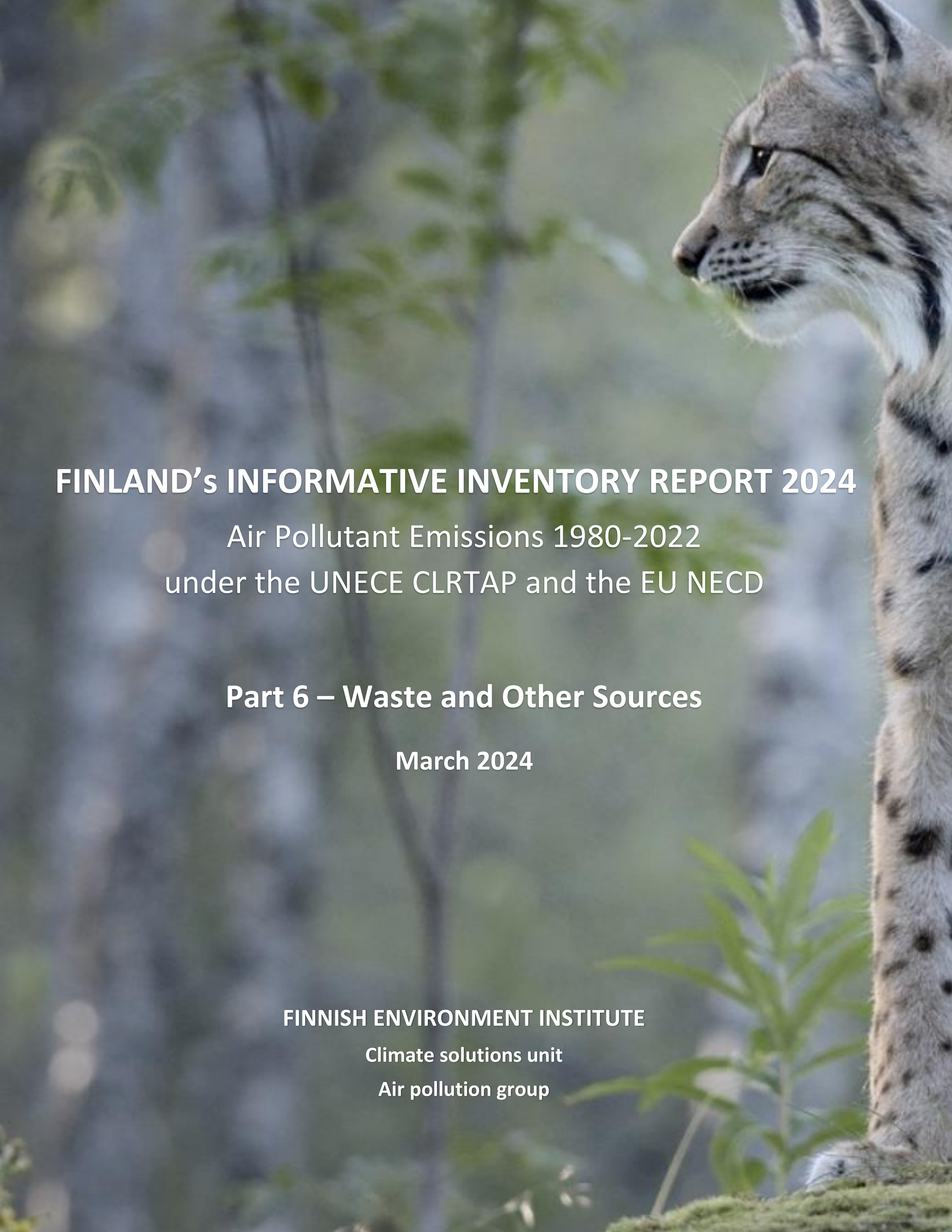

FINLAND's INFORMATIVE INVENTORY REPORT 2024

Air Pollutant Emissions 1980-2022
under the UNECE CLRTAP and the EU NECD

Part 6 – Waste and Other Sources

March 2024

FINNISH ENVIRONMENT INSTITUTE

Climate solutions unit

Air pollution group

Finland’s IIR

Part 6

Waste Sector and Other Sources

Cover page picture: Lynx (MEK 2019)

IIR - PART 6 – WASTE and OTHER SOURCES

6 WASTE (NFR 5)

7 OTHER EMISSION SOURCES (NFR 6)

Sub-chapters included under each NFR subcategory

Source category description
Emission trend
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Source-specific QA/QC and verification
Source-specific recalculations including changes in response to the review
Source-specific planned improvements

6 WASTE (NFR 5)

Changes in chapter	
March 2024	KS, JMP, TF

6.1 Source category description

Emissions from solid waste disposal on land (landfills), composting, anaerobic digestion at biogas facilities, waste incineration, cremation, wastewater treatment, latrines and other waste (house and car fires) are included in under the Waste sector inventory as presented in Table 6.1.

Emissions from waste incineration are reported under NFR 1A1a or NFR 1A2gviii because all waste incineration occurring in Finland is with energy recovery.

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

Table 6.1. Emission categories and reported emissions under NFR 5.

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, municipal and industrial sludges and industrial solid waste	NH_3
5 B 2	Biological treatment of waste – Anaerobic digestion at biogas facilities	Covers biogas reactor plants at municipal and industrial wastewater treatment plants	NH_3
5 C 1 a	Municipal waste incineration	No waste incineration occurs, all waste is combusted with energy recovery	-
5 C 1 bi	Industrial waste incineration		-
5 C 1 bii	Hazardous waste incineration	IE, emissions are allocated under energy sector, all waste incineration includes energy recovery	-
5 C 1 biii	Clinical waste incineration	Waste incineration occurred only in 1990-1993, all waste is combusted with energy recovery thereafter	-
5 C 1 biv	Sewage sludge incineration	No waste incineration occurs, all waste is combusted with energy recovery	-
5 C 1 bv	Cremation	Part of the emissions IE (under 1A1)	$PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/F, PAH-4, PCB, HCB
5 C 1 bvi	Other waste incineration	Not occuring	-
5 C 2	Open burning of waste	Not Occuring	-
5 D 1	Domestic wastewater handling	Wastewater handling, domestic, latrines	NMVOC, NH_3
5 D 2	Industrial wastewater handling	Wastewater handling, industrial	NMVOC
5 D 3	Other wastewater handling	Not Occuring	-
5 E	Other waste	Car and house fires	$PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, PCDD/F

Information on population as background data is presented in Table 6.2 for both urban and total population.

Table 6.2. Background data (total population and population in urban areas) related to the waste sectors in 1990-2022 (Statistic Finland, 2024).

Year	Total population	Urban population	Year	Total population	Urban population
1990	4998478	3095607	2007	5300484	3547955
1991	5029002	3127655	2008	5326314	3583254
1992	5054982	3153984	2009	5351427	3613215
1993	5077912	3182285	2010	5375276	3641874
1994	5098754	3211868	2011	5401267	3674047
1995	5116826	3242380	2012	5426674	3708852
1996	5132320	3267456	2013	5451270	3741991
1997	5147349	3294625	2014	5471753	3772872
1998	5159646	3320011	2015	5487308	3797978
1999	5171302	3347508	2016	5503297	3829719
2000	5181115	3372096	2017	5513130	3856747
2001	5194901	3401057	2018	5517919	3881481
2002	5206295	3423255	2019	5525292	3964111
2003	5219732	3444416	2020	5533793	3992546
2004	5236611	3467411	2021	5548241	4012715
2005	5255580	3491993	2022	5563970	4044568
2006	5276955	3519288			

6.2 Solid waste disposal on land (NFR 5A)

Changes in chapter	
March 2024	KS, JMP, TF

Source category description

Under NFR 5A Finland reports NMVOC, TSP, PM_{10} and $PM_{2.5}$ 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.

The category is not a key category for any pollutants.

Emission trend

After the implementation of the revised Waste Act (1994), the Landfill Directive (1999/31/EC) and the ban of organic waste to landfills since 2016 (Government Decree 2013) 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. The increase of waste incineration has decreased the emissions from landfills from 2008 onwards.

NMVOC and particle emissions from NFR 5A are presented in Figure 6.1. Particle emissions follow the trend of the amount of landfilled waste.

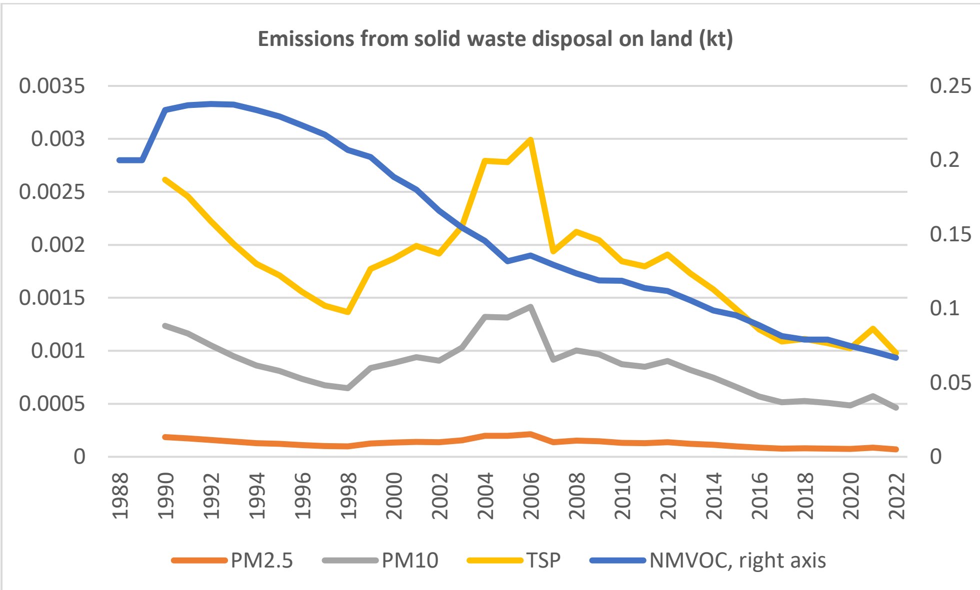

Figure 6.1. NMVOC and particle emissions reported under NFR 5A.

Contribution of NFR 5A to total emissions and the shares of emissions reported by the plants are presented in Table 6.3.

Table 6.3. Contribution of Biological treatment of waste – solid waste disposal on land (NFR 5A) to total emissions in 2022.

Pollutant	Emissions from solid waste disposal on land	Total emissions	Unit	Share of total emissions %	% reported by the plants
NMVOC	0.067	75.464	Gg	<0.1	0
PM2.5	<0.001	13.384	Gg	<0.1	0
PM10	<0.001	26.778	Gg	<0.1	0
TSP	<0.001	42.014	Gg	<0.1	0

Methodological issues

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 NID (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 (Eklund. et all, 1998), in Germany in 1999 (Schweigkofler, 1999) and in Finland in 1990

(Asshmuth, 1990), and has been estimated to correspond sufficiently to the Finnish conditions. In 2005 a study was carried out on the concentration because the Guidebook default value at that time, 5650 mg/m^3, was considered unsuitable for the Finnish conditions. The study resulted in the value of 485 mg/m3, which still may overestimate a bit, but was considered much more suitable for domestic landfills. Since 2016, according to the Government decree on landfills (331/2013), only soil and rock material that can be used in the construction of the landfill site can be landfilled. Landfilling of other waste is not allowed but shall be recycled for the material or co-combusted for energy purposes.

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 activity data used in the calculation are taken from the YLVA (formerly VAHTI) system. It includes information on all landfills in Finland excluding Åland, which is estimated according to the population. YLVA contains data on the total amounts of waste taken to landfills from 1997 onwards. In YLVA, the waste amounts 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 of the YLVA system to the classification used in the emission estimations. Corresponding data (but with volume units and a less detailed waste classification) for 1992 to 1995 were collected to the Landfill Registry of Syke. The activity data for municipal waste for 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 data (part of industrial paper waste was classified as municipal waste). The disposal data (amount and composition) at the beginning of the 1990s for industrial, construction and demolition waste are based on surveys and research by Statistics Finland (Isaksson 1993; Puolamaa et al. 1995), VTT (Perälä & Nippala 1998; Pipatti et al. 1996) and the National Board of Waters and the Environment (Karhu 1993). For the base year, activity data from studies by Isaksson (1993) and Pipatti et al. (1996) are used for construction and demolition waste, by Karhu (1993 for industrial sludges, and by Puolamaa et al. (1995) for solid industrial waste. (Finland's NID 2024)

The amount of landfilled waste in is presented in Table 6.4. As it can be seen in Table 6.4 the amount of municipal solid waste has decreased significantly since 1990. This is due the increased energy use of wastes and this trend will continue in the future, also.

Table 6.4. Landfilled waste (1 000 t). Sources: YLVA 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. (Finland's NID, 2024).

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	1 528	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	1 345	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	1 358	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	3 435	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**	**2018**	**2019**	**2020**
Municipal solid waste	1095	1033	885	685	451	318	78	19	15	25	15
Municipal sludge (d.m.)	3	2	3	3	2	5	1	0.2	0.1	0.1	0.1
Municipal sludge (wet m.)	22	23	22	22	17	14	7	3	2	2	3
Industrial sludge (d.m.)	26	27	32	32	19	7	3	4	3	2	4
Industrial sludge (wet m.)	82	78	96	94	42	20	10	10	11	11	21
Industrial solid waste	3135	3202	3227	3019	2947	2907	2862	2688	2629	2466	2622
Constr. and demol. waste	349	240	244	192	182	163	102	112	116	132	101
Waste group	**2021**	**2022**									
Municipal solid waste	13	11									
Municipal sludge (d.m.)	0.1	0.1									
Municipal sludge (wet m.)	2	3									
Industrial sludge (d.m.)	2	2									
Industrial sludge (wet m.)	9	7									
Industrial solid waste	2824	2474									
Constr. and demol. waste	97	98									

Particle emissions

Particle emissions are calculated using the default emission factors from the EMEP/EEA Emission Inventory Guidebook 2023 and landfilled waste amounts (municipal and industrial solid waste and construction and demolition waste) and are presented in Table 6.5.

Table 6.5. Calculated particle emissions from solid waste disposal on land.

Year	TSP (t)	PM_{10} (t)	$PM_{2.5}$ (t)	Year	TSP (t)	PM_{10} (t)	$PM_{2.5}$ (t)
1990	2.6	1.2	0.2	2007	1.9	0.9	0.1
1991	2.5	1.2	0.2	2008	2.1	1.0	0.2
1992	2.2	1.1	0.2	2009	2.0	1.0	0.1
1993	2.0	0.9	0.1	2010	1.8	0.9	0.1
1994	1.8	0.9	0.1	2011	1.8	0.8	0.1
1995	1.7	0.8	0.1	2012	1.9	0.9	0.1
1996	1.6	0.7	0.1	2013	1.7	0.8	0.1
1997	1.4	0.7	0.1	2014	1.6	0.7	0.1
1998	1.4	0.6	0.1	2015	1.4	0.7	0.1
1999	1.8	0.8	0.1	2016	1.2	0.6	0.1
2000	1.9	0.9	0.1	2017	1.1	0.5	0.1
2001	2.0	0.9	0.1	2018	1.1	0.5	0.1
2002	1.9	0.9	0.1	2019	1.1	0.5	0.1
2003	2.2	1.0	0.2	2020	1.0	0.5	0.1
2004	2.8	1.3	0.2	2021	1.2	0.6	0.1
2005	2.8	1.3	0.2	2022	1.0	0.5	0.1

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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.

2020

- NMVOC 2017 were recalculated due to update in activity data (minor decrease in emissions)

2023

- More detailed information on estimation of NMVOC emissions from landfills is included.

Source-specific planned improvements

None.

6.3 Composting (NFR 5B1)

Changes in chapter	
March 2024	KS, JMP, TF

Source category description

NH_3 emissions from composting are included in the category from year 1980 onwards. The shares of emissions for each air pollutant reported under the NFR category are presented in Table 6.6. The category is not a key category for NH_3.

Table 6.6. Contribution of Biological treatment of waste - Composting (NFR 5B1) to total emissions in 2022.

Pollutant	Emissions from composting	Total emissions	Unit	Share of total emissions %	% reported by the plants
NH_3	0.087	31.583	Gg	0.3	0

Emission trend

The NH_3 emission trend (Figure 6.2) from composting increased after the early 1990s due to the increased composting especially in semi-urban areas, which results from separate collection of organic waste. During the last ten years, the emissions have had a decreasing trend due to the growing share of anaerobic digestion. In 2019, the emissions increased due to changes in the treatment processes in a one major biological treatment plant.

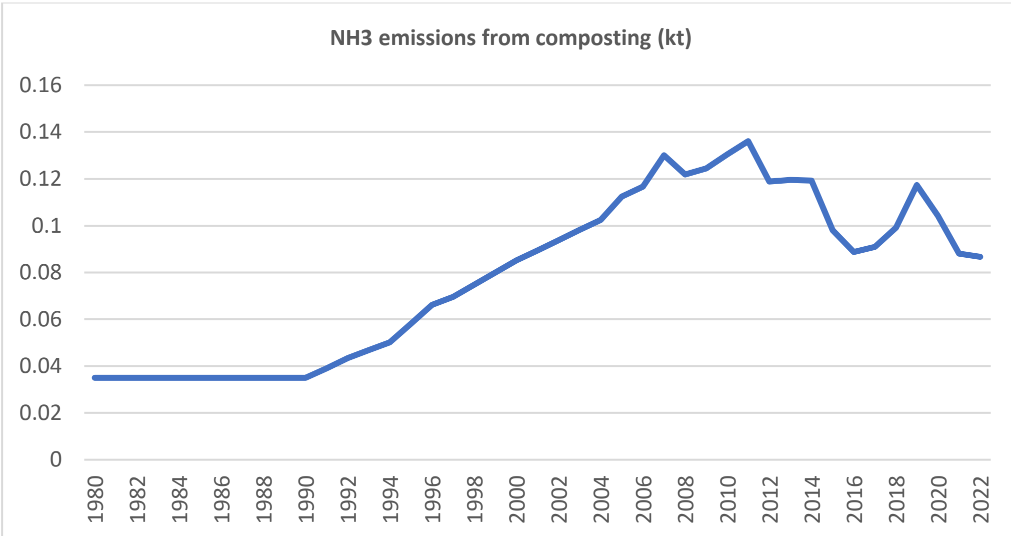

Figure 6.2. NH_3 emissions from composting 1980-2022.

Methodological issues

NH_3 emissions

The emissions are calculated for the whole time series using the emission factor of 0.24 kg/Mg organic waste from the 2023 Guidebook. The activity data is presented Table 6.7 and the emissions in Table 6.8.

Table 6.7. Composted waste with auxiliary matter in 1990-2022 by subcategory (1000 t). (Finland's NID, 2024).

	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**	**2018**	**2019**
Municipal solid waste	304	319	304	317	317	247	217	231	252	305
Municipal sludge (d.m.)	143	137	122	128	120	113	95	102	99	113
Industrial sludge (d.m.)	38	33	22	22	25	25	17	12	13	20
Industrial solid waste	60	77	47	31	35	24	40	34	49	51
	2020	**2021**	**2022**							
Municipal solid waste	288	228	207							
Municipal sludge (d.m.)	95	91	66							
Industrial sludge (d.m.)	21	19	50							
Industrial solid waste	30	29	38							

Table 6.8. NH_3 emissions from composting 1990-2022.

Year	NH_3 emission (kt)	Year	NH_3 emission (kt)	Year	NH_3 emission (kt)	Year	NH_3 emission (kt)
1990	0.035	2000	0.085	2010	0.131	2020	0.104
1991	0.039	2001	0.089	2011	0.136	2021	0.104
1992	0.043	2002	0.094	2012	0.119	2022	0.087
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	0.091		
1998	0.075	2008	0.122	2018	0.099		
1999	0.080	2009	0.124	2019	0.117		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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

2009
- NH_3 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 NH_3 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%).

2020
- For year 2017 the amounts of composted waste were updated resulting in minor increase in NH3 emissions. Due the lack of activity data the same amounts of composted waste were used for years 2017 and 2018.

2021
- Amounts of composted waste in 2018 were updated.

2022
- Amount of composted waste in 2019 were updated.

2023
- Amount of composted waste in 2020 were updated.

2024
- Amount of composted waste in 2021 were updated. During the NECD Review 2023 the TERT noticed that there was an inconsistency between the trend of NH_3 emissions and the development of activity data (kt composted) as reported in the NFR Tables for years 2019, 2020 and 2021. The AD in the NFR tables has been checked and corrected.

Source-specific planned improvements

None.

6.4 Anaerobic digestion at biogas facilities (NFR 5B2)

Changes in chapter	
March 2024	JG, TF, JMP

Source category description

The category covers NH_3 emissions from biogas reactor plants at municipal and industrial wastewater treatment plants, municipal solid waste biogas plants, sewage sludge plants and as farm-scale plants.

At the beginning of 2023, most of all biomethane and biogas was produced in plants using sewage sludge and biowaste as feedstock. The total number of biogas plants was 85: 34 farm-scale plants, 6 at industrial wastewater treatment plants, 28 biogas plants for co-treatment of municipal solid waste and sewage sludge, and 17 sewage sludge plants (Finnish Biocycle and Biogas Association, 2023)

The share of NH_3 emissions reported under the NFR category 5B2 are presented in Table 6.9. The category is not a key category for NH_3.

Table 6.9. Contribution of Biological treatment of waste – Anaerobic digestion at biogas facilities (NFR 5B2) to total emissions in 2022.

Pollutant	Emissions	Total emissions	Unit	Share of total emissions %	% reported by the plants
NH_3	0.242	31.042	Gg	0.7	0

Emission trend

The NH_3 emission trend (Figure 6.3) from biogas facilities has increased strongly after the early 2000s due to the increase in anaerobic treatment of sewage sludge, and because anaerobic treatment of other organic wastes (municipal organic waste, food waste, animal-based sludge) became more common. The share of livestock manures is small, comprising approximately 10% of all produced biogas (in 2022).

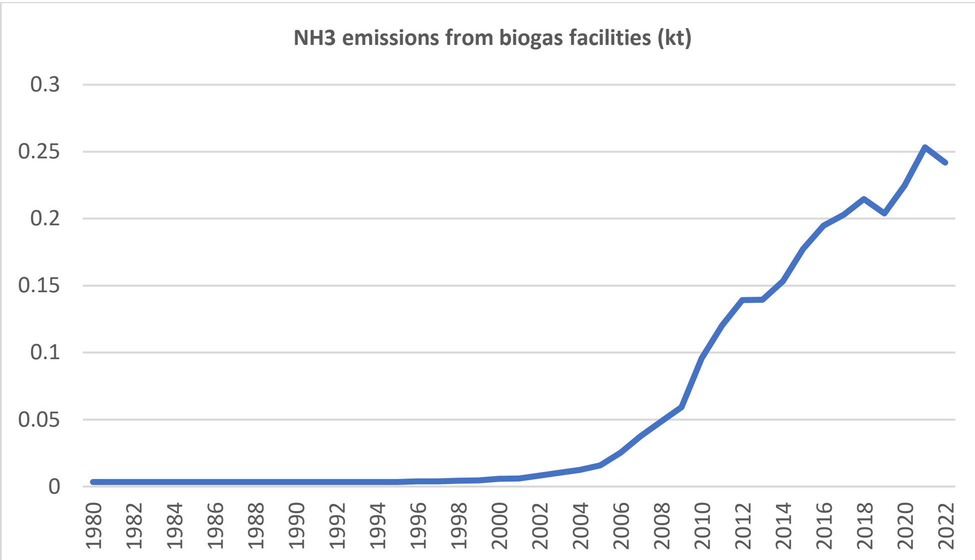

Figure 6.3. NH_3 emissions from biogas facilities 1990-2022.

Methodological issues

NH_3 emissions

The emissions are calculated for the whole time series using the emission calculation methods described in the 2023 Guidebook. Calculation includes NH_3 emissions from the following sources:

- storage of feedstock on the premises of the biogas facility;
- storage of the digestate.

For 5.B.2, the Tier 2 approach is used.

The Tier 2 approach estimates the total emission, E_{NH3} (in kg NH_3 per year), from:

$$E_{\mathrm{NH3}} = AR_{\mathrm{feedstock}} \times \sum_{\mathrm{stages}} EF_{\mathrm{NH3\text{-}N,\,stage\ i}} \times 17/14$$

where $AR_{feedstock}$ is the total annual amount of N in feedstock, in kg a^{-1}; and $EF_{NH3\text{-}N}$, stage i is the NH_3-N EF for stage i (i is the pre-storage, and storage of digestate) related to the total N in feedstock (kg NH_3-N per kg total N).

Emission factor of 0.0009 kg NH_3-N per kg N in feedstock is used for pre-storage of feedstock, and emission factor of 0.0266 kg NH_3-N per kg N in feedstock is used for storage of digestate.

The digestion of manures is calculated separately from the digestion of other organic wastes and of energy crops because the manure calculation in 5.B.2 is linked with the calculation of manure management (3.B) and manure application (3.D.a.2.a).

For digested manures, the TAN and total-N in manure (TAN_{sub} and N_{tot} respectively, kg a^{-1}) are:

$TAN_{sub} = m_{biogas\_slurry\_TAN} + m_{biogas\_solid\_TAN}$

$N_{sub} = m_{biogas\_slurry\_N} + m_{biogas\_solid\_N}$

where $m_{biogas\_slurry\_TAN}$, $m_{biogas\_solid\_TAN}$, $m_{biogas\_slurry\_N}$ and $m_{biogas\_solid\_N}$ are obtained from the manure management calculation module of the agricultural emission calculation system.

The TAN in digestate that is returned to agricultural emission calculation system is calculated using the equation:

$m_{dig\_TAN} = TAN_{sub} + f_{min} \times (N_{tot} - TAN_{sub}) – (E_{NH3} \times 14/17)$

where m_{dig_TAN}: TAN in digestate after storage in kg a^{-1}
f_{min}: relative share of organic N entering the digester that is mineralized to TAN in the digester in kg kg^{-1}
E_{NH3}: NH_3 emitted in kg a^{-1}, calculated from total N

The total-N in digestate that is returned to agricultural emission calculation system is:

$m_{dig\_N} = N_{tot\_dig} – (E_{NH3} \times 14/17)$

Because no national data are available for f_{min}, a value of 0.32 for the N-mineralization of organic N in manures digested in biogas plants is used.

TAN flow for digestion is calculated separately for the different animal categories.

For digested energy crops and waste, $N_{tot,dig}$ in digestate after storage is calculated using equation:

$N_{tot,dig} = N_{tot,sub} – (E_{NH3} \times 14/17)$

$N_{tot,dig}$: Total amount of N in digestate after storage in kg a^{-1}
$N_{tot,sub}$: Total amount of N in the feedstock entering 5.B.2 in kg a^{-1}
E_{NH3}: Ammonia emitted during storage, in kg a^{-1}

The activity data (amounts of wastes) is presented Table 6.10 and the emissions in Table 6.11.

The following total nitrogen (tot-N) concentrations (kg tot-N/kg biomass fresh weight) and dry matter content (% dry matter of fresh weight) are used for different anaerobically digested biomasses:

	kg N/kg FW	DM (% of FW)
Municipal organic waste	0.006	28%
Green waste	0.005	27%
Food waste (food processing)	0.005	40%
Sewage sludge	0.002	3%
Animal-based sludge	0.008	20%
Waste from beverage manufacturing	0.007	11%
Waste from bakeries	0.017	75%
Milk processing and milk waste	0.003	6%

Other grease wase	0.001	40%
Grass silage	0.008	30%
Grass from set-asides	0.005	40%
Straw	0.005	90%

The properties of food waste are sourced from the Guidebook, while the other values are based on the following report (in Finnish):
Final report of the biogas working group
Publications of the Ministry of Economic Affairs and Employment 2020:3
https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162032/TEM_2020_3_Biokaasuohjelmaa%20valmistelevan%20tyoryhman%20loppur%20.pdf?sequence=1&isAllowed=y

For the year 2022, the amounts of total nitrogen in the anaerobically digested masses were as follows (tonnes tot-N):

- Livestock manure: 714
- Municipal solid/organic waste: 1 726
- Municipal/sewage sludge: 3 336
- Industrial sludge (animal-based sludge): 454
- Industrial solid/organic waste (food waste): 1 016

Table 6.10. Anaerobically treated waste in 1990-2022 by subcategory (1000 t). (Finland's NID, 2024).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Municipal solid waste	0	0	0	0	0	0	0	0	0	0
Municipal sludge (d.m.)	1.8	1.8	1.8	1.8	1.8	1.8	2.0	2.1	2.3	2.5
Industrial sludge (d.m.)	0	0	0	0	0	0	0	0	0	0
Industrial solid waste	0	0	0	0	0	0	0	0	0	0
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Municipal solid waste	3.8	5.0	15.0	25.0	35.0	42.4	47.0	54.0	61.0	68.0
Municipal sludge (d.m.)	2.6	2.6	2.7	2.7	2.8	2.9	7.0	11.0	15.0	19.0
Industrial sludge (d.m.)	0	0	0	0	0	0.5	0.6	0.6	0.7	0.7
Industrial solid waste	0	0	0	0	0	5.0	10.0	30.0	40.0	50.0
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Municipal solid waste	72.2	92.3	100.6	90.4	108.0	177.6	204.5	205.6	204.6	202.7
Municipal sludge (d.m.)	22.6	32.1	40.1	39.6	45.7	49.8	55.1	51.0	50.6	49.9
Industrial sludge (d.m.)	0.8	3.3	4.4	5.1	3.6	4.4	2.8	13.4	21.5	16.8
Industrial solid waste	66.1	61.7	64.4	75.9	78.3	80.4	108.4	119.0	131.4	116.1
	2020	**2021**	**2022**							
Municipal solid waste	223.6	253.5	278.4							
Municipal sludge (d.m.)	54.4	66.9	59.3							
Industrial sludge (d.m.)	18.8	14.5	11.3							
Industrial solid waste	151.2	180.7	199.3							

Table 6.11. NH_3 emissions from biogas facilities 1990-2022.

Year	NH_3 emission (t)	Year	NH_3 emission (t)	Year	NH_3 emission (t)	Year	NH_3 emission (t)
1990	0.0034	2000	0.0057	2010	0.0936	2020	0.2247

1991	0.0034	2001	0.0059	2011	0.1202	2021	0.2532
1992	0.0034	2002	0.0082	2012	0.1392	2022	0,2420
1993	0.0034	2003	0.0102	2013	0.1393		
1994	0.0034	2004	0.0125	2014	0.1534		
1995	0.0034	2005	0.0157	2015	0.1774		
1996	0.0038	2006	0.0253	2016	0.1950		
1997	0.0039	2007	0.0378	2017	0.2030		
1998	0.0043	2008	0.0485	2018	0.2147		
1999	0.0047	2009	0.0592	2019	0.2040		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 of the IIR.

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

2022
- Calculation of NH_3 emissions included as response to the TERT 2019/2020 recommendations.

2023
- Amount of anaerobically treated waste has been updated for 2020.

2024
- Amounts of anaerobically treated wastes have been updated for the years 2014-2021, based on the data in the most recent Finland's NID, affecting the NH_3 emissions.
- The calculation of NH_3 emissions from the biological treatment of waste by anaerobic digestion at biogas facilities has been adjusted to include the manure that is removed from dry lots, which was erroneously excluded previously (only the manure managed in-house was considered). This adjustment slightly alters the results for the entire time series, particularly for animals where a portion of the manure ends up in the dry lot. Additionally, changes in nitrogen excretion rates of livestock animals also lead to some adjustments in NH_3 emissions from anaerobic digestion (see Chapter 5.4).

Source-specific planned improvements

None.

6.5 Waste Incineration (NFR 5C)

Changes in chapter	
March 2024	KS, JMP, TF

Source category description

All waste incineration in Finland includes energy recovery and the emissions are therefore reported under NFR 1A1a or NFR 1A2gviii. Only one waste incineration plant with no energy recovery has actually been in operation in Finland between the years 1969-1983 and these emissions are reported as IE under NFR 5C1a for the years 1980-1983. The only exception is ammonia, for which emission figures for 1980-1983 are reported under 5C1a. The emissions for this plant are based on data that the plant reported to the supervising authorities' data system YLVA.

The amount of landfilled municipal waste has decreased significantly (see Table 6.4 in chapter 6.2). The number of waste co-combusting plants with energy recovery has increased during the last decade for many reasons, e.g. due to implementation of the revised Waste Act, the revision of the Environmental Protection Act and the ban of organic waste to landfills since 2016 in addition to the rising cost of traditional fuels. Today there are more than 20 waste co-incineration plants in Finland. Typically, waste incineration occurs in peat and biomass firing boilers. The annual amount of waste co-incinerated is currently about 300,000 to 400,000 t/a. For more details, see IIR Part 2 Energy, chapter "Energy use of waste".

Under the NFR 5C waste incineration categories, the following emissions are reported:

- Particle, heavy metal and POP emissions from cremation (NFR 5C1bv) from 1990 onwards
- Heavy metal and POP emissions from clinical waste incineration (NFR 5C1biii) for 1990-1993

Municipal waste incineration (NFR 5C1a)

Changes in chapter	
February 2024	KS, JMP

Source category description

All waste incineration in Finland includes energy recovery and the emissions are reported under NFR 1A1a or NFR 1A2gviii. The category is not a key category for any pollutants.

Methodological issues

SO_2, NO_x, NMVOC, particle and heavy metal emissions

SO_2, NO_x, NMVOC, particle and heavy metal emissions are reported by the plants according to the monitoring requirements in the environmental permits. In the cases where there are no reported emissions, the emissions are calculated from the fuel use of the plants with domestic emission factors. Details of the methodologies used in the emission estimation are presented in the IIR Part 2 Energy.

PCB and HCB

PCB and HCB emissions are calculated from the annually incinerated municipal solid waste (data available from Statistics Finland) using Guidebook 2023 emission factors. The emissions are reported under NFR 1A2gviii.

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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 5C1biii) 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.

2020

- update of emission factors for HCB and PCB according to Guidebook 2019.

2021

- update of activity data from 2015-2018.

Source-specific planned improvements

None.

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

Changes in chapter	
February 2024	KS. JMP

Source category description

All waste incineration in Finland includes energy recovery. The emissions are reported under NFR 1A1a or NFR 1A2gviii, while the methodology to calculate the emissions is presented below.

Methodological issues

SO_2, NO_x, NMVOC, Particle and heavy metal emissions

SO_2, NO_x, NMVOC, particle and heavy metal emissions are reported by the plants according to the monitoring requirements in the environmental permits in the YLVA database. In the cases where there are no reported emissions, the emissions are calculated from the fuel use of the plants with domestic emission factors. Details of the methodologies used in the emission estimation are presented in the IIR Part 2 Energy.

PCB and HCB emissions

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.

Amounts of incinerated industrial sludges are presented in Table 6.12 (source Statistics Finland for years 2004-2006 and for 2008-2020).

For years 1990-2003, 2007, and 2014 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. When no official statistics available, waste amounts can be overestimated. 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 and HCBs containing sludges are incinerated in waste incineration plants. HCB and PCB emissions (Table 6.13) are calculated for industrial sludges using the emission factor provided in the Guidebook 2023.

Table 6.12. Amount of incinerated industrial waste and industrial sludges (t) (Statistics Finland, 2023).

Year	Incinerated sludge (t)	Incinerated sludge containing PCB/HCB (t)
1990	299288	29929
1991	299288	29929
1992	299288	29929
1993	299288	29929
1994	336699	33670
1995	374110	37411
1996	374110	37411
1997	406658	40666
1998	411521	41152
1999	341263	34126
2000	446687	44669
2001	432000	43200
2002	377975	37797
2003	302407	30241
2004	437200	43720
2005	631700	31585
2006	520400	26020
2007	549082	27454
2008	888000	44400
2009	516000	25800
2010	503000	25150
2011	470000	23500
2012	542000	27100
2013	690027	34501
2014	516065	25803
2015	85850	4293
2016	49619	2481
2017	63623	3181
2018	131526	6576
2019	87997	4400
2020	86943	4350
2021	86943*	4350

2022	86943*	4350

**2020 values have been used*

Table 6.13. 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	0.020	0.019
1996	0.095	0.176	2016	0.012	0.011
1997	0.012	0.191	2017	0.015	0.014
1998	0.200	0.193	2018	0.031	0.030
1999	0.055	0.160	2019	0.020	0.020
2000	0.329	0.210	2020	0.020	0.020
2001	0.218	0.203	2021	0.020	0.020
2002	0.283	0.178	2022	0.020	0.020
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.

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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.

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

2018
- HCB and PCB emissions recalculation using Guidebook 2016 methods

2021
- update of activity data prior to 2015, the earlier years are expert estimates

2022
-update of activity data for 2019
-2024
-update of activity data for 2020

Source-specific planned improvements

None.

Clinical waste incineration (NFR 5C1biii)

Changes in chapter	
March 2024	KS, JMP, TF

Source category description

Clinical waste incineration occurred in Finland until 1994, where after clinical waste incineration units were closed down. Thereafter clinical waste 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.

The category is not a key category for any pollutants.

Methodological issues

Activity data

Activity data is an assumption based on an expert estimate (SYKE/Merilehto Kirsi, 2000 Table 6.14).

Table 6.14. Volume of incinerated clinical waste 1990-1993 (expert estimate, Merilehto 2000).

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

Heavy metals
Heavy metals emissions from 1990-1993 are reported by the plants according to the monitoring requirements in the environmental permits.

POP compounds
PCDD/F, PAH-4, 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 the early 1990s than the Guidebook EFs. The EFs in the Guidebook are presented in the brackets. Note, that for PCB, Guidebook emission factors have been used since no other EFs have been available.

PCDD/F 7 µg I-TEQ /t (SYKE, 2001) (GB23 3 mg I-TEQ/Mg)
PAH-4 20 mg/t (EEA, 2002) (GB23 0.04 mg/Mg)
HCB 2.9 mg/t (Bailey, 2001) (GB23 0.1 g/Mg)
PCB 20 mg/t (GB23)

Emissions from clinical waste incineration 1990-1993 are presented in Table 6.15.

Table 6.15. HCB, PCB, PCCD/Fs and PAH emissions from clinical waste incineration 1990-1993.

Year	HCB (kg)	PCB (kg)	PCDD/F (ug I-TEQ)	PAH-4
1990	0.029	0.2	0.07	0.2
1991	0.029	0.2	0.07	0.2
1992	0.029	0.2	0.07	0.2
1993	0.029	0.2	0.07	0.2
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 6 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.

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.

Sewage sludge incineration (NFR 5C1biv)

No sewage sludge incineration occurs in the country.

Cremation (NFR 5C1bv)

Changes in chapter	
March 2024	KS, JMP, TF

Source category description and explanation of emission trends

Emissions from cremation are calculated from 1990 onwards. The shares of emissions for each pollutant reported under the NFR category are presented in Table 6.16.

Cremation is a key category for mercury emissions according to the level and trend (Approach 1). NOx, NMVOC, SO_x are reported under 1A1a/1A2gviii.

Table 6.16 Contribution of Cremation (NFR 5C1bv) to total emissions in 2022.

Pollutant	Tier	Emissions from cremation	Total emissions	Unit	Share of total emissions %	% reported by the plants
$PM_{2.5}$	T1	0.001	13.384	Gg	<0.1	0
PM_{10}	T1	0.001	26.778	Gg	<0.1	0
TSP	T1	0.002	42.014	Gg	<0.1	0
BC	T1	<0.001	3.121	Gg	<0.1	0
Pb	T1	0.001	12.516	Mg	<0.1	0
Cd	T1	<0.001	0.779	Mg	<0.1	0
Hg	T2/T3	0.027	0.505	Mg	5.4	0
As	T1	<0.001	1.92	Mg	<0.1	0
Cr	T1	<0.001	14.905	Mg	<0.1	0
Cu	T1	<0.001	38.391	Mg	<0.1	0
Ni	T1	<0.001	9.917	Mg	<0.1	0
Se	T1	<0.001	0.419	Mg	0.2	0
Zn	T1	0.006	131.533	Mg	<0.1	0
PCDD/F	T1	0.001	9.497	g I-Teq	<0.1	0
PAHs	T1	0.001	18.531	Mg	<0.1	0
HCB	T1	0.006	29.245	kg	<0.1	0
PCBs	T1	0.016	19.922	kg	<0.1	0

Emission trends

Cremation was not common in Finland in the 1990s and the number of cremations has gradually been increasing only since the beginning of the 2000s (Figure 6.4). Due to the low number of cremations, the first abatement technique (activated carbon filters) in a crematorium was installed in 2013. Since 2020 activated carbon filters have been used in seven out of the thirteen existing crematoria, while there is no abatement technique in the rest of the crematoria. The numbers of cremations each year in each of these 13 crematoria are available from the association of Finnish Congregations.

Emission trends are presented in Figure 6.4.

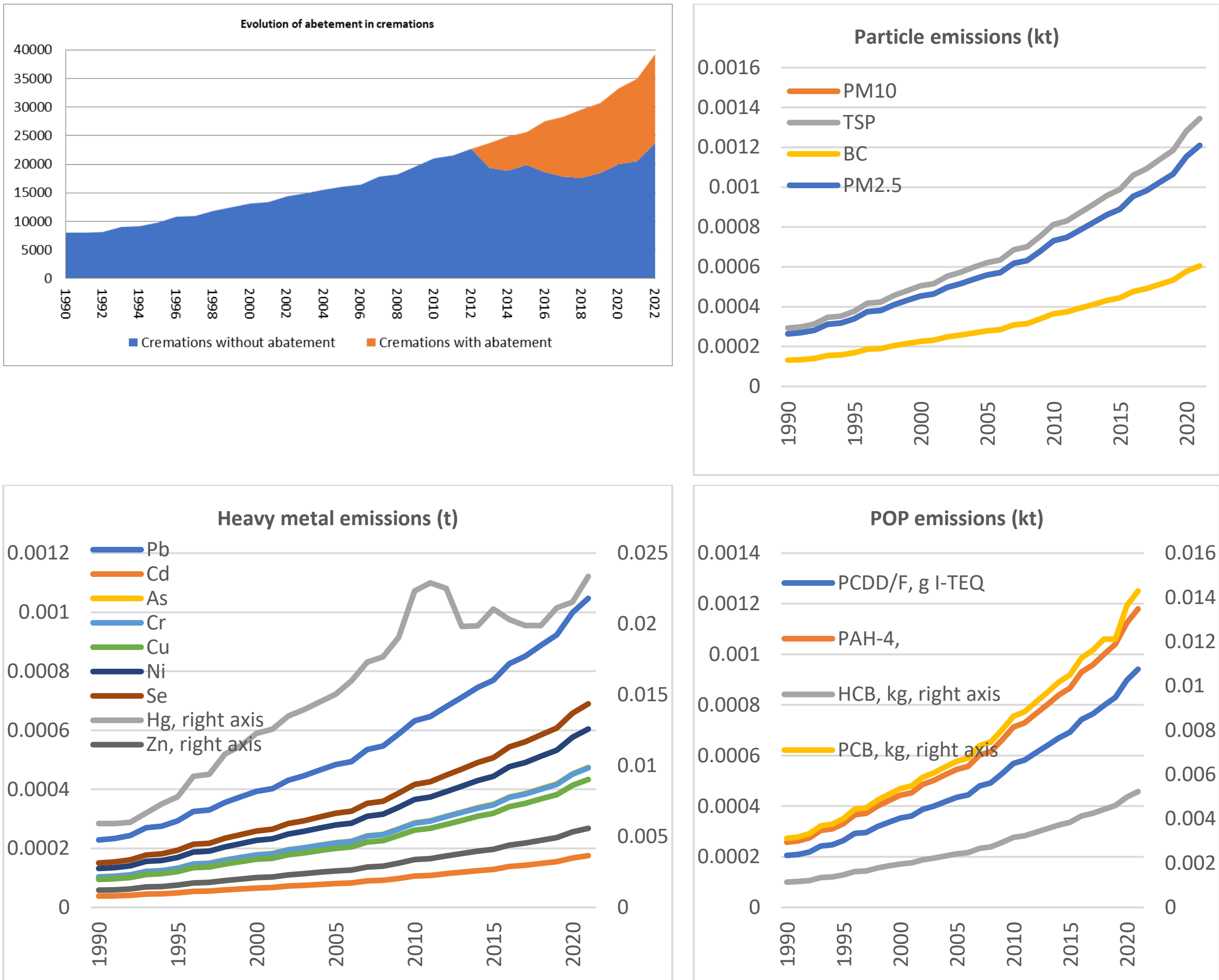

Figure 6.4. Emissions from Cremation 1990-2022.

Methodological issues

Mercury emissions from crematoria

The use of amalgam in dental fillings has been low before the 1950s in Finland and then it has decreased again since the early 2000s to almost zero today, being in 2013 only 3% of all fillings. In 2018 a ban of amalgam (EU Regulation 2017/852) was stipulated for persons of 15 years old or younger as well as for pregnant women. Most amalgam fillings in teeth have those born in 1940-1950, i.e. those currently older than 65 years.

In the calculation, the population numbers from 1990 have been divided into 3 groups: those older than 65 years, those 15-64 years and those younger than 15 years. For these three groups, the factors of 1, 0.5 and 0 have been used to quantify the cremations including amalgam tooth fillings: all in the age group >65 years, half of the age group 15-64 years and none in the age group <15 yrs. This may still lead into an overestimate (e.g. due to missing teeth). but is a considerably smaller overestimation than using only the Tier 1 emission factor for all cremations.

The emission factor of 1.48 g/cremation (without abatement from Guidebook 2023) has been used for crematoria without abatement technique and the country specific emission factor of 0.59 g Hg/cremation for those cremations in crematoria with activated carbon filters. The country specific emission factor is based on Swedish emission measurements[1], which result in concentrations below 0.1 mg/m^3(n), the removal efficiency of the activated carbon filters being 96-99.5% (Wängberg, 2013). Mercury emissions are presented in Table 6.18.

Activity data

The number of incinerated corpses is received from the Finnish Congregations (Finnish Congregations, 2023) by each crematoria, and out of these an annual share is calculated from cremations in crematoria with abatement and those without abatement (Table 6.17 and Figure 6.44).

Table 6.17. Cremations per year and annual shares with/without abatement (activated carbon).

	All	Without abatement	With abatement	Share abated		All	Without abatement	With abatement	Share abated
1990	8000	8000	0	0	2007	17796	17796	0	0
1991	8000	8000	0	0	2008	18199	18199	0	0
1992	8121	8121	0	0	2009	19561	19561	0	0
1993	8986	8986	0	0	2010	21068	21068	0	0
1994	9163	9163	0	0	2011	21540	21540	0	0
1995	9774	9774	0	0	2012	22648	22648	0	0
1996	10823	10823	0	0	2013	23702	19345	4357	0.184
1997	10977	10977	0	0	2014	24822	18900	5922	0.239
1998	11834	11834	0	0	2015	25631	19839	5792	0.226
1999	12466	12466	0	0	2016	27483	18600	8883	0.323
2000	13084	13084	0	0	2017	28336	17877	10459	0.369
2001	13391	13391	0	0	2018	29550	17539	12011	0.406
2002	14354	14354	0	0	2019	30733	18504	12229	0.398
2003	14847	14847	0	0	2020	33246	19249	13296	0.400
2004	15508	15508	0	0	2021	34861	20513	14348	0.416
2005	16108	16108	0	0	2022	39235	23683	15552	0.396
2006	16459	16459	0	0					

Particles, POPs and heavy metals

All emissions are calculated with the 2023 Guidebook EFs.

Particle and heavy metal emissions from cremation are presented in Table 6.18 and POP emissions in Table 6.19.

Table 6.18. 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	5914	228	38	104	103	95	132	151	1218
1991	0.299	0.269	0.269	0.135	5913	233	39	106	105	97	135	154	1243

[1] Source: Swedish IIR 2022. The emission level of 0.59 g Hg/cremation has been verified by the Finnish Crematoria Foundation.

1992	0.313	0.282	0.282	0.141	6008	244	41	111	110	101	141	161	1300
1993	0.347	0.312	0.312	0.156	6654	270	45	122	122	112	156	178	1439
1994	0.353	0.318	0.318	0.159	7305	275	46	125	124	114	159	181	1467
1995	0.377	0.339	0.339	0.170	7800	294	49	133	133	121	169	193	1565
1996	0.417	0.376	0.376	0.188	9241	325	54	147	147	135	188	214	1733
1997	0.423	0.381	0.381	0.190	9398	330	55	149	149	136	190	217	1758
1998	0.456	0.411	0.411	0.205	10825	355	60	161	160	147	205	234	1895
1999	0.481	0.433	0.433	0.216	11402	374	63	170	169	155	216	247	1996
2000	0.505	0.454	0.454	0.227	12273	393	66	178	177	163	227	259	2095
2001	0.516	0.465	0.465	0.232	12579	402	67	182	182	166	232	265	2144
2002	0.553	0.498	0.498	0.249	13506	431	72	195	195	178	249	284	2298
2003	0.573	0.515	0.515	0.258	13946	446	75	202	201	185	257	294	2377
2004	0.598	0.538	0.538	0.269	14510	466	78	211	210	193	269	307	2483
2005	0.621	0.559	0.559	0.279	15033	484	81	219	218	200	279	319	2579
2006	0.635	0.571	0.571	0.286	16000	494	83	224	223	205	285	326	2635
2007	0.686	0.618	0.618	0.309	17300	534	90	242	241	221	308	352	2849
2008	0.702	0.632	0.632	0.316	17692	547	92	248	247	226	315	360	2914
2009	0.754	0.679	0.679	0.339	19074	587	98	266	265	243	339	387	3132
2010	0.812	0.731	0.731	0.366	22323	633	106	287	286	262	365	417	3373
2011	0.831	0.747	0.747	0.374	22898	647	108	293	292	268	373	426	3449
2012	0.873	0.786	0.786	0.393	22525	680	114	308	307	282	392	448	3626
2013	0.914	0.822	0.822	0.411	19832	712	119	323	321	295	411	469	3795
2014	0.957	0.861	0.861	0.431	19867	745	125	338	337	309	430	491	3974
2015	0.988	0.889	0.889	0.445	21066	770	129	349	348	319	444	507	4104
2016	1.060	0.954	0.954	0.477	20318	825	138	374	373	342	476	544	4401
2017	1.093	0.983	0.983	0.492	19888	851	143	386	384	352	491	560	4537
2018	1.139	1.025	1.025	0.513	19886	887	149	402	401	367	512	585	4732
2019	1.185	1.066	1.066	0.533	21143	923	155	418	417	382	533	608	4921
2020	1.282	1.154	1.154	0.577	21545	998	167	452	451	413	576	658	5323
2021	1.344	1.210	1.210	0.605	23359	1047	175	474	472	433	604	689	5582
2022	1.513	1.361	1.361	0.681	27244	1178	197	534	532	488	680	776	6282

Table 6.19. POP emissions from cremation.

Year	HCB (kg)	PCB (kg)	PCDD/F (g I-TEQ)	B(a)P (kg)	B(b)F (kg)	B(k)F (kg)	I(1,2,3-cd)P (kg)
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
2018	0.004	0.012	0.00079	0.39	0.21	0.19	0.20
2019	0.005	0.013	0.00083	0.41	0.22	0.20	0.21
2020	0.005	0.014	0.00090	0.44	0.24	0.21	0.23
2021	0.005	0.014	0.00941	0.46	0.25	0.22	0.24
2022	0.006	0.016	0.00106	0.52	0.28	0.25	0.27

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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.

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 2013 Guidebook to 2016 for the whole time series.

2020
- A country-specific method for calculation of Hg emissions was developed.

2021
- Incorrect Hg calculation file used in 2020 reporting has been revised for whole time series.

Source-specific planned improvements

None

Other waste incineration (NFR 5C1bvi)

No "other" waste incineration occurs in the country.

Open burning of waste (NFR 5C2)

Source category description

Incineration in households is forbidden according to the Environmental Protection Act and therefore no emissions are expected from this category.

On the request of the 2020 TERT we calculated the emission levels that would result from open burning of garden waste. Household and other “real” waste is not burned in Finland and forest residues are collected to industry or household energy purposes or left in the forest to improve soil or diversity of species. Using EFs in Table 3.3 of the 2019 Guidebook we conclude that the emissions would be below 0.0001% of national totals for all pollutants and thus insignificant.

From several national reports on household waste published in 2004-2019 we conclude that open burning of garden waste is happening occasionally and seasonally in the sparsely populated areas in small amounts as explained below. The amount of garden waste is estimated as 10 kg/inhabitant/year, while the population in sparsely populated areas is about half a million, half of these inhabitants burn garden waste occasionally and the amount that then is burned is 0.1% of the amount of garden waste. Instead of burning, twigs and branches are mostly composted, chipped, used as soil enrichment/building and in more densely populated areas mainly brought to recycling facilities for composting. Twigs and branches that are of sensible size to burn are preferably combusted as fuel in small combustion equipment as almost all dwelling houses, especially in the sparsely populated areas, have these equipment.

In Finland open burning of waste is forbidden and the offender will be fined as there are strict municipal orders about this. Everywhere in the country, also in sparsely populated areas, you are not allowed to cause nuisance to neighbours or danger of fire and you are fully responsible of any damage caused. In the sparsely populated areas, taking into account all above, it is possible to burn small amounts of dry twigs and branches on your own land. You can only burn in small batches similar to small campfires during the light time of the day and you need to have fire-fighting equipment and arrange guarding of the embers after the flames have died.

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

2020

- This chapter (NFR 5C2) was accidentally removed when the IIR was thoroughly updated in the recalculation processes in 2018 and 2019 and is now returned to the IIR.

6.6 Wastewater Handling (NFR 5D)

Source category description

The emission sources under category 5D cover municipal (domestic) and industrial wastewater handling plants, latrines and septic tanks. Emissions from wastewater treatment have been 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	
March 2024	KS, JMP, TF

Source category description

NMVOC emissions from domestic wastewater handling and NH_3 emissions from latrines are reported under this category. The category is not a key category for any pollutants.

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

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 6.20.

Table 6.20. Contribution of Domestic wastewater handling (NFR 5D1) to total emissions in 2022.

Pollutant	tier	Emissions from domestic wastewater handling	Total emissions	Unit	Share of total emissions %	% reported by the plants
NMVOC	T1	0.007	75.464	Gg	<0.1	0
NH_3	T2	0.384	31. 583	Gg	1.2	1.0

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

Emission trends

The emission trends are presented in Figure 6.5. The increase in NH_3 emissions is due to the increase in number of summer cottages (used as AD in the estimation of NH_3 emissions from latrines). The NMVOC emissions follows the amounts of handled wastewater which varies between years.

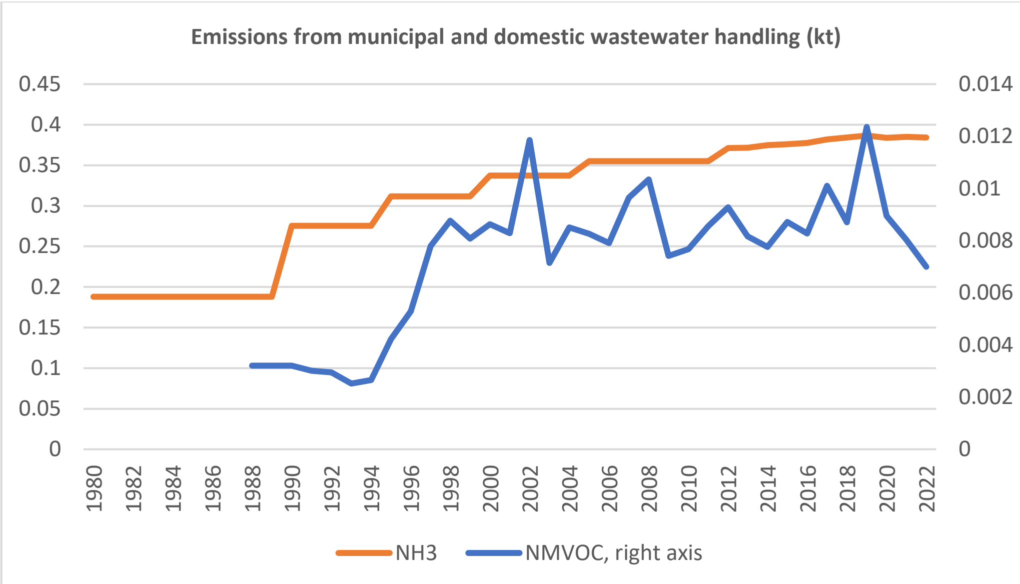

Figure 6.5. NMVOC and NH_3 emissions from municipal and domestic wastewater handling.

Methodological issues

<u>Domestic wastewater treatment</u>

NMVOC emissions

NMVOC emissions are calculated using the Tier 1 method presented in the Guidebook 2023 (Table 3-1, page 7). Activity data is taken from YLVA database as presented in Table 6.21. The activity data by plants is annually available from YLVA.

NH_3 emissions

NH_3 emissions from domestic wastewater treatment are reported by the plants. There is no methodology for estimating NH_3 emissions in the Guidebook 2023.

Table 6.21. Handled domestic wastewater 1990-2022 (1000 m³).

Year	handled domestic wastewater (1000 m³)	Year	handled domestic wastewater (1000 m³)
1990	213801	2010	511092
1991	200757	2011	570268
1992	196439	2012	618241
1993	168243	2013	543836
1994	177414	2014	516878
1995	281343	2015	580839
1996	352501	2016	551201
1997	519530	2017	673677
1998	584699	2018	5800900
1999	538664	2019	823903
2000	575409	2020	596283
2001	552574	2021	535309
2002	790886	2022	466677
2003	475846		
2004	567214		
2005	550629,3		
2006	527119		

2007	643100		
2008	690266		
2009	494373		

Latrines

NH_3

NH_3 emissions from latrines are calculated according to the Tier 2 methodology of the Guidebook 2023 (Table 3-2, page 8). 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 NH_3 emissions are presented in Tables 6.22 and 6.23, respectively.

Table 6.22. Number of summer cottages in Finland 1980-2022 (Statistics Finland, 2023).

Year	Number of summer cottages	Year	Number of summer cottages
1980	251744	2015	501600
1985	251744	2016	502900
1990	367686	2017	507200
1995	416236	2018	509800
2000	450569	2019	511990
2005	474277	2020	508000
2012	496208	2021	508919
2013	496209	2022	509652
2014	500400		

Table 6.23. NMVOC and NH_3 emissions from NFR 5D1.

Year	NMVOC (kt)	NH_3 (kt)	Year	NMVOC (kt)	NH_3 (kt)
1990	0.003	0.275	2010	0.008	0.355
1991	0.003	0.275	2011	0.009	0.355
1992	0.003	0.275	2012	0.009	0.371
1993	0.003	0.275	2013	0.008	0.371
1994	0.003	0.275	2014	0.008	0.375
1995	0.004	0.312	2015	0.009	0.376
1996	0.005	0.312	2016	0.008	0.377
1997	0.008	0.312	2017	0.010	0.382
1998	0.009	0.312	2018	0.009	0.384
1999	0.008	0.312	2019	0.012	0.387
2000	0.009	0.337	2020	0.009	0.384
2001	0.008	0.337	2021	0.008	0.385
2002	0.012	0.337	2022	0.007	0.384
2003	0.007	0.337			
2004	0.009	0.337			
2005	0.008	0.355			
2006	0.008	0.355			
2007	0.010	0.355			
2008	0.010	0.355			
2009	0.007	0.355			

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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.

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 2019.

2020

- Ammonia emissions from some point sources was accidentally excluded in the 2019 submission for the years 2012, 2014 and 2015. The missing NH_3 emissions have been included in the 2020 submission and increased slightly the emissions.

2021

- Reallocation of latrines from NFR 5E to NFR 5D1.

2024

- Activity data for domestic wastewater treatment was updated for year 2005 and from year 2010 onwards as a result of the 2023 NECD Technical Review.

Source-specific planned improvements

None.

Industrial wastewater handling (NFR 5D2)

Changes in chapter	
March 2024	KS, JMP, TF

Source category description

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 6.24. The category is not a key category for any pollutants.

Table 6.24 Contribution of Industrial wastewater handling (NFR 5D2) to total emissions in 2022.

Pollutant	Tier	Emissions from industrial wastewater handling	Total emissions	Unit	Share of total emissions %	% reported by the plants
NMVOC	T1	0.012	75.464	Gg	<0.1	0

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 calculation are the same.

Emission trend

NMVOC emission trend is presented in Figure 6.6. The NMVOC emissions follow the amounts of handled industrial wastewater which varies between years.

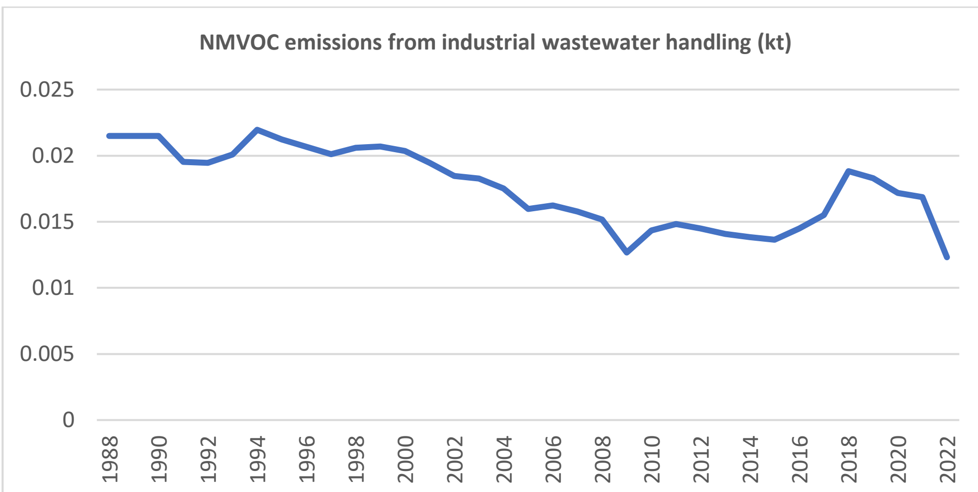

Figure 6.6. NMVOC emissions from industrial wastewater handling.

Methodological issues

NMVOC emissions

NMVOC emissions are calculated using the Tier 1 method presented in the EMEP/EEA Emission Inventory Guidebook 2023 (Table 3-1, page 7). Activity data is taken from YLVA database and presented in Table 6.25. The activity data by plants is annually available from YLVA. For some plants, the reported wastewater also includes cooling water. These are corrected manually in the calculation. However, the number of these plants is small.

Table 6.25. Handled industrial wastewater 1990-2022 (1000 m^3). (YLVA database)

Year	Handled industrial wastewater (1000 m^3)	Year	Handled industrial wastewater (1000 m^3)
1990	1433445	2010	956915
1991	1302372	2011	988090
1992	1297080	2012	966758
1993	1339249	2013	938131
1994	1463809	2014	922104
1995	1415457	2015	909001
1996	1378742	2016	966315

1997	1340104	2017	1034360
1998	1373581	2018	1255103
1999	1379977	2019	1220300
2000	1356726	2020	1145255
2001	1296868	2021	1123640
2002	1230824	2022	821103
2003	1217227		
2004	1167849		
2005	1063866		
2006	1082900		
2007	1051384		
2008	1010498		
2009	845063		

Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Annex 6 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.

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 2019.

2024

- Activity data for domestic wastewater treatment was updated for year 2005 and from year 2010 onwards as a result of the 2023 NECD Technical Review.

Source-specific planned improvements

None

Other Wastewater handling (NFR 5D3)

Changes in chapter	
March 2021	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 2024	KS, JMP, TF

Source category description

NFR 5E Other covers particle, PCDD/F and heavy metal emissions from house and car fires. The shares of emissions for each air pollutant reported under the NFR category are presented in Table 6.26.

Other waste is a key category for PCDD/F emissions according to the level and trend (Approach 1).

Table 6.26. Contribution of Other waste (NFR 5E) to total emissions in 2022.

Pollutant	Tier	Emissions from other waste	Total emissions	Unit	Share of total emissions %	% reported by the plants
$PM_{2.5}$	T2	0.122	13.384	Gg	0.9	0
PM_{10}	T2	0.122	26.778	Gg	0.5	0
TSP	T2	0.122	42.014	Gg	0.3	0
BC	T2	0.011	3.121	Gg	0.3	0
Pb	T2	<0.001	12.516	Mg	<0.1	0
Cd	T2	<0.001	0.779	Mg	<0.1	0
Hg	T2	<0.001	0.505	Mg	0.2	0
As	T2	0.001	1.920	Mg	<0.1	0
Cr	T2	0.001	14.905	Mg	<0.1	0
Cu	T2	0.003	38.391	Mg	<0.1	0
PCDD/ F	T2	1.271	9.497	g I-Teq	13.4	0

Emission trend

Emission trends from house and car fires are presented in Figure 6.7. The emission trends follow the number house and car fires available in the statistics.

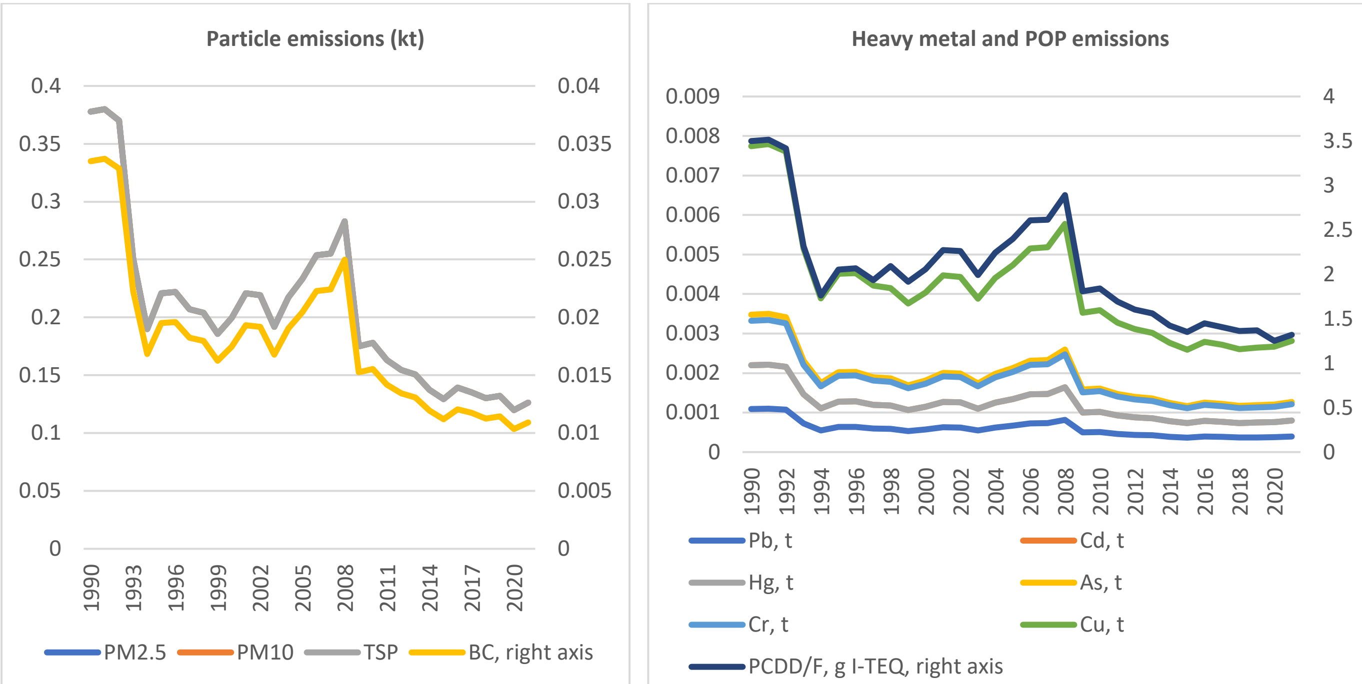

Figure 6.7 Emissions from car and house fires 1990-2022.

Methodological issues

Car and house fires

Particles

Emissions from house and car fires are calculated using Tier 2 emission factors from the Guidebook 2023 with the EF of 2.3 kg/fire (TSP, PM_{10}, $PM_{2.5}$).

Heavy metals

The emissions are calculated using Tier 2 emission factors from Guidebook 2023 (Table 6.27).

Table 6.27. Emission factors for heavy metals and PCDD/F from house fires.

Pollutant	Unit	Emission factors for house fires (Guidebook 2023), Tier 2			
		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	27.23
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

The Tier 2 emission factor of 0.048 mg/fire from Guidebook 2023 is used for car fires. For house fires, the Tier 2 emission factor presented in Table 6.27 is used.

Activity data

Activity data for 1990-2022 is presented in Table 6.28.

For house fires, it is assumed based on information from Rescue Services' Fire Statistics (2021) that:

- 25% of house fires are un-detached house fires,
- 5% detached house fires,
- 23% apartment building fires and
- 47% industrial building fires

In addition, it is assumed that all other fires that are not house or apartment building fires, are industrial building fires. In the Fire Statistics industrial buildings consists of several different building types for example office buildings, industrial buildings and farm buildings.

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

According to the statistics of the Rescue Services (2019), approximately 94% of vehicle fires are road vehicles fires, 2% off-road vehicles and 2% watercraft fires. Less than one per cent of the fires are railroad vehicle or airplane fires.

Table 6.28 Activity data: vehicle and house fires (Rescue Services, 2023)

Year	Vehicle fires	House fires	**Year**	Vehicle fires	House fires
1990	2490	6010	2007	2549	4025
1991	2350	6050	2008	2379	4485
1992	2100	5900	2009	2400	2736
1993	1400	4000	2010	2438	2789
1994	1300	3020	2011	2478	2543
1995	1800	3500	2012	2277	2413
1996	1904	3515	2013	2335	2341
1997	1962	3272	2014	1999	2144
1998	2018	3222	2015	2200	2010
1999	2231	2918	2016	2262	2164
2000	2377	3134	2017	2081	2106
2001	2631	3418	2018	2335	2018
2002	2698	3040	2019	2186	2053
2003	2400	3040	2020	2068	1857
2004	2400	3420	2021	2179	1959
2005	2630	3670	2022	2131	1888
2006	2724	3998			

Emissions of particles, heavy metals and PCDD/F from Other Waste are presented in Tables 6.29 and 6.30.

Table 6.29 Particle, heavy metals and POP emissions from house fires

Year	TSP (Gg)	PM_{10} (Gg)	$PM_{2.5}$ (Gg)	BC (Gg)	As (kg)	Cd (kg)	Cu (kg)	Cr (kg)	Pb (kg)	Hg (kg)	PCDD/F (g I-TEQ)
1990	0.37	0.37	0.37	0.03	3.48	2.20	7.75	3.32	1.09	2.20	3.38
1991	0.37	0.37	0.37	0.03	3.50	2.21	7.80	3.34	1.10	2.21	3.40
1992	0.37	0.37	0.37	0.03	3.41	2.16	7.60	3.26	1.07	2.16	3.32
1993	0.25	0.25	0.25	0.02	2.31	1.46	5.15	2.21	0.73	1.46	2.25
1994	0.19	0.19	0.19	0.02	1.75	1.10	3.89	1.67	0.55	1.10	1.70
1995	0.22	0.22	0.22	0.02	2.02	1.28	4.51	1.93	0.64	1.28	1.97
1996	0.22	0.22	0.22	0.02	2.03	1.28	4.53	1.94	0.64	1.28	1.98
1997	0.20	0.20	0.20	0.02	1.89	1.20	4.22	1.81	0.59	1.20	1.84
1998	0.20	0.20	0.20	0.02	1.86	1.18	4.15	1.78	0.58	1.18	1.99
1999	0.18	0.18	0.18	0.02	1.69	1.07	3.76	1.61	0.53	1.07	1.81
2000	0.19	0.19	0.19	0.02	1.81	1.15	4.04	1.73	0.57	1.15	1.94
2001	0.21	0.21	0.21	0.02	2.01	1.27	4.47	1.92	0.63	1.27	2.15
2002	0.21	0.21	0.21	0.02	1.99	1.26	4.43	1.90	0.62	1.26	2.13
2003	0.19	0.19	0.19	0.02	1.74	1.10	3.88	1.66	0.55	1.10	1.86
2004	0.21	0.21	0.21	0.02	1.98	1.25	4.41	1.89	0.62	1.25	2.12
2005	0.23	0.23	0.23	0.02	2.12	1.34	4.73	2.03	0.67	1.34	2.27
2006	0.25	0.25	0.25	0.02	2.31	1.46	5.15	2.21	0.73	1.46	2.47
2007	0.25	0.25	0.25	0.02	2.33	1.47	5.19	2.22	0.73	1.47	2.49
2008	0.28	0.28	0.28	0.02	2.59	1.64	5.78	2.48	0.81	1.64	2.78
2009	0.17	0.17	0.17	0.02	1.58	1.00	3.53	1.51	0.50	1.00	1.69
2010	0.17	0.17	0.17	0.02	1.61	1.02	3.59	1.54	0.51	1.02	1.72
2011	0.16	0.16	0.16	0.01	1.47	0.93	3.28	1.41	0.46	0.93	1.57
2012	0.15	0.15	0.15	0.01	1.40	0.88	3.11	1.33	0.44	0.88	1.49
2013	0.15	0.15	0.15	0.01	1.35	0.86	3.02	1.29	0.42	0.86	1.45
2014	0.13	0.13	0.13	0.01	1.24	0.78	2.76	1.18	0.39	0.78	1.33
2015	0.12	0.12	0.12	0.01	1.16	0.73	2.59	1.11	0.36	0.73	1.24
2016	0.13	0.13	0.13	0.01	1.25	0.79	2.79	1.20	0.39	0.79	1.34
2017	0.13	0.13	0.13	0.01	1.22	0.77	2.71	1.16	0.38	0.77	1.30
2018	0.12	0.12	0.12	0.01	1.17	0.74	2.60	1.11	0.37	0.74	1.25
2019	0.13	0.13	0.13	0.01	1.19	0.75	2.65	1.13	0.37	0.75	1.26
2020	0.11	0.11	0.11	0.01	1.20	0.76	2.67	1.15	0.38	0.76	1.15
2021	0.12	0.12	0.12	0.01	1.27	0.80	2.82	1.21	0.40	0.80	1.21
2022	0.12	0.12	0.12	0.01	1.22	0.77	2.71	1.17	0.38	0.77	1.17

Table 6.30 Particle and POP emissions from car fires

Year	TSP (Gg)	PM_{10} (Gg)	$PM_{2.5}$ (Gg)	PCDD/PCDF (g I-TEQ)	**Year**	TSP (Gg)	PM_{10} (Gg)	$PM_{2.5}$ (Gg)	PCDD/PCDF (g I-TEQ)
1990	0.006	0.006	0.006	0.120	2011	0.006	0.006	0.006	0.120
1991	0.005	0.005	0.005	0.113	2012	0.005	0.005	0.005	0.109
1992	0.005	0.005	0.005	0.101	2013	0.005	0.005	0.005	0.112
1993	0.003	0.003	0.003	0.067	2014	0.005	0.005	0.005	0.100
1994	0.003	0.003	0.003	0.062	2015	0.005	0.005	0.005	0.110
1995	0.004	0.004	0.004	0.086	2016	0.005	0.005	0.005	0.109
1996	0.004	0.004	0.004	0.091	2017	0.005	0.005	0.005	0.100
1997	0.005	0.005	0.005	0.10	2018	0.005	0.005	0.005	0.112
1998	0.005	0.005	0.005	0.096	2019	0.005	0.005	0.005	0.105
1999	0.005	0.005	0.005	0.108	2020	0.005	0.005	0.005	0.102
2000	0.006	0.006	0.006	0.120	2021	0.005	0.005	0.005	0.099

2001	0.006	0.006	0.006	0.125	2022	0.005	0.005	0.005	0.102
2002	0.006	0.006	0.006	0.130					
2003	0.006	0.006	0.006	0.130					
2004	0.006	0.006	0.006	0.128					
2005	0.006	0.006	0.006	0.126					
2006	0.006	0.006	0.006	0.130					
2007	0.006	0.006	0.006	0.122					
2008	0.006	0.006	0.006	0.114					
2009	0.006	0.006	0.006	0.115					
2010	0.006	0.006	0.006	0.117					

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.

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. 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 EFs 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).
- 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
- NH_3 emissions from latrines was reallocated to 5E, however, the change was done only for years 2014 and 2015 emissions.
- Heavy metal emissions from NFR 5E (house and car fires) were updated according to the Guidebook 2016.

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.

2021
- Reallocation of latrines from NFR 5E to NFR 5D1.

2023

- The error in calculation of vehicle fires was corrected in line with the TERT recommendation in the 2022 NECD review. In the earlier submissions it was assumed that out of vehicle fires 68% were passenger car fires and the emissions were calculated only for passenger car fires. In the 2023 submission the calculation was changed to cover emissions of fires of all vehicle types.

2024

- The percentage distribution of total house fires was revised due the recommendation of the TERT in the 2023 NECD review. In the earlier submissions it was estimated that 26% of house fires are un-detached house fires, 4 % detached house fires, 10% apartment building fires and 18% industrial building fires. The fires did not sum to 100% but only 58%. For the 2024 submission, the percentage distribution was corrected to sum to 100%.

Source specific planned improvements

- Possibilities to include HCB emissions from landfill fires to the inventory are studied.
- Possibilities to calculate emissions from vehicle fires using methods presented in Denmark's IIR 2021 will be further studied.

7 OTHER EMISSION SOURCES (NFR 6)

Changes in chapter	
March 2024	JG, TF, JM

7.1 Other sources (NFR 6A)

Source category description

This source category includes ammonia emissions from animals that cannot be attributed to the agricultural or natural sectors. Because in the Finnish emission inventory all horses - including agricultural, recreational and racing horses - are included in the agriculture sector, this category considers only pets, i.e., cats and dogs.

Emission trends

The ammonia emission trends follow the trends in the activity data (Figure 7.1 and Table 7.1). During the Covid pandemic, there was an increase in pet ownership, which explains at least part of the rising emissions trend.

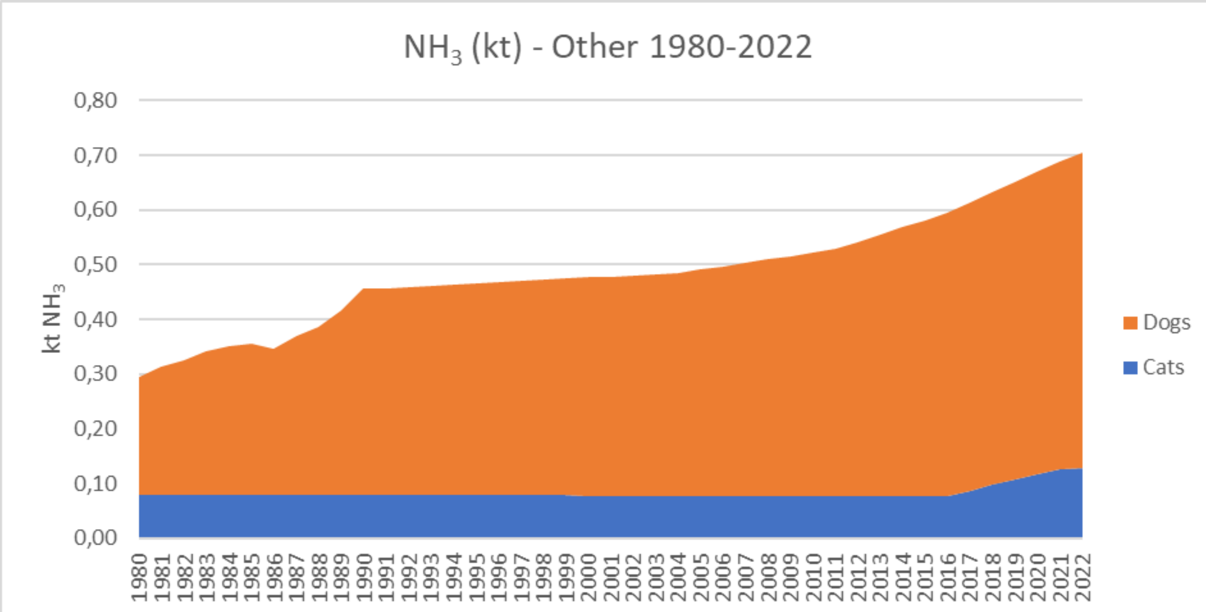

Figure 7.1. Ammonia emissions from NFR 6A 1980-2022.

Table 7.1. Ammonia emissions from NFR 6A (Gg), separately for cats and dogs and total, 1980-2022.

Year	NH_3, cats	NH_3, dogs	Total	Year	NH_3, cats	NH_3, dogs	Total
1980	0.08	0.22	0.29	2006	0.08	0.42	0.50
1981	0.08	0.22	0.29	2007	0.08	0.42	0.50
1982	0.08	0.22	0.29	2008	0.08	0.42	0.50
1983	0.08	0.22	0.29	2009	0.08	0.42	0.50
1984	0.08	0.22	0.29	2010	0.08	0.42	0.50
1985	0.08	0.22	0.29	2011	0.08	0.42	0.50
1986	0.08	0.22	0.29	2012	0.08	0.42	0.50
1987	0.08	0.22	0.29	2013	0.08	0.42	0.50
1988	0.08	0.22	0.29	2014	0.08	0.42	0.50
1989	0.08	0.22	0.29	2015	0.08	0.42	0.50
1990	0.08	0.22	0.29	2016	0.08	0.42	0.50
1991	0.08	0.22	0.29	2017	0.08	0.42	0.50
1992	0.08	0.22	0.29	2018	0.08	0.42	0.50
1993	0.08	0.22	0.29	2019	0.08	0.42	0.50
1994	0.08	0.22	0.29	2020	0.08	0.42	0.50
1995	0.08	0.22	0.29	2021	0.08	0.42	0.50
1996	0.08	0.22	0.29	2022	0.08	0.42	0.50
1997	0.08	0.22	0.29				
1998	0.08	0.22	0.29				
1999	0.08	0.22	0.29				
2000	0.08	0.22	0.29				
2001	0.08	0.22	0.29				
2002	0.08	0.22	0.29				
2003	0.08	0.22	0.29				
2004	0.08	0.22	0.29				
2005	0.08	0.22	0.29				

Methodological issues

The calculation adheres to the Tier 1 default approach outlined in the EMEP/EEA Guidebook 2023, focusing solely on ammonia emissions.

The emission of NH_3 from pets is estimated as follows:

$$E_{pets} = \sum (\mathbf{EF}_{\mathrm{pet\_i}} * \mathbf{AAP}_{\mathrm{pet\_i}})$$

where:
E_{pets} = total emission of NH_3 from pets (in kg a^{-1}),
EF_{pet_i} = emission factor of pet i (kg NH_3 a^{-1} AAP^{-1})
AAP_{pet_i} = annual average population of pet i (a^{-1}).

Ammonia emission factors of Sutton et al (2000)[2] are applied:

- 0.13 kg NH_3 a^{-1} AAP^{-1} for cats,
- 0.74 kg NH_3 a^{-1} AAP^{-1} for dogs.

Activity data

Data on cat and dog population (Table 7.2) is based on the following sources and assumptions:

- Cats
  - years 1980-1997: estimate based on the population number of the year 1998,
  - year 1998: single estimate found from the internet,
  - years 1999-2015: linear trend assumed between the years 1998 and 2016,
  - year 2016: Statistics Finland (https://www.stat.fi/til/ktutk/2016/ktutk_2016_2020-04-20_tie_001_en.html),
  - years 2017-2020: linear trend assumed between the years 2016 and 2021,
  - years 2021 and 2022: FEDIAF EuropeanPetFood (https://europeanpetfood.org/about/statistics/).

- Dogs
  - years 1980-1989: based on the register of Finnish Kennel Club and an estimate that 60% of all dogs were registered in 1980's,
  - year 1990: single estimate found from the internet,
  - years 1991-2003. linear trend assumed between the years 1990 and 2004,
  - year 2004: estimate of the Finnish Kennel Club,
  - years 2005-2010: linear trend assumed between the years 2004 and 2011,
  - year 2011: estimate of the Finnish Kennel Club,
  - years 2012-2015: linear trend assumed between the years 2011 and 2016,
  - year 2016: Statistics Finland (https://www.stat.fi/til/ktutk/2016/ktutk_2016_2020-04-20_tie_001_en.html),
  - years 2017-2020: linear trend assumed between the years 2016-2021,
  - years 2021 and 2022: FEDIAF EuropeanPetFood (https://europeanpetfood.org/about/statistics/).

[2] Sutton M.A., Dragosits, U., Tang, Y.S. and Fowler, D. 2000. Ammonia emissions from non-agricultural sources in the UK, Atmospheric Environment 34 (2000) 855-869.

Table 7.2. Estimate on cat and dog annual average population (AAP; thousands) in Finland in 1980-2022.

Year	AAP, cats	AAP, dogs	Year	AAP, cats	AAP, dogs
1980	600	291	2006	596	567
1981	600	318	2007	595	576
1982	600	333	2008	594	584
1983	600	356	2009	594	593
1984	600	369	2010	593	601
1985	600	377	2011	593	610
1986	600	362	2012	592	628
1987	600	395	2013	592	646
1988	600	418	2014	591	664
1989	600	459	2015	591	682
1990	600	510	2016	590	700
1991	600	513	2017	667	712
1992	600	516	2018	744	724
1993	600	519	2019	821	736
1994	600	521	2020	898	748
1995	600	524	2021	975	760
1996	600	527	2022	982	781
1997	600	530			
1998	600	533			
1999	599	536			
2000	599	539			
2001	598	541			
2002	598	544			
2003	597	547			
2004	597	550			
2005	596	559			

The uncertainties regarding the total number of cats throughout the entire time series, as well as for dogs during the earlier years (1980-2000), are substantial due to the absence of cat registries and the incomplete coverage of dog registrations in the Finnish Kennel Club's register. However, for the year 2016, there are some statistical estimates available for pet numbers, which have also facilitated estimations regarding the proportion of dogs registered in the Finnish Kennel Club's register.

In 2023, the Finnish Food Authority established a new dog registry in Finland. It is estimated that by the end of 2023, only approximately one third of the dogs were registered.

It's worth noting that while registration with the Finnish Kennel Club is voluntary, the new registry mandated by the Finnish Food Authority is compulsory.

Uncertainty and time series' consistency

The time series is consistent. The results of the uncertainty analysis are provided in Annex 7 of the IIR.

Source-specific QA/QC and verification

Normal statistical quality checks related to the assessment of magnitude and trends have been carried out. At present, no verification has been carried out for the specific source-sector emissions.

Source-specific recalculations including changes in response to the review

No recalculations have been conducted yet, as the emission category is included in Finland's emission inventory for the first time in submission 2024.

Source-specific planned improvements

The refinement of activity data is an ongoing process.