in Chapter 3.1. ***(note: the maps are currently in greyshade)***

[21] 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).

3.3.1 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 3.2.

- *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. Due to the pending recalculation of the time series their full impact will be seen when the recalculation is finalized.
- *NMVOC* emissions have been continuously decreasing since the base year of 1988. New sources have been included in the inventory over the years. Due to the pending recalculation of the time series their full impact will be seen when the recalculation is finalized.
- *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. As the impact of energy sector, where the recalculation of the time series is pending, is minor in ammonia emissions, the impact of added sources is visible in the trend.
- 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.

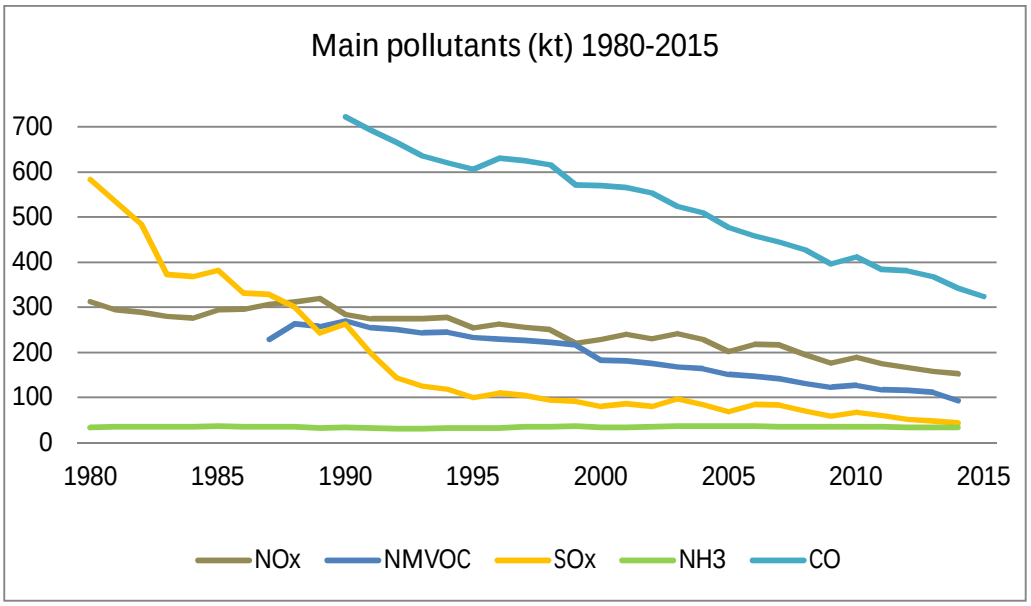


Figure 3.2. Emissions of main pollutants SO_2, NO_2, NH_3, NMVOC and CO in 1990–2015.

3.3.2 Nitrogen oxide emissions reported as nitrogen dioxide NO_2

Emission trend

In 2015 emissions of nitrogen oxides have been reduced by 52% 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 3.3. 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.

However, while the time series has not yet been recalculated for the energy sector, recalculations and adding of new sources has been carried out during the years. 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.

Note, that there are obvious inconsistencies in the allocation of emissions in the reporting categories. No major changes to the emission levels are expected either after the recalculation of the emissions has been finalized.

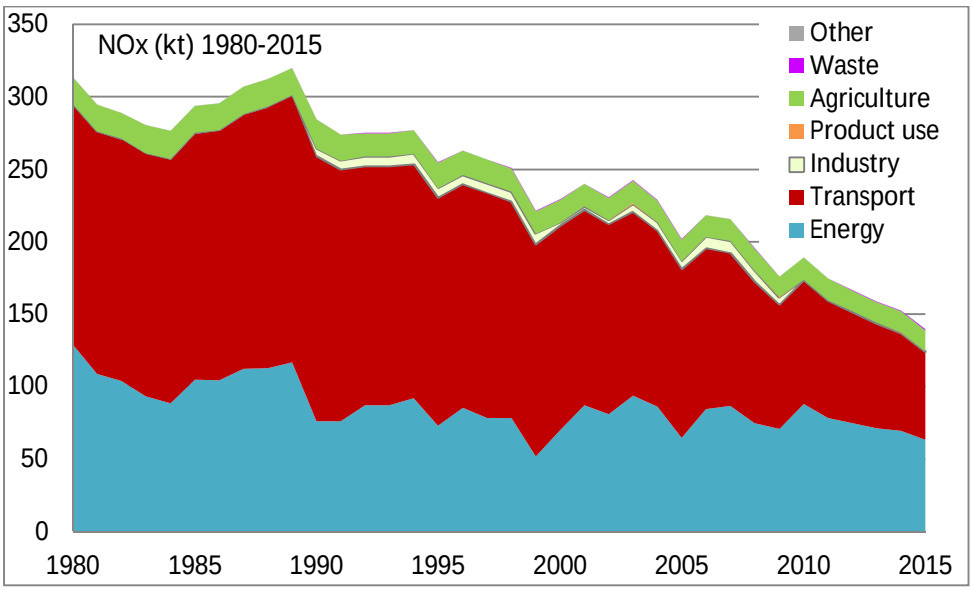
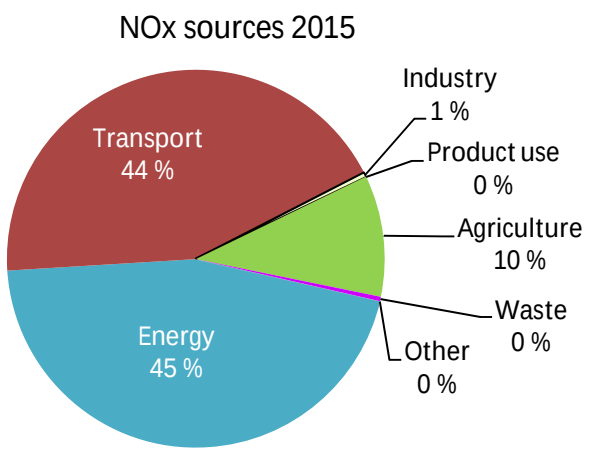


Figure 3.3 Emissions of nitrogen oxide (Gg) in 1980-2015. Note that the allocation of emissions between the energy and industrial processes sectors is not consistent over the years.

The uncertainties of emission data in 2015 are presented in Annex 7 of the IIR 2017, which will be submitted by 1st May 2017.

The contribution of different sources to emissions in 2015, the spatial distribution of emissions in 2012 and shares of emissions data reported by the plants in the 2015 emissions are presented in Figure 3.4.



Shares of data reported by the plants of total NOx emissions in 2015							
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	19.7	24.628	95.7	1A4aii	2.4	2.951	0
1A1b	1.8	2.193	100	1A4bi	4.1	5.161	0.1
1A2a	2.6	3.224	99.4	1A4bii	0.3	0.317	0
1A2b	0.2	0.241	62.3	1A4ci	0.8	0.961	0
1A2c	1.2	1.446	96.8	1A4cii	3.4	4.286	0
1A2d	13.4	16.768	98.3	1A4ciii	1.6	2.031	0
1A2e	0.2	0.286	91.4	1A5a	0.5	0.570	3.4
1A2f	1.7	2.079	99.7	1A5b	0.3	0.378	0
1A2gvii	5.6	6.964	0	1B2av	<0.1	<0.001	100
1A2gviii	3.7	4.587	13	2B10a	0.1	0.136	100
1A3ai(i)	0.5	0.646	0	2B10b	<0.1	<0.001	100
1A3aii(i)	0.1	0.179	0	2B2	0.3	0.435	100
1A3bi	8.6	10.725	0	2C1	<0.1	<0.001	100
1A3bii	4.1	43074	0	2C7c	<0.1	<0.001	100
1A3biii	15.6	19.591	0	2G	<0.1	<0.001	0
1A3biv	0.3	0.318	0	2L	<0.1	0.001	100
1A3c	1.2	1.523	0	3F	<0.1	0.071	0
1A3dii	4.5	24228	0	5C1a	0.2	0.223	100
1A3ei	<0.1	0.005	100	5C1bi	0.2	0.296	100
1A4ai	1	1.217	42991	Total	100	125.221	40.9

Figure 3.4 **The contribution of different sources and data reported by the plants in the 2015 emissions.**

3.3.3 Non-methane organic compounds emissions (NMVOC)

Emission trend

Non-methane organic compounds emissions have been reduced by 67% 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 3.5 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 time series has not fully been recalculated due to the pending recalculation in the other parts of the energy sector which has interdependencies to data in the IPPU sector due to the use of data reported by the plants.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by 1st May 2017.

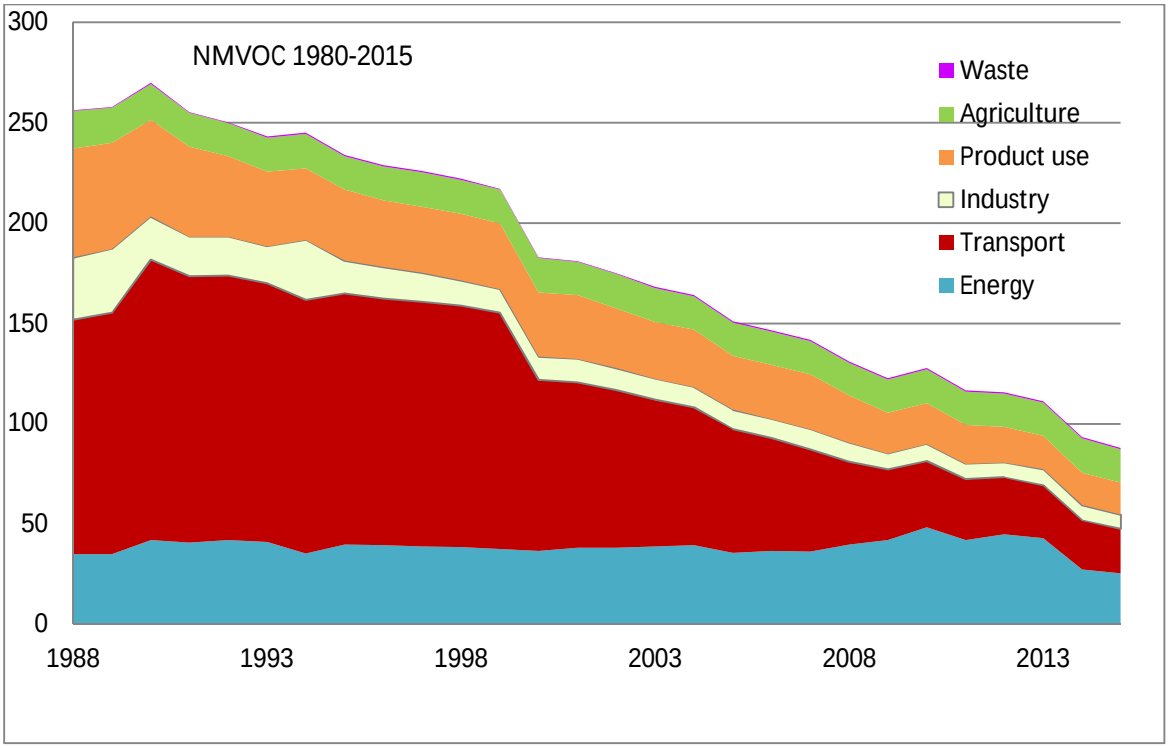
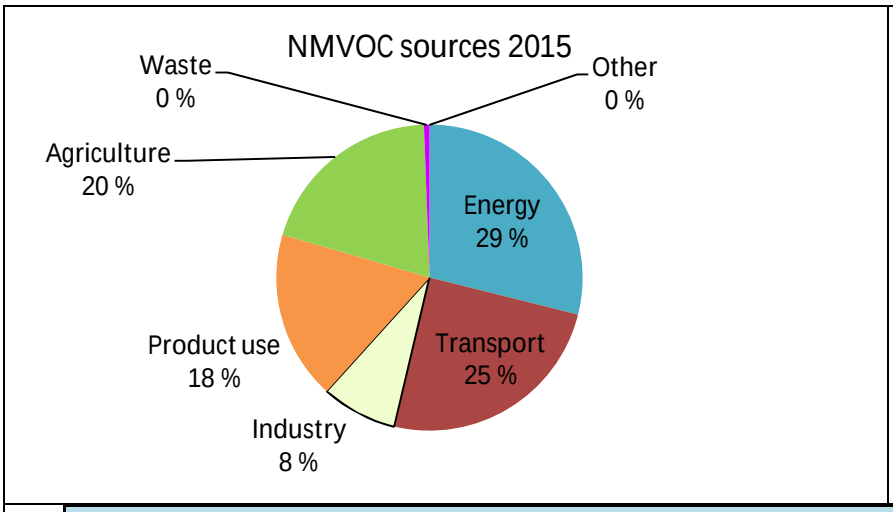


Figure 3.5. NMVOC emissions (Gg) in 1980-2015.

The contribution of different sources to NMVOC emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.6.



Shares of data reported by the plants of total NMVOC emissions in 2015							
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	1.3	0.967	42.1	2A1	<0.1	0.023	42.4
1A1b	0.1	0.079	53.6	2A3	<0.1	0.002	100
1A2a	<0.1	0.028	12.5	2B10a	3.2	2.312	100
1A2b	<0.1	0.004	6.4	2B10b	0.2	0.109	100

	1A2c	<0.1	0.037	87.8	2C1	0.2	0.177	100	
	1A2d	0.5	0.374	2.7	2C2	<0.1	<0.001	100	
	1A2e	<0.1	0.021	0	2C6	<0.1	0.001	0	
	1A2f	<0.1	0.011	32.0	2C7a	<0.1	0.009	100	
	1A2gvii	1.8	1.310	0	2C7b	<0.1	0.046	100	
	1A2gviii	0.5	0.335	0.1	2C7c	<0.1	0.012	100	
	1A3ai(i)	0.1	0.090	0	2D3a	5.8	4.220	0	
	1A3aii(i)	<0.1	0.033	0	2D3b	0.5	0.337	0	
	1A3bi	5.4	3.911	0	2D3c	0.3	0.197	0	
	1A3bii	0.9	0.652	0	2D3d	10.8	7.799	14.2	
	1A3biii	0.7	0.495	0	2D3e	0.6	0.423	2.2	
	1A3biv	2.8	2.037	0	2D3g	2.8	2.034	60	
	1A3bv	4.5	3.255	0	2D3h	1.2	0.865	79.2	
	1A3c	0.1	0.082	0	2D3i	2.1	1.512	7.4	
	1A3dii	4.7	3.410	0	2G	<0.1	<0.001	0	
	1A3ei	<0.1	<0.001	0	2H1	2.1	1.530	15.9	
	1A4ai	0.1	0.091	0.2	2H2	1.6	1.148	0.3	
	1A4aii	5.6	4.077	0	2I	1.7	1.192	43.8	
	1A4bi	23.9	17.283	0	2L	<0.1	0.004	100	
	1A4bii	1.5	1.065	0	3F	0.2	0.129	0	
	1A4ci	0.4	0.305	0	5A	0.1	0.095	0	
	1A4cii	2.1	1.492	0	5B1	<0.1	0.050	0	
	1A4ciii	0.1	0.088	0	5B2	<0.1	0.004	0	
	1A5a	<0.1	0.023	0	5C1a	<0.1	0.013	74.8	
	1A5b	<0.1	0.043	0	5C1bi	<0.1	0.038	1.4	
	1B1b	<0.1	0.067	0	5D1	0.2	0.141	4.4	
	1B2aiv	4.2	3.008	100	5D2	0.2	0.156	0	
	1B2av	4.1	2.970	7.9	Total	100	72.224	14.3	

Figure 3.6 **The contribution of different sources and data reported by the plants in the 2015 emissions.**

3.3.4 Sulphur emissions as sulphur dioxide SO_2

Emission trend

Emissions of sulphur have been reduced by 93% 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. The time-series (Figure 3.7) is not fully consistent due to slightly different methods in the calculation of emissions over the years, as well as due to differences in allocation of emission sources under the reporting categories. Recalculation of the time series has not yet been finalized.

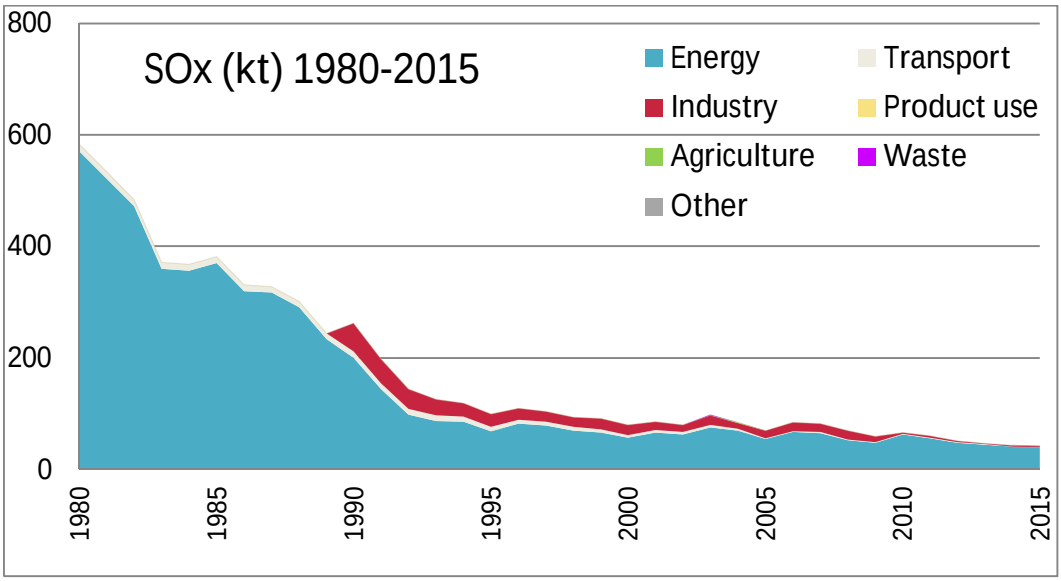
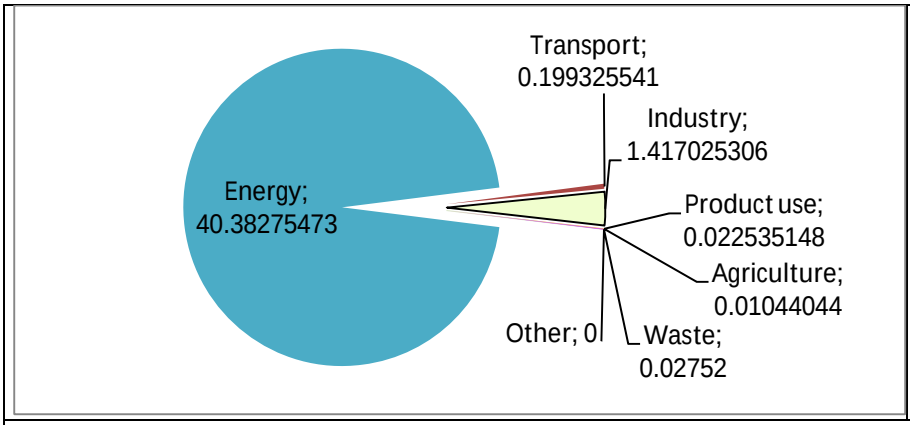


Figure 3.7. Emissions of sulphur dioxide (Gg) in 1980-2015. Note that the allocation of emissions between the energy and industrial processes sectors is not consistent over the years.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by 1st May 2017.

The contribution of different sources to SOx emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.8.



Shares of data reported by the plants of total SOx emissions in 2015							
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	35.3	14.832	95.9	1A4bi	2.4	0.997	1.4
1A1b	18.4	7.745	100	1A4bii	<0.1	<0.001	0
1A2a	4.0	1.678	99.8	1A4ci	1.3	0.557	0
1A2b	7.2	3.038	100	1A4cii	<0.1	0.003	0
1A2c	7.1	2.971	98.4	1A4ciii	<0.1	<0.001	0
1A2d	7.6	3.190	95.9	1A5a	<0.1	0.026	40.1
1A2e	0.6	0.254	88.0	1A5b	<0.1	0.031	0
1A2f	0.9	0.380	95.5	2B10a	0.9	0.376	100
1A2gvii	<0.1	0.003	0	2B10b	<0.1	<0.001	100
1A2gviii	8.7	3.653	7	2C1	<0.1	0.003	100
1A3ai(i)	<0.1	0.040	0	2C7a	<0.1	<0.001	100
1A3aii(i)	<0.1	0.012	0	2C7b	<0.1	<0.001	100
1A3bi	<0.1	0.027	0	2C7c	<0.1	<0.001	100
1A3bii	<0.1	0.003	0	2D3i	<0.1	0.014	100
1A3biii	<0.1	0.012	0	2G	<0.1	0.008	0
1A3biv	<0.1	<0.001	0	2H1	2.5	1.038	100
1A3c	<0.1	<0.001	0	2L	<0.1	<0.001	100
1A3dii	0.2	0.064	0	3F	<0.1	0.010	0
1A3ei	<0.1	<0.001	0	5C1a	<0.1	0.014	100
1A4ai	2.5	1.061	7.4	5C1bi	<0.1	0.013	100
1A4aii	<0.1	0.002	0	Total	100	42.06	83.4

Figure 3.8 The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.5 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 3.9.

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.

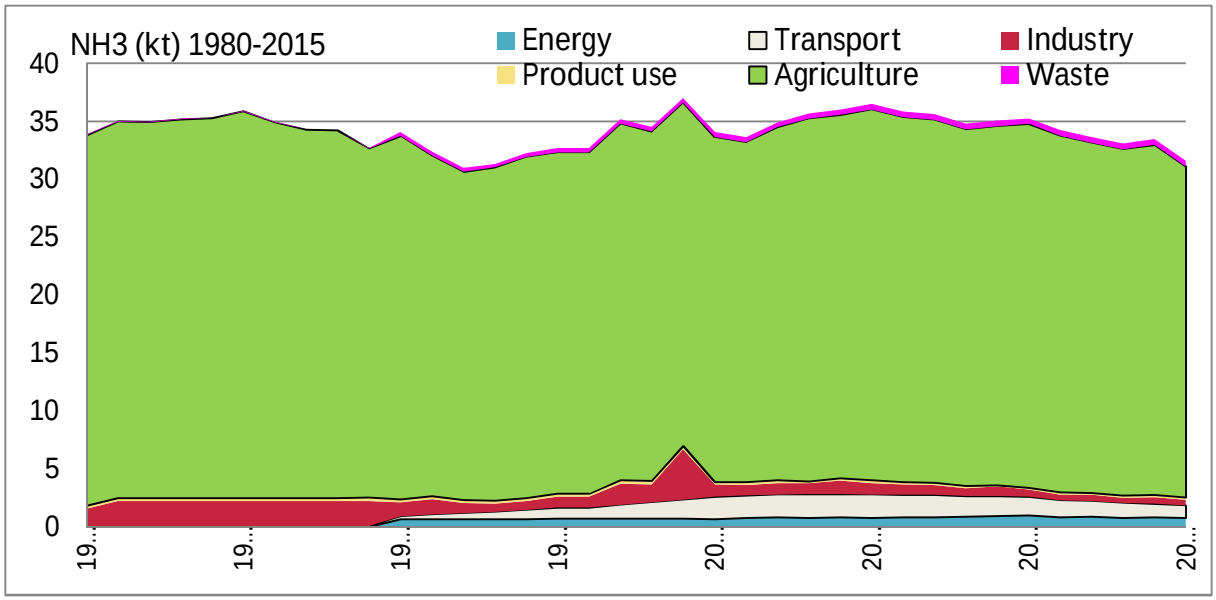
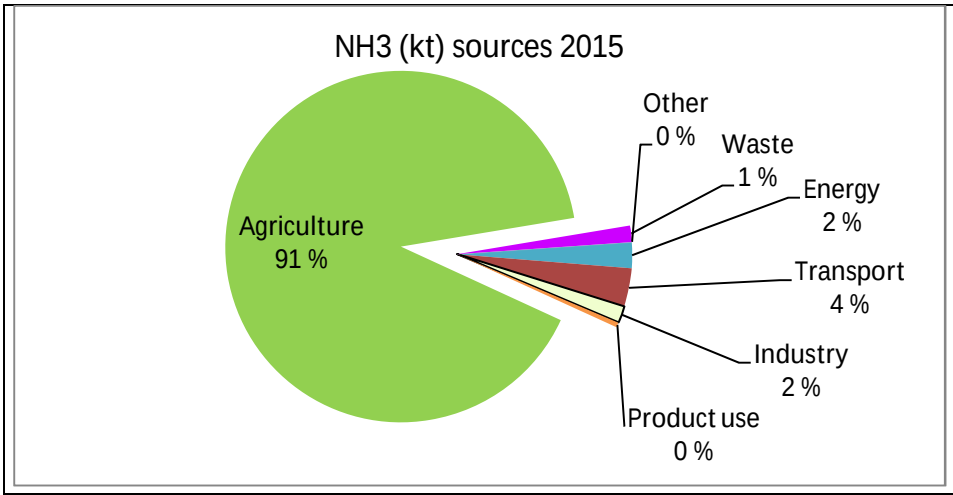


Figure 3.9. Ammonia emissions (Gg) in 1980-2014. Note, The peak NFR2 (Industry) in 1999 is due to an accidental emission reported by the plant to the environmental authorities.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017. The contribution of different sources to ammonia emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.10.



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	<0.1	0.002	100	2G	<0.1	<0.001	0
1A2gvii	<0.1	0.003	0	2H1	<0.1	0.018	100
1A3bi	2.9	1.066	0	2L	<0.1	0.001	100
1A3bii	<0.1	0.010	0	3B1a	29.6	10.82	0
1A3biii	<0.1	0.025	0	3B1b	24.2	8.843	0
1A3biv	<0.1	0.003	0	3B2	0.9	0.344	0
1A3c	<0.1	<0.001	0	3B3	11.7	4.264	0
1A3dii	<0.1	<0.001	0	3B4d	<0.1	0.010	0
1A4ai	<0.1	0.002	0	3B4e	2.7	0.972	0
1A4aii	<0.1	0.001	0	3B4gi	2.9	1.053	0
1A4bi	2.1	0.751	0	3B4gii	3.1	1.115	0
1A4bii	<0.1	<0.001	0	3B4giii	0.4	0.139	0
1A4ci	<0.1	0.005	0	3B4giv	0.9	0.325	0
1A4cii	<0.1	0.002	0	3B4h	11.7	4.266	0
1A4ciii	<0.1	<0.001	0	3Da1	3.6	1.320	0
1A5a	<0.1	<0.001	0	3Da2b	<0.1	0.002	0
1B1b	<0.1	0.003	0	3F	0.2	0.070	0
2B10a	1.1	0.403	100	5B1	0.3	0.101	0
2C7b	0.2	0.070	100	5C1a	<0.1	<0.001	100
2C7c	<0.1	<0.001	100	5D1	<0.1	<0.001	100
2D3g	<0.1	0.004	19	5E	1.0	0.375	0
2D3i	0.4	0.147	100	Total	100	36.536	1.8

Figure 3.10 **The contribution of different sources and data reported by the plants in the 2015 emissions.**

3.3.6 Carbon monoxide emissions

Emission trend

Carbon monoxide emissions have been reduced by 55% since 1990. The carbon monoxide emission trend is presented in Figure 3.11. 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 is under work.

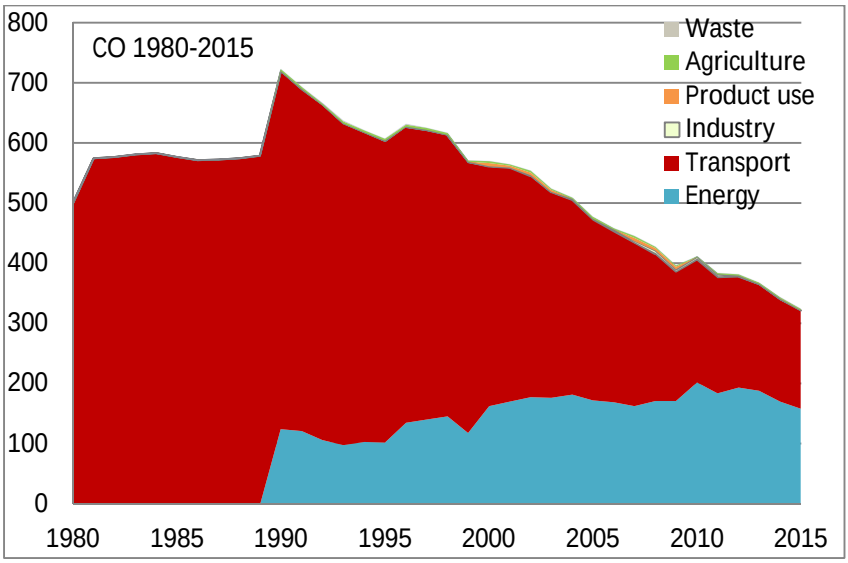
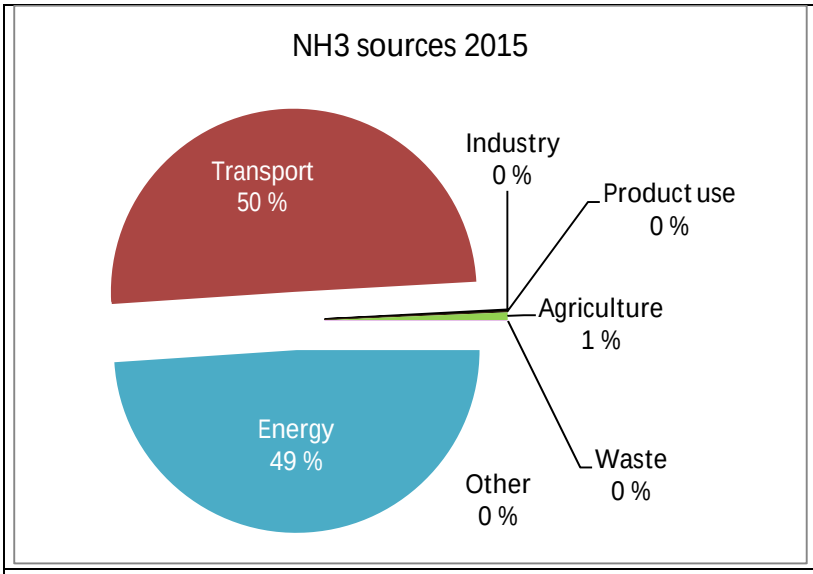
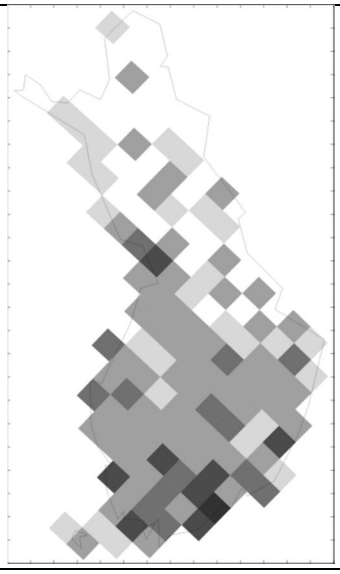


Figure 3.11. Emissions of carbon monoxide (Gg) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to carbon monoxide emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.12.





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	12.928	29.6	1A3ei	<0.1	0.001	0
1A1b	0.3	0.982	20.6	1A4ai	0.3	0.844	9.7
1A2a	0.3	0.922	0	1A4aii	11.1	36.166	0
1A2b	<0.1	0.065	0	1A4bi	32.6	105.858	0
1A2c	<0.1	0.301	3.7	1A4bii	8.2	26.491	0
1A2d	6.0	19.406	8.8	1A4ci	0.4	1.257	0
1A2e	<0.1	0.125	0.1	1A4cii	3.0	9.597	0
1A2f	1.8	5.985	32	1A4ciii	<0.1	0.292	0
1A2gvii	2.4	7.866	0	1A5a	<0.1	0.104	0
1A2gviii	3.1	10.06	1.5	1A5b	0.2	0.679	0
1A3ai(i)	0.2	0.682	0	2C1	0.2	0.513	100
1A3aii(i)	0.2	0.808	0	2C7a	<0.1	0.006	100
1A3bi	12.2	39.745	0	2G	<0.1	0.011	0
1A3bii	1.2	3.910	0	2I	<0.1	0.035	100
1A3biii	1.9	6.284	0	3F	0.7	2.265	0
1A3biv	3.2	10.374	0	5C1a	<0.1	0.007	100
1A3c	<0.1	0.198	0	5C1bi	<0.1	0.009	100
1A3dii	6.1	19.796	0	Total	100	324.572	2.6

Figure 3.12 The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.7 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 3.13.

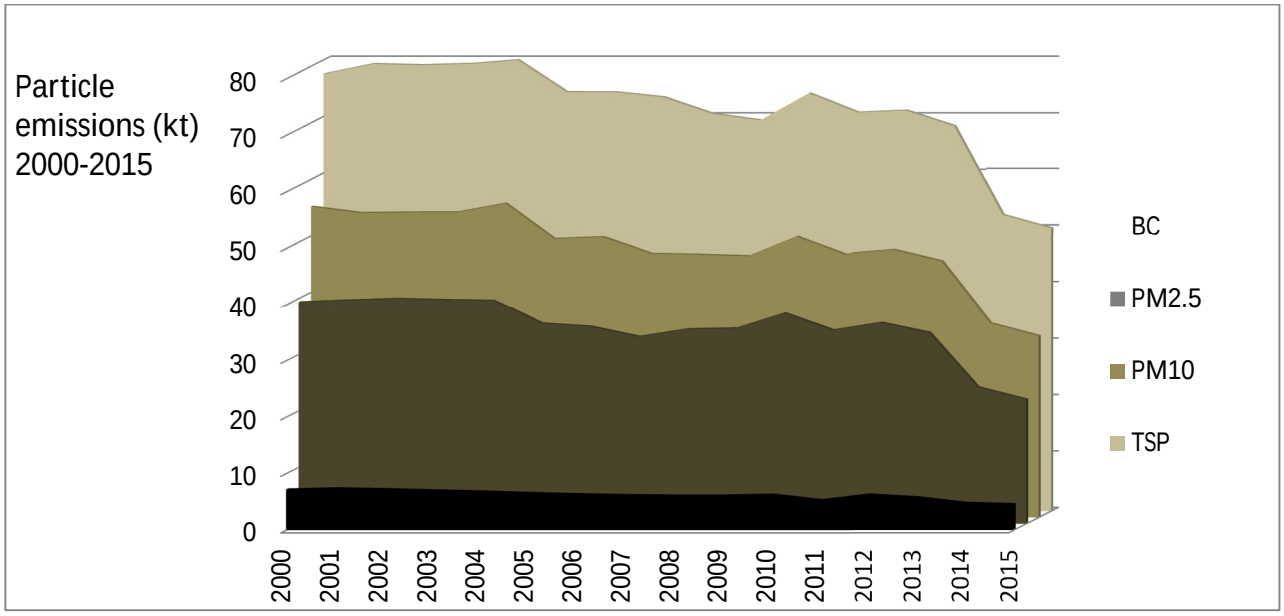


Figure 3.13 Particle emissions (TSP, PM10, PM2,5 and BC) in 2000-2015

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 that has been implemented since the 2016 inventory for 2014 emissions decreased particle emissions substantially. Detailed information on the model and methods are presented in Chapter x (NFR 1A4bi).

3.3.7.1 Particles TSP

Emission trend

The trend of TSP emissions is presented in Figure 3.14.

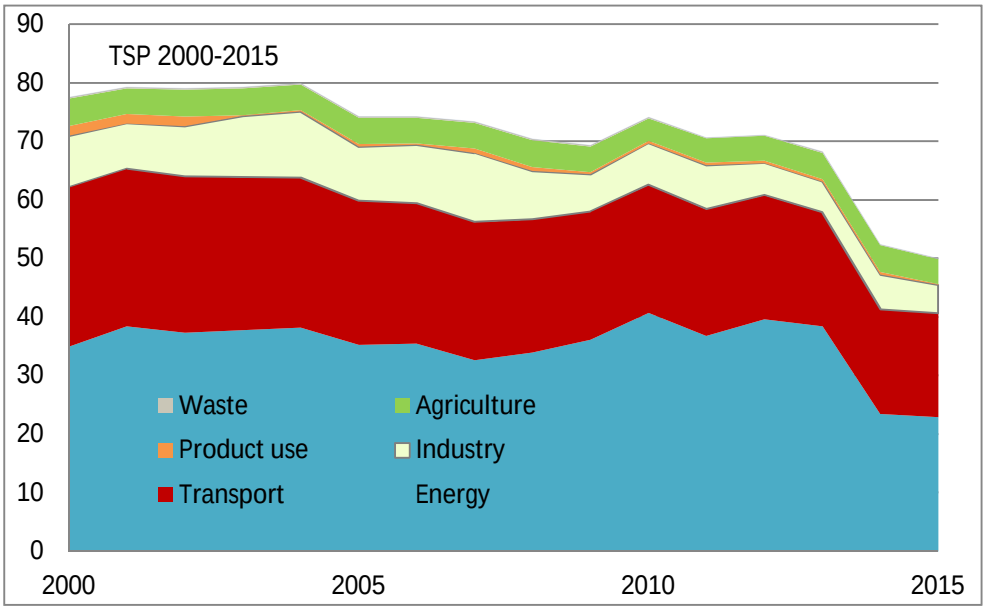
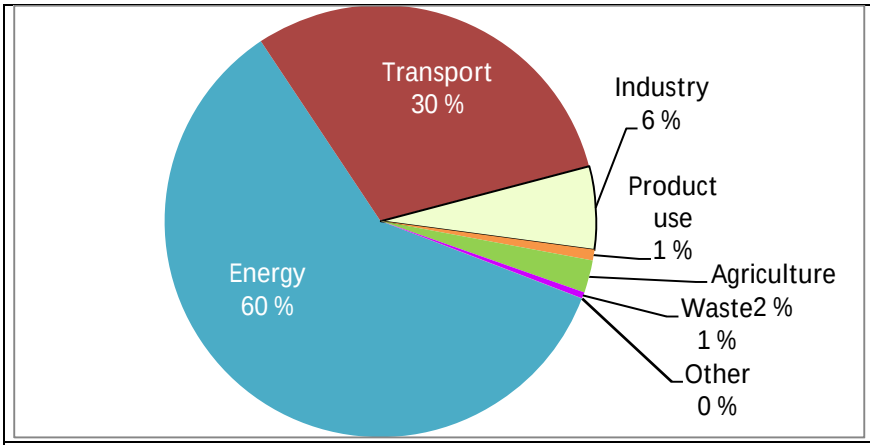


Figure 3.14. TSP emissions (kt) 2000-2015

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by 1st May 2017.

The contribution of different sources to total suspended particle emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.15.



Shares of total TSP emissions reported by the plants in 2015							
NFR	% of total	Total [Gg]	%reported by the plants	NFR	% of total	Total [Gg]	%reported by the plants
1A1a	3.5	1.753	100	2A5c	1.2	0.622	0
1A1b	1.0	0.508	100	2B10a	0.8	0.394	100
1A2a	0.2	0.101	100	2B10b	<0.1	0.033	0.4
1A2b	<0.1	0.024	100	2B6	<0.1	0.015	100
1A2c	0.2	0.107	100	2C1	0.4	0.209	100
1A2d	5.3	2.650	100	2C2	0.2	0.095	100
1A2e	<0.1	0.032	100	2C6	<0.1	0.009	100
1A2f	0.2	0.124	100	2C7a	<0.1	<0.001	100
1A2gvii	0.8	0.411	0	2C7c	<0.1	0.013	100
1A2gviii	9.5	4.731	1	2C7d	1.4	0.686	0
1A3ai(i)	<0.1	0.005	0	2D3b	0.2	0.085	0
1A3aii(i)	<0.1	0.001	0	2D3d	<0.1	0.007	100
1A3bi	0.6	0.325	0	2D3e	<0.1	<0.001	100
1A3bii	0.8	0.38	0	2D3g	<0.1	0.002	100
1A3biii	0.7	0.361	0	2D3i	0.2	0.089	100
1A3biv	0.1	0.060	0	2G	0.2	0.094	0
1A3bvi	3.1	1.529	0	2H1	0.9	0.469	100
1A3bvii	27.2	13.583	0	2H2	0.8	0.418	16.7
1A3c	<0.1	0.032	0	2I	0.3	0.129	100
1A3dii	0.7	0.329	0	2L	<0.1	0.016	100
1A4ai	0.5	0.267	2.5	3B1a	0.5	0.245	0
1A4aii	0.8	0.376	0	3B1b	0.3	0.160	0
1A4bi	21.0	10.511	0	3B3	1.3	0.629	0
1A4bii	<0.1	0.013	0	3B4e	<0.1	0.018	0
1A4ci	1.4	0.694	0	3B4gi	0.2	0.095	0
1A4cii	0.6	0.283	0	3B4gii	0.7	0.356	0
1A4ciii	<0.1	0.049	0	3B4giii	<0.1	0.008	0
1A5a	<0.1	0.019	42.5	3B4giv	0.4	0.195	0
1A5b	<0.1	0.017	0	3Da1	3.9	1.943	0
1B1c	2.8	1.425	0	3Dc	0.8	0.384	0
1B2av	<0.1	<0.001	100	3F	0.4	0.189	0
2A2	<0.1	0.003	100	5C1a	<0.1	<0.001	100

2A3	<0.1	0.008	100	5C1bi	<0.1	0.001	100
2A5a	0.2	0.088	15.8	5C1bv	<0.1	<0.001	0
2A5b	3.0	1.515	1.2	5E	0.2	0.102	0
				Total	100	50.024	13.8

Figure 3.15 The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.7.2 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 3.16.

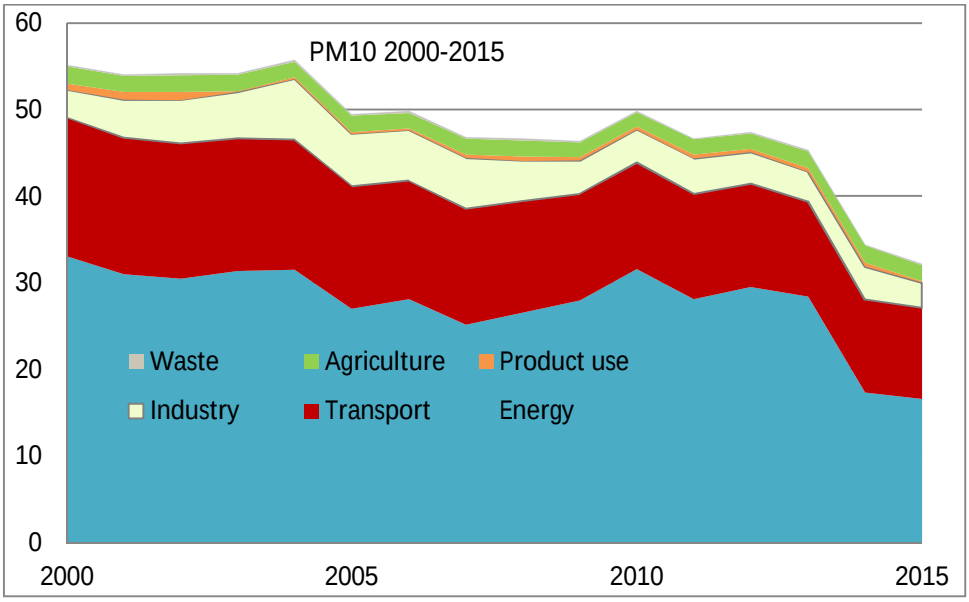
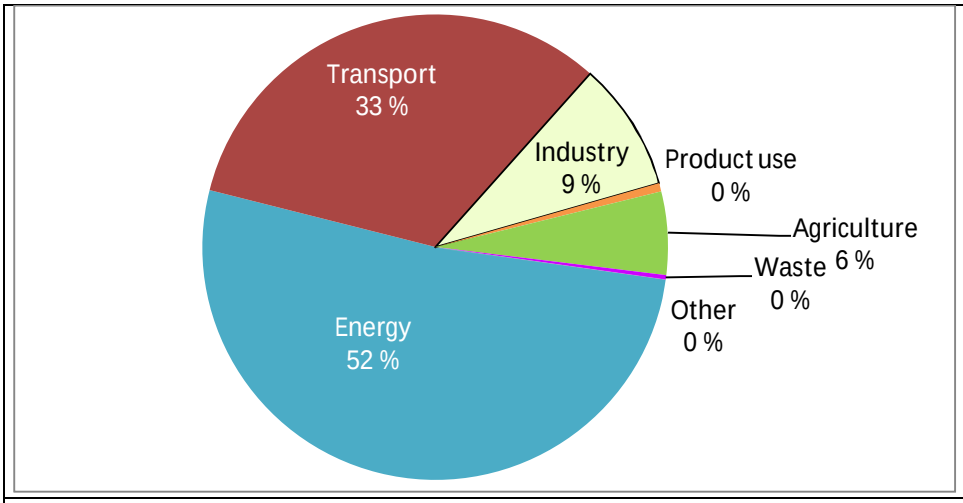


Figure 3.16. PM10 emissions (kt) in 2000-2015

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by 1st May 2017.

The contribution of different sources to PM10 emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.17



Shares of total PM10 emissions reported by the plants in 2015							
NFR	% of total	Total [Gg]	%reported by the plants	NFR	% of total	Total [Gg]	Percentage reported by the plants
1A1a	3.3	1.065	0	2A5c	0.8	0.242	0
1A1b	0.5	0.160	0	2B10a	1.0	0.324	0
1A2a	0.2	0.055	0	2B10b	<0.1	0.010	0
1A2b	<0.1	0.012	0	2B6	<0.1	0.008	0
1A2c	0.3	0.09	0	2C1	0.4	0.144	0
1A2d	6.7	2.151	0	2C2	0.3	0.087	0
1A2e	<0.1	0.019	0	2C6	<0.1	0.002	0
1A2f	0.2	0.057	0	2C7a	<0.1	<0.001	0
1A2gvii	1.2	0.396	0	2C7c	<0.1	0.008	0
1A2gviii	4.7	1.523	0	2C7d	1.0	0.322	0
1A3ai(i)	<0.1	0.005	0	2D3b	0.2	0.064	0
1A3aii(i)	<0.1	0.001	0	2D3d	<0.1	0.004	0
1A3bi	1.0	0.317	0	2D3e	<0.1	<0.001	0
1A3bii	1.2	0.371	0	2D3g	<0.1	0.001	0
1A3biii	1.1	0.352	0	2D3i	0.3	0.083	0
1A3biv	0.2	0.058	0	2G	0.3	0.094	0
1A3bvi	3.6	1.145	0	2H1	1.3	0.414	0
1A3bvii	21.1	6.789	0	2H2	1.3	0.407	0
1A3c	<0.1	0.031	0	2I	<0.1	0.026	0
1A3dii	1.0	0.326	0	2L	<0.1	0.009	0
1A4ai	0.6	0.190	0	3B1a	0.4	0.113	0
1A4aii	1.1	0.363	0	3B1b	0.2	0.074	0
1A4bi	31.3	10.072	0	3B3	1.0	0.309	0
1A4bii	<0.1	0.012	0	3B4e	<0.1	0.008	0
1A4ci	0.9	0.279	0	3B4gi	0.3	0.095	0
1A4cii	0.8	0.273	0	3B4gii	1.1	0.356	0
1A4ciii	0.1	0.048	0	3B4giii	<0.1	0.008	0
1A5a	<0.1	0.018	0	3B4giv	0.6	0.195	0

1A5b	<0.1	0.017	0	3Da1	1.3	0.411	0
1B1c	2.9	0.932	0	3Dc	0.3	0.097	0
1B2av	<0.1	<0.001	0	3F	0.6	0.186	0
2A2	<0.1	0.001	0	5C1a	<0.1	<0.001	0
2A3	<0.1	0.007	0	5C1bi	<0.1	<0.001	0
2A5a	0.1	0.043	0	5C1bv	<0.1	<0.001	0
2A5b	2.4	0.764	0	5E	0.3	0.102	0
				Total	100	32.147	0

Figure 3.17 The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.7.3 Particles PM2.5

Emission trend

The trend of PM2.5 emissions is presented in Figure 3.18.

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

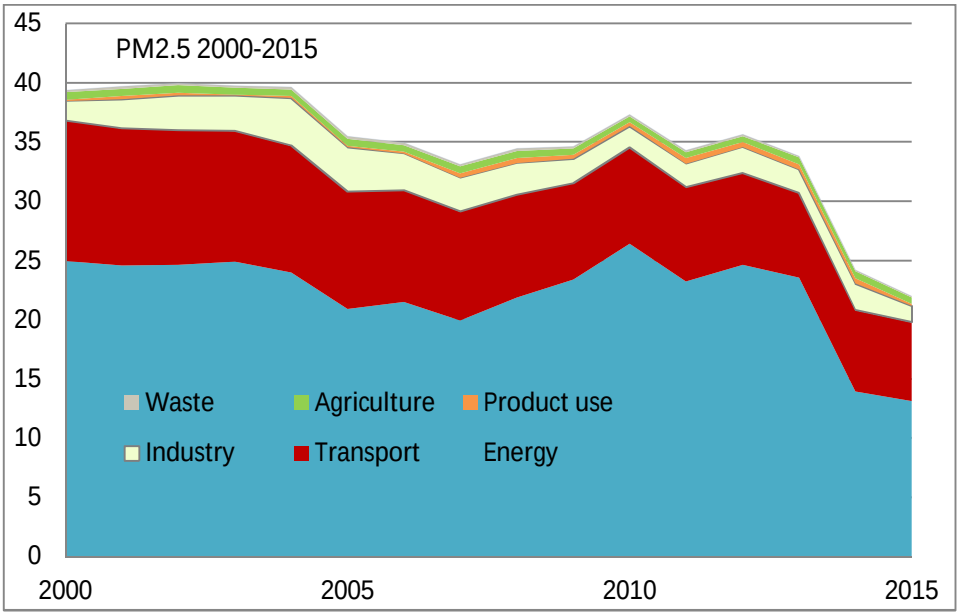
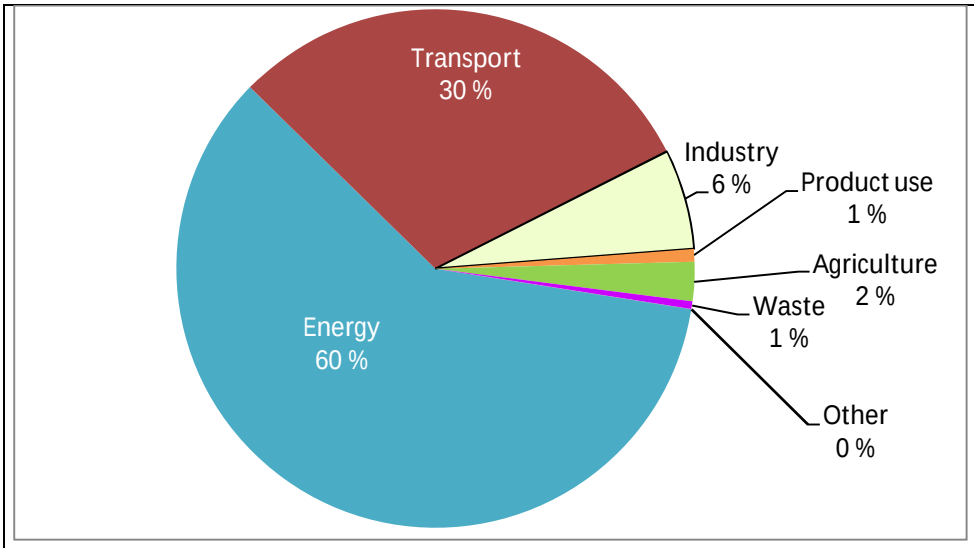


Figure 3.18. PM2.5 emissions in 2000-2015

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by 1st May 2017.

The contribution of different sources to PM2.5 emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.19.



Shares of total PM2.5 emissions reported by the plants in 2015							
NFR	% of total	Total [Gg]	Percentage reported by the plants	NFR	% of total	Total [Gg]	% reported by plants
1A1a	1.8	0.395	0	2A5c	0.1	0.025	0
1A1b	0.2	0.049	0	2B10a	0.9	0.203	0
1A2a	0.1	0.031	0	2B10b	<0.1	0.001	0
1A2b	<0.1	0.006	0	2B6	<0.1	0.002	0
1A2c	0.3	0.058	0	2C1	0.6	0.123	0
1A2d	6.5	1.436	0	2C2	0.4	0.078	0
1A2e	<0.1	0.011	0	2C6	<0.1	<0.001	0
1A2f	0.1	0.028	0	2C7a	<0.1	<0.001	0
1A2gvii	1.7	0.367	0	2C7c	<0.1	0.007	0
1A2gviii	2.2	0.476	0	2C7d	0.1	0.027	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	1.3	0.277	0	2D3e	<0.1	<0.001	0
1A3bii	1.5	0.325	0	2D3g	<0.1	<0.001	0
1A3biii	1.4	0.308	0	2D3i	0.3	0.076	0
1A3biv	0.2	0.051	0	2G	0.4	0.094	0
1A3bvi	2.8	0.626	0	2H1	1.6	0.355	0
1A3bvii	16.7	3.674	0	2H2	1.8	0.388	0
1A3c	0.1	0.027	0	2I	<0.1	0.001	0
1A3dii	1.5	0.319	0	2L	<0.1	0.004	0
1A4ai	0.6	0.122	0	3B1a	0.3	0.073	0
1A4aii	1.5	0.336	0	3B1b	0.2	0.049	0
1A4bi	44.2	9.726	0	3B3	0.2	0.050	0
1A4bii	<0.1	0.011	0	3B4e	<0.1	0.006	0
1A4ci	0.7	0.147	0	3B4gi	<0.1	0.015	0
1A4cii	1.1	0.252	0	3B4gii	0.2	0.047	0
1A4ciii	0.2	0.047	0	3B4giii	<0.1	<0.001	0
1A5a	<0.1	0.013	0	3B4giv	0.1	0.025	0

1A5b	<0.1	0.017	0	3Da1	0.4	0.083	0
1B1c	3.0	0.654	0	3Dc	<0.1	0.015	0
1B2av	<0.1	<0.001	0	3F	0.8	0.177	0
2A2	<0.1	<0.001	0	5C1a	<0.1	<0.001	0
2A3	<0.1	0.006	0	5C1bi	<0.1	<0.001	0
2A5a	<0.1	0.007	0	5C1bv	<0.1	<0.001	0
2A5b	0.4	0.086	0	5E	0.5	0.102	0
				Total	100	21.984	0

Figure 3.19 The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.7.4 Black carbon (BC)

Emission trend

The trend of black carbon emissions is presented in Figure 3.20.

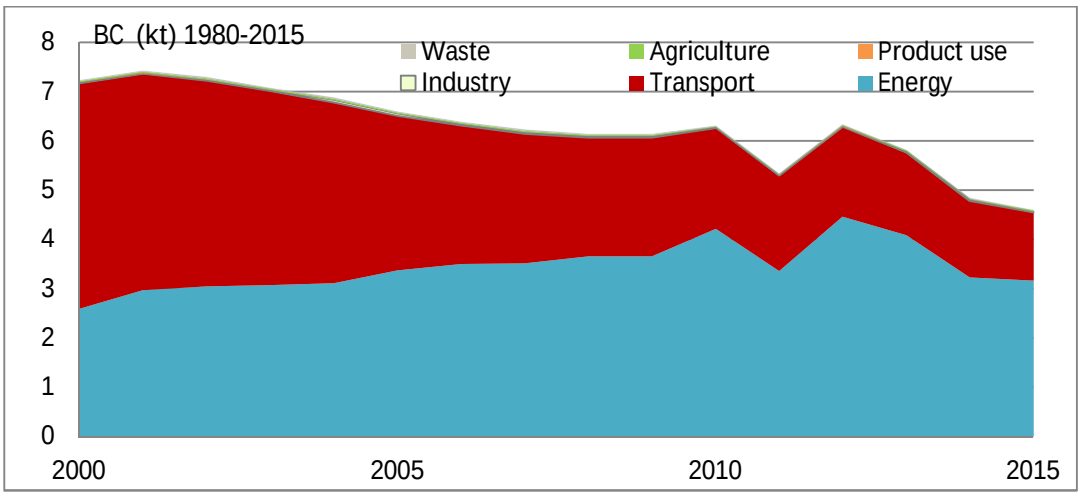
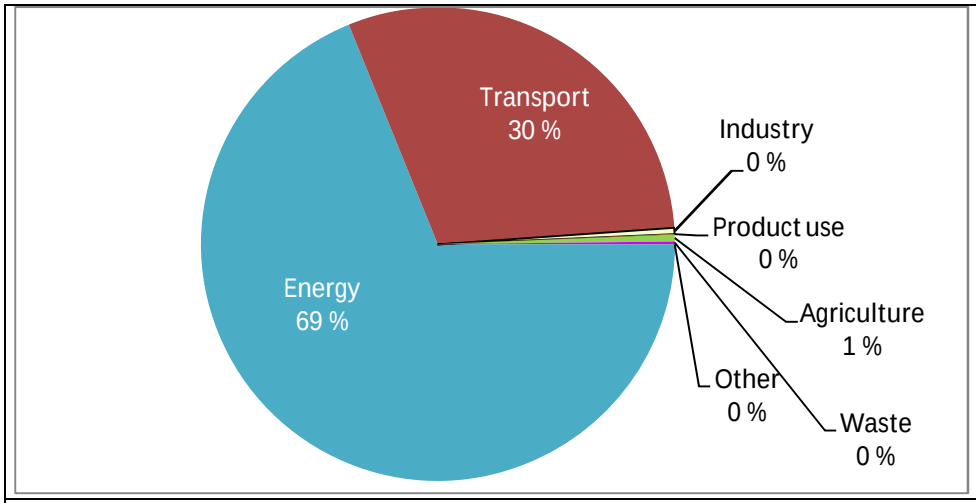
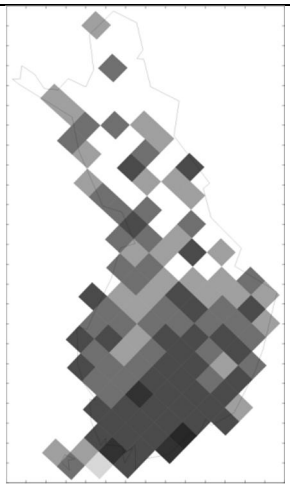


Figure 3.20. BC emissions (kt) in 2000-2015

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by 1st May 2017.

The contribution of different sources to black carbon emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.21.





Shares of total BC emissions reported by the plants in 2015							
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	0.028	0	1A4bii	<0.1	0.002	0
1A1b	0.2	0.009	0	1A4ci	0.2	0.010	0
1A2a	<0.1	0.002	0	1A4cii	3.1	0.142	0
1A2b	<0.1	0.002	0	1A4ciii	0.3	0.015	0
1A2c	0.3	0.015	0	1A5a	<0.1	0.004	0
1A2d	0.4	0.020	0	1A5b	0.2	0.008	0
1A2e	<0.1	0.003	0	2A2	<0.1	<0.001	0
1A2f	<0.1	0.003	0	2A3	<0.1	<0.001	0
1A2gvii	5.5	0.254	0	2B10a	<0.1	<0.001	0
1A2gviii	2.8	0.127	0	2C1	<0.1	<0.001	0
1A3bi	3.7	0.169	0	2C2	0.2	0.008	0
1A3bii	4.5	0.209	0	2C7a	<0.1	<0.001	0
1A3biii	4.2	0.191	0	2D3b	<0.1	0.003	0
1A3biv	0.2	0.010	0	2D3i	<0.1	<0.001	0
1A3bvi	2.7	0.123	0	2G	<0.1	<0.001	0
1A3bvii	2.4	0.113	0	2H1	0.2	0.008	0
1A3c	0.4	0.018	0	3F	0.5	0.022	0
1A3dii	1.1	0.050	0	5C1a	<0.1	<0.001	0
1A4ai	0.5	0.025	0	5C1bi	<0.1	<0.001	0
1A4aii	1.7	0.078	0	5C1bv	<0.1	<0.001	0
1A4bi	63.5	2.923	0	5E	0.2	0.009	0
				Total	100	4.602	0

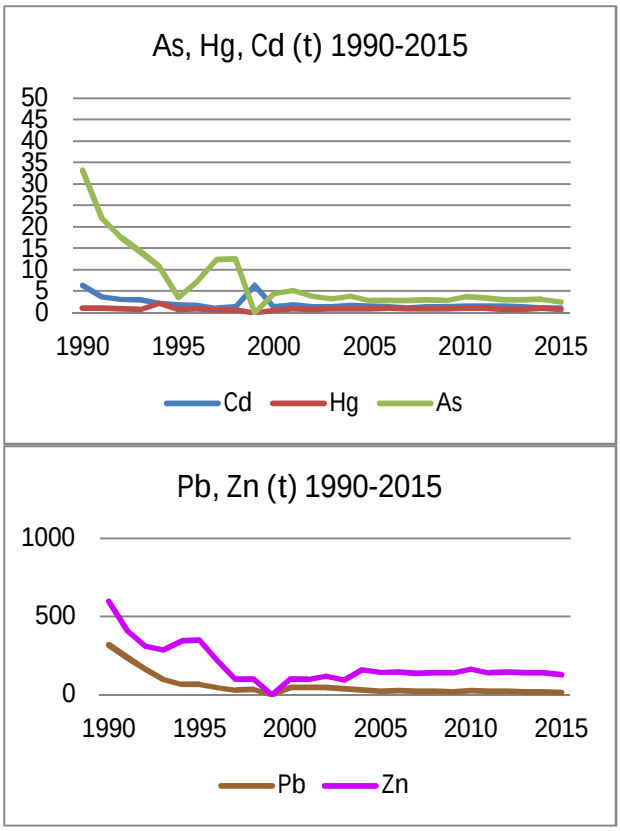
Figure 3.21 The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8 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 3.22.

Note 1: 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.

Note 2: 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.



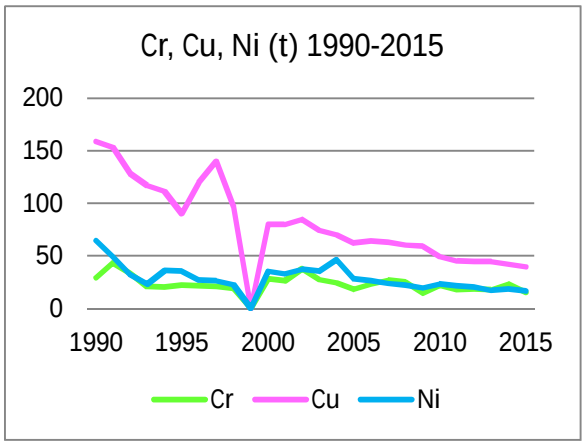


Figure 3.22. Heavy metal emissions 1990–2015

The emission trends have been strongly decreasing (Figure 3.22) 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.

3.3.8.1 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 the main source currently is combustion of wood in the residential sector (Figure 3.23).

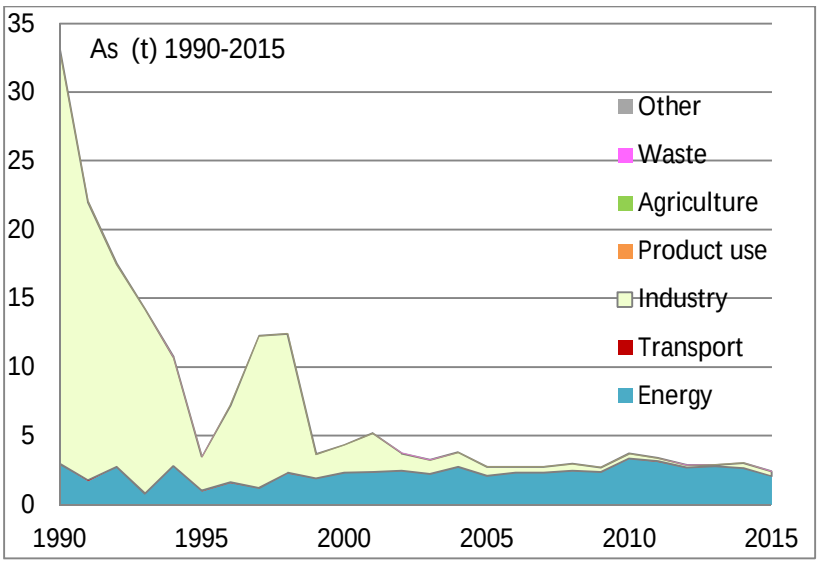
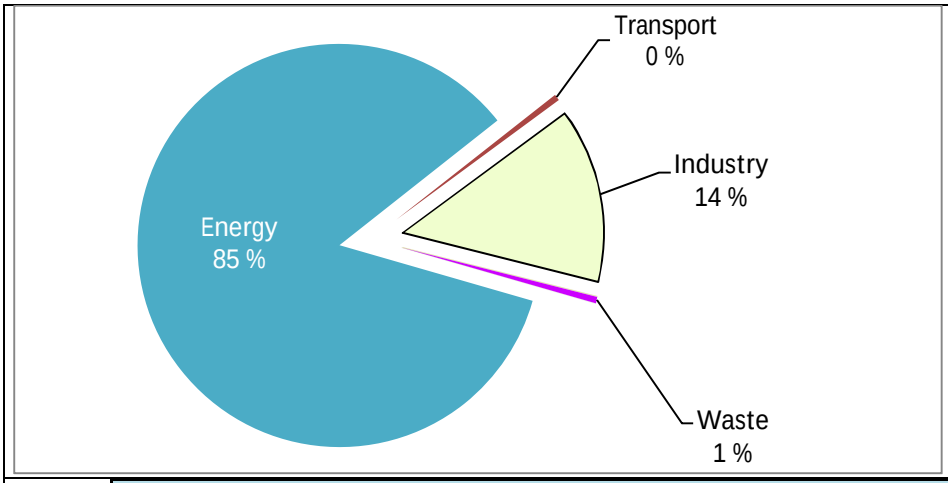
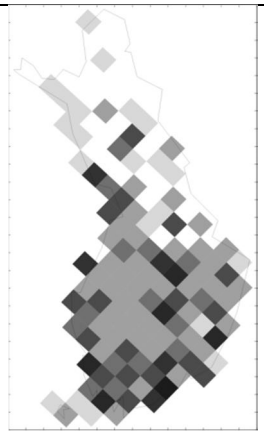


Figure 3.23. Arsenic emissions (t) in 1990-2014.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to arsenic emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.24.





Shares of total As emissions reported by the plants in 2015							
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	22.2	0.538	25.7	1A4ci	4.7	0.115	0
1A1b	20.7	0.503	0	1A4ciii	<0.1	0.001	0
1A2a	0.2	0.004	91.6	1A5a	<0.1	<0.001	0
1A2b	1.2	0.029	99.9	1B1b	0.4	0.009	100
1A2c	0.1	0.004	4.5	2A5a	0.2	0.006	100
1A2d	6.1	0.148	9.2	2A5b	0.4	0.010	100
1A2e	1.8	0.045	0	2C1	4.7	0.115	100
1A2f	10.2	0.247	0.9	2C2	<0.1	<0.001	100
1A2gviii	14.1	0.341	0.4	2C6	0.2	0.005	100
1A3bi	<0.1	<0.001	0	2C7a	2.1	0.050	100
1A3bii	<0.1	<0.001	0	2C7c	6.3	0.154	100
1A3biii	<0.1	<0.001	0	2G	<0.1	<0.001	0
1A3biv	<0.1	<0.001	0	3F	<0.1	<0.001	0
1A3bvi	<0.1	<0.001	0	5C1a	<0.1	<0.001	32.9
1A3dii	0.4	0.010	0	5C1bi	0.5	0.011	100
1A4ai	0.7	0.017	0.8	5C1bv	<0.1	<0.001	0
1A4bi	2.7	0.065	0	5E	<0.1	<0.001	0
				Total	100	2.430	22.6

Figure 3.24 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.2 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 3.25).

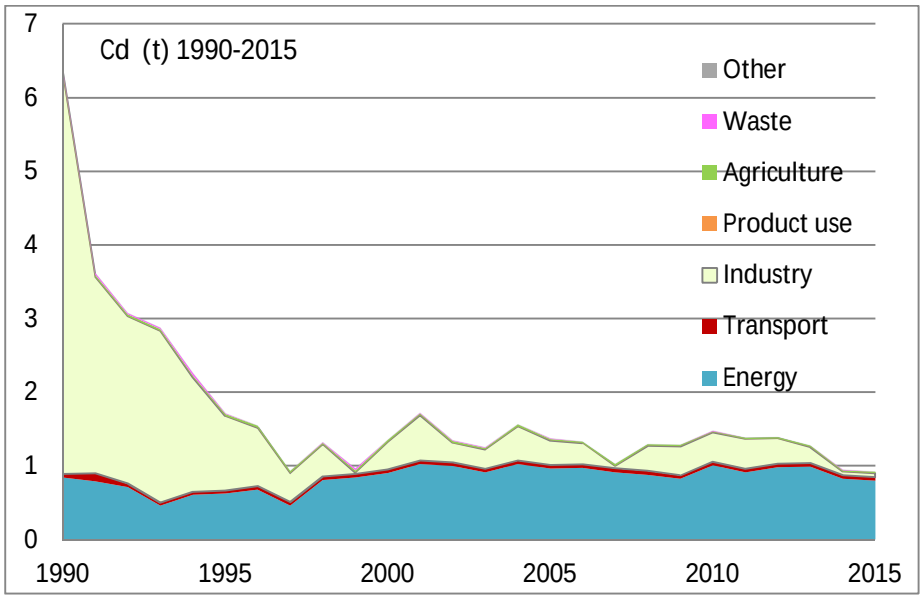
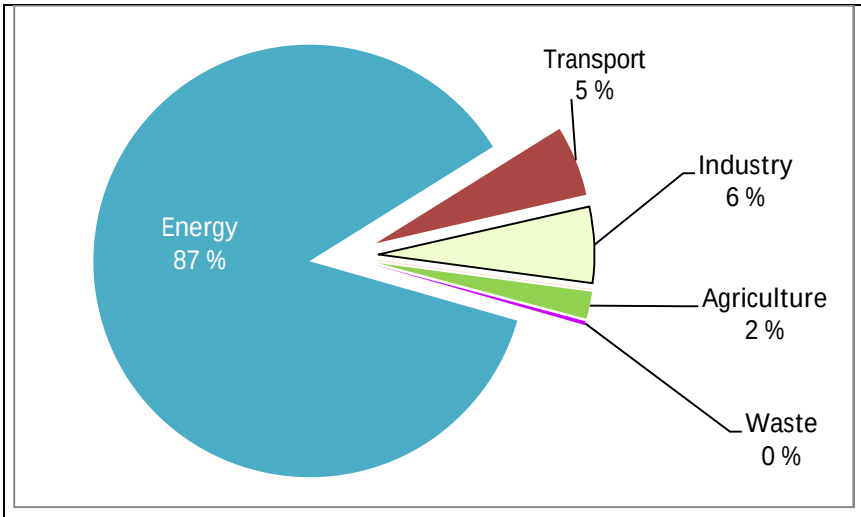


Figure 3.25. Emissions of cadmium (t) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to cadmium emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.26.



Shares of total Cd emissions reported by the plants in 2015							
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	12.2	0.113	37.5	1A4bii	<0.1	<0.001	0
1A1b	8.4	0.078	0	1A4ci	2.5	0.023	0
1A2a	0.2	0.002	93	1A4cii	0.3	0.003	0
1A2b	0.2	0.002	94.5	1A4ciii	<0.1	<0.001	0
1A2c	<0.1	<0.001	1.8	1A5a	<0.1	<0.001	0
1A2d	30.6	0.283	2	1B1b	<0.1	<0.001	100
1A2e	0.3	0.003	0	2A5a	0.1	0.001	100
1A2f	4.1	0.037	1.1	2A5b	0.4	0.004	100
1A2gvii	0.3	0.003	0	2C1	2.2	0.02	100
1A2gviii	10.7	0.099	0.1	2C2	0.3	0.003	100
1A3bi	2.3	0.021	0	2C6	2.6	0.024	100
1A3bii	0.3	0.003	0	2C7a	<0.1	<0.001	100
1A3biii	1.2	0.011	0	2C7c	<0.1	<0.001	100
1A3biv	<0.1	<0.001	0	2G	<0.1	<0.001	0
1A3bvi	0.4	0.004	0	3F	2.1	0.019	0
1A3c	<0.1	<0.001	0	5C1a	<0.1	<0.001	37.0
1A3dii	<0.1	<0.001	0	5C1bi	0.1	0.001	100
1A4ai	1.0	0.009	0.2	5C1bv	<0.1	<0.001	0
1A4aii	0.2	0.002	0	5E	<0.1	<0.001	0
1A4bi	16.3	0.151	0	Total	100	0.924	11.5

Figure 3.26 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.3 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 3.27).

The allocation of emissions between NFR categories will be checked when recalculating the time series: from 2000 onwards sources earlier reported under Industry NFRs have been reported under Energy NFRs. Emissions from industry fluctuate according to fluctuating production volumes.

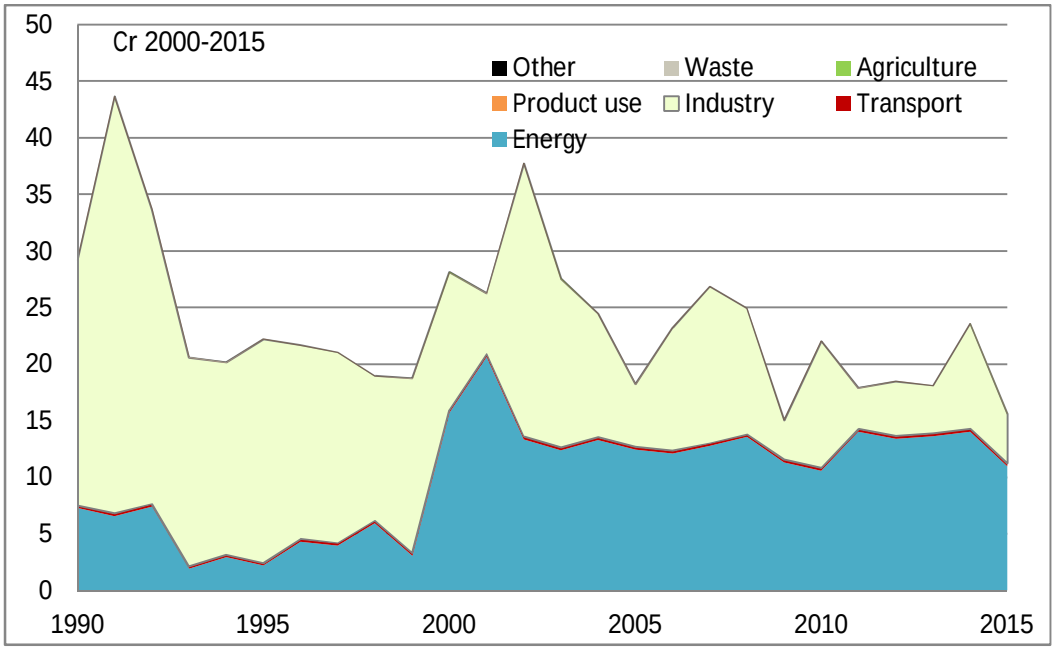
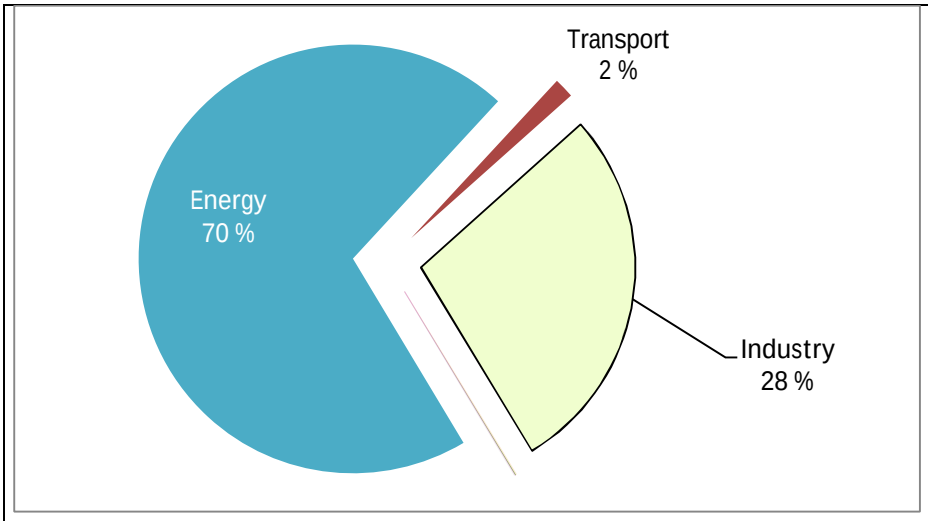
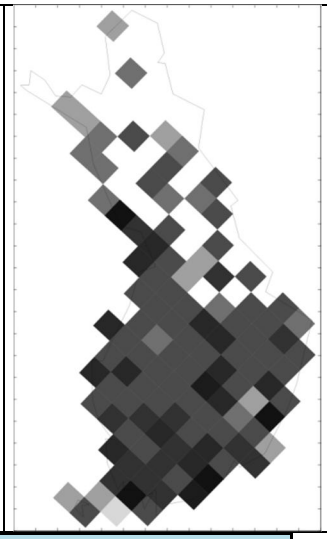


Figure 3.27. Emissions of chromium (t) in 1990-2014.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to chromium emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.28.





Shares of total Cr emissions reported by the plants in 2015							
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	7.6	1.189	23.6	1A4bi	11.4	1.785	0
1A1b	24.9	3.886	0	1A4bii	<0.1	0.001	0
1A2a	0.6	0.087	98.9	1A4ci	2.6	0.412	0
1A2b	1.4	0.219	0	1A4cii	<0.1	0.013	0
1A2c	<0.1	0.006	3.2	1A4ciii	<0.1	0.002	0
1A2d	1.6	0.249	30	1A5a	<0.1	0.001	0
1A2e	0.6	0.093	0	1B1b	<0.1	0.004	100
1A2f	11.6	1.813	0.3	2A2	<0.1	<0.001	100
1A2gvii	0.1	0.016	0	2A5a	<0.1	0.002	100
1A2gviii	7.4	1.152	0.1	2A5b	<0.1	0.003	100
1A3bi	0.3	0.045	0	2C1	25.3	3.953	100
1A3bii	<0.1	0.010	0	2C2	2.4	0.371	100
1A3biii	0.2	0.038	0	2C7c	0.3	0.041	100
1A3biv	<0.1	<0.001	0	2G	<0.1	<0.001	0
1A3bvi	0.6	0.088	0	3F	<0.1	0.003	0
1A3c	<0.1	0.001	0	5C1a	<0.1	0.002	37.4
1A3dii	<0.1	0.011	0	5C1bi	<0.1	0.004	100
1A4ai	0.8	0.119	0	5C1bv	<0.1	<0.001	0
1A4aii	<0.1	0.008	0	5E	<0.1	<0.001	0
				Total	100	15.630	30.9

Figure 3.28 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.4 Copper emissions

Emission trend

Copper emissions have been reduced by 63% since the base year 1990 (Figure 3.29)

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.

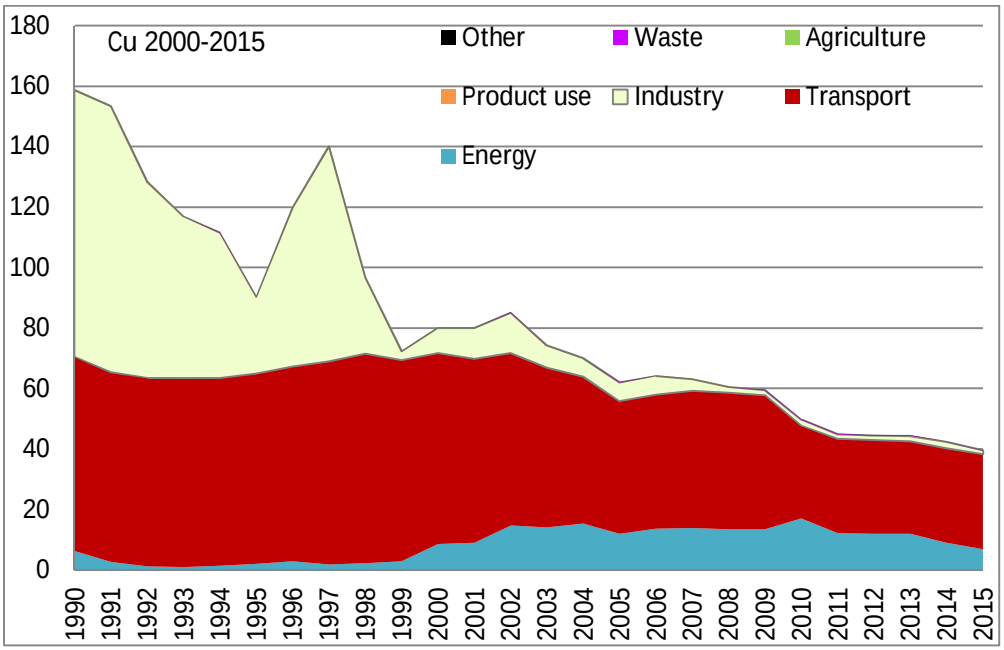
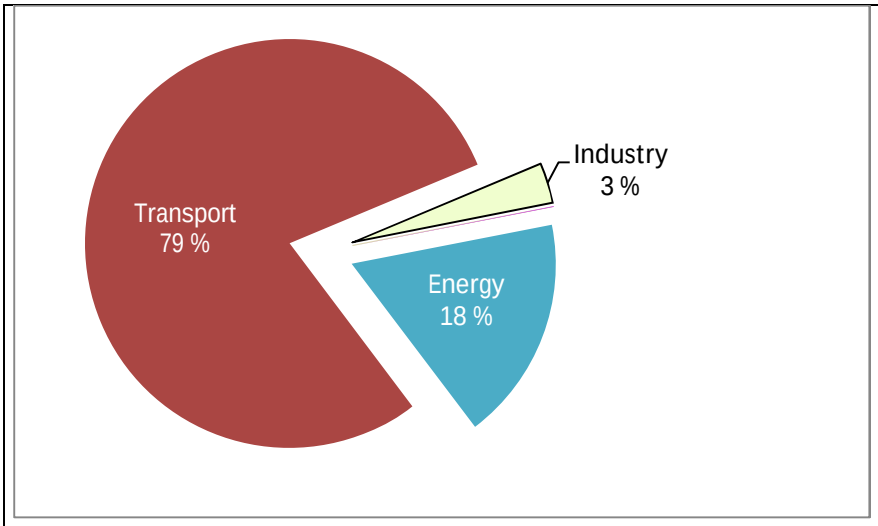
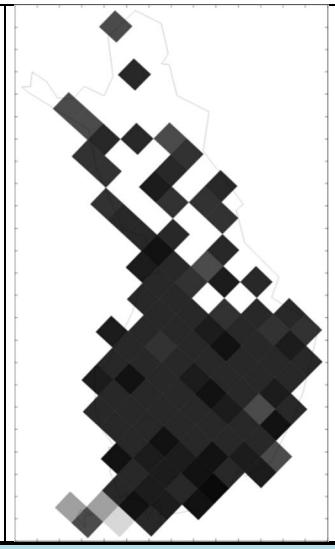


Figure 3.28. Emissions of copper (t) 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to copper emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.29.





Shares of total Cu emissions reported by the plants in 2015							
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	4.5	1.791	29.9	1A4ci	0.8	0.332	0
1A1b	3.6	1.427	0	1A4cii	1.1	0.437	0
1A2a	<0.1	0.004	70.8	1A4ciii	<0.1	0.029	0
1A2b	0.2	0.078	98.6	1A5a	<0.1	0.011	0
1A2c	<0.1	0.006	4.5	1B1b	<0.1	0.009	100
1A2d	1.0	0.391	35.3	2A2	<0.1	0.003	100
1A2e	0.3	0.128	0	2A5a	<0.1	0.039	100
1A2f	1.8	0.708	2.6	2A5b	<0.1	0.021	100
1A2gvii	1.4	0.547	0	2B10a	<0.1	0.006	100
1A2gviii	4.4	1.742	0.1	2C1	2.0	0.788	100
1A3bi	0.2	0.073	0	2C2	0.2	0.070	100
1A3bii	<0.1	0.007	0	2C6	0.2	0.066	100
1A3biii	<0.1	0.027	0	2C7a	<0.1	0.002	100
1A3biv	<0.1	0.002	0	2C7c	0.7	0.269	100
1A3bvi	75.1	29.709	0	2G	<0.1	<0.001	0
1A3c	<0.1	0.037	0	3F	<0.1	0.001	0
1A3dii	0.2	0.069	0	5C1a	<0.1	0.006	37.5
1A4ai	0.1	0.053	0.2	5C1bi	<0.1	0.011	100
1A4aii	0.7	0.279	0	5C1bv	<0.1	<0.001	0
1A4bi	0.9	0.339	0	5E	<0.1	<0.001	0
1A4bii	0.1	0.048	0	Total	100	39.568	5.2

Figure 3.29 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.5 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 3.30. The allocation of emissions between industry and energy sectors will be checked when the time series is recalculated. This will also correct the difference in emission levels between the 1990's and after 2000.

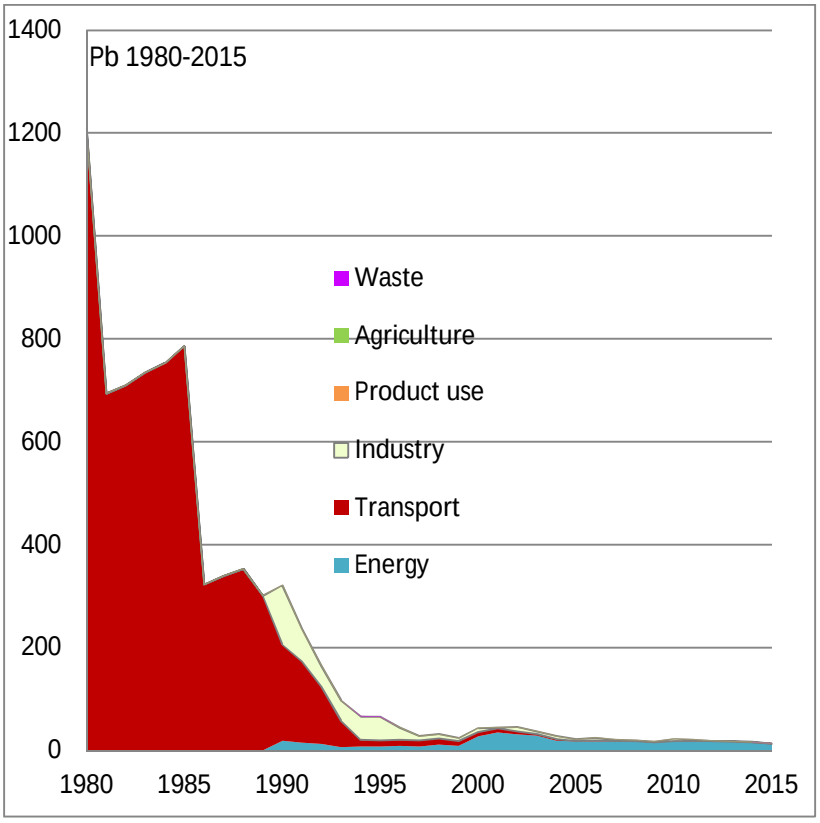
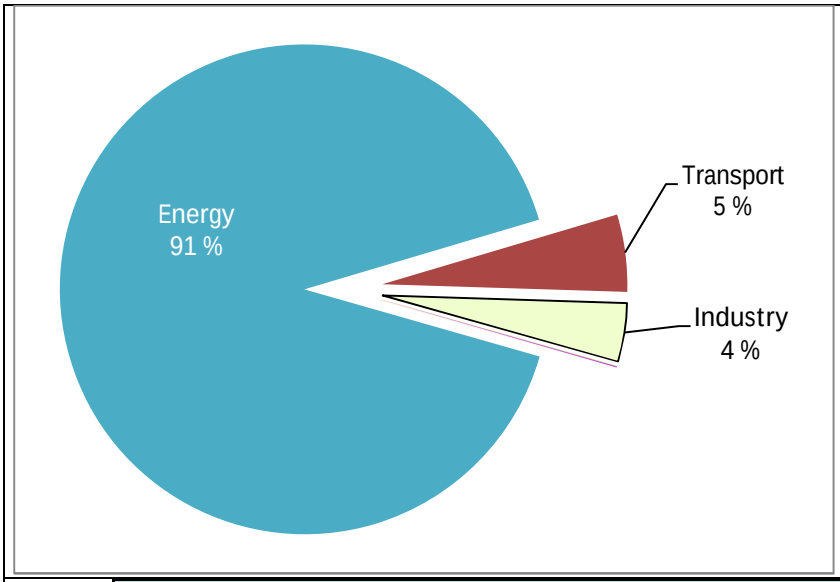
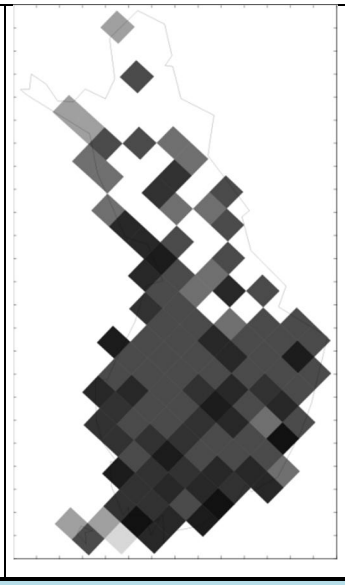


Figure 3.30. Pb emissions (Mg) in 1980-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to lead emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.31.





Shares of total Pb emissions reported by the plants in 2015							
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	10.8	1.501	30.2	1A4ci	2.1	0.299	0
1A1b	22.5	3.135	0	1A4ciii	<0.1	0.004	0
1A2a	0.2	0.030	94.6	1A5a	<0.1	0.002	0
1A2b	1.3	0.181	99.6	1B1b	0.2	0.023	100
1A2c	0.3	0.040	1.2	2A2	<0.1	<0.001	100
1A2d	25.8	3.592	2.3	2A5a	<0.1	0.001	100
1A2e	0.8	0.114	0	2A5b	<0.1	0.007	100
1A2f	11.0	1.531	1.1	2C1	1.8	0.245	100
1A2gviii	11.4	1.584	0.1	2C2	<0.1	0.013	100
1A3bi	0.6	0.086	0	2C7a	<0.1	<0.001	100
1A3bii	0.1	0.018	0	2C7c	1.9	0.269	100
1A3biii	0.5	0.066	0	2G	<0.1	<0.001	0
1A3biv	<0.1	0.002	0	3F	<0.1	0.002	0
1A3bvi	3.8	0.529	0	5C1a	<0.1	0.003	37.6
1A3dii	<0.1	0.010	0	5C1bi	<0.1	0.004	100
1A4ai	0.6	0.090	1.6	5C1bv	<0.1	<0.001	0
1A4bi	3.9	0.544	0.1	5E	<0.1	<0.001	0
				Total	100	13.925	9.6

Figure 3.31 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.6 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 3.32).

The fluctuating allocation of sources between the different years will be corrected during the future recalculation of emissions and the exceptional emission in the industry in 1994 will be rechecked.

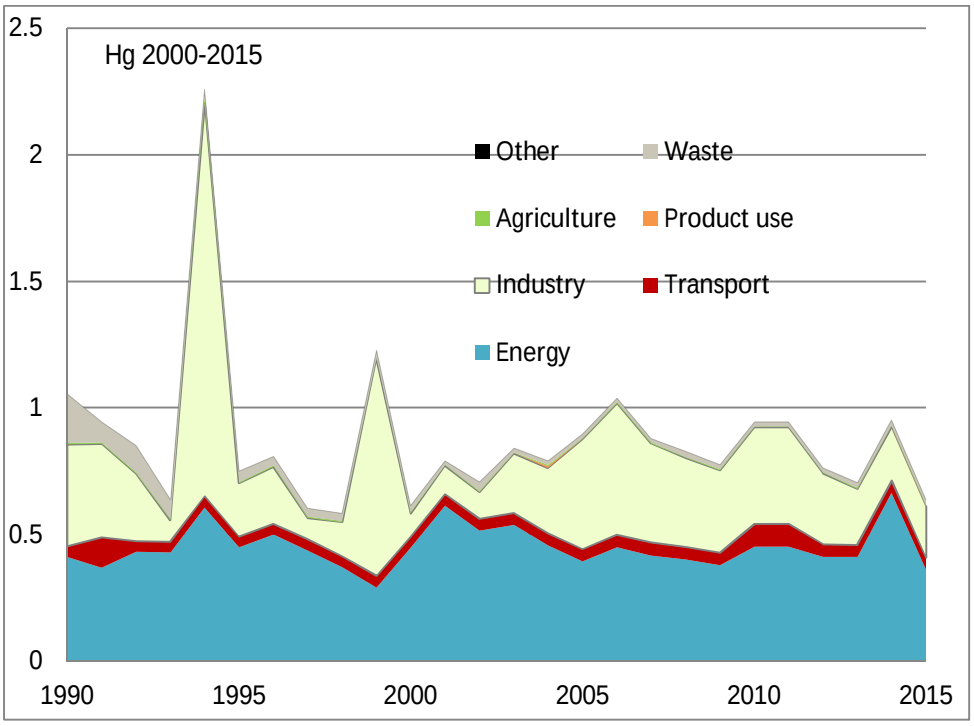
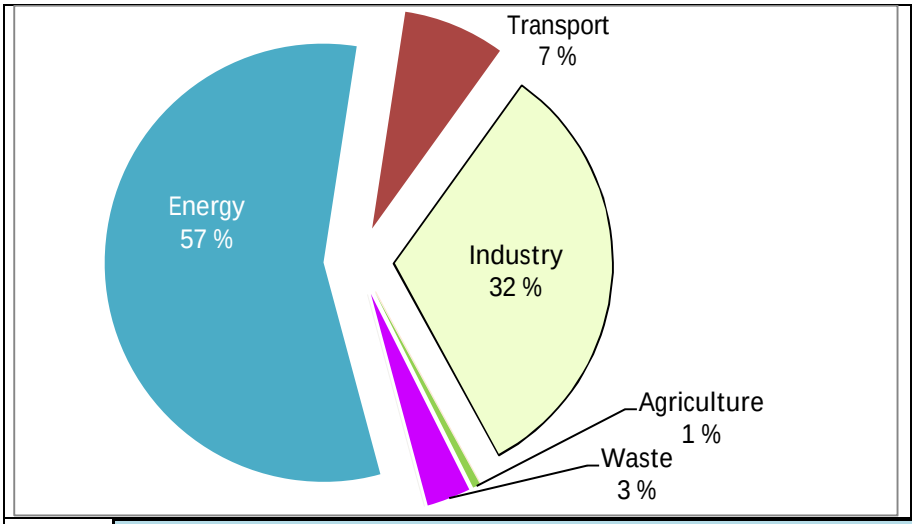


Figure 3.30. The emissions of mercury (t) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to carbon monoxide emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.31.



Shares of total Hg emissions reported by the plants in 2015							
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	26.0	0.166	71.4	1A4ci	1.1	0.007	0
1A1b	2.4	0.015	0	1A4ciii	0.2	<0.001	0
1A2a	<0.1	<0.001	87.6	1A5a	<0.1	<0.001	0
1A2b	0.1	<0.001	98.7	2A1	2.0	0.012	100
1A2c	<0.1	<0.001	65.4	2A5b	0.1	<0.001	100
1A2d	17.6	0.112	21.2	2B10a	10.8	0.069	100
1A2e	0.3	0.002	0	2C1	19.0	0.121	100
1A2f	1.5	0.010	24.6	2C2	<0.1	<0.001	100
1A2gviii	3.2	0.021	2.1	2C6	0.1	<0.001	100
1A3bi	2.5	0.016	0	2C7c	<0.1	<0.001	100
1A3bii	0.3	0.002	0	2G	<0.1	<0.001	0
1A3biii	1.1	0.007	0	3F	0.6	0.004	0
1A3biv	<0.1	<0.001	0	5C1a	0.2	0.001	100
1A3bvi	3.1	0.020	0	5C1bi	0.6	0.004	100
1A3dii	0.3	0.002	0	5C1bv	2.4	0.015	0
1A4ai	0.3	0.002	0	5E	<0.1	<0.001	0
1A4bi	4.0	0.025	0	Total	100	0.637	55.8

Figure 3.31 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.7 Nickel emissions

Emission trend

The emission trend is decreasing (Figure 3.32) 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.

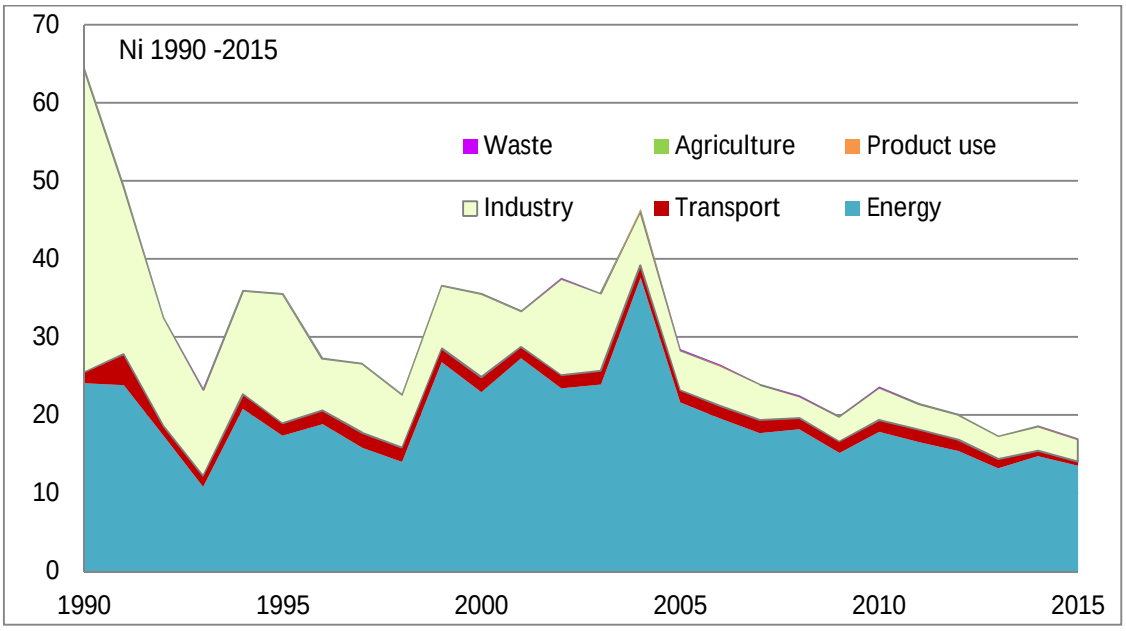
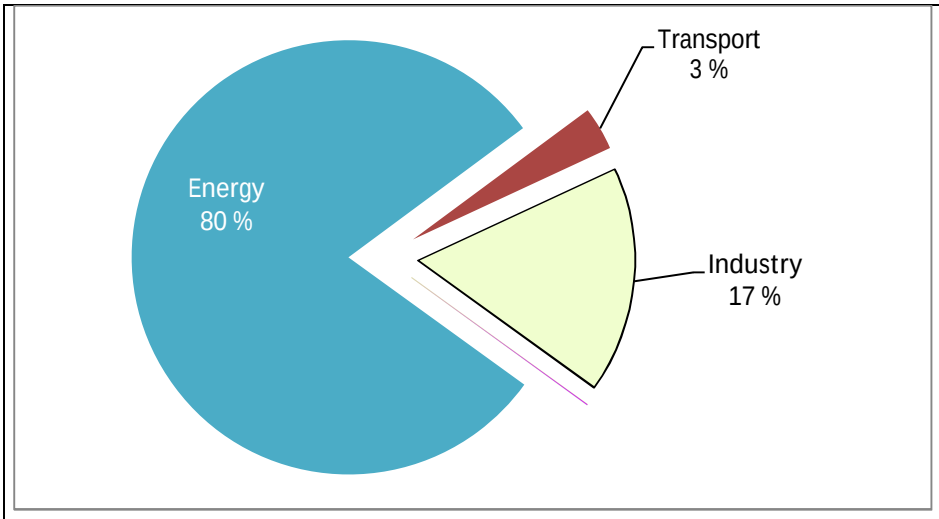
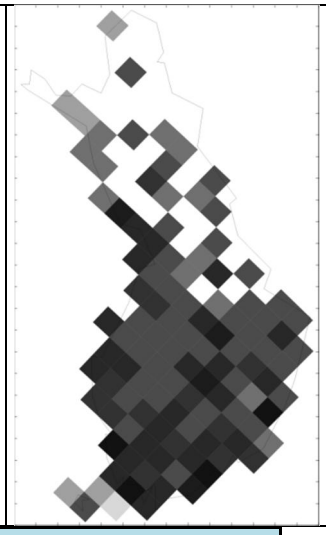


Figure 3.32. Nickel emissions (t) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to nickel emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.33.





Shares of total Ni emissions reported by the plants in 2015							
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	12.3	2.084	36.1	1A4bii	<0.1	0.002	0
1A1b	18.6	3.144	79.1	1A4ci	2.8	0.473	0
1A2a	0.6	0.097	94.4	1A4cii	0.1	0.018	0
1A2b	0.5	0.081	70.4	1A4ciii	0.2	0.033	0
1A2c	2.3	0.398	7.2	1A5a	<0.1	0.010	0
1A2d	2.9	0.495	46.2	1B1b	<0.1	0.004	100
1A2e	1.0	0.177	0.2	2A1	<0.1	0.006	100
1A2f	8.9	1.507	0.5	2A2	<0.1	<0.001	100
1A2gvii	0.1	0.023	0	2A5a	<0.1	0.002	100
1A2gviii	16.9	2.866	0.2	2A5b	<0.1	0.004	100
1A3bi	0.1	0.024	0	2B10a	0.2	0.038	100
1A3bii	<0.1	0.003	0	2C1	6.1	1.029	100
1A3biii	<0.1	0.011	0	2C2	0.5	0.089	100
1A3biv	<0.1	<0.001	0	2C7a	<0.1	<0.001	100
1A3bvi	<0.1	0.003	0	2C7b	10.0	1.692	100
1A3c	<0.1	0.002	0	2C7c	<0.1	<0.001	100
1A3dii	2.5	0.417	0	3F	<0.1	0.001	0
1A4ai	3.2	0.542	3.9	5C1a	<0.1	0.001	37.7
1A4aii	<0.1	0.011	0	5C1bi	<0.1	0.005	100
1A4bi	9.6	1.630	0.5	5C1bv	<0.1	<0.001	0
				Total	100	16.924	38.8

Figure 3.33 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.8.8 Zinc emissions

Emission trend

The emissions have been significantly reduced since the base year 1990 (Figure 3.34). 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.

The allocation of emissions between energy and industry sectors will be made consistant when the recalculation of energy sector emissions has been finalized. Also, it is not possible to indicate the current reduction level from the base year emissions due to the pending recalculation of the time series.

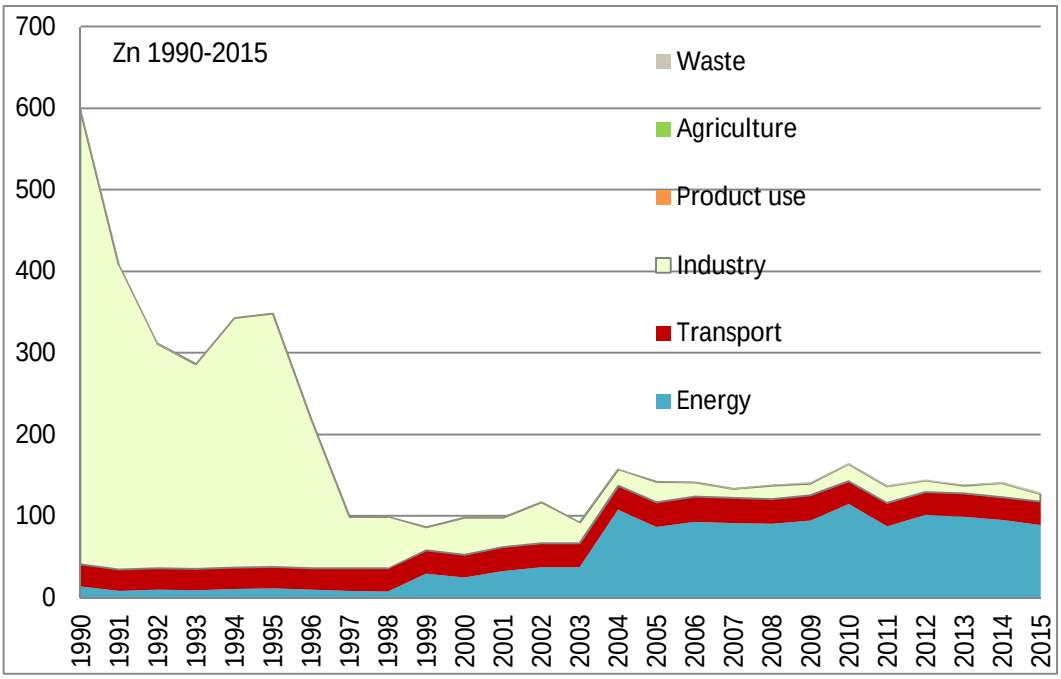
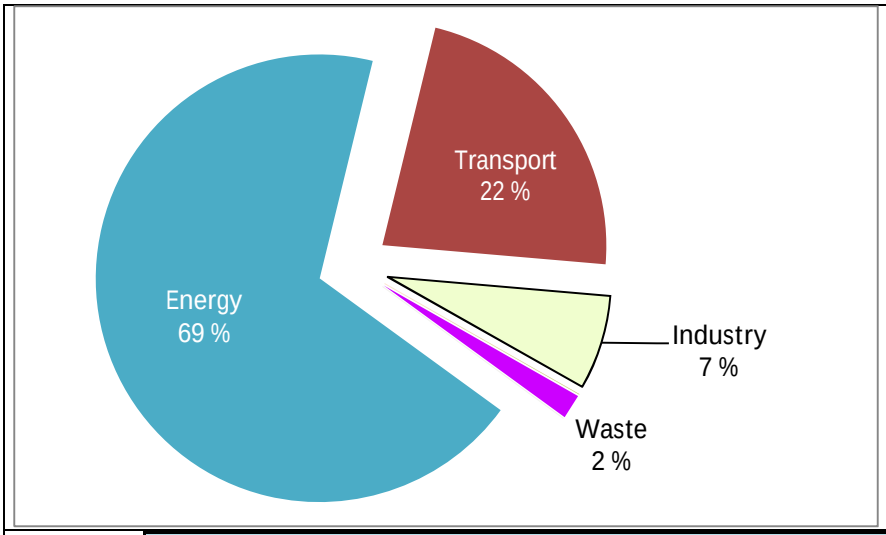
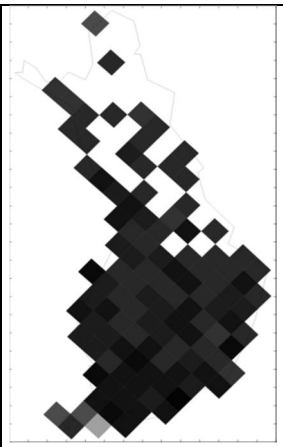


Figure 3.34. Emissions of zinc (t) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to zinc emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.35





Shares of total Zn emissions reported by the plants in 2015							
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	14.4	18.556	13.4	1A4bi	27.2	35.099	0
1A1b	5.4	6.919	0	1A4bii	<0.1	0.028	0
1A2a	<0.1	0.032	52.9	1A4ci	3.8	4.958	0
1A2b	<0.1	0.114	88.8	1A4cii	0.2	0.257	0
1A2c	<0.1	0.033	5.1	1A4ciii	<0.1	0.040	0
1A2d	2.9	3.788	14.4	1A5a	<0.1	0.020	0
1A2e	0.2	0.305	0	1B1b	<0.1	0.047	100
1A2f	2.7	3.432	0	2A2	<0.1	0.005	100
1A2gvii	0.2	0.322	0	2A5a	<0.1	0.033	100
1A2gviii	10.4	13.464	0	2C1	2.2	2.802	100
1A3bi	3.3	4.266	0	2C2	0.5	0.655	100
1A3bii	0.5	0.604	0	2C6	3.9	4.995	100
1A3biii	1.7	2.202	0	2C7a	<0.1	0.004	100
1A3biv	<0.1	0.109	0	2C7c	0.3	0.335	100
1A3bvi	16.3	21.021	0	2H2	<0.1	<0.001	100
1A3c	<0.1	0.022	0	3F	<0.1	0.016	0
1A3dii	<0.1	0.089	0	5C1a	<0.1	0.020	37.5
1A4ai	1.6	2.032	0	5C1bi	1.8	2.275	0
1A4aii	0.1	0.164	0	5C1bv	<0.1	0.004	0
				Total	100	129.066	9.3

Figure 3.35 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.9 Persistent organic pollutants

The time series 1990-2015 of PCDD/F, PAH-4, HCB and PCBs are presented in Figure 3.36.

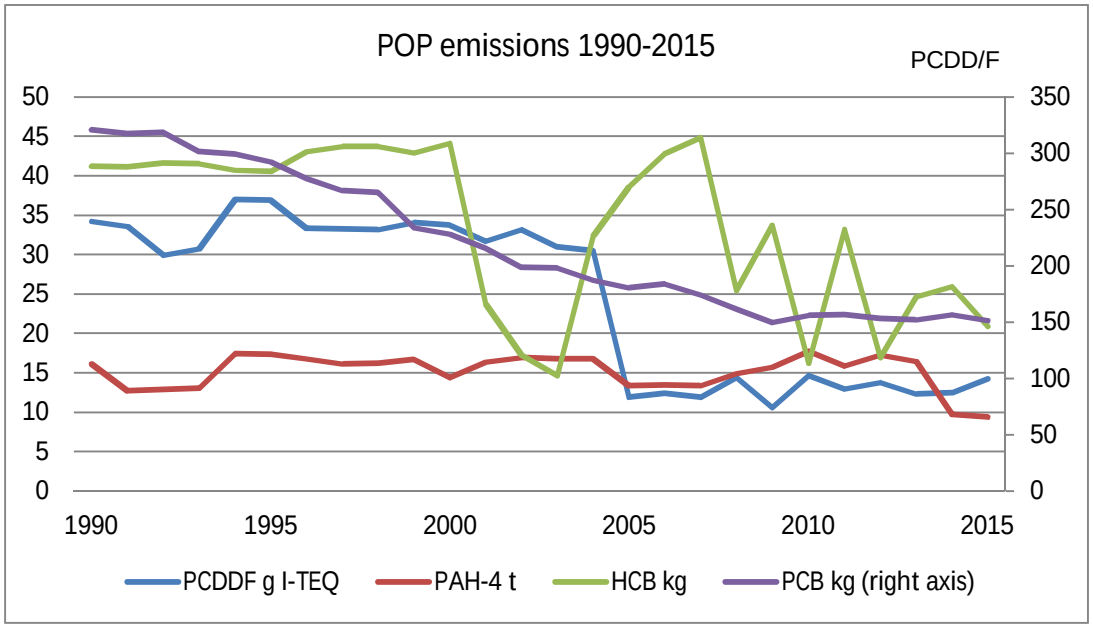


Figure 3.36 POP emissions (PCDD/F, PAH-4, HCB and PCB) emissions 1990–2015.

3.3.9.1 Polychlorinated dioxins and furanes, PCDD/F

Emission trend

The time series since 1990 is inconsistent (Figure 3.37) 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 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to PCDD/F emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.38.

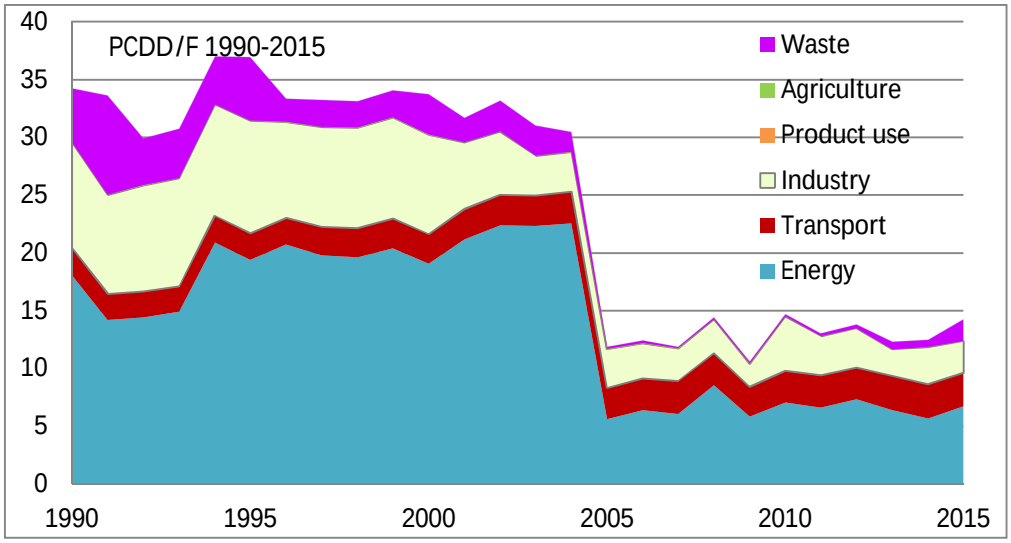
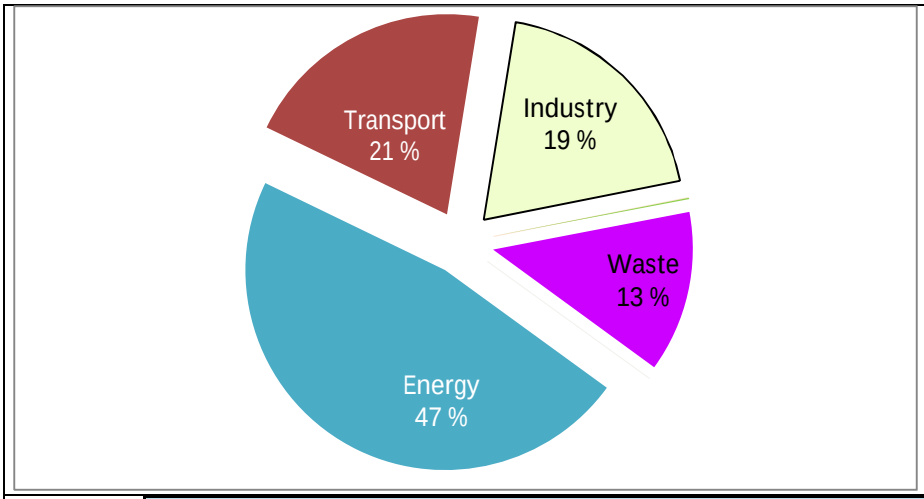


Figure 3.37. Emissions of PCDD/F (g I-Teq) in 1990-2015.



Shares of total PCDD/F emissions reported by the plants in 2015							
NFR	Percentage of national total	Total release [Gg]	% reported by the plants	NFR	Percentage of national total	Total release [Gg]	% reported by the plants
1A1a	26.2	3.734	14.6	1A5a	<0.1	0.004	0
1A1b	0.7	0.100	0	1B1b	1.4	0.201	0
1A2a	0.1	0.015	21.3	2A1	<0.1	0.010	0
1A2b	<0.1	0.002	0	2A2	0.9	0.129	0
1A2c	<0.1	0.008	2.3	2A3	<0.1	<0.001	0
1A2d	5.8	0.828	19.1	2B10a	1.1	0.150	100
1A2e	0.1	0.017	0	2C1	3.8	0.537	100
1A2f	0.5	0.065	46.1	2C6	0.2	0.030	0
1A2gviii	3.3	0.471	0	2C7a	8.1	1.157	0
1A3bi	1.1	0.160	0	2D3b	<0.1	0.011	0
1A3bii	4.1	0.585	0	2G	<0.1	<0.001	0
1A3biii	15	2.142	0	2H1	5.1	0.722	100
1A3biv	<0.1	0.004	0	2L	<0.1	0.009	0
1A3dii	<0.1	0.013	0	3F	0.1	0.015	0
1A3ei	<0.1	<0.001	0	5C1a	2.3	0.334	12.0
1A4ai	0.5	0.071	0	5C1bi	2.6	0.366	2.7
1A4bi	7.3	1.041	0	5C1bv	0.5	0.077	0
1A4ci	1.1	0.161	0	5E	7.6	1.078	0
1A4ciii	<0.1	0.004	0	Total	100	14.249	15.4

Figure 3.38(a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.9.2 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 decreasing, however there are uncertainties included in the time series which is not fully consistent due to the pending recalculations. PAH-4 emissions time-series is presented in Figure 3.39.

Energy production is the major source of PAH emissions. The allocation of emissions between the energy and industrial process emissions varies between the years, because the time series has not yet been recalculated. Therefore it is not possible to indicate the current reduction level from the base year emissions.

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 2013, however, only for 2014. However, due to the pending recalculation in the energy sector, the time series is not consistent.

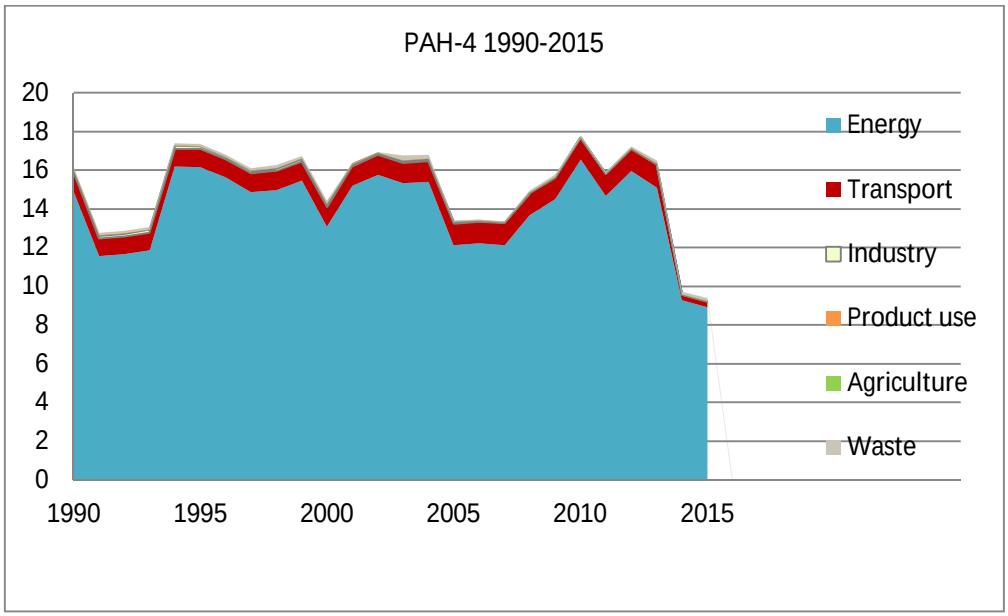
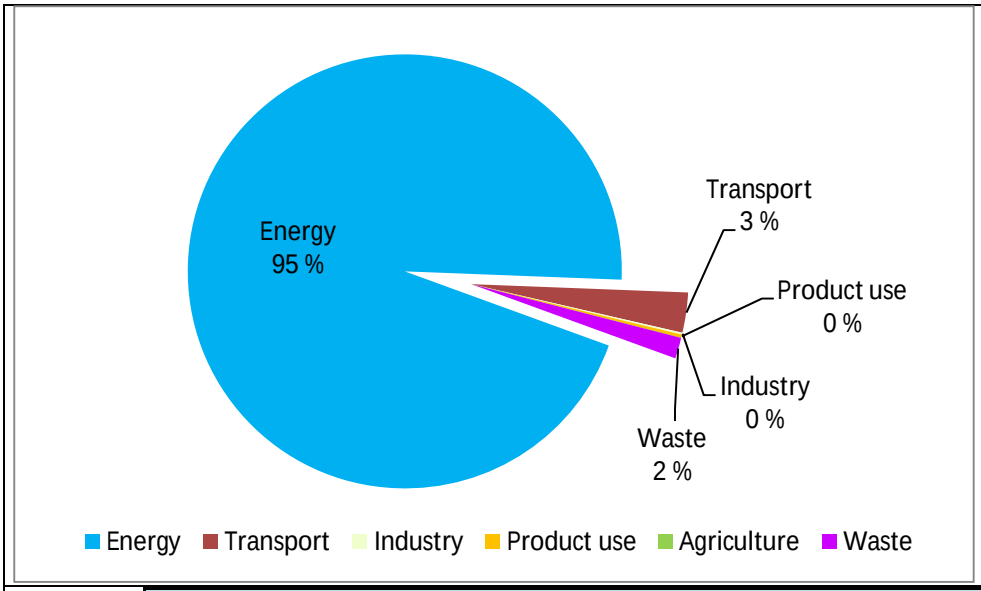
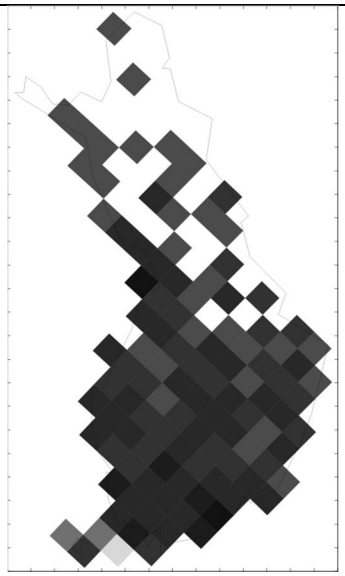


Figure 3.39. The emissions of PAH-4 (Mg) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to PAH-4 emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.40.





Shares of total PAH-4 emissions reported by the plants in 2015							
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	4.5	0.425	40.1	1A4aii	0.1	0.013	0
1A1b	0.2	0.015	0	1A4bi	80.9	7.611	0
1A2a	<0.1	0.001	0.6	1A4bii	<0.1	0.002	0
1A2b	<0.1	0.002	0	1A4ci	0.8	0.075	0
1A2c	<0.1	0.005	3.9	1A4cii	0.2	0.021	0
1A2d	2.1	0.196	52.0	1A5a	<0.1	<0.001	0
1A2e	<0.1	0.002	0	1B1b	4.9	0.464	0
1A2f	<0.1	0.003	2.6	2B10a	<0.1	<0.001	100
1A2gvii	0.3	0.026	0	2C1	0.1	0.012	17.5
1A2gviii	0.9	0.089	0	2C2	<0.1	<0.001	11.1
1A3bi	1.0	0.096	0	2D3i	0.3	0.026	0
1A3bii	0.2	0.019	0	2G	<0.1	<0.001	0
1A3biii	1.1	0.099	0	3F	<0.1	<0.001	0
1A3biv	<0.1	0.002	0	5C1a	0.6	0.056	4.2
1A3c	<0.1	0.002	0	5C1bi	1.0	0.090	0
1A4ai	0.6	0.054	0.1	5C1bv	<0.1	<0.001	0
				Total	100	9.408	2.9

Figure 3.40 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.9.3 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 3.41).

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

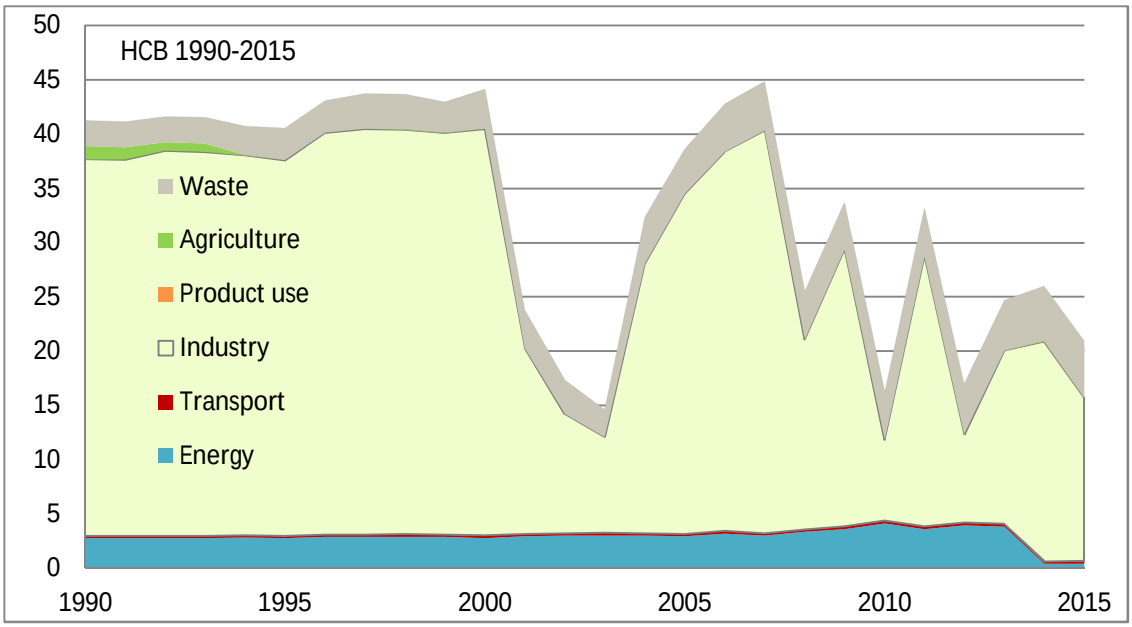
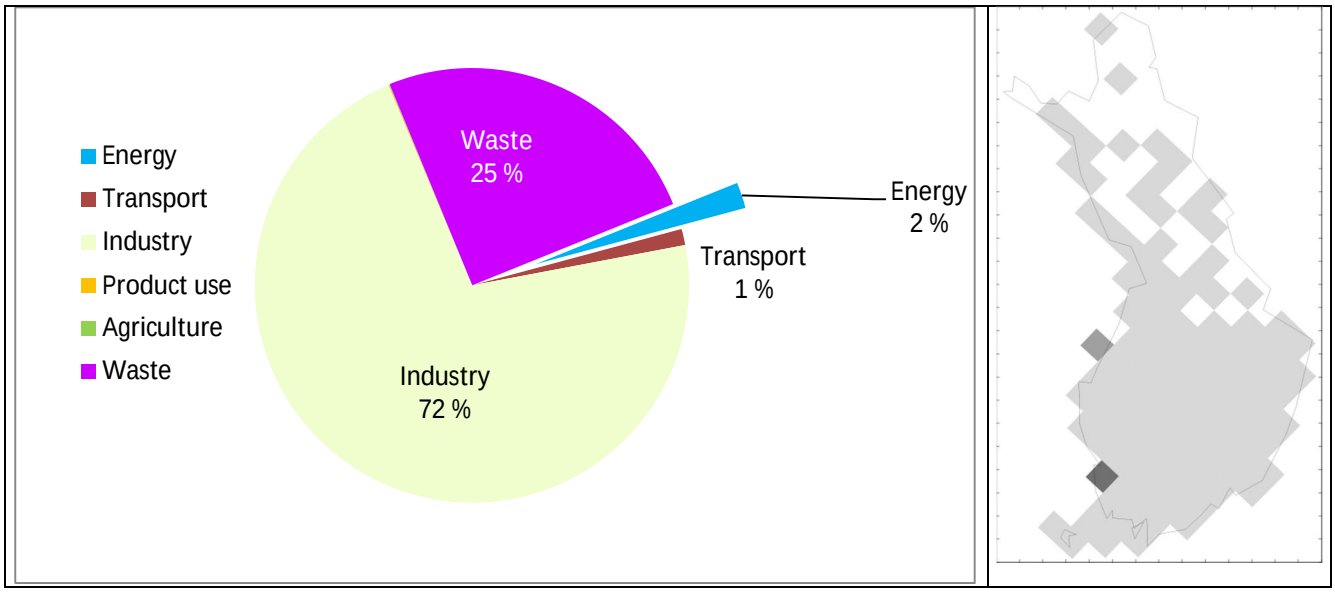


Figure 3.41. Emissions of HCB (kg) in 1990-2014

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to HCB emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.42.



Shares of total HCB emissions reported by the plants in 2015							
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	0.3	0.056	0	1A4ai	<0.1	0.014	0
1A1b	<0.1	<0.001	0	1A4bi	1.2	0.250	0
1A2a	<0.1	<0.001	0	1A4ci	0.2	0.032	0
1A2b	<0.1	<0.001	0	1A4ciii	<0.1	0.003	0
1A2c	<0.1	<0.001	0	1A5a	<0.1	<0.001	0
1A2d	0.1	0.031	0	2B10a	42.6	8.930	100
1A2e	<0.1	<0.001	0	2C7a	28.7	6.010	0
1A2f	<0.1	<0.001	0	2C7c	0.4	0.082	0
1A2gviii	0.1	0.022	0	2D3i	<0.1	0.001	0
1A3bi	0.6	0.128	0	3Df	<0.1	0.014	0
1A3bii	<0.1	0.021	0	5C1a	6.3	1.316	0
1A3biii	0.4	0.085	0	5C1bi	18.8	3.931	0
1A3biv	<0.1	0.003	0	5C1bv	<0.1	0.004	0
1A3dii	<0.1	0.007	0	Total	100	20.940	42.6

Figure 3.42 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.9.4 Polychlorinated biphenyls, PCBs

PCB emissions have been included in the inventory since 2008. The emissions may be overestimated due to the very uncertain methods.

Emission trend

The PCB emission trend (Figure 3.43) is decreasing. The main source of emissions is the waste sector. The inventory may highly overestimate emissions throughout the whole period due to the high uncertainty of estimation methods.

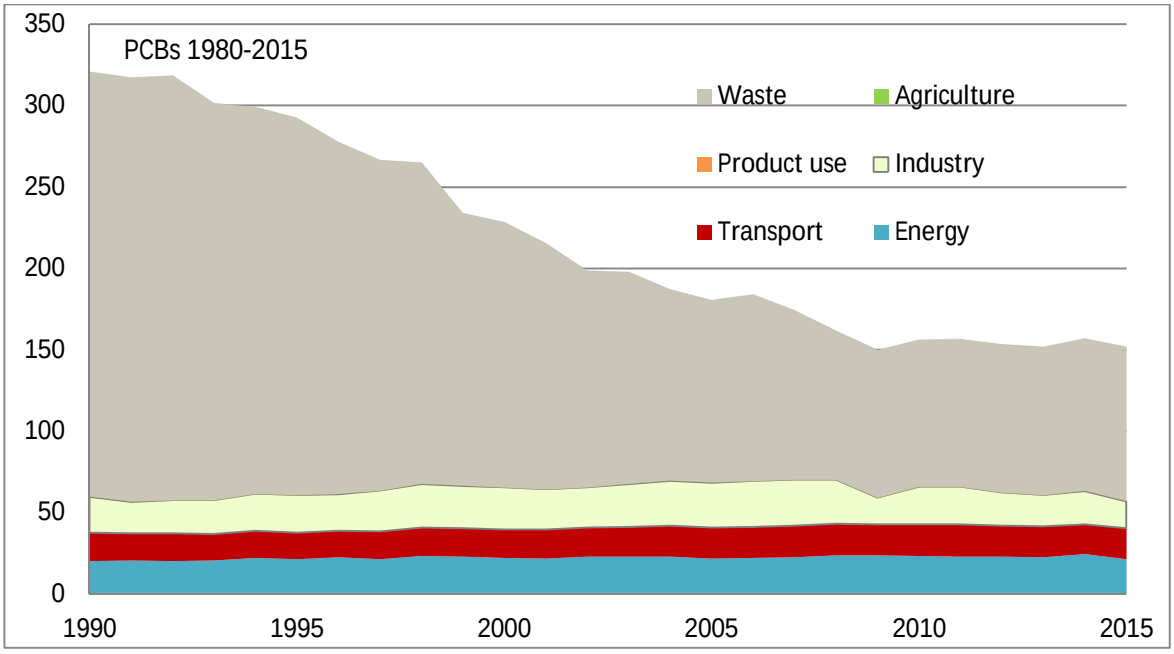
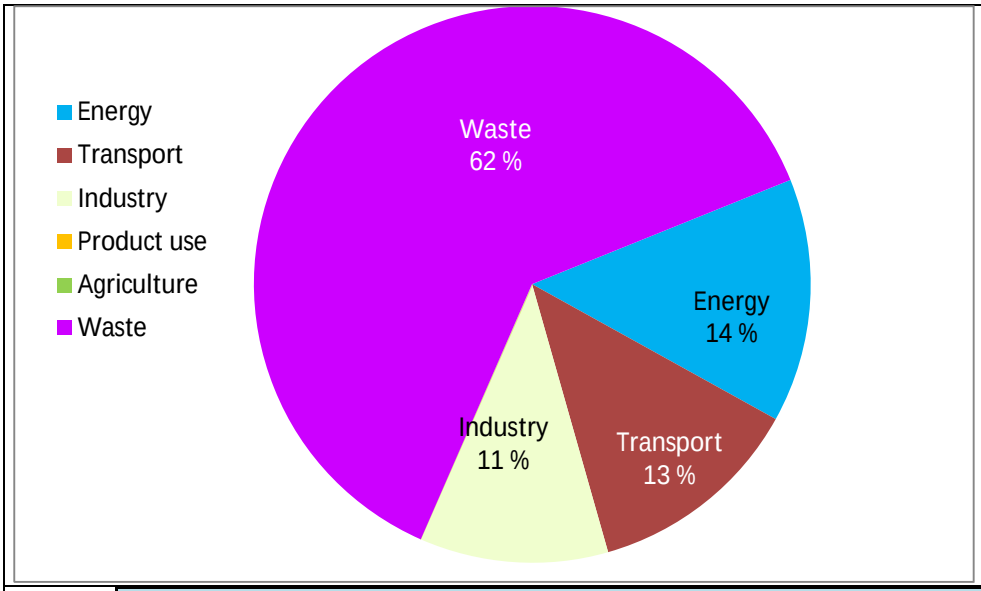


Figure 3.43. Emissions of PCB (kg) in 1990-2015.

The uncertainties of emission data in 2015 are included in Annex 7 of the IIR 2017, which will be reported by May 2017.

The contribution of different sources to PCB emissions in 2015, the spatial distribution of emissions in 2012 and the shares of data reported by operators of industrial plants of total emissions in 2015 are presented in Figure 3.43.



Shares of total PCB emissions reported by the plants in 2015							
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
1A2d	0.2	0.235	0	1B2aiv	8.0	12.17	0
1A3bi	7.0	10.651	0	2A1	1.5	2.348	0
1A3bii	1.1	1.729	0	2A2	0.2	0.248	0
1A3biii	4.2	6.344	0	2B10a	<0.1	0.004	100
1A3biv	0.2	0.256	0	2C1	9.1	13.812	31.9
1A3dii	<0.1	0.071	0	2C7a	0.1	0.176	0
1A4ai	0.6	0.967	0	2C7c	<0.1	0.096	0
1A4bi	2.7	4.154	0	5C1a	4.3	6.579	0
1A4ci	0.5	0.804	0	5C1bi	22.7	34.489	0
1A4ciii	<0.1	0.020	0	5C1bv	<0.1	<0.001	0
1B1b	2.1	3.152	0	5E	35.3	53.582	0
				Total	100	151.890	2.9

Figure 3.43 (a) The contribution of different sources and data reported by the plants in the 2015 emissions.

3.3.9.5 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 3.44).

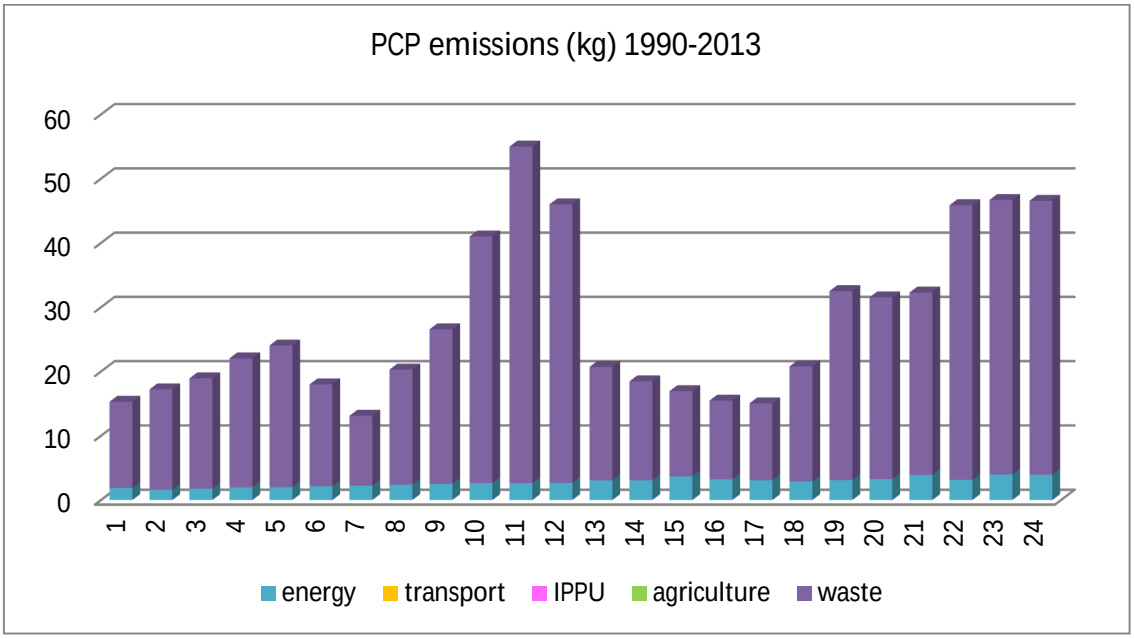


Figure 3.44. Emissions of PCP (kg) in 1990-2007.

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 3.6.

Table 3.6. 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

3.3.9.6 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.

3.4 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.