FINLAND's INFORMATIVE INVENTORY REPORT 2019

Air Pollutant Emissions 1980-2017 under the UNECE CLRTAP and the EU NECD

Part 6 Waste

March 2019

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

Finland's IIR
Part 6
Waste Sector

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IIR - PART 6 - WASTE

6 WASTE (NFR 5)

Sub-chapters included under each NFR subcategory

Source category description
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6 WASTE (NFR 5)

Changes in chapter	
Update of text	March 2019 KS. JP. JMP

6.1 Source category description

Emissions from solid waste disposal on land (landfills), waste incineration, waste water treatment composting, cremation and other waste (house and car fires, latrines) are included in under the Waste sector inventory as presented in Table 5.1.

Emissions from waste incineration are reported under NFR 1A1a or NFR 1A2gviii because all waste incineration occurring in Finland is with energy recovery. However, documentation on the methods used is presented under Waste Incineration 5C,

Air pollutant emission levels from the waste sector are minor compared to the levels of greenhouse gases.

Table 5.1 Emission categories and reported emissions under NFR 5 in 2017

NFR	Processes	Description	Emissions reported
5 A	Biological treatment of waste – Solid waste disposal on land	solid municipal, industrial, construction and demolition wastes	NMVOC, TSP PM_{10}, $PM_{2.5}$
5 B 1	Biological treatment of waste - Composting	biowaste, municipal solid waste, municpal and industrial sludges and industrial solid waste	NH3
5 B 2	Biological treatment of waste – Anaerobic digestion at biogas facilities	few biogas reactors in Finland.	-
5 C 1 a	Municipal waste incineration	No waste incineration occurs, all waste is combusted with energy recovery	Not Occuring
5 C 1 bi	Industrial waste incineration	No waste incineration occurs, all waste is combusted with energy recovery	Not Occuring
5 C 1 bii	Hazardous waste incineration	IE, emissions are allocted under energy sector, all waste incineration includes energy recovery	all
5 C 1 biii	Clinical waste incineration	No waste incineration occurs, all waste is combusted with energy recovery	Not Occuring, occured 1990-1993
5 C 1 biv	Sewage sludge incineration	No waste incineration occurs, all waste is combusted with energy recovery	Not Occuring
5 C 1 bv	Cremation	part of emissions IE	particles (PM2,5, PM10, TSP, BC), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Zn), PCDD/PCDF, PAH-4, PCB, BC
5 C 1 bvi	Other waste incineration	No waste incineration occurs, all waste is combusted with energy recovery	Not Occuring
5 C 2	Open burning of waste	NO	Not Occuring
5 D 1	Domestic wastewater handling	wastewater handling, domestic	NMVOC, NH3 other emissions IE, the notation key must be checked to next submission

5 D 2	Industrial wastewater handling	wastewater hanglind, industrial	NMVOC
5 D 3	Other wastewater handling	NO	NO
5 E	Other waste	car and house fires, latrines	NH_3, particles (PM2,5,PM10,TSP, BC) heavy metals (Pb, Cd, Hg, As,Cr, Cu) PCDD/PCDF

Information on population as background data is presented in Table 5.2 for both urban and total population.

Table 5.2 Background data (total population and population in urban areas) related to the waste sectors in 1990-2017 (Statistic Finland, 2019).

Year	Total population	Urban population	Year	Total population	Urban population
1990	4998478	3095607	2006	5276955	3519288
1991	5029002	3127655	2007	5300484	3547955
1992	5054982	3153984	2008	5326314	3583254
1993	5077912	3182285	2009	5351427	3613215
1994	5098754	3211868	2010	5375276	3641874
1995	5116826	3242380	2011	5401267	3674047
1996	5132320	3267456	2012	5426674	3708852
1997	5147349	3294625	2013	5451270	3741991
1998	5159646	3320011	2014	5471753	3772872
1999	5171302	3347508	2015	5487308	3797978
2000	5181115	3372096	2016	5503297	3829719
2001	5194901	3401057	2017	5513130	3856747
2002	5206295	3423255			
2003	5219732	3444416			
2004	5236611	3467411			
2005	5255580	3491993			

6.2 Solid waste disposal on land (NFR 5A)

Changes in chapter	
Update of text	March 2019 KS. JMP

Source category description

Under NFR 5A Finland reports NMVOC emissions from disposal of solid municipal, industrial, construction and demolition wastes, as well as municipal (domestic) and industrial sludges. The emission reporting under the UNECE CLRTAP, the EU NECD and the UNFCCC are consistent.

The energy produced in waste incineration is utilised and the emissions are therefore reported in the Energy sector. Implementation of landfill gas recovery has also had a significant decreasing impact on the emissions.

Emission trend

After the implementation of the revised Waste Act (1994) and the Landfill Directive (1999/31/EC) minimisation of waste generation, recycling and reuse of waste material, landfill gas recovery and alternative treatment methods to landfills have been endorsed. Similar developments have occurred in the treatment of industrial waste, and municipal and industrial sludges. While the emissions from solid waste disposal on lands have decreased, the emissions from composting have increased until 2007 where after the changes in the emissions have been small. In addition, the increase of waste incineration has decreased the emissions from landfills from 2008 onwards.

NMVOC and particle emissions from NFR 5A are presented in Figures 5.1a and 5.1b. For the years 1988 and 1989 NMVOC emissions can be overestimated.

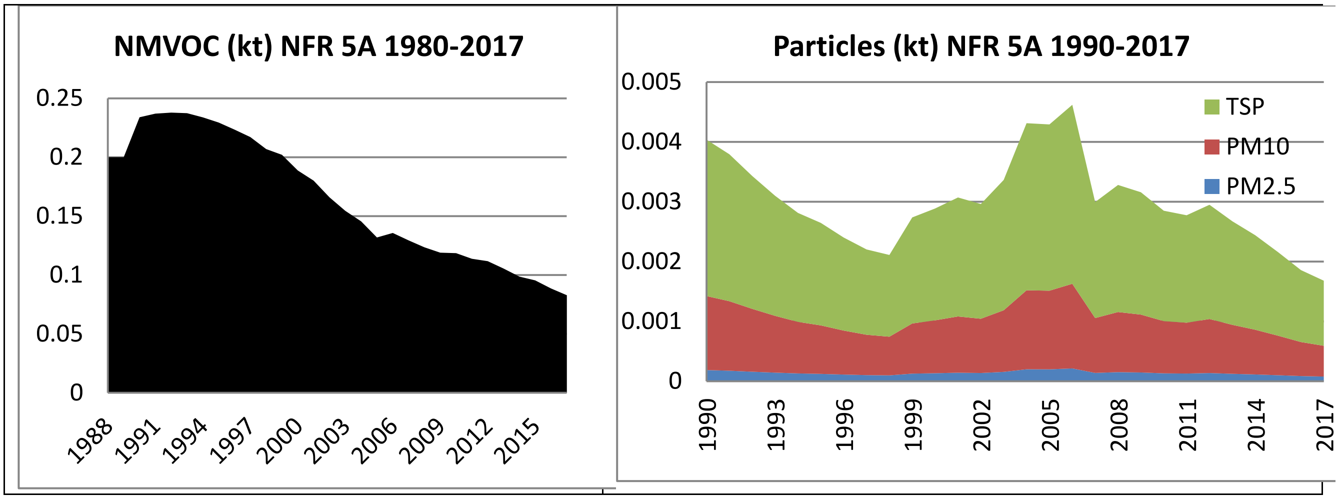

Figure 5.1a NMVOC emissions and Figure 5.1b particle emissions reported under NFR 5A

Methodological issues

Contribution of NFR 5A to total emissions and the shares of emissions reported by the plants are presented in Table 5.3

Table 5.3 Contribution of Biological treatment of waste – solid waste disposal on land (NFR 5A) to total emissions in 2017.

Pollutant	Emissions from solid waste disposal on land in 2017	Total emissions in 2017	Unit	Share of total emissions %	% reported by the plants
NMVOC	0,083	88,32301	Gg	<0.1	0
PM2.5	<0.001	17,8	Gg	<0.1	0
PM10	<0.001	29.179	Gg	<0.1	0
TSP	0.001	43.614	Gg	<0.1	0

NMVOC emissions

NMVOC emissions from solid waste disposal on land are calculated using the same method as in calculation of greenhouse gases described in the Finnish NIR (http://www.stat.fi/tup/khkinv/khkaasut_raportointi_en.html), where methane emissions and the volume of landfill gas have been calculated using the First Order Decay (FOD) method.

The calculation of NMVOC emissions is based on the NMVOC concentration in landfill gas taking into account the recovery rate and other reductions. NMVOC concentration in the landfill gas is assumed to be 485 mg/m^3 (Myllyperkiö, 2005) based on the average of studies carried out in the US in 1998, in Germany in 1999 and in Finland in 1990, and has been estimated to correspond sufficiently to the Finnish conditions. The volume of landfill gas is derived from the density of methane (0.718 kg/m^3) and from the fraction of CH_4 in landfill gas (0.5)

Activity data

The total amount of waste taken to landfills from 1997 onwards is used as activity data in the calculation of methane emissions. This activity data is available in VAHTI and includes information on all landfills in Finland excluding the Åland territory, for which an estimate according to the population is used. The waste amount data are registered according to the EWC (European Waste Catalogue) classification (both EWC 1997 and EWC 2002). Sampling routines have been developed to convert the classification used in VAHTI to the classification used in the emission estimations. Corresponding data (but with volume units and the waste classification is less detailed) for the years 1992-1996 were collected to the Landfill Registry of the Finnish Environment Institute. The activity data for municipal waste for the year 1990 are based on the estimates of the Advisory Board for Waste Management (1992) for municipal solid waste generation and treatment in Finland in 1989 with the correction of double counting in paper waste. The disposal data (amount and composition) at the beginning of the 1990's for industrial, construction and demolition waste are based on surveys and research by Statistics Finland (Isaksson 1993; Puolamaa et al., 1995), VTT Technical Research Centre of Finland (Perälä & Nippala 1998; Pipatti et al. 1996) and the National Board of Waters and the Environment (Karhu 1993). For base year activity data Isaksson (1993) and Pipatti et al. (1996) are used for construction and demolition waste. Karhu (1993) is used for industrial sludges and Puolamaa et al. (1995) is used for solid industrial waste. (Finland's GHG NIR, 2017)

The amount of landfilled waste in 1990-2017 is presented in Table 5.4 and additional background data in Table 5.5.

Table 5.4 Landfilled waste (1 000 t).

Sources: VAHTI database, Landfill Registry of the Finnish Environment Institute. Advisory Board for Waste Management 1992, Vahvelainen & Isaksson 1992, Isaksson 1993, Pipatti et al. 1996, Puolamaa et al. 1995, Perälä & Nippala 1998, Karhu 1993. Directly or indirectly interpolated values are presented in italics).(Finland's NIR, 2019)

Waste group	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Municipal solid waste	2 400	*2 230*	2 070	1 909	1 725	1 682	*1 599*	1 535	1	1 586
Municipal sludge (d.m.)	47	*48*	48	*47*	46	25	21	7	6	5
Municipal sludge (wet m.)	498	*504*	510	*505*	501	298	212	84	71	67
Industrial sludge (d.m.)	337	*318*	299	*285*	*268*	*260*	*248*	229	182	140
Industrial sludge (wet m.)	1 193	*1 129*	1 065	*999*	*935*	*881*	*790*	695	606	559

Industrial solid waste	2 135	2 107	2 079	1 892	1 706	1 519	1 332	1 146	1	2 316
Constr. and demol. waste	1 262	*1 110*	*781*	*667*	*639*	*637*	*567*	540	438	415
Waste group	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Municipal solid waste	1 602	1 542	1 507	1 488	1 423	1 462	1 485	1 411	1	1 128
Municipal sludge (d.m.)	6	8	6	6	6	6	5	4	4	3
Municipal sludge (wet m.)	70	79	66	63	58	53	51	39	27	26
Industrial sludge (d.m.)	118	97	65	42	29	48	44	32	15	18
Industrial sludge (wet m.)	550	329	209	198	127	161	144	119	49	55
Industrial solid waste	2 390	2 659	2 562	3 041	4 781	4 682	5 142	2 996	3	3 570
Constr. and demol. waste	454	457	377	401	373	390	353	336	331	229
Waste group	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**		
Municipal solid waste	1095	1033	885	685	451	318	78	19		
Municipal sludge (d.m.)	3	2	3	3	2	5	1	0		
Municipal sludge (wet m.)	22	23	22	22	17	14	7	3		
Industrial sludge (d.m.)	26	27	32	32	19	7	3	4		
Industrial sludge (wet m.)	82	78	96	94	42	20	10	11		
Industrial solid waste	2661	2742	3312	3175	3074	2841	2420	2221		
Constr. and demol. waste	342	240	241	196	180	161	100	106		

Table 5.5 Additional background data (Finland's NIR, 2017)

Description	Value	Unit
Waste generation rate	1.39	kg/capita/day
Fraction of MSW disposed to SWDS	32	%

Particle emissions

Particle emissions are calculated using the default emission factors from the EMEP/EEA Emission Inventory Guidebook 2016 and landfilled waste amounts (municipal and industrial solid waste and construction and demolition waste) presented in Table 5.6

Table 5.6 Calculated particle emissions from solid waste disposal on land 1990-2017

Year	TSP (t)	PM10 (t)	PM2.5 (t)	Year	TSP (t)	PM10 (t)	PM2.5 (t)
1990	2.6	1.2	0.2	2005	2.8	1.3	0.2
1991	2.5	1.2	0.2	2006	3.0	1.4	0.2
1992	2.2	1.1	0.2	2007	1.9	0.9	0.1
1993	2.0	0.9	0.1	2008	2.1	1.0	0.2
1994	1.8	0.9	0.1	2009	2.0	1.0	0.1
1995	1.7	0.8	0.1	2010	1.8	0.9	0.1
1996	1.6	0.7	0.1	2011	1.8	0.8	0.1
1997	1.4	0.7	0.1	2012	1.9	0.9	0.1
1998	1.4	0.6	0.1	2013	1.7	0.8	0.1
1999	1.8	0.8	0.1	2014	1.6	0.7	0.1
2000	1.9	0.9	0.1	2015	1.4	0.7	0.1
2001	2.0	0.9	0.1	2016	1.2	0.6	0.1
2002	1.9	0.9	0.1	2017	1.1	0.5	0.1
2003	2.2	1.0	0.2				
2004	2.8	1.3	0.2				

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2018

- Particle emissions were included in the inventory due to the recommendation from the 2017 NECD Review.

Source-specific planned improvements

None.

6.3 Composting (NFR 5B1)

Changes in chapter	
March 2019	KS. JMP

Source category description

NH_3 emissions from composting are included in the category from year 1990 onwards. The shares of emissions for each air pollutant reported under the NFR category are presented in Table 5.7

Table 5.7 Contribution of Biological treatment of waste - Composting (NFR 5B1) to total emissions in 2017.

Pollutant	Emissions from composting in 2017	Total emissions in 2017	Unit	Share of total emissions %	% reported by the plants
NH3	0.089	**31.083**	Gg	0,3	0

Emission trend

The NH3 emission trend (Figure 5.3) from composting increased after the early 1990's due to the increased composting especially in semi-urban areas, which results from separate collection of organic waste.

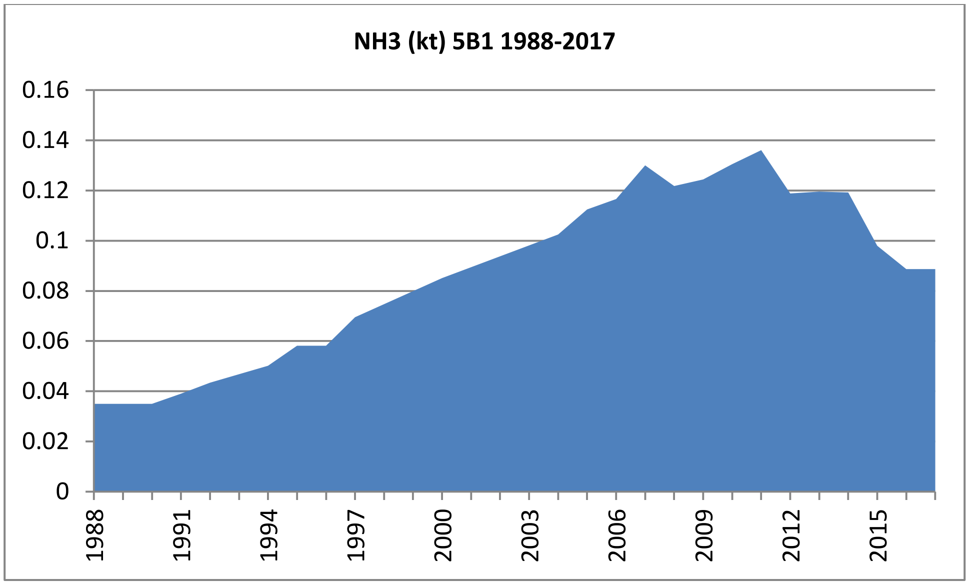

Figure 5.3 NH3 emissions from composting 1980-2017

Methodological issues

NH_3 emissions

The emission are calculated for the whole time series using the emission factor of 0.24 kg/Mg organic waste from the 2016 Guidebook. The activity data is presented Table 5.9 and the emissions in Table 5-10.

Table 5.8 Composted waste with auxiliary matter in 1990-2017 by subcategory (1000 t). (Finland's NIR, 2019)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Municipal solid waste	60	66	72	77	83	102	122	141	154	167
Municipal sludge (d.m.)	60	72	83	90	97	110	123	120	123	125
Industrial sludge (d.m.)	13	12	12	12	12	12	12	7	10	13
Industrial solid waste	12	13	14	16	17	18	19	21	24	28
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Municipal solid waste	180	190	199	209	218	233	232	289	284	281
Municipal sludge (d.m.)	128	131	133	136	138	159	160	151	155	142
Industrial sludge (d.m.)	15	18	21	23	26	32	36	42	33	33
Industrial solid waste	31	34	38	41	45	45	61	52	35	57
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**		
Municipal solid waste	304	319	304	317	317	247	217	217		
Municipal sludge (d.m.)	143	137	1121	128	120	113	95	95		
Industrial sludge (d.m.)	38	33	22	22	25	25	17	17		
Industrial solid waste	60	77	47	31	35	24	40	40		

Table 5.9 NH_3 emissions from composting 1990-2017

Year	NH_3 emission (kt)	Year	NH_3 emission (kt)	Year	NH_3 emission (kt)
1990	0.035	2000	0.085	2010	0.131
1991	0.039	2001	0.089	2011	0.136
1992	0.043	2002	0.094	2012	0.119
1993	0.047	2003	0.098	2013	0.120
1994	0.050	2004	0.102	2014	0.119
1995	0.058	2005	0.112	2015	0.098
1996	0.066	2006	0.117	2016	0.089
1997	0.070	2007	0.130	2017	0.089
1998	0.075	2008	0.122		
1999	0.080	2009	0.124		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR to be submitted by 1st May 2017.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes made in response to the review process

2009

- NH3 emissions from composting were included in the inventory
-

2016

- NMVOC emissions were recalculated for whole time series (1990 onwards) to be consistent with UNFCCC reporting.

2018

- NMVOC emissions were excluded from the inventory, because no default method is presented in the Guidebook and due to the recommendation of the 2017 NECD Review.
- The mistake in the calculation of NH3 emissions (incorrect amount of industrial solid waste in 2015, value was corrected from 35 to 24 kt) observed during the 2017 NECD Review was corrected. The impact of the mistake was far below the threshold of significance for a technical correction (2%).

Source-specific planned improvements

None.

6.4 Anaerobic digestion at biogas facilities (NFR 5B2)

Changes in chapter	
March 2019	KS JMP

Finland reported earlier emissions from this category using a rough method based on the concentration of NMVOC in biogas (485 mg/m3, according to Myllyperkiö, 2006), derived from the average results of studies in the US 1998, Germany 1999 and Finland 1990. However, as there is no method in the Guidebook and the NECD TERT was not convinced of the validity of this method, the emissions have been removed. The earlier reported emissions are presented in Figure 5.11.

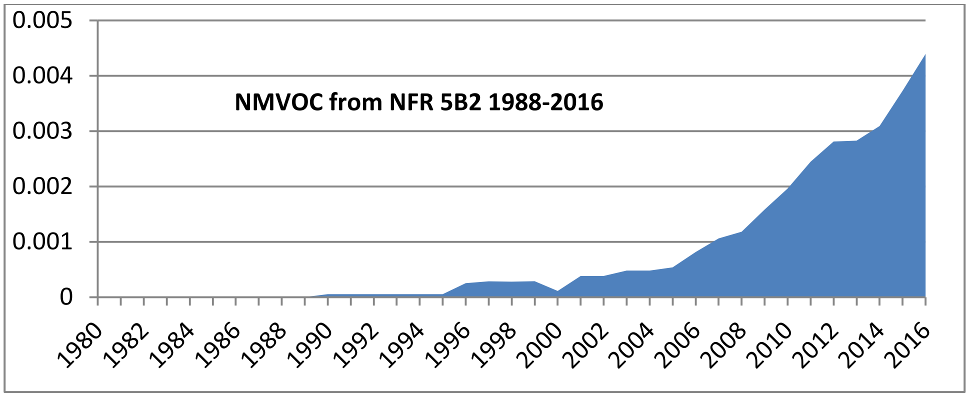

Figure 5.4 NMVOC emissions from NFR 5B2 1988-2016 (1988 is the base year for NMVOC) not included in the NFR as the method was not accepted by the NECD TERT,

In 2016 the amount of biogas produced by the reactor installations was 77.6 million m^3 and the combustion of surplus biogas 7.4 million m^3. Production of thermal, electrical and mechanical energy was 382.9 GWh. The following facilities were in use in 2016: 16 biogas reactor plants at municipal wastewater treatment plants, 3 anaerobic industrial wastewater treatment plants, 13 farm-scale biogas plants and 16 municipal solid waste biogas plants.

In 2016 there were 40 landfill gas recovery plants. The amount of recovered biogas was 78.5 million m^3 out of which 60 million m3 was used for production of 239.7 GWh electrical and thermal energy

Source: Finnish national biogas statistics, University of Eastern Finland, ref. Huttunen M., J and Kuittinen V., 2017

6.5 Waste Incineration (NFR 5C)

Changes in chapter	
March 2019	KS JMP

Source category description

The amount of municipal waste at landfills is decreasing heavily. In 2012 the reduction was over one-quarter from the previous year and the same rate seems to be continuing in 2013 as well. Only 670.000 tonnes of municipal waste was deposited at landfills in 2013. For example in 2008 the amount was still 1.400.000 tonnes. The co-combustion of waste with energy recovery is on the rise as can be seen from 0e 5.12. If the current development continues, landfills for municipal waste will become history, as is already the case in many other European countries.

The number of waste co-combusting waste with energy recovery has been rapidly increasing since 1994 due to implementation of the revised Waste Act and the revision of the Environmental Protection Act.

All waste incineration in Finland includes energy recovery and the emissions are therefore reported under NFR 1A1a or NFR 1A2gviii.

Table 5.12 Volume of incinerated wastes (1000 t) and number of cremated corpses in Finland

Waste and corpses burned	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Domestic and municipal wastes	60.0	70.6	74.9	76.5	91.6	84.5	81.8	114.2	142.1	196.8
Industrial wastes	4 000	4 000	4 000	4 000	4 500	5 000	5 000	5 435	7 206	4 561
Corpses	7 609	7 764	8 121	8 986	9 163	9 774	10 823	10 977	11 834	12 466
Waste and corpses burned	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Domestic and municipal wastes	221.2	229.6	189.4	222.8	235.9	226.8	222.3	310.4	360.0	463.0
Industrial wastes	5 970	5 774	5 052	4 042	7 129	6 813	7 339	7 339	7 339	7 339
Corpses	13 084	13391	14 354	14 847	15 508	16 108	16459	17 796	18 199	19 561
Waste and corpses burned	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**		
Domestic and municipal wastes	463.0	679.0	679.0	679.0	1 137	1 312	1 515	1 192		
Industrial wastes	7 339	7 339	7 339	7 339	7 339	7339	7339	7339		
Corpses	21068	21 540	22648	23702	24822	25631	27483	28336		

Municipal waste incineration (NFR 5C1a)

Changes in chapter	
March 2019	KS. JMP

Source category description

All waste incineration in Finland includes energy recovery and the emissions are reported under NFR 1A1a or NFR 1A2gviii.

Methodological issues

SO_2. NOx. NMVOC. Particle, POP and heavy metal emissions

SO_2, NOx, NMVOC, particle and heavy metal emissions are reported by the plants according to the monitoring requirements in the environmental permits.

<u>POP emissions</u>

PCDD/F and PAH-4 emissions are reported by plants. The related emission data will be included in the 2020 submission to the table below.

HCB and PCB emissions are calculated using Guidebook 2016 emission factors and reported under 1A2gvii.

Table 5.13 POP emissions from waste incineration reported under the Energy sector

Year	HCB (kg)	PCB (kg)	PAH-4	PCDD/F	Year	HCB (kg)	PCB (kg)	PAH-4	PCDD/F
1990	2.47	0.19			2010	25.18	1.42		
1991	2.89	0.22			2011	30.67	2.14		
1992	3.19	0.24			2012	30.67	2.14		
1993	3.76	0.28			2013	30.67	2.14		
1994	4.14	0.31			2014	51.39	3.70		
1995	4.17	0.31			2015	59.48	4.47		
1996	3.95	0.15			2016	68.47	5.15		
1997	5.60	0.25			2017	68.47	5.15		
1998	6.80	0.34							
1999	9.40	0.55							
2000	10.00	0.59							
2001	10.38	0.62							
2002	8.56	0.48							
2003	10.07	0.59							
2004	10.66	0.64							
2005	10.25	0.61							
2006	10.05	0.59							
2007	14.03	0.89							
2008	21.60	1.47							
2009	20.92	1.41							

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2010 emissions.

Source-specific recalculations including changes made in response to the review Process

2015

- Emissions before 2011 were corrected by removing double values: NFR 5C1a to NE (includes emissions from WWTPs), the emissions were allocated under 5D1.

2016

- Ammonia, PCDD/F and PAH-4 emissions in 5C1a were revised for whole time series. In previous submissions Finland has reported emissions from clinical waste incineration (NFR 5C1 biii) although actually no incineration of clinical waste in hospital sites has occurred after the year 1993. At the end of 1993 the new Waste Act (1994) and Environment Protection Act came in force, where after clinical waste has been managed in larger toxic waste disposal plants or landfilled. In 2016 landfilling has been forbidden and all clinical waste has to be incinerated in waste incineration plants.
  - HCB, PCB and PCP from waste incineration were included in the inventory.
  -

2018

  - HCB and PCB emissions were recalculated using Guidebook 2016 emission factors for the whole time series
  - The notation key for waste incineration NFR categories were changed to NO

Source-specific planned improvements

None.

Industrial waste incineration including hazardous waste and sewage sludge (NFR 5C1b)

Changes in chapter	
March 2019	KS. JMP

Source category description

All waste incineration in Finland includes energy recovery. The emissions are reported under NFR 1A1a or NFR 1A2gviii.

Methodological issues

SO_2. NOx. NMVOC. Particle, POP and heavy metal emissions

SO_2, NOx, NMVOC, particle and heavy metal emissions are reported by the plants according to the monitoring requirements in the environmental permits in the VAHTI database.

POP emissions

PCDD/F, PAH-4, PCB and HCB emissions are partly reported by the plants and have been completed with calculated emission data for those plants that do not report their emissions to the supervising authorities.

Revision of the calculation of HCB emissions

HCB emissions were earlier calculated from the total volume of incinerated industrial waste. In the revised calculation carried out for the 2018 submission, HCB emissions are calculated for industrial sludges using the emission factor provided in the Guidebook 2016.

The assumptions made for PCB containing sludges presented below are also assumed for HCB containing sludges and the calculation follows that of PCB emissions.

Revision of the calculation of PCB emissions

PCB emissions were earlier calculated from the total volume of incinerated industrial waste. In the revised time series PCB emissions are reported by the plants according to their environmental permit conditions for the years 1993-2006. For the remaining years the emissions are completed by calculated emissions using the EMEP EEA Guidebook 2016 emission factors. The method to calculate emissions will be reconsidered for the next submission taking into account the possibility of using national EFs instead of Guidebook EFs.

Amounts of incinerated industrial sludges are presented in Table 5.14 (source Statistics Finland for years 2004-2006 and for 2008-2013).

For years 1990-2003, 2007 and from 2014 onwards there is no official statistics available, that's why in the calculation it is assumed that 20% of the total incinerated industrial waste amounts were industrial sludges. According to an expert estimate (Espo, 2018) 10% of industrial sludges contains

PCB for years 1990-2004, from 2005 onwards the percentage of PCBs containing sludges is 5 %. All PCBs containing sludges are incinerated in waste incineration plants. The accuracy and relevancy of the method will be further studied for the next submission and the use of emission factors derived from data reported by the plants will be studied.

Table 5.14 Amounts of incinerated industrial waste and industrial sludges (t) (Statistics Finland, 2018)

	Incinerated industrial waste (t)	Industrial sludges (t) (Statistics Finland)	Incinerated sludge (t)	Incinerated sludge containing PCB/HCB (t)
1990	1200000	-	299288	29929
1991	1200000	-	299288	29929
1992	1200000	-	299288	29929
1993	1200000	-	299288	29929
1994	1350000	-	336699	33670
1995	1500000	-	374110	37411
1996	1500000	-	374110	37411
1997	1630500	-	406658	40666
1998	1650000	-	411521	41152
1999	1368300	-	341263	34126
2000	1791000	-	446687	44669
2001	1732110	-	432000	43200
2002	1515495	-	377975	37797
2003	1212504	-	302407	30241
2004	2138841	437200	437200	43720
2005	2043758	631700	631700	31585
2006	2201553	520400	520400	26020
2007	2201553	-	549082	27454
2008	2069170	888000	888000	44400
2009	2069170	516000	516000	25800
2010	2069170	503000	503000	25150
2011	2069170	470000	470000	23500
2012	2069170	542 000	542000	27100
2013	2069170	690027	690027	34501
2014	2069170	-	516065	25803
2015	2069170	-	516065	25803
2016	2069170	-	516065	25803
2017	2069170	-	516065	25803

Table 5.15 HCB and PCB emissions from industrial waste incineration

Year	HCB (kg)	PCB (kg)	Year	HCB (kg)	PCB (kg)
1990	0.135	0.141	2010	0.113	0.118
1991	0.135	0.141	2011	0.106	0.110
1992	0.135	0.141	2012	0.122	0.127
1993	0.140	0.141	2013	0.155	0.162
1994	0.012	0.158	2014	0.116	0.121
1995	0.080	0.176	2015	0.116	0.121
1996	0.095	0.176	2016	0.116	0.121
1997	0.012	0.191	2017	0.116	0.121
1998	0.200	0.193			
1999	0.055	0.160			
2000	0.329	0.210			
2001	0.218	0.203			

2002	0.283	0.178			
2003	0.208	0.142			
2004	0.117	0.205			
2005	0.219	0.148			
2006	0.105	0.122			
2007	0.124	0.129			
2008	0.200	0.209			
2009	0.116	0.121			

PCDD/F and PAH-4

The emissions are reported by the operators.

PCP

Emissions from hazardous waste incineration are based on data reported by the operators

Emission factors for municipal waste incineration were derived at SYKE from emission data available from VAHTI as a mean of the annual emission rates at hazardous waste incineration facilities. The first emission factor (233.6 mg/t) is used for the years 1990-2001, except for the biggest incineration plant which improved its technology in 1994. The revised emission factor (4.5 mg/t) for this plant was used after 1994. The emission factor that is used for the other plants for the more recent years (2002-2011) is 67.4 mg/t, since the abatement techniques and limit values for waste incineration have been improved in the 2000's. The change in the emission factor results in large variations in the calculated PCP emissions but the use of the same emission factor throughout the whole time series would either underestimate the emissions in the early 1990's or overestimate emissions in the recent years.

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2010 emissions.

Source-specific recalculations including changes made in response to the review Process

2018
- HCB and PCB emissions recalculation using Guidebook 2016 methods

Source-specific planned improvements

2019
- The possibility to develop national emission factors for the calculation of HCB and PCB emissions will be further studied.

Clinical waste incineration (NFR 5C1biii)

Changes in chapter	
March 2019	KS. JMP

Source category description

Clinical waste incineration occurred in Finland until 1994, where after clinical waste incineration units were closed down. Thereafter was treated in a large toxic waste disposal plant or landfilled. From 2016 onwards clinical waste has been co-combusted in energy production plants. Thus, emissions prior to 1994 are reported under NFR 5C1biii and from the year 1994 onwards under NFR 1A1a or 1A2gviii.

The allocation of emissions was changed in the 2018 submission because all waste incineration in Finland has included energy recovery after the year 1993. This is due to the implementation of the 1994 Waste Act and the revised Environmental Protection Act, which came into force and resulted in a change also regarding clinical waste management. According to the legislation clinical waste had to be managed in larger toxic waste disposal plants or landfilled, and in 2016 landfilling was also forbidden.

Methodological issues

Activity data

Activity data is an assumption based on an expert estimate (SYKE/Merilehto Kirsi, 2000 Table 5.7 above.) .

Table 5.7. Volume of incinerated clinical waste since 1990 (expert estimate, Merilehto 2000)

Year	waste amount
1990	10 000 t
1991	10 000 t
1992	10 000 t
1993	10 000 t

Emission factors

Heavy metals emissions from 1990-1993 are reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available, the emissions have been estimated.

POP compounds

PCDD/F, PAH4, HCB and PCB emissions for the years 1990-1993 are calculated with the following emission factors, which are assumed to be more suitable for the Finnish conditions in early 1990's than the Guidebook 2016 EFs. The EFs in the 2016 Guidebook are presented in the brackets.

PCDD/ F 7 µg I-TEQ /t (SYKE, 2001) (GB16 40 mg I-TEQ/Mg)
PAH-4 20 mg/t (EEA, 2002) (GB16 0.04 mg/Mg)

HCB 2.9 mg/t (Bailey, 2001) (GB16 0.1 g/Mg)
PCB 20 mg/t (GB 2016)

Emissions from clinical waste incineration 1990-1993 are presented in Table 5.16

Table 5.16 HCB, PCB, PCCD/Fs and PAH emissions from clinical waste incineration 1990-1993

Year	HCB (kg)	PCB (kg)	PCDD/PCDF (ug I-TEQ)	
1990	0.029	0.2	0.07	
1991	0.029	0.2	0.07	
1992	0.029	0.2	0.07	
1993	0.029	0.2	0.07	
Year	**B(a)P (kg)**	**B(b)F (kg)**	**B(k)F (kg)**	**I(1,2,3-cd)P (kg)**
1990	0.05	0.05	0.05	0.05
1991	0.05	0.05	0.05	0.05
1992	0.05	0.05	0.05	0.05
1993	0.05	0.05	0.05	0.05

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission.

Source-specific recalculations including changes made in response to the review Process

2016

- Emissions from year 1994 onwards were included in NFR 5Ca1. In the 1990-2015 submissions emissions from clinical waste incineration (NFR 5C1 biii) were erroneously reported although no incineration of clinical waste occurred at hospital sites after the year 1993.

2018

- The notation key was changed to “NO” from 1994 onwards

Source-specific planned improvements

None.

Cremation (NFR 5C1bv)

Changes in chapter	
March 2019	KS. JMP

Source category description

Emissions from cremation are calculated from 1990 onwards. The shares of emissions for each pollutant reported under the NFR category are presented in Table 5.17.

Table 5.17 Contribution of Cremation (NFR 5C1bv) to total emissions in 2017.

Pollutant	Emissions from cremation in 2017	Total emissions in 2017	Unit	Share of total emissions %	% reported by the plants
PM2.5	<0.001	17,79965	Gg	<0.1	0
PM10	<0.001	29,17878	Gg	<0.1	0
TSP	0,001	43,61372	Gg	<0.1	0
BC	<0.001	4,113472	Gg	<0.1	0
Pb	<0.001	15,57612	Mg	<0.1	0
Cd	<0.001	0,95589	Mg	<0.1	0
Hg	0,017	0,578899	Mg	2,9	0
As	<0.001	2,439968	Mg	<0.1	0
Cr	<0.001	16,46258	Mg	<0.1	0
Cu	<0.001	36,43057	Mg	<0.1	0
Ni	<0.001	14,75166	Mg	<0.1	0
Se	<0.001	0,868942	Mg	<0.1	0
Zn	0,005	118,7413	Mg	<0.1	0
PCDD/	<0.001	13,40218	g I-Teq	<0.1	0
PAHs	<0.001	10,14612	Mg	<0.1	0
HCB	0,004	33,48766	kg	<0.1	0
PCBs	0,012	25,86231	kg	<0.1	0

Methodological issues

Activity data

Emissions from cremation are calculated using the amount of incinerated corpses received from the Finnish Congregations (Finnish Congregations, 2019) (Table 5.18) as activity data.

Table 5.18 Incinerated corpses 1990-2017 (Finnish Congregations) and Hg EF (Swedish IIR 2014)

Year	Incinerated corpses	EF (Hg) (kg/body)	Year	Incinerated corpses	EF (Hg) (kg/body)
1990	7610	0.00296	2006	16459	0.00076
1991	7764	0.00295	2007	17796	0.00074
1992	8121	0.00295	2008	18199	0.00071
1993	8986	0.00295	2009	19561	0.00072
1994	9163	0.00293	2010	21068	0.00071
1995	9774	0.00287	2011	21540	0.00065
1996	10823	0.00277	2012	22648	0.00059
1997	10977	0.00263	2013	23702	0.00059
1998	11834	0.00236	2014	24822	0.00059
1999	12466	00.201	2015	25631	0.00059
2000	13084	0.00168	2016	27483	0.00059
2001	13391	0.00102	2017	28336	0.00059
2002	14354	0.001			

2003	14847	0.00099			
2004	15508	0.00093			
2005	16108	0.00087			

Mercury

Finland reports Hg emissions from cremation using emission factor from Sweden's IIR 2014 which are considered to be more suitable for the calculation of emissions than those presented in 2016 Guidebook. Mercury EFs are presented in Table 5.18.

Particles, POPs and heavy metals

All other emissions than Hg are calculated with the 2016 Guidebook EFs.

Particle and heavy metal emissions from cremation are presented in Table 5.20 and POP emissions in Table 5.21.

Table 5.20 Particle and heavy metal emissions from cremation

Year	TSP (t)	PM_{10} (t)	$PM_{2.5}$ (t)	BC (t)	Hg(g)	Pb(g)	Cd (g)	As (g)	Cr(g)	Cu(g)	Ni(g	Se(g)	Zn(g)
1990	0.293	0.264	0.264	0.132	22522	228	38	104	103	95	132	151	1218
1991	0.299	0.269	0.269	0.135	22903	233	39	106	105	97	135	154	1243
1992	0.313	0.282	0.282	0.141	23957	244	41	111	110	101	141	161	1300
1993	0.347	0.312	0.312	0.156	26509	270	45	122	122	112	156	178	1439
1994	0.353	0.318	0.318	0.159	26848	275	46	125	124	114	159	181	1467
1995	0.377	0.339	0.339	0.170	28051	294	49	133	133	121	169	193	1565
1996	0.417	0.376	0.376	0.188	29980	325	54	147	147	135	188	214	1733
1997	0.423	0.381	0.381	0.190	28870	330	55	149	149	136	190	217	1758
1998	0.456	0.411	0.411	0.205	27928	355	60	161	160	147	205	234	1895
1999	0.481	0.433	0.433	0.216	25057	374	63	170	169	155	216	247	1996
2000	0.505	0.454	0.454	0.227	21981	393	66	178	177	163	227	259	2095
2001	0.516	0.465	0.465	0.232	13659	402	67	182	182	166	232	265	2144
2002	0.553	0.498	0.498	0.249	14354	431	72	195	195	178	249	284	2298
2003	0.573	0.515	0.515	0.258	14699	446	75	202	201	185	257	294	2377
2004	0.598	0.538	0.538	0.269	14422	466	78	211	210	193	269	307	2483
2005	0.621	0.559	0.559	0.279	14014	484	81	219	218	200	279	319	2579
2006	0.635	0.571	0.571	0.286	12509	494	83	224	223	205	285	326	2635
2007	0.686	0.618	0.618	0.309	13169	534	90	242	241	221	308	352	2849
2008	0.702	0.632	0.632	0.316	12921	547	92	248	247	226	315	360	2914
2009	0.754	0.679	0.679	0.339	14084	587	98	266	265	243	339	387	3132
2010	0.812	0.731	0.731	0.366	14958	633	106	287	286	262	365	417	3373
2011	0.831	0.747	0.747	0.374	14001	647	108	293	292	268	373	426	3449
2012	0.873	0.786	0.786	0.393	13362	680	114	308	307	282	392	448	3626
2013	0.914	0.822	0.822	0.411	13984	712	119	323	321	295	411	469	3795
2014	0.957	0.861	0.861	0.431	14645	745	125	338	337	309	430	491	3974
2015	0.988	0.889	0.889	0.445	15122	770	129	349	348	319	444	507	4104
2016	1.060	0.954	0.954	0.477	16215	825	138	374	373	342	476	544	4401
2017	1.093	0.983	0.983	0.492	16718	851	143	386	384	352	491	560	4537

Table 5.21 POP emissions from cremation

Year	HCB (kg)	PCB (kg)	PCDD/PCDF (g I-	B(a)P (kg)	B(b)F (kg)	B(k)F (kg)	I(1,2,3-cd)P
1990	0.001	0.003	0.00021	0.10	0.05	0.05	0.05
1991	0.001	0.003	0.00021	0.10	0.06	0.05	0.05
1992	0.001	0.003	0.00022	0.11	0.06	0.05	0.06
1993	0.001	0.004	0.00024	0.12	0.06	0.06	0.06
1994	0.001	0.004	0.00025	0.12	0.07	0.06	0.06
1995	0.001	0.004	0.00026	0.13	0.07	0.06	0.07
1996	0.002	0.004	0.00029	0.14	0.08	0.07	0.08
1997	0.002	0.005	0.00030	0.14	0.08	0.07	0.08
1998	0.002	0.005	0.00032	0.16	0.09	0.08	0.08
1999	0.002	0.005	0.00034	0.16	0.09	0.08	0.09
2000	0.002	0.005	0.00035	0.17	0.09	0.08	0.09
2001	0.002	0.005	0.00036	0.18	0.10	0.09	0.09
2002	0.002	0.006	0.00039	0.19	0.10	0.09	0.10
2003	0.002	0.006	0.00040	0.20	0.11	0.10	0.10
2004	0.002	0.006	0.00042	0.20	0.11	0.10	0.11
2005	0.002	0.007	0.00043	0.21	0.12	0.10	0.11
2006	0.002	0.007	0.00044	0.22	0.12	0.11	0.12
2007	0.003	0.007	0.00048	0.23	0.13	0.11	0.12
2008	0.003	0.007	0.00049	0.24	0.13	0.12	0.13
2009	0.003	0.008	0.00053	0.26	0.14	0.13	0.14
2010	0.003	0.009	0.00057	0.28	0.15	0.14	0.15
2011	0.003	0.009	0.00058	0.28	0.16	0.14	0.15
2012	0.003	0.009	0.00061	0.30	0.16	0.15	0.16
2013	0.004	0.010	0.00064	0.31	0.17	0.15	0.17
2014	0.004	0.010	0.00067	0.33	0.18	0.16	0.17
2015	0.004	0.011	0.00069	0.34	0.18	0.17	0.18
2016	0.004	0.011	0.00074	0.36	0.20	0.18	0.19
2017	0.004	0.011	0.00077	0.37	0.20	0.18	0.20

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2014 emissions.

Source-specific recalculations including changes made in response to the review Process

2013

- Inclusion of heavy metal emissions

2017

- The method was revised to the emission factors from the 2016 Guidebook 2016 for the whole time series.

Source-specific planned improvements

2020

The possibility to use Guidebook 2016 emission factor also for Hg will be further studied.

6.6 Wastewater Handling (NFR 5D)

Source category description

The emission sources cover municipal (domestic) and industrial wastewater handling plants and septic tanks. Emissions from wastewater treatment are declining since 1990 due to increasingly efficient treatment of wastewater which has also been implemented in sparsely populated areas, as well as a lower nitrogen burden released from industrial wastewaters into waterbodies.

Domestic wastewater handling (NFR 5D1)

Changes in chapter	
Update of text	May 2018 KS. JMP

Source category description

In Finland there are approximately 540 municipal wastewater treatment plants, each of them treat wastewater from more than 50 people (Finnish Water Utilities Association, FIWA), 2016).

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 5.22.

Table 5.22 Contribution of Domestic wastewater handling (NFR 5D1) to total emissions in 2017.

Pollutant	Emissions from domestic wastewater handling in 2017	Total emissions in 2017	Unit	Share of total emissions %	% reported by the plants
NMVOC	0,009	88.323	Gg	<0.1	0
NH3	0,003	31.083	Gg	<0.1	100

The NMVOC emissions reported under the UNECE CLRTAP and the EU NECD are also reported under the UNFCCC and the activity data and methods used in the calculations are the same.

Methodological issues

NMVOC emissions

NMVOC emissions are calculated using the method presented in the EMEP/EEA Emission Inventory Guidebook 2016. Activity data is taken from YLVA database and presented in Table 5.24.

Table 5.24 Handled domestic wastewater 1990-2017 (1000m3).

Year	handled domestic wastewater (1000 m3)	Year	handled domestic wastewater (1000 m3)
1990	213801	2010	510019
1991	200757	2011	569107
1992	196439	2012	618240
1993	168243	2013	539609
1994	177414	2014	512343
1995	281343	2015	566967
1996	352501	2016	513002
1997	519530	2017	620757
1998	584699		
1999	538664		
2000	575409		
2001	552574		
2002	790886		
2003	475846		
2004	567214		
2005	550628		
2006	527119		
2007	643100		
2008	690266		
2009	494373		

NH_3 emissions

NH3 emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available, the emissions have been calculated.

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied since the 2012 submission.

Source-specific recalculations including changes made in response to the review process

2016

- Previously NMVOC emissions from industrial and domestic wastewater handling were reported aggregated under NFR 5D3 Other wastewater handling and have since the 2016 submission been reported under NFRs 5D1 and 5D2.

2018

- The recommendation of the 2017 NECD Technical Review to revise the method to calculate NMVOC emissions could not be implemented because the wastewater volume data is not accurate enough to implement the method from the 2016 Guidebook. The current method is considered to be more accurate and is also consistent with the one used in the greenhouse gas reporting

2019

- NMVOC emissions are calculated as described Guidebook 2016.

Source-specific planned improvements

None

Industrial wastewater handling (NFR 5D2)

Changes in chapter	
March 2019	KS & JMP

Source category description

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 5.27.

Table 5.27 Contribution of Industrial wastewater handling (NFR 5D2) to total emissions in 2017.

Pollutant	Emissions from industrial wastewater handling in 2017	Total emissions in 2017	Unit	Share of total emissions %	% reported by the plants
NMVOC	0.018	88.32	Gg	<0.1	0

The NMVOC emissions reported under the UNECE CLRTAP and the EU NECD are also reported under the UNFCCC reporting and the activity data and methods used in the calculation are the same.

Methodological issues

NMVOC emissions

NMVOC emissions are calculated using method presented in the EMEP/EEA Emission Inventory Guidebook 2016. Activity data is taken from YLVA database and presented in Table 5.28

Table 5.28 Handled industrial wastewater 1990-2017 (1000m3).

Year	handled industrial wastewater (1000 m3)	Year	handled industrial wastewater (1000 m3)
1990	1433445	2010	936139
1991	1302372	2011	968823
1992	1297080	2012	913886
1993	1339249	2013	881691

1994	1463809	2014	868204
1995	1415457	2015	849596
1996	1378742	2016	910491
1997	1340104	2017	1184187
1998	1373581		
1999	1379977		
2000	1356726		
2001	1296868		
2002	1230824		
2003	1217227		
2004	1167849		
2005	1047229		
2006	1082900		
2007	1051384		
2008	1010498		
2009	845063		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2014 emissions.

Source-specific recalculations including changes made in response to the review process

2016

- Previously NMVOC emissions from industrial and domestic wastewater handling were reported aggregated under NFR 5D3 Other wastewater handling and have since the 2016 submission been reported under NFRs 5D1 and 5D2.

2018

- The recommendation of the 2017 NECD Technical Review to revise the method to calculate NMVOC emissions could not be implemented because the wastewater volume data is not accurate enough to implement the method from the 2016 Guidebook. The current method is considered to be more accurate and is also consistent with the one used in the greenhouse gas reporting

2019

- NMVOC emissions are calculated as described Guidebook 2016.

Source-specific planned improvements

None

Other Wastewater handling (NFR 5D3)

Changes in chapter	
March 2019	KS & JMP

No “other” wastewater handling occurs in the country.

Source-specific recalculations including changes made in response to the review process

2016

- The allocation of NMVOC emissions under NFR categories was checked to be consistent with UNFCCC CRF categories since the 2016 submission. NMVOC emissions from wastewater handling previously reported under NFR 5D3 Other wastewater handling are now reported under NFRs 5D1 and 5D2 for the whole time series.

2018

- The notation key was changed from “NA” to “NO”

6.7 Other waste (NFR 5E)

Changes in chapter	
March 2019	KS & JMP

Source category description

NFR 5 E Other covers emissions from

- house and car fires (particles, PCDD/F and heavy metals)
- latrines (NH3)

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 5.29.

Table 5.29 Contribution of Other waste (NFR 5E) to total emissions in 2017.

Pollutant	Emissions from other waste in 2017	Total emissions in 2017	Unit	Share of total emissions %	% reported by the plants
NH3	0.379	31.08332	Gg	1,2	0
PM2.5	0.107	17.79965	Gg	0,6	0
PM10	0.107	29.17878	Gg	0,4	0
TSP	0.107	43.61372	Gg	0,2	0
BC	0.009	4.113472	Gg	0,2	0
Pb	<0.001	15.57612	Mg	<0.1	0
Cd	<0.001	0.95589	Mg	<0.1	0
Hg	<0.001	0.578899	Mg	0,1	0
As	<0.001	2.439968	Mg	<0.1	0
Cr	<0.001	16.46258	Mg	<0.1	0
Cu	0.002	36.43057	Mg	<0.1	0
PCDD/ F	1.103	13.40218	g I-Teq	8,2	0

Methodological issues

<u>Car and house fires</u>

Particles

Emissions from house and car fires are calculated using emission factors: from the Guidebook 2016 as follows; car fires 2.3 kg/fire (TSP PM10,PM2.5), house fires (detached houses) 143.82 kg /fire (TSP, PM10, PM2.5), house fires (undetached houses) 61.62 kg/fire (TSP, PM10, PM2.5), house fires (apartment buildings) 43.78 kg/fire (TSP, PM10, PM2.5) and house fires (industrial buildings) 27.23 kg/fire (TSP, PM10, PM2.5). In 2016 submission the whole time series has been recalculated as result from correct emission factors in Guidebook 2016. As described in Guidebook: *Personal contact with Kristin Aasestad has provided a correction of the units which are inaccurate in the text of Aasestad (2007). Previously EF:s from Norwegian IIR has been used and the EF as a result of wrong unit has been 1000x to small. Black carbon emissions from house fires are calculated using emission factor 9% of PM2.5 (Aasestad, 2013).

Heavy metals

Emission factors for heavy metals are taken from Guidebook2016 and presented in Table 5.30

Table 5.30 Emission factors for heavy metals from house fires.

Pollutant	Unit	Emission factors for house fires (Guidebook 2016)			
		Detached houses	Undetached houses	Apartment buildings	Industrial buildings
TSP	kg/fire	143.82	61.62	43.78	27.23
PM10	kg/fire	143.82	61.62	43.78	27.24
PM2.5	kg/fire	143.82	61.62	43.78	27.23
Pb	g/fire	0.42	0.18	0.13	0.08
Cd	g/fire	0.85	0.36	0.26	0.16
Hg	g/fire	0.85	0.36	0.26	0.16
As	g/fire	1.35	0.58	0.41	0.25
Cr	g/fire	1.29	0.55	0.39	0.24
Cu	g/fire	2.99	1.28	0.91	0.57
PCDD/F	mg/fire	1.44	0.62	0.44	0.27

PCDD/F

Emission factors from car and house fires are from Guidebook 2016 and presented in Table 5.30 above.

Activity data

Activity data for 1990-2016 is presented in Table 5.31.

For house fires it is assumed based on information from Rescue Services' Fire Statistics that

26% of house fires are un-detached house fires
4% detached house fires
10% apartment building fires
18% industrial building fires[1]

The Fire Statistics were changed in 2009 resulting in a lower number of house fires compared to the previous years.

Out of vehicle fires 68% are passenger car fires (Rescue Services, 2002).

Table 5.31 Activity data: car and house fires (Rescue Services, 2017)

Year	**Car fires** (Rescue Services)	**House fires** (Rescue Services)	**Year**	**Car fires** (Rescue Services)	**House fires** (Rescue Services)
1990	1693 car fires	6 010 house fires	2006	1852 car fires	3 998 house fires
1991	1598 car fires	6 050 house fires	2007	1733 car fires	4 025 house fires
1992	1428 car fires	5 900 house fires	2008	1 618 car fires	4 485 house fires
1993	952 car fires	4 000 house fires	2009	1 632 car fires	2 736 house fires
1994	884 car fires	3 020 house fires	2010	1 658 car fires	2 786 house fires

Year	Car fires (Rescue Services)	House fires (Rescue Services)	Year	Car fires (Rescue Services)	House fires (Rescue Services)
1995	1224 car fires	3 500 house fires	2011	1 685 car fires	2 543 house fires
1996	1292 car fires	3 550 house fires	2012	2 277 car fires	2 413 house fires
1997	1353 car fires	3 020 house fires	2013	1 588 car fires	2 341 house fires
1998	1360 car fires	3 020 house fires	2014	1999 car fires	2144 house fires
1999	1530 car fires	2 900 house fires	2015	2 200 car fires	2010 house fires
2000	1632 car fires	3 010 house fires	2016	2 262 car fires	2164 house fires
2001	1768 car fires	3 040 house fires	2017	2 081 car fires	2106 house fires
2002	1836 car fires	3 040 house fires			
2003	1836 car fires	3 040 house fires			
2004	1809 car fires	3 420 house fires			
2005	1788 car fires	3 670 house fires			

Latrines

NH_3

NH3 emissions are calculated according to Guidebook 2016.

Latrines are mainly used at summer cottages in Finland. It is assumed that latrines exist at 70% of summer cottages and are used by approximately 2 persons during the summer months, i.e. 4 months per year. The number of summer cottages and NH3 emissions are presented in Table 5.32.

Table 5.32 Number of summer cottages in Finland 1990-2017 (Statistics Finland)

Year	Number of summer cottages	NH3 (kt)	Year	Number of summer cottages	NH3 (kt)
1980-84	251744	0.188	2012	496208	0.371
1985-89	251744	0.188	2013	496209	0.371
1990-94	367686	0.275	2014	500400	0.374
1995-99	416236	0.310	2015	501600	0,375
2000	450569	0.336	2016	502900	0,375
2005	474277	0.354	2017	507200	0.379

Emissions of particles, heavy metals and PCDD/F from Other Waste are presented in Table 5.33

Table 5.33 Particle, heavy metal and POP emissions from other waste (NFR 5E)

Year	TSP (Gg)	PM_{10} (Gg)	$PM_{2.5}$ (Gg)	As (kg)	Cd (kg)	Cu (kg)	Cr (kg)	Pb (kg)	Hg (kg)	PCDD/PCDF (g I-TEQ)
1990	0.30	0.30	0.30	2.77	1.74	6.14	2.64	0.86	1.74	3.03
1991	0.30	0.30	0.30	2.78	1.76	6.18	2.66	0.87	1.76	3.05
1992	0.29	0.29	0.29	2.72	1.71	6.03	2.59	0.85	1.71	2.97
1993	0.20	0.20	0.20	1.84	1.16	4.09	1.76	0.58	1.16	2.01
1994	0.15	0.15	0.15	1.39	0.88	3.09	1.33	0.43	0.88	1.53
1995	0.17	0.17	0.17	1.61	1.02	3.58	1.54	0.50	1.02	1.78
1996	0.18	0.18	0.18	1.62	1.02	3.59	1.55	0.51	1.02	1.81
1997	0.16	0.16	0.16	1.51	0.95	3.34	1.44	0.47	0.95	1.55
1998	0.16	0.16	0.16	1.48	0.94	3.29	1.42	0.46	0.94	1.55
1999	0.15	0.15	0.15	1.34	0.85	2.98	1.28	0.42	0.85	1.50

2000	0.16	0.16	0.16	1.44	0.91	3.20	1.38	0.45	0.91	1.56
2001	0.17	0.17	0.17	1.60	1.01	3.54	1.52	0.50	1.01	1.58
2002	0.17	0.17	0.17	1.58	1.00	3.52	1.51	0.49	1.00	1.58
2003	0.15	0.15	0.15	1.39	0.87	3.08	1.32	0.43	0.87	1.58
2004	0.17	0.17	0.17	1.57	0.99	3.50	1.50	0.49	0.99	1.77
2005	0.18	0.18	0.18	1.69	1.07	3.75	1.61	0.53	1.07	1.89
2006	0.20	0.20	0.20	1.84	1.16	4.09	1.76	0.57	1.16	2.05
2007	0.20	0.20	0.20	1.85	1.17	4.11	1.77	0.58	1.17	2.06
2008	0.22	0.22	0.22	2.06	1.30	4.58	1.97	0.64	1.30	2.28
2009	0.14	0.14	0.14	1.26	0.79	2.80	1.20	0.39	0.79	1.42
2010	0.14	0.14	0.14	1.28	0.81	2.85	1.22	0.40	0.81	1.45
2011	0.13	0.13	0.13	1.17	0.74	2.60	1.12	0.37	0.74	1.33
2012	0.12	0.12	0.12	1.11	0.70	2.47	1.06	0.35	0.70	1.26
2013	0.12	0.12	0.12	1.08	0.68	2.39	1.03	0.34	0.68	1.23
2014	0.11	0.11	0.11	0.99	0.62	2.19	0.94	0.31	0.62	1.12
2015	0.10	0.10	0.10	0.93	0.58	2.05	0.88	0.29	0.58	1.06
2016	0.10	0.10	0.10	0.99	0.63	2.21	0.95	0.31	0.63	1.14
2017	0.10	0.10	0.10	0.97	0.61	2.15	0.93	0.30	0.61	1.10

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of the magnitude and trends has been carried out. The quality system is implied in the calculation of 2010 emissions.

Source-specific recalculations including changes made in response to the review process

2009
- PCDD/F and PCB emissions from unintentional landfill fires were included.

2013
- NH_3 emissions from latrines were included.

2015
- Emissions from car and house fires were moved from NFR 2G (NFR09) to NFR 5E (NFR2014).

2016

- Emissions from car and house fires were recalculated as the result of correction of emission factors in Guidebook 2016.
- Emissions were reallocated to the NFR 5E from NFR 2G from the year 2014 emissions.
- Emissions from car, house and unintentional landfill fires are included in the inventory in the NFR 5E.

2017
- NH3 emissions from latrines was reallocated to 5E, however, the change was done t only for years 2014 and 2015 emissions.
- Heavy metal emissions from NFR 5E (house and car fires) were updated according Guidebook 2016. Source-specific planned improvements

2018

- No methodology is provided in the Guidebook to estimate emissions from landfill fires. The method used to calculate all emissions in the earlier submissions was considered to be uncertain and the emissions were removed to this submission.

Source specific planned improvements

Possibilities to include HCB emissions from landfill fires to the inventory are studied.

9 OTHER NFR 6A

No emissions are occurring from other anthropogenic sources.