

FINLAND'S INFORMATIVE INVENTORY REPORT 2024

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

Part 1B - General

March 2024

FINNISH ENVIRONMENT INSTITUTE

Climate solutions unit

Air pollution group

PART 1B - GENERAL

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Overall description and methodologies

International aviation cruise (civil)

Domestic aviation cruise civil

International maritime navigation

Multilateral operations

Transport (fuel used)

Other not included in national total of the entire territory

Volcanoes

Forest fires

Other natural emissions

REFERENCES

8.1 RECALCULATIONS AND IMPROVEMENTS

Changes in chapter	
March 2024	TF

8.1.1 Summary of recalculations, explanations and justifications

Requested information

According to the Reporting Guidelines this chapter should include information relevant for assessment of compliance with each Protocol including a description of sources that were not included in the base year but have been added since as well as for sources that were included in the base year and are no longer applicable.

There was no obligation to document this information in the early years of reporting air pollutant emission inventories in the 1990s and the reporting guidelines have much developed since, therefore it has not been possible to present the requested information for the early years.

In the IIR sub-chapters “**Source specific recalculations**” of each Sector Chapter, information on annually conducted recalculations is presented for those years when the documentation item already existed.

Recalculations prior to the 2018 submission

The first full recalculation of the time series 1980-2016 was carried out to the submission in 2018. The recalculation of the energy sector time series from the 1990s was initiated in 2002, however, completed first to the 2018 submission. Due to the pending energy sector recalculations, it was not possible to fully recalculate interconnected data due to the complex structure of the inventory as explained in details in Chapter 2.3.2 in Part 1A – General of the IIR. However, individual emission figures and notation keys were corrected in the NFR tables when errors were found, in addition to sources where the activity data did not interfere with data reported by the plants. The ammonia emissions time-series was an exception, and was recalculated because sparse ammonia sources are related to data reported by the operators. The allocation of emissions under consistent reporting categories in the time series was not realized until the full recalculation to the 13 April 2018 resubmission. No impact assessments of the partial recalculations until 2018 were performed due to resource limitations and the fact that the impact on the non-recalculated time series would anyway be highly uncertain.

Resubmissions in 2018-2022

- 15 Feb 2018 Finland submitted the old time series for the years 1990-2015 and new data for 2016. This was because the energy sector data was not finalized by the deadline of the NFR tables.
- 15 Mar 2018 Finland submitted the first recalculated time series, however, it would not have been mature for submission due to lack of checks that could not be done in the window between the late finalization of the energy sector data and the 4 weeks time frame for resubmissions.
- 13 Apr 2018 Finland submitted a recalculated time series that had undergone several QA/QC procedures, however, still having remaining reallocation issues. Due to the UNECE CLRTAP S3 Review and the EU NECD Technical Review, both in June 2018, the data needed to be available.
- 15 Feb 2019 Finland submitted the recalculated time series which included further harmonized

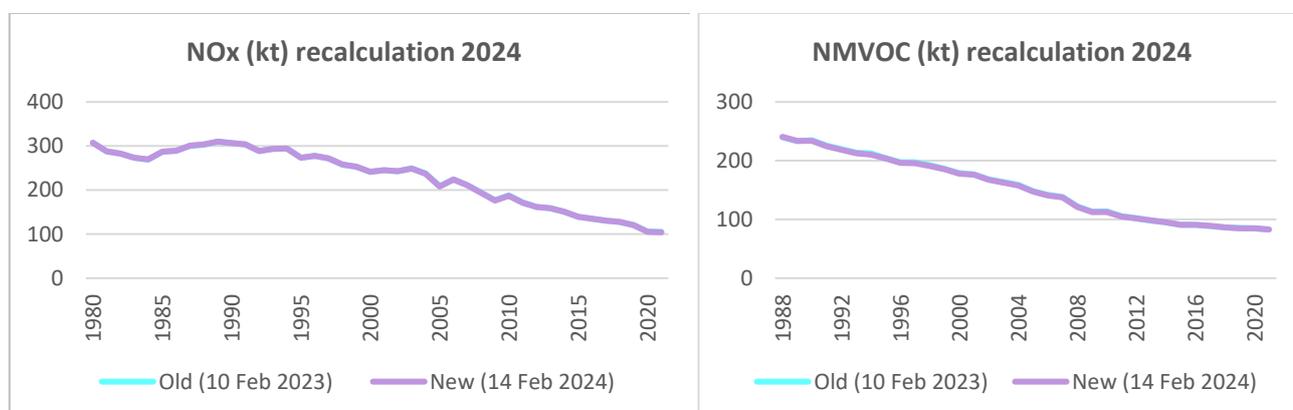
emissions allocations in the time series, however, also some errors were discovered after the submission deadline

- 15 Mar 2019 Finland submitted additional corrections to the submission of 15 Feb 2019.
- 13 Mar 2020 Finland submitted corrections to the submission of 13 Feb 2020 (errors and omissions) due to time constraint caused by unexpected data flows: (1) renewal of the contents of the YLVA database with deletion of technical details used in the energy sector inventory and pre-scheduled initiation of the new energy sector calculation model, (2) errors identified in the agriculture sector calculation model formulas, (3) omission of recalculated values from the submission (agriculture HCB), (4) missing values not captured into the submission 13 February 2020.
- 15 Mar 2022 Finland submitted corrections due to errors in NH3 from 5B2 and some AD changes. In addition, the 2019 adjustment values for 2019 were accidentally included for the year 2020 and were removed.
- 10 Feb 2022 Finland submitted minor recalculations that were due to update of statistical data and in some cases application of new emission factors, or due to new information from the plants.

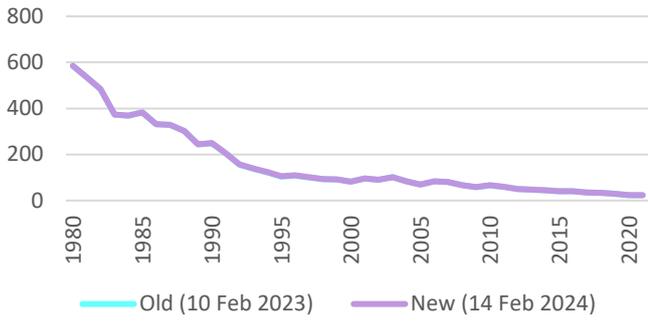
8.1.2 Impacts of recalculations in the 2024 submission

Recalculations to the 2024 submission are explained in detail in the respective IIR chapters (Parts 2-6 of the IIR). Most of the recalculations are due to update of statistical data, introduction of the new methodologies or emission factors from the EMEP/EEA Guidebook 2023, and in some cases due to new information from the plants. In the case of ammonia, the most significant recalculations originate from the agriculture sector and were due to update of nitrogen excretion data for all cattle categories and sheeps and implementation of new emission factors from the EMEP/EEA Guidebook 2023 in category 3Da1.

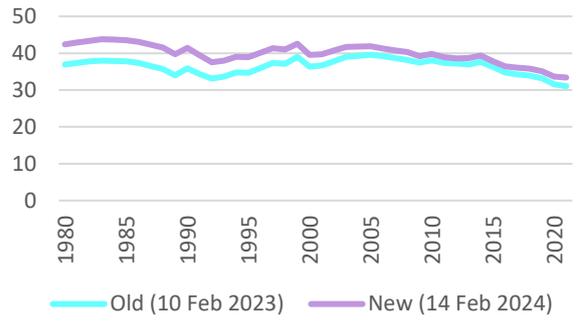
Below is an overview of the impacts of the recalculations to the 2024 submission in Figure 8.1 and Table 8.1.



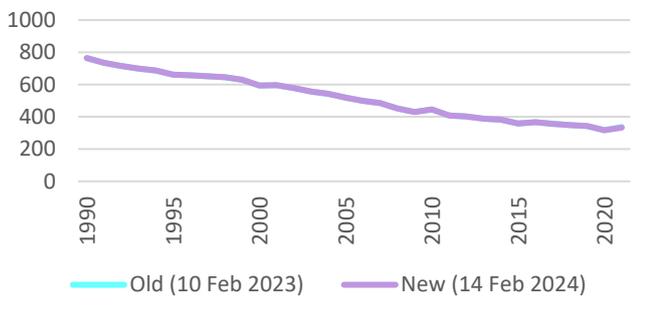
SOx (kt) recalculation 2024



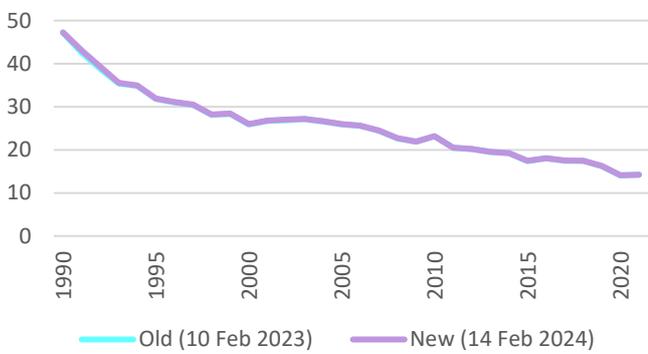
NH3 (kt) recalculation 2024



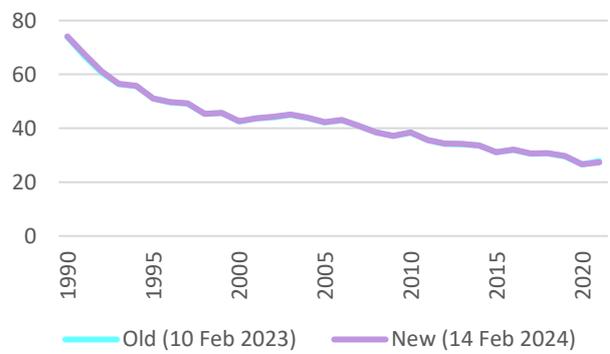
CO (kt) recalculation 2024



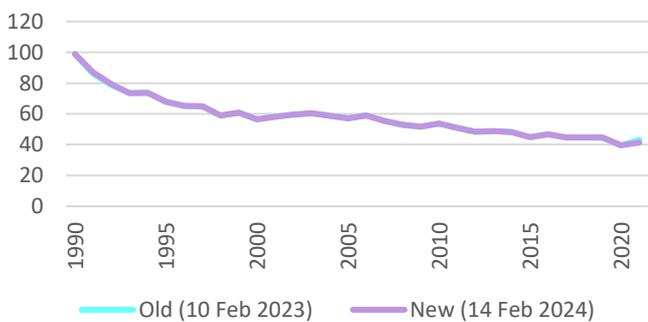
PM2.5 (kt) recalculation 2024



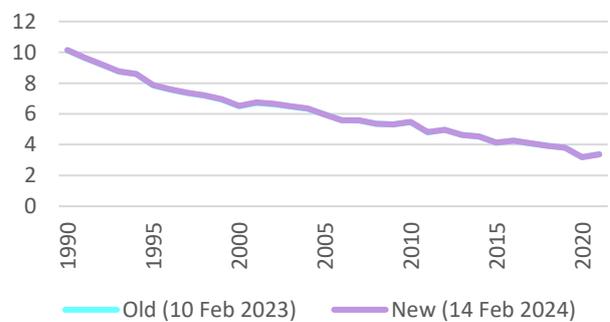
PM10 (kt) recalculation 2024



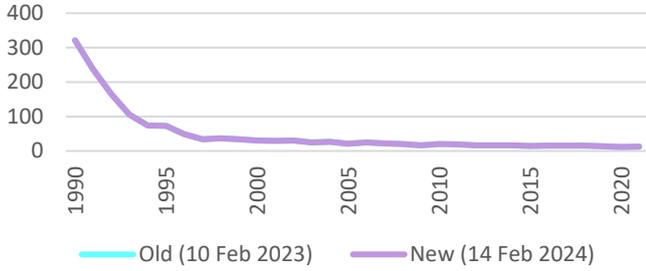
TSP (kt) recalculation 2024



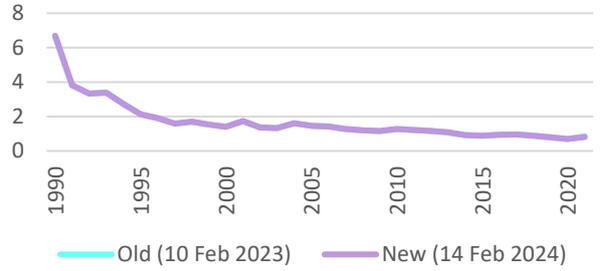
BC (kt) recalculation 2024



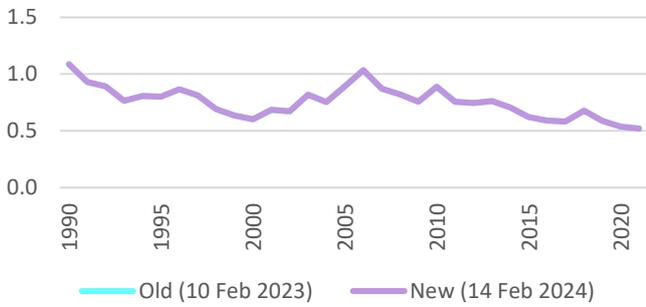
Pb (t) recalculation 2024



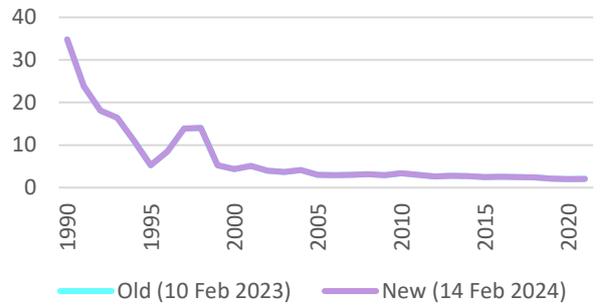
Cd (t) recalculation 2024



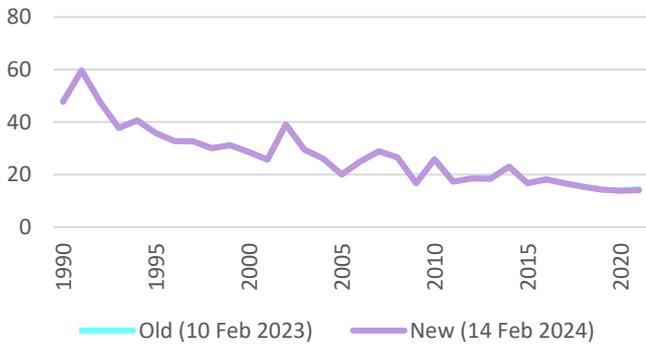
Hg (t) recalculation 2024



As (t) recalculation 2024



Cr (t) recalculation 2024



Cu (t) recalculation 2024



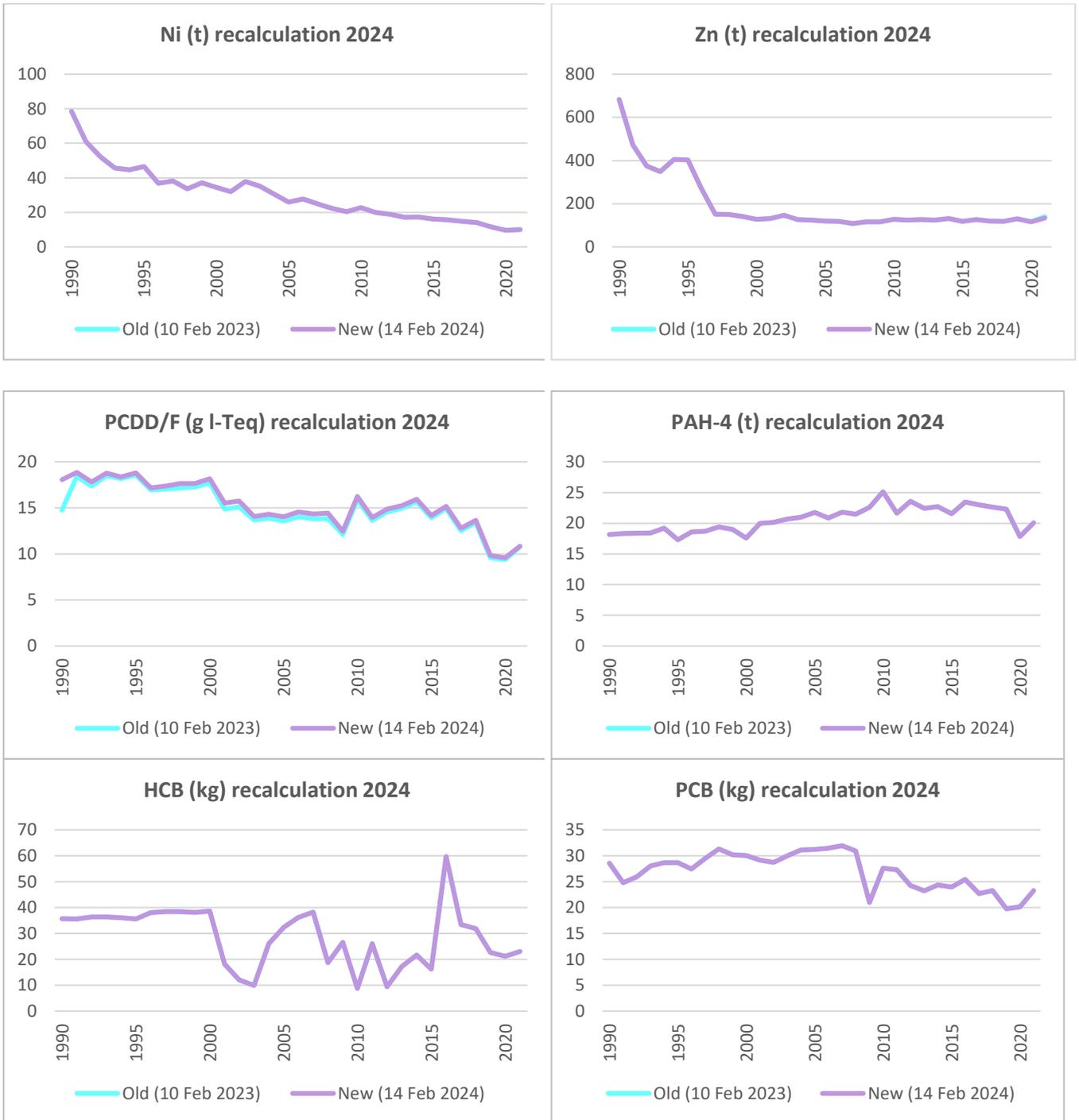


Figure 8.1 Impact of recalculations in the 2024 submission compared to the 2023 submission.

Table 8.1 Impact of recalculations in the 2024 submission compared to the 2023 submission.

NOx															
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
10 February 2023	307.310	287.732	282.580	273.461	269.288	287.133	288.909	300.330	303.293	309.780	306.578	303.711	288.155	293.389	294.137
14 February 2024	307.267	287.726	282.611	273.499	269.378	287.256	289.061	300.504	303.491	309.996	306.768	303.880	288.303	293.513	294.250
Difference	-0.043	-0.006	0.031	0.038	0.090	0.123	0.152	0.174	0.198	0.216	0.190	0.169	0.148	0.124	0.113
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.0 %	0.0 %
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
10 February 2023	273.175	277.568	271.717	257.638	252.916	241.309	244.674	242.541	249.025	237.454	208.471	224.154	211.267	193.962	176.690
14 February 2024	273.262	277.673	271.804	257.707	252.959	241.308	244.655	242.519	248.981	237.389	208.395	224.041	211.144	193.822	176.518
Difference	0.087	0.105	0.087	0.069	0.043	-0.001	-0.019	-0.022	-0.044	-0.065	-0.076	-0.113	-0.123	-0.140	-0.172
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021			
10 February 2023	187.477	171.623	161.719	158.832	151.163	139.294	134.881	130.693	127.419	120.244	105.614	105.102			
14 February 2024	187.267	171.403	161.491	158.648	150.985	139.104	134.724	130.542	127.278	120.094	105.343	104.127			
Difference	-0.210	-0.220	-0.228	-0.184	-0.178	-0.190	-0.157	-0.151	-0.141	-0.150	-0.271	-0.975			
%	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.1 %	-0.3 %	-0.9 %			
SOx															
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
10 February 2023	585.029	534.931	484.785	372.765	368.704	382.708	331.549	328.697	302.705	244.651	248.820	205.522	156.202	137.604	122.681
14 February 2024	585.029	534.931	484.785	372.765	368.704	382.708	331.549	328.697	302.705	244.651	249.475	205.845	156.829	138.414	123.269
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.655	0.323	0.627	0.810	0.588
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.3 %	0.2 %	0.4 %	0.6 %	0.5 %
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
10 February 2023	104.542	109.073	100.669	93.402	91.836	81.808	95.775	90.387	101.105	83.529	69.551	82.914	81.170	66.837	58.906
14 February 2024	105.201	109.221	100.807	93.529	91.944	81.876	95.898	90.475	101.194	83.594	69.607	82.974	81.235	66.902	58.963
Difference	0.659	0.148	0.138	0.127	0.108	0.068	0.123	0.088	0.089	0.065	0.056	0.060	0.065	0.065	0.057
%	0.6 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021			
10 February 2023	66.096	60.217	49.949	47.612	44.251	40.829	39.809	35.021	33.124	29.592	23.218	23.296			
14 February 2024	66.157	60.283	50.018	47.710	44.277	40.850	39.838	35.046	33.144	29.613	23.228	23.109			
Difference	0.061	0.066	0.069	0.098	0.026	0.021	0.029	0.025	0.020	0.021	0.010	-0.187			
%	0.1 %	0.1 %	0.1 %	0.2 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.0 %	-0.8 %			
NH3															
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
10 February 2023	36.932	37.351	37.809	37.940	37.876	37.789	37.375	36.530	35.732	34.018	35.872	34.349	33.082	33.642	34.788
14 February 2024	42.402	42.923	43.339	43.783	43.693	43.554	43.113	42.317	41.482	39.664	41.402	39.401	37.557	37.966	39.036

Difference	5.470	5.572	5.530	5.843	5.817	5.765	5.738	5.787	5.750	5.646	5.530	5.052	4.475	4.324	4.248
%	14.8 %	14.9 %	14.6 %	15.4 %	15.4 %	15.3 %	15.4 %	15.8 %	16.1 %	16.6 %	15.4 %	14.7 %	13.5 %	12.9 %	12.2 %
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
10 February 2023	34.675	35.940	37.329	37.134	38.969	36.302	36.636	37.776	38.980	39.298	39.576	39.190	38.692	38.140	37.476
14 February 2024	38.942	40.178	41.348	41.015	42.583	39.496	39.663	40.700	41.691	41.759	41.865	41.254	40.700	40.286	39.183
Difference	4.267	4.238	4.019	3.881	3.614	3.194	3.027	2.924	2.711	2.461	2.289	2.064	2.008	2.146	1.707
%	12.3 %	11.8 %	10.8 %	10.5 %	9.3 %	8.8 %	8.3 %	7.7 %	7.0 %	6.3 %	5.8 %	5.3 %	5.2 %	5.6 %	4.6 %
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021			
10 February 2023	38.085	37.347	37.206	36.950	37.587	36.197	34.759	34.242	33.875	33.176	31.529	31.042			
14 February 2024	39.764	38.910	38.614	38.633	39.368	37.817	36.411	36.032	35.777	35.116	33.598	33.393			
Difference	1.679	1.563	1.408	1.683	1.781	1.620	1.652	1.790	1.902	1.940	2.069	2.351			
%	4.4 %	4.2 %	3.8 %	4.6 %	4.7 %	4.5 %	4.8 %	5.2 %	5.6 %	5.8 %	6.6 %	7.6 %			

NMVOG

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10 February 2023	240.040	233.439	235.049	225.471	219.559	213.406	212.465	204.380	197.280	197.098	192.575	185.992	178.816	176.534	168.003
14 February 2024	240.494	233.833	233.663	224.489	218.770	212.579	210.622	203.678	196.503	195.951	191.068	185.390	177.884	176.010	167.299
Difference	0.454	0.394	-1.386	-0.982	-0.789	-0.827	-1.843	-0.702	-0.777	-1.147	-1.507	-0.602	-0.932	-0.524	-0.704
%	0.2 %	0.2 %	-0.6 %	-0.4 %	-0.4 %	-0.4 %	-0.9 %	-0.3 %	-0.4 %	-0.6 %	-0.8 %	-0.3 %	-0.5 %	-0.3 %	-0.4 %
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
10 February 2023	163.833	158.771	147.654	141.776	138.014	122.172	113.159	113.729	105.453	102.019	98.070	95.284	90.587	90.565	88.604
14 February 2024	162.790	157.911	147.170	141.049	137.477	121.446	112.615	112.507	104.883	101.884	98.383	95.440	90.640	90.859	89.240
Difference	-1.043	-0.860	-0.484	-0.727	-0.537	-0.726	-0.544	-1.222	-0.570	-0.135	0.313	0.156	0.053	0.294	0.636
%	-0.6 %	-0.5 %	-0.3 %	-0.5 %	-0.4 %	-0.6 %	-0.5 %	-1.1 %	-0.5 %	-0.1 %	0.3 %	0.2 %	0.1 %	0.3 %	0.7 %
	2018	2019	2020	2021											
10 February 2023	86.630	85.136	84.731	82.697											
14 February 2024	86.640	84.654	84.832	82.892											
Difference	0.010	-0.482	0.101	0.195											
%	0.0 %	-0.6 %	0.1 %	0.2 %											

CO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	764.457	735.842	715.135	700.247	686.537	661.765	656.805	651.390	646.260	629.839	593.765	596.047	577.497	556.342	541.870
14 February 2024	764.457	735.842	715.135	700.247	686.537	661.765	656.805	651.390	646.260	629.839	593.765	596.047	577.497	556.342	541.870
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	519.417	499.247	486.034	452.015	428.960	446.004	407.361	401.564	388.655	382.571	359.420	366.263	357.066	348.589	343.290
14 February 2024	519.417	499.247	486.034	452.015	428.960	446.004	407.361	401.564	388.655	382.571	359.420	366.263	357.066	348.589	343.290
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2020	2021													
10 February 2023	317.162	337.654													
14 February 2024	316.834	332.910													
Difference	-0.328	-4.744													
%	-0.1 %	-1.4 %													

TSP

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	98.738	86.065	78.671	73.414	73.597	67.756	65.178	64.852	58.873	60.677	56.420	58.162	59.340	60.380	58.790
14 February 2024	98.873	86.876	79.264	73.523	73.693	67.858	65.281	64.952	58.972	60.772	56.517	58.207	59.549	60.421	58.834
Difference	0.135	0.811	0.593	0.109	0.096	0.102	0.103	0.100	0.099	0.095	0.097	0.045	0.209	0.041	0.044

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
%	0.1 %	0.9 %	0.8 %	0.1 %	0.1 %	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.1 %	0.4 %	0.1 %	0.1 %
10 February 2023	57.080	58.880	55.476	52.805	51.737	53.669	50.849	48.403	48.804	48.183	44.827	46.794	44.725	44.649	44.529
14 February 2024	57.137	58.941	55.528	52.873	51.781	53.705	50.882	48.438	48.834	48.210	44.853	46.822	44.755	44.676	44.554
Difference	0.057	0.061	0.052	0.068	0.044	0.036	0.033	0.035	0.030	0.027	0.026	0.028	0.030	0.027	0.025
%	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %
	2020	2021													
10 February 2023	39.495	43.281													
14 February 2024	39.590	41.347													
Difference	0.095	-1.934													
%	0.2 %	-4.5 %													

PM10

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	73.970	66.705	60.598	56.368	55.699	50.998	49.612	49.126	45.293	45.668	42.511	43.631	44.064	45.039	43.835
14 February 2024	74.093	67.369	61.088	56.465	55.784	51.089	49.703	49.214	45.380	45.752	42.597	43.676	44.240	45.079	43.879
Difference	0.123	0.664	0.490	0.097	0.085	0.091	0.091	0.088	0.087	0.084	0.086	0.045	0.176	0.040	0.044
%	0.2 %	1.0 %	0.8 %	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.2 %	0.1 %	0.4 %	0.1 %	0.1 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	42.180	43.023	40.853	38.417	37.136	38.387	35.598	34.259	34.137	33.625	31.087	32.006	30.585	30.707	29.618
14 February 2024	42.235	43.081	40.902	38.482	37.178	38.422	35.630	34.293	34.167	33.653	31.113	32.035	30.614	30.734	29.644
Difference	0.055	0.058	0.049	0.065	0.042	0.035	0.032	0.034	0.030	0.028	0.026	0.029	0.029	0.027	0.026
%	0.1 %	0.1 %	0.1 %	0.2 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %	0.1 %
	2020	2021													
10 February 2023	26.569	27.809													
14 February 2024	26.615	27.344													
Difference	0.046	-0.465													
%	0.2 %	-1.7 %													

PM2.5

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	47.150	42.550	38.765	35.415	34.835	31.838	31.040	30.424	28.151	28.356	25.916	26.717	26.856	27.148	26.570
14 February 2024	47.262	43.067	39.280	35.501	34.908	31.918	31.120	30.500	28.227	28.428	25.991	26.761	26.999	27.188	26.613
Difference	0.112	0.517	0.515	0.086	0.073	0.080	0.080	0.076	0.076	0.072	0.075	0.044	0.143	0.040	0.043
%	0.2 %	1.2 %	1.3 %	0.2 %	0.2 %	0.3 %	0.3 %	0.2 %	0.3 %	0.3 %	0.3 %	0.2 %	0.5 %	0.1 %	0.2 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	25.891	25.582	24.411	22.668	21.877	23.148	20.458	20.180	19.505	19.197	17.406	18.044	17.460	17.425	16.214
14 February 2024	25.944	25.633	24.456	22.731	21.918	23.184	20.490	20.213	19.535	19.224	17.432	18.074	17.490	17.453	16.241
Difference	0.053	0.051	0.045	0.063	0.041	0.036	0.032	0.033	0.030	0.027	0.026	0.030	0.030	0.028	0.027

% -0.1 % -3.4 %

Cd

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	6.685	3.811	3.326	3.387	2.720	2.127	1.910	1.590	1.694	1.534	1.411	1.745	1.375	1.327	1.615
14 February 2024	6.686	3.811	3.327	3.387	2.720	2.127	1.910	1.590	1.694	1.535	1.412	1.745	1.375	1.328	1.615
Difference	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.1 %	0.1 %	0.0 %	0.0 %	0.1 %	0.0 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	1.451	1.426	1.266	1.206	1.153	1.283	1.219	1.170	1.079	0.919	0.889	0.940	0.955	0.881	0.789
14 February 2024	1.451	1.426	1.266	1.206	1.154	1.283	1.219	1.170	1.080	0.919	0.889	0.940	0.955	0.881	0.789
Difference	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.1 %	0.0 %	0.0 %	0.0 %	0.1 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2020	2021													
10 February 2023	0.700	0.850													
14 February 2024	0.696	0.803													
Difference	-0.004	-0.047													
%	-0.6 %	-5.5 %													

Hg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	1.086	0.929	0.891	0.765	0.808	0.801	0.865	0.813	0.692	0.636	0.603	0.684	0.672	0.819	0.753
14 February 2024	1.087	0.930	0.891	0.766	0.808	0.801	0.865	0.813	0.693	0.636	0.603	0.685	0.672	0.819	0.754
Difference	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001
%	0.1 %	0.1 %	0.0 %	0.1 %	0.0 %	0.0 %	0.0 %	0.0 %	0.1 %	0.0 %	0.0 %	0.1 %	0.0 %	0.0 %	0.1 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	0.891	1.034	0.873	0.821	0.756	0.887	0.755	0.745	0.762	0.707	0.621	0.591	0.582	0.679	0.587
14 February 2024	0.892	1.035	0.873	0.821	0.756	0.888	0.755	0.745	0.762	0.707	0.621	0.591	0.582	0.679	0.587
Difference	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.1 %	0.1 %	0.0 %	0.0 %	0.0 %	0.1 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2020	2021													
10 February 2023	0.538	0.523													
14 February 2024	0.537	0.519													
Difference	-0.001	-0.004													
%	-0.2 %	-0.8 %													

As

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	34.816	23.859	18.044	16.386	10.996	5.222	8.498	13.863	13.982	5.206	4.361	5.121	3.991	3.668	4.112
14 February 2024	34.817	23.860	18.045	16.386	10.996	5.222	8.499	13.863	13.983	5.207	4.362	5.122	3.991	3.669	4.113

Difference	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.001
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	2.992	2.945	2.959	3.136	2.893	3.400	2.981	2.642	2.755	2.709	2.457	2.578	2.446	2.408	2.058
14 February 2024	2.992	2.946	2.960	3.136	2.893	3.400	2.982	2.643	2.756	2.709	2.457	2.578	2.446	2.408	2.058
Difference	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2020	2021													
10 February 2023	1.993	2.065													
14 February 2024	1.992	2.047													
Difference	-0.001	-0.018													
%	-0.1 %	-0.9 %													

Cr

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	47.670	59.685	47.624	37.721	40.668	35.827	32.754	32.627	30.070	31.226	28.563	25.694	39.075	29.455	26.034
14 February 2024	47.670	59.686	47.625	37.722	40.668	35.827	32.754	32.628	30.070	31.226	28.564	25.694	39.075	29.455	26.034
Difference	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	20.008	24.921	28.824	26.508	16.662	25.884	17.371	18.559	18.434	23.065	16.716	18.172	16.651	15.343	14.286
14 February 2024	20.009	24.922	28.825	26.509	16.662	25.885	17.371	18.559	18.434	23.065	16.716	18.172	16.652	15.343	14.286
Difference	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2020	2021													
10 February 2023	13.893	14.337													
14 February 2024	13.844	14.005													
Difference	-0.049	-0.332													
%	-0.4 %	-2.3 %													

Cu

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	156.893	148.869	124.283	111.539	106.193	116.485	109.524	129.013	84.473	68.124	65.333	66.239	69.277	61.898	59.981
14 February 2024	156.894	148.871	124.284	111.540	106.193	116.486	109.525	129.014	84.474	68.125	65.333	66.240	69.278	61.899	59.982
Difference	0.001	0.002	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	58.051	58.644	44.146	42.042	40.414	41.965	42.401	41.201	42.378	43.074	40.744	41.641	40.634	40.069	40.077
14 February 2024	58.052	58.646	44.147	42.043	40.415	41.965	42.401	41.202	42.379	43.075	40.744	41.642	40.635	40.070	40.077

Difference	-0.985	-6.345
%	-0.8 %	-4.5 %

PCDD/F

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	14.754	18.428	17.385	18.485	18.158	18.562	16.946	17.030	17.140	17.258	17.697	14.876	15.109	13.685	13.872
14 February 2024	18.051	18.856	17.803	18.768	18.372	18.810	17.177	17.386	17.651	17.640	18.158	15.529	15.745	14.055	14.309
Difference	3.297	0.428	0.418	0.283	0.214	0.248	0.231	0.356	0.511	0.382	0.461	0.653	0.636	0.370	0.437
%	22.3 %	2.3 %	2.4 %	1.5 %	1.2 %	1.3 %	1.4 %	2.1 %	3.0 %	2.2 %	2.6 %	4.4 %	4.2 %	2.7 %	3.2 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	13.564	14.044	13.820	13.842	12.117	15.878	13.637	14.548	14.961	15.659	13.918	14.917	12.527	13.408	9.581
14 February 2024	14.033	14.554	14.334	14.414	12.466	16.234	13.962	14.858	15.260	15.933	14.174	15.179	12.790	13.660	9.830
Difference	0.469	0.510	0.514	0.572	0.349	0.356	0.325	0.310	0.299	0.274	0.256	0.262	0.263	0.252	0.249
%	3.5 %	3.6 %	3.7 %	4.1 %	2.9 %	2.2 %	2.4 %	2.1 %	2.0 %	1.7 %	1.8 %	1.8 %	2.1 %	1.9 %	2.6 %
	2020	2021													
10 February 2023	9.384	10.778													
14 February 2024	9.588	10.841													
Difference	0.204	0.063													
%	2.2 %	0.6 %													

PAH-4

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	18.174	18.330	18.357	18.426	19.210	17.303	18.565	18.704	19.415	18.994	17.596	19.987	20.148	20.701	20.968
14 February 2024	18.174	18.330	18.357	18.426	19.210	17.303	18.565	18.704	19.415	18.994	17.596	19.987	20.148	20.701	20.968
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10 February 2023	21.778	20.853	21.783	21.462	22.597	25.124	21.654	23.590	22.409	22.713	21.536	23.456	23.011	22.623	22.314
14 February 2024	21.778	20.853	21.783	21.462	22.597	25.124	21.654	23.590	22.409	22.713	21.536	23.456	23.011	22.623	22.314
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
%	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
	2020	2021													
10 February 2023	17.838	20.091													
14 February 2024	17.837	20.060													
Difference	-0.001	-0.031													
%	0.0 %	-0.2 %													

HCB

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10 February 2023	35.677	35.567	36.361	36.379	36.054	35.572	38.003	38.458	38.377	38.126	38.596	18.186	12.024	9.912	26.039

8.1.3 Improvements and Reviews

Changes in chapter	
March 2024	TF

Inventory improvement programme at Finnish Environment Institute

Identification of further development needs in the Finnish air pollutant inventory is carried out on a continuous basis according to annual work programmes although larger scale improvements are possible only when the necessary resources for the improvement projects are available.

In the past years the inventory improvement programme was strongly linked with the national emission data production methods provided to the operators in their reporting to emission registers such as the E-PRTR. Finnish Environment Institute maintains information on emission estimation methodologies and emission factors on a website (<https://www.ymparisto.fi/fi/saasteettomuus-ja-ymparistoriskit/ilmansuojelu/ilman-epapuhtauksien-paastot-suomessa/paastotiedon-tuottaminen-ja-ilmoittaminen-paastorekistereihin/paastorekisterit>) (in Finnish). These methods should be applied in the E-PRTR reporting by the plant operators whenever no plant specific data is available. This procedure has been developed to ensure consistency between the data reported by the plants and the emission inventory.

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

National emission factors are derived from data reported by the plants when these are based on site-specific measurements and other site-specific data. In the later years, the obligation to use the latest version of the Guidebook emission factors has been more dominant. In the coming years, emphasis will be given to check and further develop national emission factors based on data reported by the plants and replace the Guidebook EFs with these where feasible.

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

Review, Improvement and Harmonization of the Nordic Air Emission Inventories in the Nordic Air Emission Experts Group

Changes in chapter	
March 2021	KS

Since 2004 the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) have carried out several projects on reviewing, improving and harmonizing the national air pollutant emission inventories. The work has been funded by the Nordic Council of Ministers. The target of the cooperation is to share knowledge and resources and to increase the quality of the Nordic CLRTAP air emission inventories with respect to accuracy, comparability, transparency and completeness. Until now, POP, NMVOC, particle and partly also heavy metal emission inventories in the Nordic countries have improved. Several improvements to the national inventories have been made in all Nordic countries due to the results of the work, for instance in NMVOC and particle emission inventories.

In addition to the overall review (2004), the following specific sectors have been under work:

- particulate emissions from small scale wood combustion and road transport (2006)
- emissions from the use of products (2006-2011)

- NMVOC inventories from the domestic product use sector (2010)
- SLCP emissions (2014-2017)
- POP and heavy metals from all sectors (2016-2018).
- POP and heavy metals and particles (2019-2023)

Improvements in the Finnish Inventory due to the Inventory Review Processes

UNECE CLRTAP In-Depth Review of Inventories, Stage 3 Review Report 2023

Changes in chapter	
March 2024	TF

The improvements made to the 2024 inventory submission in response to the UNECE CLRTAP In-Depth Review of Inventories (Stage 3) in 2023 are presented in Table 8.2.

Table 8.2. Improvements made in response to UNECE CLRTAP Stage 3 Review in 2023.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
Finland-2023-3B-1	NMVOG	3B1a, 3B1b, 3B4e	Yes (3B1a, 3B1b)	T2	R	T
<p>Observation The ERT noted that small recalculations of NMVOG emissions for NFR categories 3B1a (2018-2020), 3B1b (2019, 2020) and 3.B.4.e (nearly entire time series) were not described in the IIR (p. 47, 48). During the review Finland provided detailed information on the recalculations and informed the ERT that both issues will be documented in the next IIR.</p> <p>Recommendation The ERT recommends Finland to describe recalculations transparently in its IIR for future submissions.</p> <p><i>Actions up to March 2024</i> <i>The descriptions of recalculations of emissions made in the agricultural sector have been improved in the IIR Part 5 Agriculture to the 2024 submission to increase the transparency in line with the recommendation.</i></p>						
ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
Finland-2023-3D-1	PM	3Da1	No	-	R	C ₂
<p>Observation For PM emissions from category 3Da1 the notation key IE is reported in the NFR. This issue was already questioned in the previous CLRTAP Review and it was recommended that Finland reports the notation key "NE" for TSP, PM₁₀ and PM_{2.5} emissions from NFR category 3Da1. During the review Finland explained that the notation key will be changed to NE in the next submission.</p> <p>Recommendation The ERT recommends Finland to change the notation key from "IE" to "NE" for TSP, PM₁₀ and PM_{2.5} emissions from NFR category 3.D.a.1.</p> <p><i>Actions up to March 2024</i> <i>The notation key for TSP, PM₁₀ and PM_{2.5} emissions from NFR category 3.D.a.1 was changed to "NE" to the 2024 submission in line with the recommendation.</i></p>						
ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
Finland-2023-3D-2	NH ₃ , NO _x	3Da1	Yes	T2 (NH ₃), T1 (NO _x)	R	AC ₃

Observation

The ERT noted that for NFR category 3Da1 NH₃ and NO_x emission values are exactly the same for 2020 and 2021. The amount of mineral fertilizer reported in the NFR for 2021 equals also the value for 2020. However, this is not consistent with the values in Table 5.26 of the IIR. During the review Finland explained that the emission values for 2021 have not been updated in the NFR table and that the values in the IIR are the correct ones. The ERT was informed that this issue will be corrected in the next reporting.

Recommendation

The ERT recommends Finland to update emissions values for NH₃ and NO_x of NFR category 3.D.a.1 in the NFR tables for the next submission and to strengthen its quality procedures in order to avoid update mistakes.

Actions up to March 2024

In submission 2024, the amount of mineral fertilizers reported in the NFR tables equals the figures presented in table 5.26 in chapter 5.5.1 of the IIR Part 5 Agriculture. NH₃ emissions in category 3.D.a.1 were recalculated for the whole time series due to implementation of new emission factors from Guidebook 2023. In addition, the mineral fertilizer data for 2021 was updated, which resulted in the recalculation of NO_x and NH₃ emissions for 2021.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
Finland-2023-5B2-1	NH ₃	5B2	No	T2	R	T

Observation

The ERT noted, that in the waste chapter of the IIR it is described that the digestion of manures is calculated separately from the digestion of other organic wastes and of energy crops, because the manure calculation in 5B2 is linked with the calculation of manure management (3.B) and manure application (3Da2a). During the review Finland provided the calculations and informed the ERT that it would be possible to add this kind of additional information on nitrogen flows in the Agriculture chapter for future submissions.

Encouragement

The ERT encourages Finland to include additional information on nitrogen flows (e.g. N amounts digested) of NFR category 5B2 in the IIR chapter on Agriculture in order to increase transparency in future submissions.

Actions up to March 2024

In the 2024 submission, a new chapter describing general methodological issues has been included in the IIR Part 5 Agriculture (chapter 5.3 General methodological issues, pp. 22-25). The new chapter and a new annex to the Agriculture IIR include additional information on nitrogen flows. A description of a nitrogen flow checking tool that was added to the agricultural emission calculation system to verify that the mass balance calculation of manure-related nitrogen emissions is working as expected has also been included.

EU Technical Review under the NECD in 2023

Changes in chapter	
March 2024	TF

The improvements made to the 2024 inventory submission in response to the EU Technical Review under the NECD in 2023 are presented in Table 8.3.

Table 8.3 Improvements in response to the 2022 EU Technical Review under the NECD (Final Review Report), actions made in the column to the right

NOTE1 – Responses to NECD Projections Review are provided under the Projections Chapter below.
NOTE2 – Responses to earlier NECD and CLRTAP Reviews can be found in the earlier versions of the IIR.

2023 Review Report Table 4: All findings for NO_x, NMVOC, SO₂, NH₃, PM_{2.5} and PM₁₀, including those made during the 2023 NECD inventory review and those not implemented from previous reviews.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-1A2-2023-0001	No	1A2 Stationary combustion in manufacturing industries and construction, SO ₂ , NO _x , NH ₃ , NMVOC, PM _{2.5} , PM ₁₀ , 2019-2021	NA	No	No
<p>Recommendation</p> <p>For 1A2 Stationary combustion in manufacturing industries and construction, NO_x, NH₃, NMVOC, SO₂, PM_{2.5} and PM₁₀, 2019-2021, the TERT notes that there is a lack of transparency regarding the updates of boiler technology data and abatement techniques. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Finland explained that, as of yet, the data is not sufficient, and a project is ongoing to obtain more data, which will be used in the inventory when available and the quality is good enough, though Finland states that the likely effect on emissions will be small.</p> <p>The TERT recommends that Finland provide a short update on the progress of the project in the next submission or include transparent explanations for recalculations if data is available to make updates.</p> <p><i>Actions up to March 2024</i></p> <p><i>The description of the status of the new data collection to fulfill the data gaps related technology data has been included in chapter 2B in IIR Part 2 energy (p. 30) in line with the recommendation to the 2024 submission.</i></p>						
Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-1A3ei-2023-0001	No	1A3ei Pipeline transport, PM _{2.5} , PM ₁₀ , 1990-2021	NA	No	No

Recommendation

For 1A3ei Pipeline transport, PM_{2.5}, PM₁₀, all years, no emissions are reported. The TERT would expect emissions to be reported for these pollutants because emissions of other pollutants are reported for this category. It is noted that many European countries do report particle emissions from pipeline transport, gaseous fuels, even at very small numbers. The relevant chapter of the 2019 EMEP/EEA Guidebook for 1A3ei suggests that PM emission factors from sources using natural gas are used from the 2006 IPCC Guidelines and/or the small combustion chapter 1.A.4. In response to a question raised during the review, Finland answered that primary particulate matter emissions from gas turbines using good quality natural gas are negligible. Hence, they do not use the emission factors suggested by the 2019 EMEP/EEA Guidebook, since they do not fit the situation of Finland. Three references were provided by Finland to justify their approach. The TERT accepts these explanations and acknowledges that particle emissions from pipeline transport using natural gas are indeed very small in the countries which do report these emissions.

The TERT recommends that Finland provide these explanations in the IIR to improve transparency.

Actions up to March 2024

The description of the category 1A3ei in chapter 3.15 in IIR Part 3 Transport (P. 59) has been updated to increase transparency in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-1B1b-2023-0001	No	1B1b Fugitive emission from solid fuels: Solid fuel transformation, SO ₂ , 2000-2021	NA	No	No

Recommendation

For 1B1b Fugitive emission from solid fuels: Solid fuel transformation, SO₂, between 2000-2021 the TERT notes that there is a lack of transparency regarding the time series, where SO₂ emissions are approximately doubling then halving every other year. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Finland explained that the higher SO₂ emissions in some years are due to the maintenance shutdown of the desulphurization unit of the coking plant, including a Claus process, which happens approximately every other year.

The TERT recommends that Finland include this transparency information in the next IIR submission.

Actions up to March 2024

The description of the category 1B1b in chapter 4 in IIR Part 2 Energy (p. 59) has been updated to increase transparency in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-2D3a-2023-0002	Yes	2D3a Domestic solvent use including fungicides, NMVOC, 1990-2021	NA	No	No

Recommendation

For 2D3a Domestic solvent use including fungicides, NMVOC, 1990-2021, the TERT notes that there is an indication in the IIR that a Tier 1 methodology is used for NMVOC emission calculations related to the use of pharmaceuticals, adhesives and filling agents. The TERT notes that the issue is below the threshold of significance. In response to a question raised during the review Finland provided additional data which confirmed that the issue does not relate to changes in emissions above the threshold of significance and informed the TERT that it was not necessary to process the new data as a revised estimate. Finland also explained that the text of the methodology description for this category in the IIR has not been updated to reflect the current state of the inventory.

The TERT recommends that Finland include this data in the next submission and update the methodology description in the IIR to reflect the current state of the inventory.

Actions up to March 2024

The new activity data was included in the inventory and the NMVOC emissions from category 2D3a were recalculated for the whole time series. In addition, the methodological description of the category 2D3a in chapter 4.5 in IIR Part 4 IPPU (p. 86-90) has been updated to increase transparency in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-2H1-2023-0001	No	2H1 Pulp and paper industry, NO _x , 1990-2021	NA	No	No

Recommendation

For 2H1 Pulp and paper industry, NO_x, 1990-2021, the TERT notes that there is a lack of transparency regarding the reporting of emissions as 'NA' (Not Applicable). Finland reported in the IIR (page 120) that NO_x emissions from the pulp and paper industry are allocated in the inventory as fuel-based emissions under NFR 1A2d which also includes process emissions of these compounds. This is done because NO_x emissions are based on data reported by the plants to the supervising authorities. According to the explanation in the IIR, the TERT considers that the correct reporting for NO_x emissions is 'IE' (Included Elsewhere). This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Finland explained that the reporting of the notation key 'NA' is correct, but acknowledged that the text in the IIR is outdated. Finland intends to update it in the next submission.

The TERT recommends that Finland update the description in the IIR about the reporting of NO_x emissions in alignment with the explanation given during the review.

Actions up to March 2024

The methodological description of NO_x emissions from the category 2H1 in chapter 4.6 in IIR Part 4 IPPU (p. 127) has been updated to increase transparency in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-3B-2023-0001	No	3B Manure management, NMVOC, 1990-2021	NA	No	No

Recommendation

For category 3B Manure management for NMVOC and all years, the TERT notes that there is a lack of transparency regarding Finland's correct interpretation of the meaning of the FRAC_silage parameter in the Tier 2 method to estimate NMVOC emissions from silage feeding and silage stores. According to chapter 3B of the 2019 EMEP/EEA Guidebook (p. 29), FRAC_silage should be the fraction of feed in dry matter during housing that is silage, out of the maximum proportion of silage possible in the feed composition. Above table 5.23 in the IIR (p. 41 of Part 5), the parameter FRAC_silage is defined as Proportion of silage as feed (%), with no mention of this being the fraction of the maximum amount. In response to a question raised during the review, Finland clarified that the values in Table 5.23 in the IIR (Part 5, p.41) are presented as proportion of silage as a fraction of the maximum proportion of silage, and that the table caption needs to be corrected. However, based on the cattle feeding specialists at the Natural Resources Institute Finland, cattle (excluding calves under 1 year) feed can potentially consist entirely of silage, along with appropriate mineral and vitamin supplements. This is not a common practice in Finland, but it is known to be used on some farms, particularly for bulls. However, it is unlikely to be used on any dairy farms for lactating cows even if it were possible. Finland noted that the corresponding section in the chapter 3B of the 2019 EMEP/EEA Guidebook needs clarification and the TERT thanks Finland for this useful feedback. The TERT notes that this issue does not relate to an over or under-estimate of emissions.

The TERT recommends that in the next IIR submission, Finland correct the caption above table 5.23 in the IIR to accurately describe the numbers in the table as silage in feed as a fraction of the maximum proportion of silage.

Actions up to March 2024

The caption of the table 5.23 in the IIR Part 5 Agriculture (p. 52) has been corrected in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-3B4h-2023-0001	Yes	3B4h Manure management - Other animals, NH ₃ , 1990-2021	NA	No	No

Recommendation

For category 3B4h Manure management - Other livestock (fur animals), NH₃, for all years, the TERT noted that there is a lack of transparency regarding how annual average population (AAP) of fur animals is calculated in the 2023 submission, following recalculations compared to the 2022 submission. The TERT notes that an explanation for the recalculation is provided on p.47-48 of the agriculture chapter, stating that a new data source (number of produced cubs) is now thought more reliable than the previously used source (number of sold pelts). The TERT was unable to find information on how the number of produced cubs has been converted into an annual average population figure in the IIR. In response to a question raised during the review, Finland explained that the nitrogen excretion values of cubs (provided by the Natural Resources Institute Finland, Luke) are calculated to include also the excretion of breeding animals, eliminating the need for separate calculations of emissions from breeding animals. The same methodology and activity data is used in the national greenhouse gas emission inventory, where a similar transition from using the number of cubs instead of the number of sold pelts has also been implemented. The problem with using the number of sold pelts as activity data was that in recent years, the quantity of pelts sold no longer corresponded to the level of production. A significant portion of the pelts appeared to be stored, presumably in anticipation of better selling prices. The TERT notes that for calculation of PM and NMVOC emissions, AAP and VS excretion are required as activity data for fur animals, for which an explanation should also be provided in the IIR. The TERT notes that this issue does not relate to an over or under-estimate of emissions.

The TERT recommends that in the next IIR submission, Finland include this additional explanation regarding nitrogen excretion rates in the description of activity data, along with an explanation of how AAP and VS excretion are estimated from the data on number of cubs produced.

Actions up to March 2024

Additional explanation regarding nitrogen excretion rates in the description of activity data, along with an explanation of how AAP and VS excretion are estimated from the data on number of cubs produced has been included in the IIR Part 5 Agriculture (p. 35) has been corrected in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-5B1-2023-0001	No	5B1 Biological treatment of waste - Composting, NH ₃ , 2019-2021	NA	No	No

Recommendation

For 5B1 Biological treatment of waste - Composting, NH₃, 2019-2021, the TERT notes that there is an inconsistency between the trend of NH₃ emissions and the development of activity data (kt composted) as reported in the NFR Tables. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Finland confirmed that the activity data presented in the NFR table is not correct, but the IIR shows the right figures.

The TERT recommends that Finland correct the data in the NFR of the next submission.

Actions up to March 2024

The activity data reported in the NFR tables in category 5B1 was corrected to the 2024 submission. The the same activity data in also presented in the IIR in chapter 6.3 in IIR Part 6 Waste (p. 10).

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-5B2-2023-0001	No	5B2 Biological treatment of waste - Anaerobic digestion at biogas facilities, NH ₃ , 1990-2021	NA	No	No

Recommendation

For 5B2 Biological treatment of waste - Anaerobic digestion of waste, NH₃, all years, the TERT notes that there is a lack of transparency regarding annual amounts of nitrogen in the feedstock entering the biogas plants used for calculation of emissions from biogenic waste other than manure. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Finland provided very detailed information and indicated that the nitrogen values will be included in the IIR in the next reporting.

The TERT recommends that Finland include the information provided during the review in the 2024 IIR as stated in the answer.

Actions up to March 2024

The methodological description of the category 5B2 in chapter 6.4 in IIR Part 6 Waste (pp.13-16) has been updated to increase transparency in line with the recommendation to the 2024 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC in 2022	RE, TC, or UPTC in 2023	Tier 1 used for Key Category
2023 (1)	FI-5E-2023-0001	No	5E Other waste, PM _{2.5} , PM ₁₀ , TSP, 1990-2021	NA	No	No

Recommendation

For 5E Other Waste, PM_{2.5}, PM₁₀, TSP, all years, the TERT notes that there is an inconsistency of information provided in the IIR 2023, Part 6 - Waste, section 6.7, page 37, and emission data reported in the NFR. The TERT notes that the issue is below the threshold of significance. In response to a question raised during the review, Finland provided corrected data and confirmed that the issue does not relate to changes in emissions above the threshold of significance. Finland informed the TERT that emissions of PM and other gases (heavy metals, dioxins) from this category will be revised and the text updated in the next submission.

The TERT recommends that Finland include this data in the 2024 submission and adapt the methodological description accordingly.

Actions up to March 2024

The activity data was revised for the whole time series and all particle, heavy metal and dioxin emissions were recalculated for 1990-2021 for the 2024 submission. In addition, the methodological description of the category 5E in chapter 6.7 in IIR Part 6 Waste (pp.37-40) has been updated.

8.2 PROJECTIONS

Changes in chapter	
Update of text March 2024	KS, MS, TF
Update of projections	Every 1-3 years, since 2020 every 2 years

8.2.1 Projections for 2025, 2030, 2040, 2050

With existing measures (WM) projections

Finland updated the Energy and Climate Strategy – Carbon neutral Finland 2035 – in 2022 (Huttunen 2022¹). To support the preparation of the strategy, an extensive background study called Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies and abbreviated as HIISI² was commissioned. The HIISI project was succeeded by the HIISI² follow-up study, completed in February 2022. The aim of the further study was to assess the impacts of the Government's latest climate and energy policies on Finland's greenhouse gas emissions and the energy and national economy. The HIISI projects laid out the activity pathways of two scenarios: With Existing Measures and With Additional Measures. As with the original National Air Pollution Control Programme 2030 (Ministry of the Environment, 2019³), the First Update Report of the programme⁴ (published in May 2023) concludes that the With Existing Measures scenario, Finland will be able to meet the air pollution emission reductions for 2030. Based on that, an air pollutant emission scenario, called WM, is presented in this chapter.

Finland is currently in the process of updating its Energy and climate strategy, starting from baseline for primary energy consumptions. To support the preparation of the strategy, an extensive background study has been commissioned (abbreviated as PEIKKO, due to be finalized in the spring 2024). In March 2024, the first version of the baseline scenario was available. In the Energy sector, this new data has been compared with the HIISI study. Using relative changes in key fuel combustion activities, emissions projected in 2023 have been modified to make a preliminary estimate of that better reflects the new baseline. As the baseline is finished, proper emission estimates will be calculated and reported in 2025. In the transport sector, the results of the PEIKKO project were available in the update of projections to the 2024 submission.

Base years

The base years for the projections depend on the sector as follows:

Energy	2019
Transport	2022
IPPU & Waste	the projections are running averages or scaled in line with capita projections
Agriculture	the projections are based on animal number forecasts, no base year

¹ Huttunen R. (Ed.) 2022:17. Government Report on the National Energy and Climate Strategy for 2030. Carbon neutral Finland 2035 – national climate and energy strategy. Publications of the Ministry of Economic Affairs and Employment Energy • 2022:55 Publications of the Ministry of Economic Affairs and Employment, 2017-02-08.

² The HIISI report <http://urn.fi/URN:ISBN:978-952-383-257-2>

³ Ministry of the Environment. 2019. National Air Pollution Control Programme 2030. Publications of the Ministry of Environment 2019:7

⁴ Ministry of the Environment. 2023. First update of the national air pollution control programme 2030. Publications of the Ministry of the Environment 2023:24.

Note that the energy sector projections in the 2024 submission are based on a yet preliminary activity data. The recommendation received in the 2023 NECD projections review related to the harmonization of the base years in different sector will be fully addressed in the 2025 submission. The new energy sector baseline activity data mentioned above will be available when preparing the emission projections for the 2025 submission.

In the 2024 projections submission, the year 2022 has been reported as the base year in the Annex IV reporting table.

Projections for 2025, 2030, 2040 and 2050

Emission projections for 2025, 2030, 2040 and 2050 submitted in 2024 cover nitrogen oxides, sulphur oxides, non-methane volatile organic compounds, ammonia, fine particles (PM2.5) and black carbon. Estimates for 2040 and 2050 are not available for all sources, therefore total emissions are reported as NE.

For agriculture and road transport sectors, emission scenarios are available up to 2050. For energy, scenarios are available up to 2040. For IPPU, fugitive emissions and waste sector, expert estimates were made also for the years 2040 and 2050 for the 2024 submission, however, these will be further developed in the coming years. The current projected emission values are presented in Table 8.3.

In the 2024 projection submission, all the activity data in Annex IV reporting table are reported as 'NA'. However, the reporting of the activity data will be revised for 2025 submission, and activity data figures will be reported in the categories where it is possible.

Table 8.3. Projected national total emissions for 2025, 2030, 2040, 2050 as reported on 15 March 2024.

Pollutant	Unit	WM projections				
		2022	2025	2030	2040	2050
SO _x	kt	23	20	18	NE	NE
NO _x	kt	99	87	74	NE	NE
NMVOC	kt	75	79	73	NE	NE
NH ₃	kt	32	30	29	NE	NE
PM _{2.5}	kt	13	12	10	NE	NE
BC	kt	3.1	2.7	2.2	NE	NE

QA/QC measures and sensitivity analysis

In general, the same sectoral QA/QC activities that are carried out for the historical emissions, and described in the sectoral chapters in the IIR, are also carried out for the projected emissions. For instance, in the case of activity data, these include the cross-checking of possible anomalies. In addition, especially in agriculture, the same activity data is also used by Natural Resources Institute Finland in the production of ghg-emission projections. They also carry out QA/QC activities for the activity data and the results of these activities are available for the air pollutant emission projections. Regarding the sensitivity analysis, no specific sensitivity analyses have been carried out. In many cases, some specific sensitivity analyses have not been considered necessary. E.g. in the energy sector, according to the projections, almost all the 2030 targets will be met and the technological development and the increasing share of non-combustible renewables will decrease the emissions in the future. The EMEP/EEA Emission Inventory Guidebook 2023 provides only a short introduction to

the sensitivity analysis and no detailed methodological guidance are provided. In addition, the use of sensitivity analyses is not a shall requirement in the reporting guidelines. However, the appropriateness of the sensitivity analyses will be examined for the future submissions.

8.2.2 Projections for Energy

Changes in chapter	
Update of text March 2024	MS, KS, TF
Update of projections	Every 1-3 years, since 2020 every 2 years

The following text describes how projections for energy projection facilities, industry and households were calculated in the 2023 submission. Finland is currently in the process of updating its Energy and climate strategy, starting from baseline for primary energy consumptions. In March 2024, the first version of the baseline scenario was available. This new data has been compared with the HII SI study (explained below). Using relative changes in key fuel combustion activities, emissions projected in 2023 have been modified to make a preliminary estimate of that better reflects the new baseline. As the baseline is finished, proper emission estimates will be calculated and reported in submission 2025.

The projection has been calculated at the Finnish Environment Institute. The latest national Energy and climate strategy has been used as basis of the emission calculations from the energy sector, as explained in chapter 8.2.1. The primary energy consumption up to 2050 for energy production facilities and households were estimated in the HII SI study, and the data has been obtained from the VTT Technical Research Centre of Finland Ltd. Using this activity data, the Finnish Regional Emissions scenario (FRES) model (Karvosenoja 2008⁵) was used to calculate emission projections for combustion plants and residential combustion. It covers the emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x) non-methane volatile organic compounds (NMVOCs) (from residential combustion only) and primary particulate matter (TSP, PM₁₀, PM_{2.5}, PM₁ and PM_{0.1}). Primary PM includes the fractionation to main chemical species (black and organic carbon, sulfate, main heavy metals and mineral matter). For NH₃ and NMVOC emissions from the energy sector (with the exception of NMVOC emissions from residential combustion), projections are expert estimates based on historical emissions. Only ammonia slips from SCR/SNCR are considered as ammonia emissions are not expected from biomass combustion with the technologies used in Finnish heat and power production.

FRES is a scenario model, where a new reference year is added every five years (2010, 2015 etc.) and target years are selected according to specific needs and available activity data. However, since 2020 was an unusual year because of covid-19 restrictions and a very warm winter, year 2019 has been used as the latest reference year. In this assessment, emissions were calculated for the target years 2030 and 2050. They were then used to estimate emissions for the years 2025 and 2040, assuming linear progression. The FRES model is not completely aligned with the NFR reporting scheme in all aspects, however, and thus it has been used to estimate relative changes in emissions. These relative changes are then implied to emissions reported for 2019 in the NFR.

Model parameters

The emissions are calculated from the parameters of activity levels, emission factors and emission control technology removal efficiencies and utilization rates (Figure 8.2). The energy consumption and industrial production scenarios produced in the HII SI study are used as input to the model (Annex IV B-WM). In the FRES model the activity unit for combustion processes is annual primary energy use (e.g. PJ a-1). Emission sources are treated as point sources (~450 combustion plants and ~130 process industry plants) or area sources (residential combustion and small or less active combustion plants).

For some combustion plants the emissions and fuel use data are reported in the national YLVA database so that plant-specific emission factors can be calculated. If the data is not available, emission factors will

⁵ Karvosenoja N. 2008 Emission scenario model for regional air pollution. *Morographs Boreal Environ. Res.* 32. 2008.

be implemented based on legislation (current or upcoming, depending on the year) for the type of plant in question. The statutes affecting the emission limits of combustion plants are:

- The Industrial Emissions Directive, and the BAT conclusions concerning energy production and different industrial sectors, Medium Combustion Plant Directive
- Environmental Protection Act (527/2014)
- Government Decree on Limiting Emissions from Large Combustion Plants (936/2014)
- Government Decree on Environmental Protection Requirements for Medium-sized Energy Production Units (1065/2017)
- Government Decree on Waste Incineration (151/2013)

Based on these a table has been compiled, where emission factors are given for each fuel type and plant size category, taking into account the date of the start of the operation of the plant (available at request).

Small-scale residential combustion is the biggest source of PM and NMVOC emissions in Finland. The emission calculation scheme for residential (wood) combustion is described in Savolahti et al. (2016)⁶. It includes 5 categories for small-scale central heating boilers and 9 categories for stoves or fireplaces. All of them have separate emission factors based mostly on national measurements, and annual activities based on questionnaires. We have also tried to take into account the suboptimal combustion practices of some stove users. Based on emission factors from literature and info from chimney sweeps, we have used a coefficient for “poor combustion”, resulting in an increase of the average emission factors. Future emissions in the projection are determined by activity changes, natural development of the appliance stock and the Ecodesign directive (2015/1195 and 2015/1189 for residential combustion). The prevalence of wood combustion has been increasing during the last decades but was relatively stable from 2008 to 2017 (estimate based on questionnaires). Mostly due to improvements in energy efficiency, this trend is expected to start to decline in the future. In 2019, wood consumption in residential, agricultural, commercial and industrial buildings was 61 PJ. In the WM scenario, this is expected to decline to 57 PJ in 2030 and 46 PJ in 2050. Ecodesign will not have a major impact until 2030, since it mainly targets appliances with a very long service life (e.g. ~35 years for masonry heaters) and does not cover sauna stoves, which are a considerable polluter in Finland. However, the natural development of the appliance stock towards cleaner stoves and boilers is expected to notably decrease the average emission factors of the sector already by 2030, and thus decrease the emissions. Due to these two factors, emissions (mostly PM and NMVOC) from the residential sector are expected to decrease significantly in the projection.

For ammonia from residential combustion, the projections are expert estimates based on historical emissions and estimated fuel use for future years.

⁶ Savolahti M., Karvosenoja N., Tissari J., Kupiainen K., Sippula O. & Jokiniemi J. 2016. Black carbon and fine particle emissions in Finnish residential wood combustion: Emission projections, reduction measures and the impact of combustion practices. *Atmospheric Environment* 140 (2016) 495-505. <https://doi.org/10.1016/j.atmosenv.2016.06.023>

8.2.3 Projections for Transport

Changes in chapter	
Update of text March 2024	AL, JoMa, KS
Update of projections	Every 1-3 years, since 2020 every 2 years

Emission projections for the transport sector are presented in Figure 8.3.

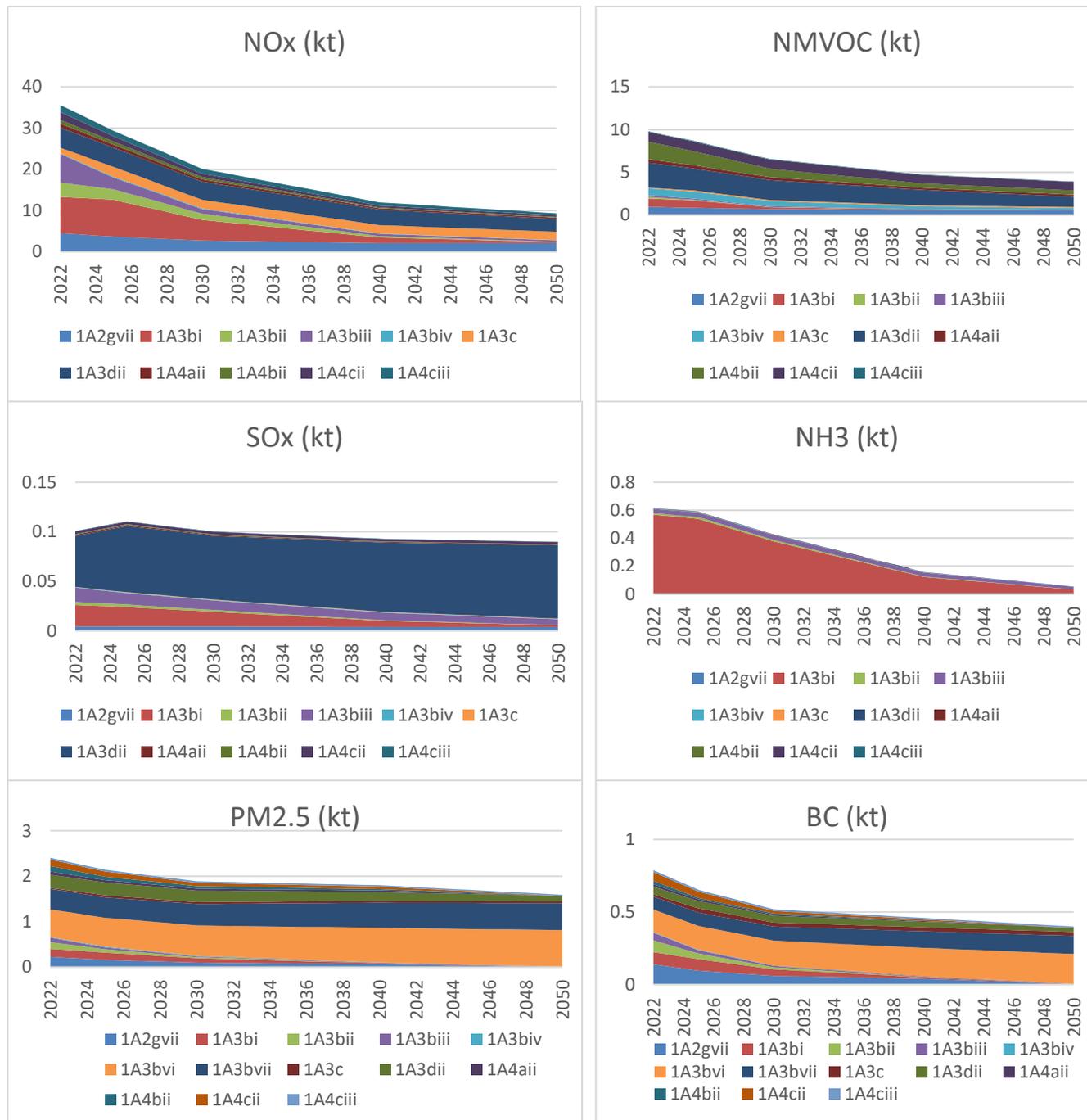


Figure 8.3 Emission projections for the transport sector.

Projections for road and rail transport as well as aviation and working machines are produced using VTT's LIPASTO system, which has a time series for the years 1980-2050.

Road transport

In road transport, the projections are based on the authorities' (The Finnish Transport Infrastructure Agency) forecast of vehicle kilometrage until 2060⁷. The vehicle kilometrage forecast is affected by several factors: most importantly, forecasted development of economy, population growth and cost of driving. A major change in methodology has increased the passenger kilometrage: the relatively inexpensive driving of battery electric vehicles is assumed to increase the total passenger vehicle kilometrage. In the ELIISA model⁸, average annual kilometrages for vehicles are adjusted so that the national kilometrage forecast is achieved with the same size of vehicle fleet as used in the national kilometrage projections. Thus, the composition of the fleet (vehicle types and motive powers) is linked to the projected kilometrage development – as the composition of the fleet varies, the total kilometrage varies also and may not fully match to the national projections. Kilometrage projections include also the impacts of other local policies, which have an assumed impact on kilometrage such as governmental support for public transport and the investment program for walking and bicycling infrastructure (for more details, see attachment 1a in Lauhkonen & Markkanen 2023⁹). Projection includes also a new estimate for the impact of the ETS2 for road transport starting from 2028 onwards¹⁰.

Sales forecasts cover both new vehicles and imported used vehicles: imported vehicles add also a significant amount of vehicles to Finland's vehicle fleet. Scrappage rate is a function of end-of-life-age of vehicles: it is based on actual changes in the fleet. The model considers the penetration of the Euro classes based on statistical data. Assumptions of fuel efficiency development of passenger cars and vans are in line with the CO₂ emission regulation by EU¹¹, which implies the end of sales for new combustion engine vehicles by 2035. For buses, the model assumes fuel efficiency development according to the EC proposal for new heavy duty vehicles¹². For trucks, fuel efficiency development follows a recent expert evaluation of the emergence of electric and fuel cell trucks in Finland⁹. Vast increases in electric and fuel cell vehicle registrations are introduced to the model to simulate the implementation of EU's updated CO₂ emission regulation.

The modelled fleet is divided into different sub-types: eight main types including passenger cars (with and without catalytic converter), vans, buses, rigid and articulated trucks, mopeds, motorcycles and quadricycles. These, in turn, are divided into seven propulsion groups: gasoline, diesel, E85 (ethanol-petrol vehicles), ED95 (ethanol-diesel vehicles), methane, electricity (including plug-in hybrids) and hydrogen. Each of these have their own forecasts of shares of annual sales and imports and fuel efficiency development. In addition, regarding consumed fuels, the proportions of fossil and renewable fuel components are considered. The use of biofuels will increase from 10 % in 2020 (by energy content, of annual liquid and gaseous fuel sales) up to 34 % in 2030 due to the biofuel obligation in Finland¹³ with a temporary decreases in 2022 and 2023 (12 % and 13.5 %, respectively). Biogas and P2X-fuels are included in the obligation since 2022, although P2X fuels are not separately modelled.

The fleet turnover rate of passenger vehicles will be 4.4 % in 2025, 4.5 % in 2030, 4.6 % in 2040 and 4.6 % in 2050. The corresponding figures for vans are: 4.9 %, 4.9 %, 4.8 % and 4.6 %, and for trucks: 4.0 %, 3.8 %, 3.9 % and 3.7 %. A special feature in Finland are the very heavy trucks (gigatrucks),

⁷ Moilanen, P., Lapp, T., Niinikoski, M., Blomqvist, P. & Rinta-Piirto, J.. 2022. National transport forecasts (in Finnish). Traficom Research Reports 6/2022. Available at: <https://www.traficom.fi/sites/default/files/media/publication/VLE%202022.pdf>

⁸ Markkanen, J., Lauhkonen, A., & Niemi, A. (2023). Scenarios for greenhouse gas emissions and energy consumption of road transport in Finland: Exploring the impact of existing policies. VTT Technical Research Centre of Finland. VTT Technology No. 413 <https://doi.org/10.32040/2242-122X.2023.T413>

⁹ Lauhkonen, A. & Markkanen, J. 2023. Tieliikenteen ajoneuvokanta- ja päästöennusteen päivitys 2023 (in Finnish). Available at: https://www.traficom.fi/sites/default/files/media/publication/Tieliikenne_PaastoPaivitys_2023.pdf

¹⁰ PEIKKO (updated national scenarios with existing measures) -final report, upcoming publication, estimated 04/2024.

¹¹ Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles

¹² Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Regulation (EU) 2019/1242 as regards strengthening the CO₂ emission performance standards for new heavy-duty vehicles and integrating reporting obligations, and repealing Regulation (EU) 2018/956 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2023:88:FIN>

¹³ Finnish Act on biofuels 20.12.2022/1134. Available at: <https://www.finlex.fi/fi/laki/alkup/2022/20221134>

which reduce the number of trucks with trailer. The increase in the number and kilometrage of motorcycles, mopeds and quadricycles is expected to stabilise in the coming years. The vehicle fleet development is based on an expert estimate on the current sales trends of available powertrains and the availability of new vehicles in the European market as well as on CO₂-limits of new vehicles as set in EU-legislation. The development in the forecast is dominated by increase of battery electric vehicles, which replace conventional gasoline and diesel vehicles in all vehicle categories except in trucks, for which CNG/LNG-powered vehicles replace conventional vehicles. The demand for electric vehicles remains high as the total share of battery-powered (plug-ins included) cars exceeded 50 % of all new car sales in 2023.

Ammonia

In transport, most NH₃ emissions originate from passenger cars equipped with catalytic converters. Improvements in technology have substantially reduced NH₃ emissions from passenger cars after 2005 and the development is continuing in the projections. On the other hand, the introduction of the urea additive in heavy vehicles since Euro V significantly increases their ammonia emissions. However, since heavy-duty NH₃ emissions are one-tenth of NH₃ emissions from passenger cars, emissions from passenger cars dominate and overall emissions are decreasing in the projections.

PM 2.5 and BC

Car exhaust emissions of particulate matter (PM_{2.5}) and black carbon (BC) have fallen to less than a quarter since the year 2000 and the development is continuing in the projections. However, emissions from tyre and brake wear and road abrasion are increasing. According to the forecast, the vehicle kilometrage for passenger cars especially, increases from 2020 until 2050. One key reason for this is relatively inexpensive driving of battery electric vehicles.

NM VOC

NM VOC emissions are decreasing due to the renewal of vehicle fleet. A significant share of these emissions is caused by mopeds and motorcycles. The increase in the number and kilometrage of motorcycles and mopeds is expected to stabilise in the coming years and the vehicle fleet renewal towards greater share of newer Euro-classes is continuing in the projections. Currently there is no detailed information on the development of NM VOC emissions in the coming years.

Railways

The forecast for rail transport is based on the expert estimation of the development of diesel train transport volume (gross tonne kilometres). This development follows the national transport forecasts⁷ on transported tonnes. The proportion of diesel trains has decreased significantly in recent years and they are mainly used in non-electrified, smaller rail sections. In 2022, transport activity reduced substantially especially in diesel-powered freight transport mainly due to the economic sanctions against Russia. No other major changes to the development are expected.

National navigation

In maritime transport, the calculation of the MEERI model is mainly based on the number of port calls at Finnish ports. The forecasts therefore have focused on experts' (The Finnish Transport Infrastructure Agency's) estimation of the development of port calls. These estimates have been updated based on Traficom's (Finnish Transport and Communications Agency) national transport forecasts⁷ (2022). Emission factor forecasts are based on expert estimation on the development of different Tier emission levels in ships and the use of different fuels (HFO, HFO with scrubbers, MDO/MGO, diesel, LPG). For icebreakers, where emissions are dependent on highly changing yearly ice conditions, forecasts are based on a 10-year average. In work vessels, ferry boats, fishing vessels and leisure boats the situation has been stabilised and no changes are expected.

Working machines

For working machines, the forecasts are based on a recent analysis of alternative powertrains and their market penetration in Finland¹⁴. Evolution of fleet (50 different machine types) is affected by, the penetration of emission standards (Stage levels) for ICE-powertrains and the market penetration of electric work machines in Finland. Mechanisation of the work has reached its maximum and the sales of new machines is mainly replacing scrapped machines and the number of most of the machine types is stabilised. Increased efficiency of machines, work and emission restrictions and increasing electrification of machines will reduce emissions in projections.

Aviation

There is currently no model to calculate aviation emissions, which are minor and are not considered to impact the projected trends.

¹⁴ Markkanen, J., & Lauhkonen, A. (2021). Työkoneiden päästöjen perusennuste ja sähköistymisen vaikutus päästöihin (in Finnish). VTT Technical Research Centre of Finland. VTT Asiakasraportti No. VTT-CR-00245-21. Available at: <https://cris.vtt.fi/en/publications/ty%C3%B6koneiden-p%C3%A4st%C3%A4st%C3%B6jen-perusennuste-ja-s%C3%A4hk%C3%B6istymisen-vaikutus-p%C3%A4st%C3%A4st%C3%B6ihin>

8.2.4 Projections for IPPU and Waste

Changes in chapter	
Update of text March 2024	KS, MS, TF
Update of projections	Every 1-3 years, since 2020 every 2 years

Projections for the IPPU sector were updated based on best available information depending on the activity sector as described below in Table 8.4.

For those pollutants indicated below to be based on the FRES model for the reference year the projections are based on historical emissions (average of 3 preceding years) of the industrial facilities as reported in the national YLVA database. The projections are a combination of assumed activity changes and developments in cleaner technology. A specific inquiry of the future development prospects was conducted to main industrial sectors as part of the National Air Pollution Control Programme 2030.

Table 8.4. Methods and assumptions used in IPPU and Waste sector projections.

Sector		Method	
2A1	Cement production	<p>NMVOC emissions occur from 2A1 and 2A3 but are minor and are considered to be already included in the uncertainty of the air pollutant emissions from the major IPPU sectors.</p> <p>NOx from 2A2 and 2A3 are included in the energy sector projections as is the case also are in the inventory of historic years.</p> <p>All NOx, SOx, PM2.5 and BC projections are estimated in the FRES model based on the average of the preceding years and are a combination of assumed activity changes and developments in cleaner technology. A specific inquiry of the future development prospects was conducted to main industrial sectors as part of the National Air Pollution Control Programme 2030. In the 2024 projections submission, these emissions for 2025 and 2030 were grouped under NFR category 2L while notation key 'IE' was used for the other NFR categories. Emissions were not estimated for 2040 and 2050.</p>	
2A2	Lime production		
2A3	Glass production		
2A5a	Quarrying and mining of minerals other than coal		
2A5b	Construction and demolition		
2A5c	Storage, handling and transport of mineral products		
2B2	Nitric acid production		
2B6	Titanium dioxide production		
2B10a	Chemical industry: Other		<p>NMVOC and NH3 emissions projections are estimated based on the running average of the last three years.</p> <p>NOx from 2C1 is included in the energy sector projections as they also are in the inventory of historic years.</p> <p>SOx, PM2.5 and BC emissions projections are estimated in the FRES model based on the average of the preceding years and are a combination of assumed activity changes and developments in cleaner technology. A specific inquiry of the future development prospects was conducted to main industrial sectors as part of the National Air Pollution Control Programme 2030. In the 2024 projections submission, these emissions for 2025 and 2030 were grouped under NFR category 2L while notation key 'IE' was used for the other NFR categories. Emissions were not estimated for 2040 and 2050.</p>
2B10b	Storage, handling and transport of chemical products		
2C1	Iron and steel production		
2C2	Ferroalloys production		
2C3	Aluminium production		
2C6	Zinc production		
2C7a	Copper production		
2C7b	Nickel production		
2C7c	Other metal production		

2C7d	Storage, handling and transport of metal products	
2D3a	Domestic solvent use including fungicides	NMVOC projections are calculated using capita forecasts as a surrogate.
2D3b	Road paving with asphalt	<p>NMVOC and NH3 projections are based on the running average of last three years. No forecast is available for the development of the sector.</p>
2D3c	Asphalt roofing	
2D3d	Coating applications	
2D3e	Degreasing	
2D3f	Dry cleaning	
2D3g	Chemical products	
2D3h	Printing	
2D3i	Other solvent use	
2G	Other product use	
2H1	Pulp and paper industry	<p>SOx, PM2.5 and BC emissions projections are estimated in the FRES model based on average of preceding years and are a combination of assumed activity changes and developments in cleaner technology. A specific inquiry of the future development prospects was conducted to main industrial sectors as part of the National Air Pollution Control Programme 2030. In the 2024 projections submission, these emissions for 2025 and 2030 were grouped under NFR category 2L while notation key 'IE' was used for the other NFR categories. Emissions were not estimated for 2040 and 2050.</p> <p>NMVOC and NH3 emission projections are based on the running average of last three years.</p>
2H2	Food and beverages industry	NMVOC projection is based on a running three year average of in relation to capita forecasts for the projected years.
2I	Wood processing	NMVOC emission projection is based on the running average of last three years. No forecast is available for the development of the sector.
2L	Other production, consumption, storage, transportation or handling of bulk products	IPPU sector emissions are minor and are thus considered to be included in the uncertainty of the air pollutant emissions from the other IPPU sectors.
5A	Biological treatment of waste - Solid waste disposal on land	A minor and constantly decreasing source of NMVOC and particle emissions due to constantly increasing incineration of waste with energy recovery. The emissions are minor and are projected based on capita forecasts.
5B1	Biological treatment of waste - Composting	A minor source of air pollutants, estimated to be constant
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	The forecast for NH3 is estimated based on principles explained below for the agriculture sector projections.

5C1bv	Cremation	NOx , SOx and NMVOC projections from 2G are included in the energy sector projections as they also are in the inventory of historic years. PM2.5 and BC emissions are minor and are thus considered to be included in the uncertainty of the emissions from the other IPPU sectors.
5D1	Domestic wastewater handling	NMVOC emissions are minor and are projected using capita forecasts as surrogate. NH3 projection is estimated using capita forecasts for the projected years as surrogate.
5D2	Industrial wastewater handling	NMVOC emissions are minor and are calculated as running 3-year average.
5E	Other waste	PM2.5 and BC emissions are minor and are considered to be included in the uncertainty of the emissions from the other IPPU sectors.

Population forecasts, GDP, GDP/capita, GCP forecasts and GDP growth forecasts used in the preparation of the IPPU and Waste sector projections are presented in Table 8.5. The figures in orange italics are calculated from the latest data available (2020) with GDP growth forecast in relation to population forecasts.

In the projections the structural changes in the Finnish economy 1975-2021 (Figure 8.4) are taken into account, especially the latest years decreasing trends due to covid and the Ukrainian war, that impact negatively the IPPU activities in Finland. In addition, for the past decades, the emission levels in Finland have decreased even when the activity levels have increased, due to implementation of BAT technologies.

Table 8.5 Population forecasts, GDP, GDP/capita, GCP forecasts and GDP growth forecasts (figures in red are calculated from historical values using GDP forecasts as surrogate)

Year	Population (mill.) (Statistics Finland)	GDP (Statistics Finland)	GDP/capita (Statistics Finland)	GDP growth forecast ¹⁾ ¹⁵
1980	4.8	33657	7030	
1990	5.0	90959	18197	
2000	5.2	136442	26334	
2005	5.3	164687	31070	
2010	5.4	188143	35002	
2013	5.5	204321	37481	
2015	5.5	211385	38411	
2018	5.5	233462	42253	
2020	5.5	238038	43015	
2021	5.5	250664	45189	3.0
2022	5.6	267688	48111	3.0
2023	5.6	269026	48364	0.5
2024	5.6	272793	48978	1.4
2025	5.6	276612	49606	1.4
2030	5.6	279931	49998	1.2
2040	5.5	281331	50345	0.5
2050	5.5	282738	51190	0.5
2060	5.3	284151	52164	0.5
2070	5.2	285572	53078	0.5

¹⁵ Publications by Statistics Finland [Tilastokeskus - \(stat.fi\)](https://tilastokeskus.fi), [Bruttokansantuote ja -tulo sekä tarjonta ja kysyntä, vuosittain muuttujina Taloustoimi, Vuosi ja Tiedot. PxWeb \(stat.fi\)](https://bruttokansantuote-ja-tulo-seka-tarjonta-ja-kysynta-voosittain-muuttujina-taloustoimi-voosi-ja-tiedot.pxweb.stat.fi), Pellervo [PowerPoint-esitys \(ptt.fi\)](https://powerpoint-esitys.ptt.fi) and Government https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164334/VM_2022_58.pdf?sequence=7, Bank of Finland <https://www.suomenpankki.fi/globalassets/fi/media-ja-julkaisut/puheet/documents/2022-01-20-or-kuntaliitto-c23.pdf>

Talouden rakennemuutos

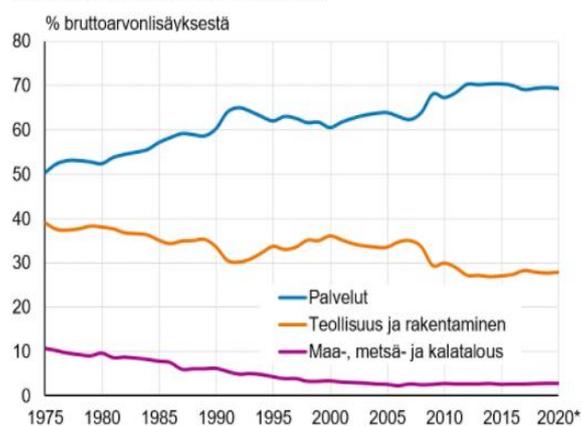


Figure 8.4. Structural changes in economy (% of brutto value addition): Services (blue line), Industry and construction (orange line), Agriculture, Forestry and Fishing industry (red line). Reference: suomilukuina_tau_kan004.xlsx (live.com)

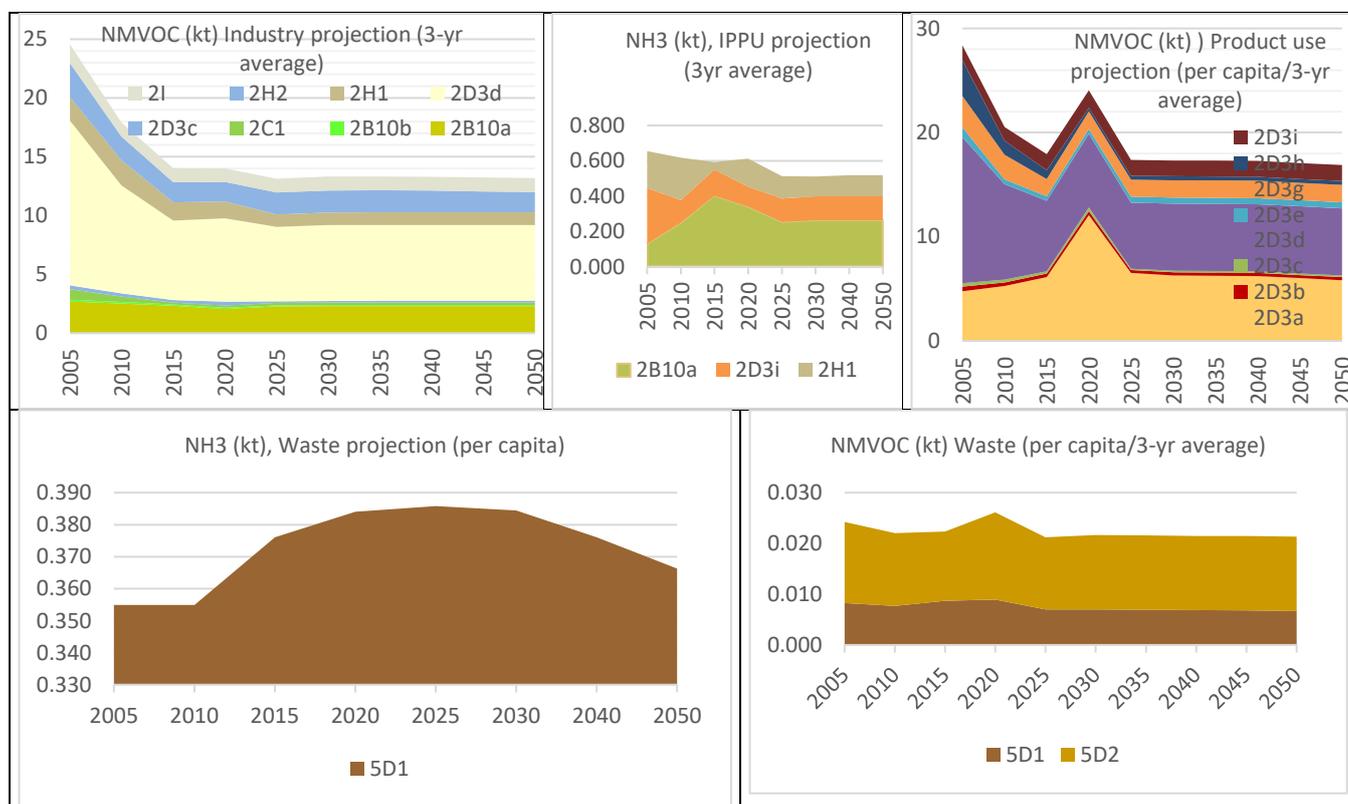


Figure 8.5 Industry, product use and waste projections for NMVOC and NH3 up to 2050

8.2.5 Projections for Agriculture

Changes in chapter	
Update of text March 2024	JG, TF
Update of projections	Every 1-3 years, since 2020 every 2 years

Projections for agriculture are based on the Finnish Agricultural Emission Calculation System available up to 2050. The projected emissions are calculated using the same Tier methodologies as are used in the historical inventory. The animal numbers and the use of mineral fertilizers are forecasts by Natural Resources Institute Finland (Luke). The forecasts are based on the Dynamic Regional Sector Model of Finnish Agriculture, Dremfia, except for fur animals and reindeer, for which the numbers are estimated from existing statistics assuming that there will not be major changes in the coming years. (Lehtonen, 2023¹⁶).

In terms of emissions from the field operations (3De, 3Dc) and sewage sludge applied to soils (3Da2b), emission projections are based on historical emissions. More specifically, they are average emissions calculated from the emissions between 2013 and 2022. For activity data of anaerobically digested other organic waste and energy crops, values of 2022 have been used. For activity data of composted other organic waste and energy crops, as well as for unprocessed organic wastes, average values from the past 10 years (2013-2022) have been used.

The Dremfia model has been utilized in several research projects to produce various agricultural development pathways for the future and assess their climate impacts. The latest project has been the PEIKKO-project, where the future development of greenhouse gas emissions and removals in Finland under current energy and climate policy measures have been assessed, taking into account the heightened geopolitical situation and its recent consequences. The development of animal numbers and use of mineral fertilisers of the **PEIKKO WEM-low** -scenario for agriculture has been utilized when the emission projections for agriculture have been produced.

The PEIKKO WEM-scenarios for agriculture are (Lehtonen, 2023):

- WEM-Baseline: conservative development, no change in human diets.
- WEM-High: Investments in clean technologies and new products are progressing faster than in the WEM-Baseline scenario. Dietary changes are occurring: meat and dairy products -33%, more grains and legumes for food 2020-2050.
- WEM-Low: Weak economic development. Slower technological development compared to the WEM-High scenario. Slow dietary change between 2020-2050: red meat -33%, milk -20%, poultry +20%. Slower development of biogas production than in WEM-high.

For emissions originating from manure, differences in animal numbers and estimations of inorganic fertilizer use are one reason why projected emissions for agriculture differ from those presented in the previous report. Another reason is the changes in estimated nitrogen excretion rates; the nitrogen excretion rates of cattle and sheep were re-estimated based on the new historic excretion time series generated by Luke.

Activity data for agricultural emission projections

- *Animal numbers and inorganic nitrogen use* data used in the emission projections are shown in the table 8.6. This data has been updated since the previous reporting, as was described above.
- *Nitrogen excretion rate estimations* are based on the recent development and are shown in the table 8.7. As described in the Agriculture-chapter of the IIR, the whole excretion time series for

¹⁶ Lehtonen, H. 2023. Personal communication 20.12.2023. Natural Resources Institute Finland (Luke)

all cattle categories and sheep have been updated, affecting also the excretion rates used in the emission projections calculation.

- Estimated evolution of *manure management practices* is described in the tables 8.8 - 8.19. There have been no changes compared to the previous reporting.
- *Efficiencies of the emission abatement measures* (as well as the unabated emission factors used) can be found from the Table 5.12 of the Agriculture-chapter of the IIR. There have been no changes compared to the previous reporting.
- *Other activity data*: see text above. Changes have occurred in the amounts of organic wastes compared to the previous reporting.

As mentioned above, the development of animal numbers and the use of mineral fertilizers are projected up to 2050 in Natural Resources Institute Finland (Luke) based on the Dynamic Regional Sector Model of Finnish Agriculture, Dremfia. This model is based on agricultural economics principles, is well validated in terms of production and land use 1995-2020, and has been frequently used in analysing agricultural and agri-environmental policies (Lehtonen & Niemi 2018, Lehtonen & Niskanen 2016, Lehtonen & Rankinen 2015). However, the development of the numbers of fur animals, lambs, goats and reindeers, which have a small economic role and a small contribution to e.g. greenhouse gases and ammonia, are estimated from existing statistics assuming that there will not be major changes in the coming years. These assumptions and principles have been used when projecting development of agriculture and greenhouse gases in Finland in recent years (see e.g. Aakkula et al. 2019, Koljonen et al. 2020, Lehtonen & Rämö 2020).

The DREMFA sector model has produced several times projections of animal numbers which fit very well the post-development 1995-2020. In fact, the animal number projections in the references above, shows decreasing numbers of bovine animals and pigs, but non-decreasing numbers of poultry animals for years after 2020. This is because of the increasing milk yield of dairy cows which imply reduced numbers of other bovine animals. Pig numbers have been decreasing since ten years due to gradually decreasing domestic demand of pig meat and reduced profitability of production while consumers have substituted poultry meat for pork and thus the number of poultry animals have been in the increase. There is a reason to assume, based on healthiness and climate awareness of consumers, that red meat production (beef, pork) in Finland will continue on gradually decreasing trend and thus the numbers of bovine animals and pigs will remain below the current levels in the future.

Note on 3F, Field burning and other agriculture projections: Field burning is forbidden starting from 1.1.2021

Table 8.6. Animal numbers and use of inorganic nitrogen fertilisers in 2015-2022 and as prediction for 2025-2050

	Cattle					Fur Animals			Horses and ponies		Pigs			
	Bull >1 yr	Calf <1 yr	Dairy cow	Heifer >1 yr	Suckler cow	Fox and racoon	Mink and fitch	Reindeer	Horse	Pony	Boar (50- kg)	Fattening pig (50-kg)	Sow (with piglets)	Weaned pig (20-50 kg)
Finland 2017	110 767	297 334	274 954	150 269	59 854	2 282 000	1 448 000	193 142	64 000	10 400	1 400	446 900	99 100	248 500
Finland 2018	105 770	298 882	271 429	146 100	60 096	2 092 000	1 368 000	184 958	64 000	10 400	1 400	425 000	95 200	246 200
Finland 2019	104 485	288 066	262 292	142 430	60 349	2 060 000	1 042 000	188 190	63 900	10 400	1 300	438 600	92 200	257 700
Finland 2020	98 187	290 199	259 579	136 445	61 975	1 413 000	768 000	194 972	64 000	10 000	1 100	450 600	88 700	263 700
Finland 2021	101 472	288 872	253 527	136 469	63 698	1 266 000	778 000	182 454	64 000	10 000	1 000	405 400	93 000	255 900
Finland 2022	102 217	281 339	248 008	137 280	65 151	773 000	538 000	185 356	59 000	13 000	810	379 840	85 000	230 300
Finland 2025	98 215	270 446	233 467	131 965	67 606	1 000 000	700 000	190 000	59 000	13 000	1 172	355 668	79 670	206 036
Finland 2030	95 892	264 049	229 833	128 843	64 119	1 000 000	700 000	190 000	59 000	13 000	1 049	318 559	71 357	184 539
Finland 2035	92 292	254 135	217 137	124 006	65 778	1 000 000	700 000	190 000	59 000	13 000	990	300 678	67 352	174 181
Finland 2040	87 788	241 734	206 942	117 954	62 167	1 000 000	700 000	190 000	59 000	13 000	930	282 301	63 235	163 535
Finland 2045	79 532	219 001	184 953	106 862	58 849	1 000 000	700 000	190 000	59 000	13 000	824	250 125	56 028	144 896
Finland 2050	73 438	202 218	159 840	98 673	65 279	1 000 000	700 000	190 000	59 000	13 000	814	247 150	55 362	143 172

	Poultry						Goat and sheep		Inorg. N	
	Broiler breeder hen	Broiler	Laying hen pullet	Cockerel	Laying hen	Other poultry	Turkey	Goat	Sheep	Use of inorg. N-fert. as N (tonnes)
Finland 2017	472 976	8 046 698	508 874	22 335	3 745 944	47 213	291 579	5 278	155 926	138 948
Finland 2018	424 296	8 780 903	607 630	17 426	3 984 824	26 135	299 093	5 437	154 999	138 385
Finland 2019	394 715	9 111 743	647 260	16 405	3 900 385	26 758	262 646	5 925	144 876	146 798
Finland 2020	396 097	8 507 327	566 326	17 958	3 811 547	9 639	267 986	6 034	140 171	139 316
Finland 2021	468 282	8 499 274	796 124	21 549	3 728 997	11 187	287 180	5 931	131 086	145 807
Finland 2022	597 651	8 900 737	664 534	24 183	3 865 831	8 696	294 206	6 304	132 084	145 807
Finland 2025	599 755	10 031 093	459 603	18 486	3 014 195	20 000	341 677	6 300	132 100	132 633
Finland 2030	618 645	10 347 033	444 503	17 879	2 915 164	20 000	352 438	6 300	132 100	130 765
Finland 2035	620 298	10 374 673	429 028	17 257	2 813 677	20 000	353 380	6 300	132 100	132 248
Finland 2040	625 810	10 466 865	413 258	16 622	2 710 253	20 000	356 520	6 300	132 100	133 042
Finland 2045	626 293	10 474 944	414 149	16 658	2 716 099	20 000	356 795	6 300	132 100	132 063
Finland 2050	626 627	10 480 535	452 706	18 209	2 968 962	20 000	356 985	6 300	132 100	124 248

Table 8.7 Nitrogen excretion rates (kg N/animal place/year) in 2015-2022 and as prediction for 2025-2050

		Dairy cow	Heifer >1 yr	Calve <1 yr	Suckler cow	Bull >1 yr	Sow	Boar	Fattening pig	Weaned pig	Horse	Pony	Sheep	Goat
Finland	2017	134,892	58,341	36,065	66,891	68,550	31,952	20,813	17,217	9,131	61,972	44,476	7,653	10,700
Finland	2018	136,367	58,326	36,326	66,852	69,428	32,876	21,025	17,206	9,162	61,898	44,593	7,815	10,700
Finland	2019	140,101	59,907	37,311	67,778	70,672	32,268	20,941	17,170	9,162	61,769	44,681	7,951	10,700
Finland	2020	144,608	61,692	38,408	69,714	72,069	33,794	20,692	17,064	9,177	61,664	44,693	7,945	10,700
Finland	2021	144,957	62,761	38,804	69,836	71,364	33,483	20,574	16,978	9,192	61,642	44,639	7,841	10,700
Finland	2022	143,364	62,286	38,240	69,826	70,351	33,154	20,212	16,919	9,207	63,927	44,551	7,930	10,700
Finland	2025	144,000	63,000	40,000	70,000	70,500	33,500	20,558	17,275	9,210	61,987	44,515	7,700	10,700
Finland	2030	150,000	65,000	40,000	71,000	70,500	33,500	20,558	17,275	9,210	61,987	44,515	7,700	10,700
Finland	2035	155,000	66,000	40,000	72,000	70,500	33,500	20,558	17,275	9,210	61,987	44,515	7,700	10,700
Finland	2040	160,000	66,000	40,000	73,000	70,500	33,500	20,558	17,275	9,210	61,987	44,515	7,700	10,700
Finland	2045	160,000	66,000	40,000	74,000	70,500	33,500	20,558	17,275	9,210	61,987	44,515	7,700	10,700
Finland	2050	160,000	66,000	40,000	74,000	70,500	33,500	20,558	17,275	9,210	61,987	44,515	7,700	10,700

		Broiler	Broiler hen	Laying hen	Laying hen pullet	Cockerel	Turkey	Other poultry	Fox and racoon	Mink and fitch	Reindeer
Finland	2017	0,478	0,992	0,601	0,389	0,969	1,663	0,636	3,000	1,305	10,700
Finland	2018	0,478	0,992	0,601	0,389	0,969	1,640	0,636	3,000	1,305	10,700
Finland	2019	0,478	0,992	0,583	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2020	0,479	0,992	0,593	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2021	0,479	0,992	0,574	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2022	0,478	0,992	0,522	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2025	0,478	0,992	0,590	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2030	0,478	0,992	0,590	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2035	0,478	0,992	0,590	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2040	0,478	0,992	0,590	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2045	0,478	0,992	0,590	0,388	0,969	1,695	0,636	3,000	1,305	10,700
Finland	2050	0,478	0,992	0,590	0,388	0,969	1,695	0,636	3,000	1,305	10,700

Manure management data for 2020 and as a prediction for 2025, 2030 and 2040 In most cases, the values used for 2050 are the same as those used for 2040).

All values: % of manure unless otherwise stated.

Table 8.8. General information on cattle manure management and grazing in Finland in 2020 and as a prediction for 2025, 2030 and 2040.

	Dairy cows				Suckler cows				Heifers				Bulls				Calves <1 yr			
	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040
<u>Manure management</u>																				
Treated as slurry (%)	78	78	78	78	6	4	1	1	59	60	65	65	59	55	50	40	44	45	50	50
Treated as deep litter (%)	3	3	3	3	35	37	40	40	7	7	5	5	11	15	20	30	15	15	15	15
Treated as solid manure (%), of which	19	19	19	19	59	59	59	59	34	33	30	30	30	30	30	30	41	40	35	35
urine not separated (FYM, %)	23	23	23	23	91	91	91	91	58	58	58	58	88	88	88	88	63	63	63	63
urine separated (%)	77	77	77	77	9	9	9	9	42	42	42	42	12	12	12	12	37	37	37	37
<u>Grazing</u>																				
Grazing period (days)	138	138	138	138	171	171	171	171	134	134	134	134	161	161	161	161	127	127	127	127
Grazed animals (%)	73	73	73	73	92	90	90	90	68	65	65	65	9	9	9	9	31	30	30	30
Animals inside in nights (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Time inside at night (h)	12	12	12	12	1	1	1	1	1,5	1,5	1,5	1,5	1	1	1	1	2	2	2	2
Manure excreted on pasture (%)	14	14	14	14	41	40	40	40	23	22	22	22	4	4	4	4	10	10	10	10

Table 8.9. General information on manure management and grazing of sheep, goats, horses, ponies, fur animals and reindeer in Finland in 2020 and as a prediction for 2025, 2030 and 2040.

	Sheep & Goat 2020-2040	Horses & Ponies 2020-2040	Fur animals 2020-2040	Reindeer 2020-2040
<u>Manure management</u>				
Treated as slurry (%)	0	0	0	-
Treated as deep litter (%)	50	13	0	-
Treated as solid manure (%), of which	50	87	100	-
urine not separated (FYM, %)	100	100	100	-
urine separated (%)	0	0	0	-
<u>Grazing</u>				
Grazing period (days)	153	180	-	365
Grazed animals (%)	90	97	-	100
Animals inside in nights (%)	100	100	-	0
Time inside at night (h)	2	6	-	0
Manure excreted on pasture (%)	35	36	-	100

Table 8.10. Percentages (%) of management methods for pig manure in Finland in 2020 and as a prediction for 2025, 2030 and 2040.

	Sows				Fattening pigs 2020-2040	Boars 2020-2040	Weaned pigs 2020-2040
	2020	2025	2030	2040			
Treated as slurry (%)	90	85	80	70	100	90	90
Treated as deep litter (%)	0	5	10	20	0	0	4
Treated as solid manure (%), of which	10	10	10	10	0	10	6
urine not separated (FYM, %)	30	30	30	30	18	30	11
urine separated (%)	70	70	70	70	82	70	89

Table 8.11. Percentages (%) of management methods for poultry manure in Finland in 2020 and as a prediction for 2025, 2030 and 2040.

	Laying hens				Broilers 2020 – 2040	Laying hen pullets				Cockerels 2020-2040	Broiler hens 2020 - 2040	Turkeys 2020 - 2040	Other poultry 2020- 2040
	2020	2025	2030	2040		2020	2025	2030	2040				
Slurry	0	0	0	0	0	0	0	0	0	0	0	0	0
Deep litter	10	25	25	25	100	40	40	40	40	50	100	100	40
Solid manure	90	75	75	75	0	60	60	60	60	50	0	0	60

Table 8.12. Detailed information on slurry management in animal shelters and manure storages in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total slurry per animal species.

Abatement measures	Slurry											
	Cattle				Pigs				Poultry (no slurry systems in 2020 or later)			
	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040
<u>Animal shelter (% of manure)</u>												
Improved cleaning of surfaces	15	17	20	25	20	20	20	20	0	0	0	0
Flushing	2	2	2	2	4	4	4	4	0	0	0	0
Increased manure removal frequency	4	4	4	4	10	15	30	50	0	0	0	0
Rapid urine separation	-	-	-	-	-	-	-	-	-	-	-	-
Biological or chemical air scrubbers	0	0	0	0	2	2	2	2	0	0	0	0
Cooling of manure channels	0	0	0	0	15	20	25	50	-	-	-	-
Drying of manure on manure belt	-	-	-	-	-	-	-	-	-	-	-	-
Non-leaking drinking system	-	-	-	-	-	-	-	-	-	-	-	-
<u>Manure storage (% of manure)</u>												
No measures	0	0	0	0	27	23	15	15	27	23	15	15
Tight roof (concrete)	2	2	2	2	3	3	2	2	3	3	2	2
Semi-tight roof (floating covers)	5	5	4	4	33	35	43	43	33	35	43	43
Natural crust	65	63	54	50	0	0	0	0	0	0	0	0
Tent, roof	28	30	40	44	37	39	40	40	37	39	40	40
Filling of storage from the bottom	95	95	95	95	90	95	95	95	75	75	75	75

Table 8.14. Detailed information on solid manure (FYM) management in animal shelters and manure storages in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total solid manure per animal species.

Abatement measures	Solid manure (FYM)																							
	Cattle				Pigs				Poultry				Sheep + Goat				Horses				Fur animals			
	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040
<u>Animal shelter</u> <u>(% of manure)</u>																								
Improved cleaning of surfaces	14	14	14	14	12	12	12	12	5	5	5	5	1	1	1	1	15	15	15	15	0	0	0	0
Flushing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
Increased manure removal frequency	4	4	4	4	2	2	2	2	95	95	95	95	0	0	0	0	-	-	-	-	0	0	0	0
Rapid urine separation	2	2	2	2	5	5	5	5	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
Biological or chemical air scrubbers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
Cooling of manure channels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drying of manure on manure belt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-leaking drinking system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Manure storage</u> <u>(% of manure)</u>																								
Solid manure covering	55	60	65	65	55	60	65	65	59	60	65	65	60	60	65	65	60	60	65	65	0	0	0	0
Filling of storage from the bottom	35	35	35	35	50	50	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.15. Detailed information on separately collected urine and dung management in animal shelters and manure storages in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total urine and dung per animal species.

Abatement measures	Urine								Dung							
	Cattle				Pigs				Cattle				Pigs			
	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040
<u>Animal shelter (% of manure)</u>																
Improved cleaning of surfaces	14	14	14	14	12	12	12	12	14	14	14	14	12	12	12	12
Flushing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increased manure removal frequency	-	-	-	-	-	-	-	-	4	4	4	4	2	2	2	2
Rapid urine separation	2	2	2	2	2	2	2	2	-	-	-	-	-	-	-	-
Biological or chemical air scrubbers	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
Cooling of manure channels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drying of manure on manure belt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-leaking drinking system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Manure storage (% of manure)</u>																
Tight roof (concrete)	8	8	8	8	8	8	8	8	-	-	-	-	-	-	-	-
Natural crust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tent, roof, floating cover	72	72	72	72	72	72	72	72	-	-	-	-	-	-	-	-
Solid manure covering	-	-	-	-	-	-	-	-	55	60	65	65	55	60	65	65
Filling of storage from the bottom	-	-	-	-	-	-	-	-	35	35	35	35	50	50	50	50

Table 8.16. Detailed information on slurry application in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total slurry per animal species.

Abatement measures	Slurry											
	Cattle				Pigs				Poultry (no slurry systems in 2020 or later)			
	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040
<u>Type of surface for application</u>												
Arable land	31	31	31	31	44	44	44	44	44	44	44	44
Plant covered land	44	44	44	44	31	31	31	31	31	31	31	31
Stubble	25	25	25	25	25	25	25	25	25	25	25	25
<u>Application on arable land</u>												
Injection	65	70	70	70	65	70	70	70	62	70	70	70
Band spreading	25	30	30	30	25	30	30	30	24	30	30	30
Broadcast spreading	10	0	0	0	10	0	0	0	14	0	0	0
Of manure spread on soil surface:												
No incorporation	0	0	0	0	0	0	0	0	0	0	0	0
Incorp. with ploughing < 4 h	10	15	20	20	15	15	20	20	15	15	20	20
Incorp. with ploughing < 12 h	14	14	20	20	11	14	20	20	11	14	20	20
Incorp. with ploughing 12-24 h	22	11	0	0	20	11	0	0	20	11	0	0
Incorp. with harrowing < 4 h	16	25	30	30	24	25	30	30	24	25	30	30
Incorp. with harrowing < 12 h	16	24	30	30	13	24	30	30	13	24	30	30
Incorp. with harrowing 12-24 h	22	11	0	0	17	11	0	0	17	11	0	0
<u>Application on plant covered land</u>												
Injection	65	70	70	70	65	70	70	70	62	70	70	70
Band spreading	25	30	30	30	25	30	30	30	24	30	30	30
Broadcast spreading	10	0	0	0	10	0	0	0	14	0	0	0
<u>Application on stubble</u>												
Injection	65	70	70	70	65	70	70	70	62	70	70	70
Band spreading	25	30	30	30	25	30	30	30	24	30	30	30
Broadcast spreading	10	0	0	0	10	0	0	0	14	0	0	0
Of manure spread on soil surface:												
No incorporation	0	0	0	0	0	0	0	0	0	0	0	0
Incorp. with ploughing < 4 h	14	15	20	20	12	15	20	20	12	15	20	20
Incorp. with ploughing < 12 h	15	14	20	20	21	14	20	20	21	14	20	20
Incorp. with ploughing 12-24 h	27	11	0	0	22	11	0	0	22	11	0	0
Incorp. with harrowing < 4 h	15	25	30	30	15	25	30	30	15	25	30	30
Incorp. with harrowing < 12 h	13	24	30	30	14	24	30	30	14	24	30	30
Incorp. with harrowing 12-24 h	16	11	0	0	16	11	0	0	16	11	0	0

Table 8.17. Detailed information on deep litter application in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total deep litter per animal species.

Abatement measures	Deep litter														
	Cattle			Pigs			Poultry			Sheep + Goat			Horses		
	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040
<u>Type of surface for application</u>															
Arable land	68	68	68	88	88	88	88	88	88	68	68	68	76	76	76
Plant covered land	32	32	32	12	12	12	12	12	12	32	32	32	24	24	24
Stubble	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<u>Application on arable land</u>															
No incorporation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incorp. with ploughing < 4 h	15	15	20	14	15	20	14	15	20	15	15	20	14	15	20
Incorp. with ploughing < 12 h	16	25	20	13	25	20	13	25	20	16	25	20	17	25	20
Incorp. with ploughing 12-24 h	28	15	0	30	15	0	30	15	0	28	15	0	27	15	0
Incorp. with harrowing < 4 h	15	20	30	14	20	30	14	20	30	15	20	30	11	20	30
Incorp. with harrowing < 12 h	3	12	30	14	12	30	14	12	30	3	12	30	14	12	30
Incorp. with harrowing 12-24 h	23	10	0	15	10	0	15	10	0	23	10	0	17	10	0
<u>Application on plant covered land</u>															
Broadcast spreading	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 8.19. Detailed information on separately collected urine and dung application in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total solid manure per animal species.

Abatement measures	Urine						Dung					
	Cattle			Pigs			Cattle			Pigs		
	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040
<u>Type of surface for application</u>												
Arable land	17	17	17	23	23	23	68	68	68	88	88	88
Plant covered land	63	63	63	26	26	26	32	32	32	12	12	12
Stubble	20	20	20	51	51	51	-	-	-	-	-	-
<u>Application on arable land</u>												
Injection	62	70	70	62	70	70	-	-	-	-	-	-
Band spreading	24	30	30	24	30	30	-	-	-	-	-	-
Broadcast spreading	14	0	0	14	0	0	-	-	-	-	-	-
Of manure spread on soil surface:												
No incorporation	0	0	0	0	0	0	0	0	0	0	0	0
Incorp. with ploughing < 4 h	10	15	20	15	15	20	15	15	20	14	15	20
Incorp. with ploughing < 12 h	14	14	20	11	14	20	16	25	20	13	25	20
Incorp. with ploughing 12-24 h	22	11	0	20	11	0	28	15	0	30	15	0
Incorp. with harrowing < 4 h	16	25	30	24	25	30	15	20	30	14	20	30
Incorp. with harrowing < 12 h	16	24	30	13	24	30	3	15	30	14	15	30
Incorp. with harrowing 12-24 h	22	11	0	17	11	0	23	10	0	15	10	0
<u>Application on plant covered land</u>												
Injection	62	70	70	62	70	70	-	-	-	-	-	-
Band spreading	24	30	30	24	30	30	-	-	-	-	-	-
Broadcast spreading	14	0	0	14	0	0	100	100	100	100	100	100
<u>Application on stubble</u>												
Injection	62	70	70	62	70	70	-	-	-	-	-	-
Band spreading	24	30	30	24	30	30	-	-	-	-	-	-
Broadcast spreading	14	0	0	14	0	0	-	-	-	-	-	-
Of manure spread on soil surface:												
No incorporation	0	0	0	0	0	0	-	-	-	-	-	-
Incorp. with ploughing < 4 hrs	14	15	20	12	15	20	-	-	-	-	-	-
Incorp. with ploughing < 12 h	15	14	20	21	14	20	-	-	-	-	-	-
Incorp. with ploughing 12-24 h	27	11	0	22	11	0	-	-	-	-	-	-
Incorp. with harrowing < 4 h	15	25	30	15	25	30	-	-	-	-	-	-
Incorp. with harrowing < 12 h	13	24	30	14	24	30	-	-	-	-	-	-
Incorp. with harrowing 12-24 h	16	11	0	16	11	0	-	-	-	-	-	-

8.2.6 Emission reductions based on existing measures and measures that have been adopted in the legislation

Sulphur emissions

Sulphur dioxide emissions originate mainly from energy production and industrial processes. Emissions from industry decreased already between 2005-2010 in line with the limits presented in the LCPD (2001/80/EY), although the uses of both coal and peat in 2010 were higher than in 2005. Between 2010 and 2020 emissions from energy production are projected to decrease sharply due to decreasing combustion of coal, peat and HFO and the limitations in the IED. From 2020 to 2030 combustion of coal will further decrease.

Emissions from industrial processes follow the projected increase of production volumes, while a slight decrease is projected to the emission factors for metal industry and refineries due to technical improvements of processes.

Nitrogen oxides

The main sources for NO_x are road transport, off-road machinery and energy production. Emissions from the transport sector are projected to decrease due to EU legislation although transport volumes increase. The main contributor to decreases will be the implementation of EURO6 standards from 2015 onwards,

NO_x emissions from energy production decreased only slightly between 2005-2010 when the uses of peat, coal and biomass were restored to the normal level from their exceptional levels in 2005 when the lock-out in forest industries and the extraordinary good water situation in production of hydroelectric power decreased the demand of fuels.

The IED restricts emissions from the use of coal and biomass. The use of coal and peat also decrease notably towards 2020-2030, although biomass use is expected to increase.

Emissions from industrial processes depend on the development of production volumes and in small scale combustion on the amount of wood combusted. Impacts to emission levels from small technical improvements in both the process industry and small-scale combustion are included in the projections.

Particles

Important particulate matter sources are residential wood combustion, traffic, industry and peat production. In the national Energy and Climate strategy it is assumed that the combustion volume will increase slightly from 2015 to 2030, but particulate emissions will decrease due to the renewal of the combustion equipment stock.

In transport, exhaust gas emissions decrease due to the increasing number of EURO6 standard vehicles. Although direct particulate emissions in exhaust gases almost cease by 2030, traffic dust will still remain an issue. PM emissions from traffic are a significant contributor to health impacts because the emissions occur at the height of inhalation and concentrate in high density population areas.

Emissions from peat production, i.e. operations related to extraction of peat, vary annually due to peat production volumes which depend on weather (for instance between 2005–2012 from 2.7 to 5.5 kt. In the

scenarios these emissions are projected to follow the projected use of peat each target year. During the last two years, peat production volumes in Finland have decreased significantly. This development is expected to continue and will probably be reflected in the renewal of the Energy and Climate Strategy.

The increasingly stringent emission regulation in combustion plants decrease emissions only slightly, since biomass consumption is expected to increase significantly

For industrial processes, no changes have been made in the projected emission factors over the years and the emissions follow development of production volumes.

Ammonia

The main ammonia source is agriculture where manure management drives the emissions. Small emissions are generated in transport, waste handling and industrial processes. The emission ceiling of 31 kt under the NECD and the Gothenburg Protocol is based in calculations in the RAINS model (Regional Air Pollution INformation and Simulation). In the revision of the NECD the target was to limit emissions to the level of 2010. For Finland this means a reduction of 20% in ammonia emissions from 2005, while the optimization in the GAINS would have been 15% for 2030.

In the base line approach, reductions in agricultural ammonia emissions follow the decrease in animal numbers, impacts from liquid manure systems to become more common in line with the growth of the unit size, as well as the implementation of new regulations for storage and spreading of sludge according to the updated nitrates directive (Government Decree VNa 1250/2014). On the other hand, increased production volumes raise the level of nitrogen excretion, which partly cancel the reduction by the decrease in animal numbers.

Although ammonia emissions from transport already have decreased due to improvements in technology and will further decrease, the emissions in the model are estimated at the level in 2012.

Emissions from energy production were not included in the inventory the time the FRES model was updated. These emissions will be included in the model when the inventory results are finalized.

NMVOG

NMVOG emissions have been decreased between 2005 - 2010 and further thereafter. The most important source is transport where emission reductions are expected due to EURO5/6 standard vehicles. Half of exhaust gas emissions originate in gasoline vehicles and half from fuel refining, storage and distribution.

LIPASTO and FRES models only covers NMVOG emission from transport and small combustion. In the WM scenario up to 2030, projections for emissions from industry and product use are based on national emission inventory values in 2016¹⁷.

These emissions have decreased since the beginning of the 2000s' due to implementation of VOC Directives (1999/13/EC and 2004/42/EC), In Finland also the levels of activities in these sectors have decreased. For oil refineries the emission factor is estimated to decrease by 2030, however, the expected growth of the activity volume keeps the projected emission levels constant.

¹⁷ In the 2022 submission of projections, IPPU projections are updated based on estimations that are in detail explained above in Chapter Projections for IPPU and Waste (p. 31)

8.2.7 NECD 2023 review of projections

In Table 8.20 below recommendations presented in the Review Report of the 2023 NECD Review of Projections are presented with actions made on the right hand side column.

Table 8.20 - Review Report Table 4-2 Recommendations from the 2021 projections review ¹⁸

Observation	Original review year	NFR	Pollutant	Projection's year(s)	Scenario	KC	Recommendation	Response
FI-0A-2023-0004	2023	0A National total (based on fuel sold)	SO ₂ , PM _{2.5} , NMVOC, NH ₃ , NO _X	2025, 2030, 2040, 2050	WM	n.a	For IIR Part 1B Chapter 8.2 the TRT noted that that there is a lack of transparency related to QA/QC activities and sensitivity assessment which have been carried out on the projected emissions. In response to a question raised during the review, Finland explained in detail that the same sectoral QA/QC activities that are carried out for the historical emissions, and described in the sectoral chapters in the IIR, are also carried out for the projected emissions. The TRT notes that this issue does not relate to an over or under-estimate and recommends that Finland adds the detailed text provided to the TRT into the IIR to aid overall transparency.	The description of the QA/QC activities carried out on the projected emissions has been included in chapter 8.2.1 of the IIR in the 2024 submission.
FI-1A1-2023-0001	2023	1A1 Energy industries (Combustion in power plants & Energy Production)	SO ₂ , NO _X	2025, 2030, 2040, 2050	WM	Yes	For category 1A1 Energy industries and pollutants NO _X and SO _X (and to a lesser extent BC, NH ₃ , NMVOC and PM _{2.5}) the TRT noted that there is a lack of transparency regarding which Base Year has been used. Category 1A1 is a key category for NO _X and SO _X in the historical inventory. In response to a question raised during the review, Finland explained that the base years are not the same for the different sectors. Year 2019 is indicated as the base year for energy, the base year for transport is 2021 and the base year for other sectors is 2020. The TRT notes that this issue does not relate to an over or under-estimate and recommends that Finland harmonise the base years for all the sectors and to use (x-3) [or (x-2)] as the base year - where 'x' is the submission year. The	The harmonization of the base years in different sectors will be implemented in the 2025 projection submission.

¹⁸ Where multiple pollutants are included, the issue is flagged as referring to a key category if relevant for one or more of the pollutants.

Observation	Original review year	NFR	Pollutant	Projection's year(s)	Scenario	KC	Recommendation	Response
							reporting guidance clearly states that the base year for projections should be x-3 (i.e. 2020).	
FI-1A3a,c,d,e-2023-0001	2023	1A3a,c,d,e Off-road transport	PM2.5, NH3, NOX	2025, 2030, 2040, 2050	WM	No	For categories 1A3a,c,d,e Off-road transport and pollutants PM2.5, NH3, and NOX for the reference year (2020), the TRT noted that emissions in Annex IV and in NFR tables are not the same. In response to a question raised during the review, Finland explained that the values in the projections NFR table (Annex IV) were accidentally changed, and this caused differences in the decimals. The TRT notes that this relates to an over or under-estimate of the projections in all years and recommends that Finland provides consistent emissions in Annex IV and in NFR tables.	In 2024 projection submission, consistent emissions in Annex IV and in NFR tables have been reported.
FI-1A3b-2023-0001	2023	1A3b Road Transport	SO2	2025, 2030, 2040, 2050	WM	No	For categories 1A3bi, 1A3bii, 1A3biii and 1A3biv and pollutant SO2 for the reference year (2020), the TRT noted that emissions in Annex IV and in NFR tables are not the same. In response to a question raised during the review, Finland explained that the values in the projections NFR table (Annex IV) were accidentally changed, and this caused differences in the decimals. The TRT notes that this relates to an over or under-estimate of the projections in all years and recommends that Finland provide consistent emissions in Annex IV and in NFR tables.	In 2024 projection submission, consistent emissions in Annex IV and in NFR tables have been reported.

Observation	Original review year	NFR	Pollutant	Projection's year(s)	Scenario	KC	Recommendation	Response
FI-2D, 2G-2023-0001	2023	2D, 2G Solvent and other product use	NMVOC	2025, 2030, 2040, 2050	WM, WAM	Yes	For NFR 2D,G Solvent and other product use and NMVOC the TRT noted that there may be an over-estimate in the projections. In response to a question raised during the review, Finland explained that there was an issue with the calculations that would require correction in future submission. The TRT notes that this issue relates to an over or under-estimate and recommends that Finland correction the calculations in time for the next projection submission.	The issue has been corrected in the 2024 projection submission.
FI-3B-2023-0001	2023	3B Animal husbandry and manure management	NMVOC	2025, 2030	WM	No	For 3B Animal husbandry and manure management, NMVOC projections in the years 2025 and 2030 the TRT noted that there was an unusual trend in emissions compared to non-dairy cattle numbers. According to the data reported in Annex IV B, between 2020 and 2025 the number of non-dairy cattle is projected to reduce by around 3.5%, whereas the NMVOC emissions are projected to increase by around 5%. However, between 2025 and 2030 the change in emissions (-6.4%) is more negative than the change in population (-5.2%). This implies a higher emission factor per head in 2025 (7.24kg /head) than either in 2020 (6.64 kg/head) or 2030 (7.15 kg/head). In response to a question raised during the review, Finland explained that an error had been identified in the activity data, specifically in the feed intake gross energy (MJ/animal/day) for bulls in 2021, resulting in NMVOC emission that are too high. This error was not spotted until after their submission. The TRT notes that this issue relates to an over or under-estimate and recommends that this error is corrected in the next submission.	The issue has been corrected in the 2024 projection submission.

Observation	Original review year	NFR	Pollutant	Projection's year(s)	Scenario	KC	Recommendation	Response
FI-3B-2023-0002	2023	3B Animal husbandry and manure management	PM2.5, NMVOC, NH3, NOx	2025	WM	No	For categories 3B4g poultry, 3B4h other animals and 3D Plant production and agricultural soils, and pollutants NH3, NMVOC, NOx and PM2.5 for the year 2020 the TRT noted that the emission value provided in the projections submission does not precisely match the value for 2020 in the historical inventory upon which the projections are based. In most cases the numbers reported in the projections appear to be equal to those in the historical inventory when the latter are rounded to 3 decimal places (e.g., NH3 emissions from 3B4g poultry is 0.9656368 in the historical inventory, and 0.9660 in the projections submission). However, for NOx emissions from 3B4g poultry a difference to 3 decimal places remains even after rounding; the value in the historical inventory is 0.1461001, and that in the projections 0.1469681. In response to a question raised during the review, Finland explained that in the projections reporting template there is an error in cell C38 (NOX from 3B4g). It mistakenly references cell E37, which represents the value for 2025. The correct value for 2020, as reported in the historical inventory, should be 0.1461001. The TRT notes that this issue does not relate to an over or under-estimate in projected emissions, but recommends that in the next projections submission Finland correct this error and also submit unrounded values where possible for all categories.	In the 2024 projection submission, unrounded values have been submitted for all categories.

Table 8.19 - Review Report Table 4-3 Encouragements from the 2022 projections review.

Observation	Original review year	NFR	Pollutant	Projection's year(s)	Scenario	KC	Encouragement	Response
FI-3B-2023-0003	2023	3B Animal husbandry and manure management	PM2.5, NMVOC, NH3, NOX	2025, 2030, 2040, 2050	WM	No	For 3B Animal husbandry and manure management, PM2.5, NMVOC, NH3, NOX and all projected years, the TRT noted that there is a lack of transparency in the projections chapter of the IIR regarding which policies and measures (PaMs) are taken into account in the With Measures (WM) scenario. In response to a question raised during the review, Finland explained that the WM scenario is based on the same assumptions for development of the agricultural policy and prices as were used in the HIISI project which was established to support the preparation of the update of the Finland's Energy and Climate Strategy – Carbon neutral Finland 2035. Finland also provided a summary of the main drivers included within the HIISI WEM scenario for agriculture for the years 2020-2050 e.g., slight decrease in the use of inorganic fertilisers due to rising fertiliser prices; decline in milk and cattle meat production resulting from increasing production costs, reduced hectare yields and a decline in cattle meat price. The TRT notes that a reference to this study is provided in section 8.2.1 of the IIR, but that it would improve transparency to include a summary of the key policies and measures and other drivers directly in the IIR, as was provided by Finland in response to the review question. The TRT notes that this issue does not relate to an over or under-estimate and encourages Finland to include a clear explanation of which PaMs are taken into account in the WM scenario in the IIR submitted along the next projections submission.	Information on the key policies and measures have been included in the chapter 8.2.5 of the IIR in submission 2024.
FI-3B-2023-0004	2023	3B Animal husbandry and manure management	PM2.5, NMVOC, NH3, NOX	2025, 2030, 2040, 2050	WM	No	For 3B Animal husbandry and manure management, PM2.5, NOX, NH3 and NMVOC in all years, the TRT noted that the IIR does not state which Tier methodology has been used to calculate projected emissions. In response to a question raised during the review, Finland explained that the projections were calculated using the same Tier methodology (Tier 2/3) as the historical emissions	Information that the projected emissions are calculated using the same Tier methodologies as are used in the historical inventory, has been

Observation	Original review year	NFR	Pollutant	Projection's year(s)	Scenario	KC	Encouragement	Response
							inventory. The TRT notes that this issue does not relate to an over or under-estimate and encourages Finland to clearly state which Tier methodology was used to calculate projections in the IIR submitted with the next projections submission.	included in the chapter 8.2.5 of the IIR in submission 2024.
FI-5-2023-0001	2023	5 Waste	NOX, SO2	2025, 2030	WM	No	For category 5 Waste and pollutants NOX and SO2 the TRT noted that no emissions are reported for the years 2025, 2030. In response to a question raised during the review, Finland explained that SO2 and NOX emitting sources (incineration/combustion/burning or cremation) are allocated under NFRs 1A1a or 1A2gviii in the Finnish inventory. The TRT notes that this issue does not relate to an over or under-estimate and encourages Finland to use in Annex IV the notation key 'IE' instead of 'NA'.	The notation key 'IE' has been used in 2024 projections submission.

8.3. GRIDDED EMISSIONS AND LPS

8.3.1 Gridded data

Changes in chapter	
March 2023	JM, KS , TF
Change in methodology	New grid 2015

Background

The new EMEP grid of 0.1 degrees introduced in the 2014 Reporting Guidelines was implemented in the inventory system in 2015. Finland lies between the northern latitudes of 60° and 70°, where one degree corresponds to approximately to a 7 km *7 km area (Figure 8.10)

The presentation of gridded data in the 1° * 1° format has at the moment been implemented for the land cover of activities only in 2005. It is planned to prepare datasets also for the earlier years as well as for future years when resources are available for this kind of work.

Gridded data in the resolution of 50 km * 50 km according to the earlier versions of the Reporting Guidelines is available also for the earlier reporting years.

Submissions of gridded data are presented in Table 1.07 in IIR Part 1A.



Figure 8.10. Geographical location of Finland (Maps of the World 2016)

Developments in land use

In comparison to other European countries, Finland is still a sparsely populated country with a small urban zone in the Southern part of the country. Only the capital region is a highly urbanized area according to the classifications of EuroStat and OECD.

In addition to the low population density, a specific feature of Finland is the share of rural areas and long distances between inhabitant centres. An exceptional feature compared to other low density countries is that almost all of Finland is populated and the most distant rural areas are rather vital. In an European comparison Finland was one of the top 5 countries in the share of rural areas of total area.

During the last decades more people have moved to the population centres, rural centres of their vicinity and especially in the Southern part of Finland. Inside municipalities, population is more and more moving from sparsely populated areas to villages. Largest growth can be seen in population centres exceeding 100 000 inhabitants and secondly in 1000 - 100 000 population centres. Growth rate has been high also in centres less than 1000 inhabitants, while the sparsely populated areas continue to lose their inhabitants.

Sources included

The reporting of gridded data includes the following pollutants: NO_x (as NO₂), NMVOC, SO_x (as SO₂), NH₃, PM_{2.5}, PM₁₀, BC, CO, Pb, Cd, Hg, PCDD/F, PAH-4, HCB and PCBs. Emission data is collected from the Finnish Air Emission Information System (IPTJ). Emission and location data of installations subject to environmental permit reporting are obtained from YLVA database. Data from regional emission sources (eg. transport and agriculture) are based on calculation and have been geographically distributed on the basis of more detailed national emission data.

The emission source classifications are based on the UN classification of climate and long-range transport agreements and GNFR sectors reported are A_PublicPower, D_Fugitive, B_Industry, C_OtherStationaryComb, I_Offroad, H_Aviation, F_RoadTransport, G_Shipping, E_Solvents, M_Other, J_Waste, K_AgriLivestock and L_AgriOther. (Tables 8.21-8.22)

Table 8.21 – Air pollutant emissions of GNFR categories for the year 2018.

Pollutant	Unit	A_PublicPower	B_Industry	C_OtherStationaryComb	D_Fugitive	E_Solvents	F_RoadTransport	G_Shipping	H_Aviation	I_Offroad	J_Waste	K_AgriLivestock	L_AgriOther
NOx	t	24357.9	29347.2	10098.6		6.1	30429.7	6472.7	1017.8	15420.5		423.5	9020.9
NMVOC	t	1603.3	15041.4	22130.0	6075.5	9860.3	5111.1	2937.2	140.2	6171.5	88.4	12978.6	3161.7
SOx	t	12457.4	16699.1	3667.4	52.8	5.0	46.8	84.4	64.1	42.2			7.9
NH3	t	3.7	659.9	1172.6	3.2	234.1	838.1	1.0		6.3	475.1	18324.0	10471.5
PM2.5	t	336.3	2770.2	9541.2	1189.5	203.3	1911.7	298.4	7.4	919.6	103.9	166.5	350.0
PM10	t	1178.1	4140.0	10574.6	1697.0	214.8	7560.0	330.4	7.4	924.8	104.4	571.4	3812.8
BC	t	18.0	75.3	2704.8	0.0	3.7	704.0	61.4	3.7	414.4	9.4		18.8
CO	t	15646.9	33040.7	167383.1		187.1	37153.7	19565.3	1204.9	74447.8			1901.5
Pb	kg	2188.9	9983.0	1573.7	4.0	1113.3	491.7	12.6	36.3	3.7	1.2		1.6
Cd	kg	134.4	458.0	244.2	0.2	19.4	2.2	1.0		8.4	0.7		14.6
Hg	kg	160.0	424.7	42.8	0.0	0.1	25.1	2.7		0.9	18.1		2.9
PCDD/F	g	3.7	4.4	1.6	2.6	0.0	1.0	0.0		0.0	1.1		0.0
PAHs	g	546245.6	366667.6	8318764.0	456176.8	11384.1	225747.3			64521.5	1000.0		10.6

HCB	kg	0.5	31.0	0.3		0.0	0.2	0.0		0.0	0.0		0.0
PCBs	g	319.7	19145.1	3760.3	3098.6		0.2	9.2		1.1	12.1		

The categories contain point sources and non-point sources as illustrated in the table below.

Table 8.21 - The relative shares of emissions from point and non-point sources per aggregate category

Pollutant	Public power and industries*		Other stationary combustion**		Traffic and agriculture***		Products and waste****	
	Point sources	Non-point sources	Point sources	Non-point sources	Point sources	Non-point sources	Point sources	Non-point sources
NOx	98.5 %	1.5 %	0.4 %	99.6 %	0.0 %	100.0 %	0.0 %	100.0 %
NMVOc	50.8 %	49.2 %	0.0 %	100.0 %	0.0 %	100.0 %	21.0 %	79.0 %
SOx	98.1 %	1.9 %	0.3 %	99.7 %	0.0 %	100.0 %	14.1 %	85.9 %
NH3	99.5 %	0.5 %	0.0 %	100.0 %	0.0 %	100.0 %	31.2 %	68.8 %
TSP	58.8 %	41.2 %	0.1 %	99.9 %	0.0 %	100.0 %	20.1 %	79.9 %
PM10	63.3 %	36.7 %	0.0 %	100.0 %	0.0 %	100.0 %	20.2 %	79.8 %
PM2.5	62.7 %	37.3 %	0.0 %	100.0 %	0.0 %	100.0 %	19.0 %	81.0 %
BC	98.6 %	1.4 %	0.0 %	100.0 %	0.0 %	100.0 %	0.0 %	100.0 %
CO	99.2 %	0.8 %	0.0 %	100.0 %	0.0 %	100.0 %	0.0 %	100.0 %
Pb	94.4 %	5.6 %	0.3 %	99.7 %	0.0 %	100.0 %	0.0 %	100.0 %
Cd	98.1 %	1.9 %	0.0 %	100.0 %	0.0 %	100.0 %	0.0 %	100.0 %
Hg	98.2 %	1.8 %	0.2 %	99.8 %	0.0 %	100.0 %	0.0 %	100.0 %
As	84.4 %	15.6 %	0.8 %	99.2 %	0.0 %	100.0 %	0.0 %	100.0 %
Cr	94.9 %	5.1 %	0.1 %	99.9 %	0.0 %	100.0 %	0.0 %	100.0 %
Cu	85.2 %	14.8 %	0.4 %	99.6 %	0.0 %	100.0 %	0.0 %	100.0 %
Ni	94.1 %	5.9 %	0.1 %	99.9 %	0.0 %	100.0 %	0.0 %	100.0 %
Zn	97.1 %	2.9 %	0.0 %	100.0 %	0.0 %	100.0 %	0.0 %	100.0 %
PCCD/F	98.0 %	2.0 %	0.1 %	99.9 %	0.0 %	100.0 %	0.0 %	100.0 %
PAH-4	99.0 %	1.0 %	0.0 %	100.0 %	0.0 %	100.0 %	13.0 %	87.0 %
HCb	99.3 %	0.7 %	0.0 %	100.0 %	0.0 %	100.0 %	0.0 %	100.0 %
PCB	85.3 %	14.7 %	0.0 %	100.0 %	0.0 %	100.0 %	0.0 %	100.0 %

The headers aggregate the GNFR categories as follows:

* Public power and industries: A_PublicPower, D_Fugitive, B_Industry

** Other stationary combustion: C_OtherStationaryComb

*** Traffic and agriculture: I_Offroad, H_Aviation, F_RoadTransport, G_Shipping, K_AgriLivestock, L_AgriOther

**** Products and waste: E_Solvents, M_Other, J_Waste

Point sources are distributed by Tier 3 methodology. IPTJ contains coordinate data as WGS84 for all known point sources. Non-point sources vary between Tier 1 and 2 based on the activity. The table below presents the primary tier and the secondary tier in brackets. The secondary tier applies to the point or non-point emissions of the category which contributes to the lesser half of total emissions (for categories with both emission sources present). (Table 8.22)

Table 8.22 – Tier categorisation of spatial disaggregation of GNFR-categories

GNFR19	A_PublicPower	B_Industry	C_OtherStationaryComb	D_Fugitive	E_Solvents	F_RoadTransp	G_Shipping	H_Aviation	I_Offroad	J_Waste	K_AgriLivestoc	L_AgriOther
Tier	3 (1)	3 (1)	1 (3)	1	1 (3)	2	2	2	2	1 (3)	1	1

Data sources for disaggregation of non-point emission sources

Changes in chapter	
March 2022	JM

The geographical distribution of non-point emission sources, such as transport, households, agriculture and small-scale wood burning utilizes Finnish-wide proxies, which aim to represent each emission source with highest applicable level of accuracy. The spatial data set of the national road and street information system (Digiroad) is used as a medium for traffic emissions. Numerous different data sources have been utilized in allocating the calculated regional emissions to the map. The most commonly used source material is Corine Land Cover (CLC2006), which describes the Finnish land use and land cover in 2006. The material covers built land, agricultural areas, forests, open canals and rocky lands, wetlands and bogs and water areas. The data extracted from CLC2006 is supplemented with SLICES (Separated Land Use & Cover information System) data. Built environment is modelled with the Building and Housing Register (RHR) data. Activities without suitable proxies are distributed according to population density.

Point source sources, such as power plants and industrial operational plants, are shown according to their coordinates. Non-point emission sources such as emissions from transport, consumption and production, agriculture, and small-scale wood burning, cannot be allocated to a single point, but will use the indirect data that best represent each emission source. An activity for which no suitable medium exists is distributed according to population density. The proxies are currently based on land use of 2010 +/- 5 years depending on the availability of the data.

The proxies for non-point emission-sources are linked to the emissions by SNAP categorization. The table below presents the proxies and their corresponding SNAP, NFR and GNFR categorizations as are used in the GRID inventory submission of 2020 (Table 8.23).

Table 8.23 – List of used proxies per SNAP category in the inventory submission of 2020 of gridded emissions

GNFR19	NFR	NFR Description	SNAP	SNAP Description	Proxy	Source
A_Public Power	1A1a	Public electricity and heat production	010205	District heating - Stationary engines	Industrial areas and services	Corine land cover 2006
B_Industry	2C1	Iron and steel production	040208	Rolling mills	Industrial areas and services	Corine land cover 2006
	2H2	Food and beverages industry	040627	Meat, fish etc. frying / curing	Industrial areas and services	Corine land cover 2006
	2B1	Ammonia production	040403	Ammonia	Industrial areas and services	Corine land cover 2006
	2D3c	Asphalt roofing	040610	Asphalt roofing materials	All buildings - floor area	National building and dwelling register
	2I	Wood processing	040620	Wood processing	Industrial areas and services	Corine land cover 2006
	2C7c	Other metal production	040309z	Other	Industrial areas and services	Corine land cover 2006
	2H2	Food and beverages industry	040606	Wine	Wineries	Public listing
	2A5b	Construction and demolition	040624	Public works and building sites	All buildings - floor area	National building and dwelling register
	2H2	Food and beverages industry	040625	Sugar production	Industrial areas and services	Corine land cover 2006
	2A5c	Storage, handling and transport of mineral products	040900	Storage, handling and transport of mineral products	Industrial areas and services	Corine land cover 2006

2B10a	Chemical industry: Other (Please specify in the IIR)	040407	NPK fertilisers	Industrial areas and services	Corine land cover 2006
2B10b	Storage, handling and transport of chemical products (Please specify in the IIR)	040415	Storage and handling of inorganic chemical prod. (o)	Mines and industrial areas	Separated Land Use/Land Cover Information System (SLICES)
2H2	Food and beverages industry	040605	Bread	Industrial areas and services	Corine land cover 2006
2H2	Food and beverages industry	040607	Beer	Breweries	Public listing
2A5a	Quarrying and mining of minerals other than coal	040616	Extraction of mineral ores	Mines	Separated Land Use/Land Cover Information System (SLICES)
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (Please specify in the IIR)	030326	Other	Facilities for energy production	National building and dwelling register
2A3	Glass production	040613	Glass (decarbonizing)	Industrial areas and services	Corine land cover 2006
2C7c	Other metal production (Please specify the sources included/excluded in the notes column to the right)	040210	Other	Industrial areas and services	Corine land cover 2006
2C3	Aluminium production	040301	Aluminium production (electrolysis)	Industrial areas and services	Corine land cover 2006
2H1	Pulp and paper industry	040602	Paper pulp (kraft process)	Industrial areas and services	Corine land cover 2006
2L	Other production, consumption, storage, transportation or handling of bulk products	040617	Other (including asbestos products manufacturing)	Industrial areas and services	Corine land cover 2006
2D3b	Road paving with asphalt	040611	Road paving with Asphalt	Streets under construction	Digiroad
2C7d	Storage, handling and transport of metal products	040211	Storage, handling and transport of ferrous metal products	Population density	National building and dwelling register
2A2	Lime production	040614	Lime (decarbonizing)	Industrial areas and services	Corine land cover 2006
2C1	Iron and steel production	040209	Sinter and pelletizing plant (except comb. 030301)	Industrial areas and services	Corine land cover 2006
2A1	Cement production	040612	Cement (decarbonizing)	Industrial areas and services	Corine land cover 2006
C_Other Stationary Comb	1A5a Other stationary (including military)	020106	Commercial and institutional - Other stationary equipment (n)	Industrial areas and services	Corine land cover 2006
	1A4ci Agriculture/Forestry/Fis hing: Stationary	020305	Agri./forest/aqua. - Other stationary equipment (n)	Built agricultural land	Separated Land Use/Land Cover

						Information System (SLICES)
	1A4bi	Residential: Stationary	020205	Residential - Other equipment (stoves, fireplaces, cooking)	Buildings with wood as the primary heat source	National building and dwelling register
	1A4ai	Commercial / institutional: Stationary	020103b	Commercial and institutional - Combustion plants < 20 MW (boilers)	Population density	National building and dwelling register
	1A5a	Other stationary (including military)	020103b	Commercial and institutional - Combustion plants < 20 MW (boilers)	Population density	National building and dwelling register
	1A4bi	Residential: Stationary	020202b	Residential - Combustion plants < 20 MW (boilers)	Population density	National building and dwelling register
	1A4ai	Commercial / institutional: Stationary	020106	Commercial and institutional - Other stationary equipment (n)	Industrial areas and services	Corine land cover 2006
	1A4ci	Agriculture/Forestry/Fishing: Stationary	020302b	Agri./forest/aqua. - Combustion plants < 20 MW (boilers)	Population density	National building and dwelling register
D_Fugitive	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	050601	Pipelines (q)	Industrial areas and services	Corine land cover 2006
	1B1c	Other fugitive emissions from solid fuels	050121	Peat production	Population density	National building and dwelling register
	1B2av	Distribution of oil products	050502	Transport and depots (except 050503)	Industrial areas and services	Corine land cover 2006
	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	040201	Coke oven (door leakage and extinction)	Industrial areas and services	Corine land cover 2006
	1B2av	Distribution of oil products	050503	Service stations (including refuelling of cars)	Service stations	National building and dwelling register
E_Solvents	2G	Other product use	060601	Use of fireworks	Population density	National building and dwelling register
	2D3e	Degreasing	060204	Other industrial cleaning	All buildings - volume	National building and dwelling register
	2D3g	Chemical products	060314	Other	Population density	National building and dwelling register
	2D3i	Other solvent use	060412	Other (preservation of seeds,...)	Agricultural land in use (overall)	Separated Land Use/Land Cover Information System (SLICES)
	2D3i	Other solvent use	060406	Preservation of wood	All buildings - floor area	National building and dwelling register
	2D3a	Domestic solvent use including fungicides	060408	Domestic solvent use (other than paint application)	Buildings used for permanent residence	National building and dwelling register

	2D3d	Coating applications	060103	Paint application : construction and buildings (except item 060107)	All buildings - floor area	National building and dwelling register
	2D3d	Coating applications	060108	Other industrial paint application	Industrial areas and services	Corine land cover 2006
	2D3g	Chemical products	060310	Asphalt blowing	Population density	National building and dwelling register
	2D3d	Coating applications	060109	Other non-industrial paint application	All buildings - floor area	National building and dwelling register
	2D3h	Printing	060403	Printing industry	Population density	National building and dwelling register
	2D3i	Other solvent use	060404	Fat, edible and non-edible oil extraction	Population density	National building and dwelling register
	2D3g	Chemical products	060313	Leather tanning	Population density	National building and dwelling register
	2D3g	Chemical products	060307	Paints manufacturing	Population density	National building and dwelling register
	2G	Other product use	060602	Use of tobacco	Population density	National building and dwelling register
F_Road Transport	1A3bv	Road transport: Gasoline evaporation	070600	Gasoline evaporation from vehicles	Service stations	National building and dwelling register
	1A3biii	Road transport: Heavy duty vehicles and buses	070300	Heavy duty vehicles > 3.5 t and buses	Streets and roads (weighed with no. vehicles)	Digiroad
	1A3biv	Road transport: Mopeds & motorcycles	070500	Motorcycles > 50 cm3	Streets and roads (weighed with no. vehicles)	Digiroad
	1A3bi	Road transport: Passenger cars	070100	Passenger cars	Streets and roads (weighed with no. vehicles)	Digiroad
	1A3bvii	Road transport: Automobile road abrasion	070800	Road abrasion	Streets and roads (weighed with no. vehicles)	Digiroad
	1A3bii	Road transport: Light duty vehicles	070200	Light duty vehicles < 3.5 t	Streets and roads (weighed with no. vehicles)	Digiroad
	1A3bvi	Road transport: Automobile tyre and brake wear	070700	Automobile tyre and brake wear	Streets and roads (weighed with no. vehicles)	Digiroad
G_Shipping	1A3dii	National navigation (Shipping)	080303	Personal watercraft	Water bodies over 200 hectares and built water environments	Other
	1A3dii	National navigation (Shipping)	080304	Inland goods carrying vessels	Water bodies over 200 hectares and built water environments	Other
	1A3dii	National navigation (Shipping)	080302	Motorboats / workboats	Water bodies over 200 hectares and built water environments	Other
	1A3dii	National navigation (Shipping)	080402	National sea traffic within EMEP area	National ports (incl. onland area occupied)	Corine land cover 2006
H_Aviation	1A3ai(i)	International aviation LTO (Civil)	080502	International airport traffic (LTO cycles - <1000 m)	Airports (weighed with passenger numbers)	Separated Land Use/Land Cover Information System (SLICES)

	1A3aii(i)	Domestic aviation LTO (Civil)	080501	Domestic airport traffic (LTO cycles - <1000 m)	Airports (weighed with passenger numbers)	Separated Land Use/Land Cover Information System (SLICES)
I_Offroad	1A3c	Railways	080200	Railways	Railroads	Railroads
	1A4ciii	Agriculture/Forestry/Fishing: National fishing	080403	National fishing	Water bodies over 200 hectares and built water environments	Other
	1A4aii	Commercial / institutional: Mobile	081000	Other off-road	All buildings - count	National building and dwelling register
	1A5b	Other, Mobile (including military, land based and recreational boats)	080100	Military	Population density	National building and dwelling register
	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	080700	Forestry	New tree stumps from 2009 to 2011	Finnish Forest Institute
	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	080600	Agriculture	Agricultural land in use (overall)	Separated Land Use/Land Cover Information System (SLICES)
	1A2gvii	Mobile Combustion in manufacturing industries and construction: (Please specify in the IIR)	080800	Industry – off road	Industrial areas and services	Corine land cover 2006
	1A4bii	Residential: Household and gardening (mobile)	080900	Household and gardening	Buildings used for permanent residence	National building and dwelling register
	J_Waste	5D1	Domestic wastewater handling	091002	Waste water treatment in residential and commercial sect.	Population density
5C1bv		Cremation	090901	Incineration of corpses	Crematoriums	Public listing
5A		Biological treatment of waste - Solid waste disposal on land	090401	Managed Waste Disposal on Land	Landfills	Other
5C1biii		Clinical waste incineration	090207	Incineration of hospital wastes	Population density	National building and dwelling register
5B1		Biological treatment of waste - Composting	091005	Compost production	Sparse residential areas	Corine land cover 2006
5E		Other waste (Please specify in IIR)	091101	Unintentional house fires	Population density	National building and dwelling register
5A		Biological treatment of waste - Solid waste disposal on land	090403	Other	Population density	National building and dwelling register
5E		Other waste (Please specify in IIR)	091007	Latrines	Sparse residential areas	Corine land cover 2006
5D2		Industrial wastewater handling	091001	Wastewater treatment in industry	Industrial areas and services	Corine land cover 2006
5E		Other waste (Please specify in IIR)	091102	Unintentional car fires	Population density	National building and dwelling register
K_Agri Livestock	3B4giii	Manure management - Turkeys	100509a	Turkeys	Farmhouses (Swine and bovine)	National building and dwelling register
	3B1a	Manure management - Dairy cattle	100501	Dairy cows	Farmhouses (Swine and bovine)	National building and dwelling register

	3B3	Manure management - Swine	100504	Sows	Farmhouses (Swine and bovine)	National building and dwelling register
	3B2	Manure management - Sheep	100505	Sheep	Farmhouses (Other animals)	Separated Land Use/Land Cover Information System (SLICES)
	3B4gi	Manure management - Laying hens	100507	Laying hens	Farmhouses (Swine and bovine)	National building and dwelling register
	3Da3	Urine and dung deposited by grazing animals	100517	Urine and dung deposited by grazing animals	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3B4e	Manure management - Horses	100506	Horses	Stables	National building and dwelling register
	3B4gii	Manure management - Broilers	100508	Broilers	Farmhouses (Other animals)	Separated Land Use/Land Cover Information System (SLICES)
	3B4giv	Manure management - Other poultry (please specify in the IIR)	100509z	Other poultry (ducks, geese ,etc.)	Population density	National building and dwelling register
	3B4h	Manure management - Other animals (please specify in the IIR)	100510	Fur animals	Farmhouses (Other animals)	Separated Land Use/Land Cover Information System (SLICES)
	3B4h	Manure management - Other animals (please specify in the IIR)	100516	Reindeer	Population density	National building and dwelling register
	3B1b	Manure management - Non-dairy cattle	100502	Other cattle	Farmhouses (Swine and bovine)	National building and dwelling register
	3B3	Manure management - Swine	100503	Fattening pigs	Farmhouses (Swine and bovine)	National building and dwelling register
	3B4d	Manure management - Goats	100511	Goats	Farmhouses (Other animals)	Separated Land Use/Land Cover Information System (SLICES)
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)	100104	Market gardening	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3Df	Use of pesticides	100600	Use of pesticides and Limestone	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3Da2b	Sewage sludge applied to soils	100906	Sewage sludge applied to soils	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	101000	Farm-level storage, handling and transport of agricultural products	Built agricultural land	Separated Land Use/Land Cover Information System (SLICES)
	3Da1	Inorganic N-fertilizers (includes also urea application)	100101	Permanent crops	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)

	3Da2a	Animal manure applied to soils	100905	Animal manure applied to soils	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3F	Field burning of agricultural residues	100300	On-field burning of stubble, straw, etc.	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3Da1	Inorganic N-fertilizers (includes also urea application)	100102	Arable land crops	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3Db	Indirect emissions from managed soils	100208	Indirect emissions from managed soils	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
	3Da1	Inorganic N-fertilizers (includes also urea application)	100105	Grassland	Fields and fallows	Separated Land Use/Land Cover Information System (SLICES)
O_AviCruise	1A3ai(ii)	International aviation cruise (Civil)	080504	International cruise traffic (>1000 m)	Population density	National building and dwelling register
	1A3aii(ii)	Domestic aviation cruise (Civil)	080503	National cruise traffic (>1000 m)	Population density	National building and dwelling register
P_IntShippi ng	1A3di(i)	International maritime navigation	080404	International sea traffic (international bunkers)	Population density	National building and dwelling register

Corine Land Cover 2006

CORINE Land Cover 2006 (CLC2006) dataset provides information on Finnish land cover and land use. The data is derived from the European CLC 2006 project and it includes raster data with the resolution of 25 x 25 metres. The data is produced by SYKE based on automated interpretation of satellite images and data integration. The standard CLC nomenclature contains 44 categories for land cover of which the following are selected to be used as basis of distribution:

- Class 1110 — Dense residential
- Class 1120 — Sparse residential
- Class 1210 — Industry and Services
- Class 1220 — Transportation
- Class 1230 — Harbour areas
- Class 1310 — Land extraction areas
- Class 1320 — Landfills
- Class 1330 — Construction areas
- Class 1421 — Second houses and non-permanent living

The data is extracted from original source and converted from raster data into point. These points are aggregated into EMEP grid cells, where their total count within a cell acts as the density defining factor for the given cell. The accuracy of the method is dependent on the accuracy of the source material. Using land use as the basis for basis for distribution of diffuse emissions does not take into account the rate of activity within the given area. Some accuracy is also lost during conversion. However, an example analysis made for land extraction areas reveals a correlation with land use and the Salpausselkä ridge system. which is known of possessing a high activity rate for land extraction. (Figure 8.11)

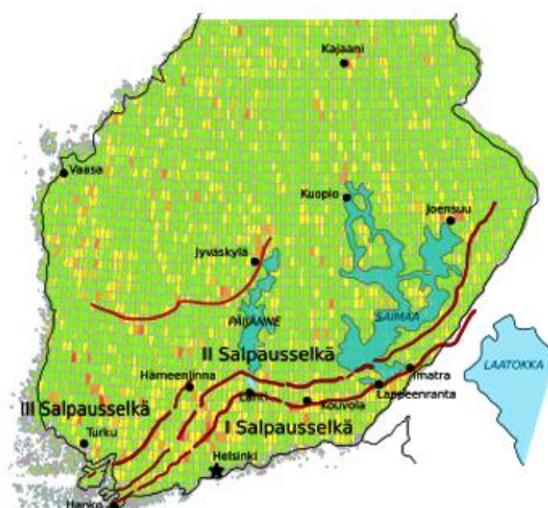


Figure 8.11 – CLC2006 marked land extraction areas in EMEP grid (background) and their correlation with the Salpausselkä ridge system (foreground)

SLICES

Separated Land Use/Land Cover Information System (SLICES) is a land use dataset from a joint operation between National Land Survey of Finland (NLS), Finnish Environment Institute (SYKE) and the Finnish Forest Research Institute (METLA, currently known as the Natural Resources Institute Finland). As a source material it is handled with the same principles as CLC data, as SLICES is a sub-constituent to CLC material. The categorization of data however differs and the following models are extracted based on SLICES data:

- Airports (by land use)
- Storage areas
- Agricultural areas with activity
- Agricultural fallows
- Built agricultural land
- Mines and other mineral extraction
- Extraction of sand, gravel and other land extraction

The emissions of GNFR H_Aviation are distributed to the land used by airports, which are weighed by the statistics of Finavia for the year 2013. Table 8.24 presents the passenger numbers for selected cities.

Table 8.24 – Passenger numbers per airport used to scale aviation emissions

ObjectID	Municipality	Passengers
32	Vantaa	15278994
190	Oulu	877080
204	Pirkkala	466671
234	Rovaniemi	427367
284	Turku	324687
296	Vaasa	319315
252	Siilinjärvi	261151
97	Kittilä	237222
49	Inari	146314
146	Liperi	131291
31	Helsinki	100000
ObjectID	Municipality	Passengers
133	Lappeenranta	98300
119	Kuusamo	74583
71	Kajaani	74558

111	Kruunupyy	68991
88	Kemi	57681
65	Jyväskylä	50570
207	Pori	26229
11	Enontekiö	20169
246	Savonlinna	12215
59	Joroinen	6759
109	Kouvola	500

For some airports no passenger data is available. For these 100 passengers is assumed. These municipalities are Alajärvi, Alavus, Asikkala, Imatra, Jomala, Jämijärvi, Jämsä, Kauhajoki, Kauhava, Keminmaa, Kitee, Kokemäki, Kontiolahti, Kotka, Kuhmo, Kemijärvi, Lieksa, Loppi, Oripää, Pudasjärvi, Raahe, Rautavaara, Salo, Sodankylä, Suomussalmi, Tampere, Vihti, Ylivieska, Eura. Hyvinkää airport is assumed to be used only for non-motorized air vehicles.

Building and Dwelling Register

Building and Dwelling Register (here referred as BDR, fin Rakennus- ja Huoneistorekisteri. RHR) is the national register for buildings and dwellings. The use of the register is limited by several laws. The data of BDR is used only as the basis of analysis. No detailed information or exact counts of buildings or housing in an area can by any means be backtracked based on the published data. Based on BDR data the following models are constructed to be used as basis for distribution:

- Population density
- All buildings – by count
- All buildings – by floor area
- All buildings – by overall volume
- Residential buildings – permanent
- Residential buildings – temporary
- Energy production facilities
- Energy production facilities with wood based fuels as primary heat source
- Commercial buildings with wood based fuels as primary heat source
- Residential buildings with wood based fuels as primary heat source
- Agriculture – Horse stables and other animal shelters
- Agriculture – Piggeries, cattle shelters and henhouses
- Agriculture – grain drying kilns and facilities
- Petrol stations and other automobile service facilities

For models based on all buildings several models were constructed based on count, floor area and the overall volume to be used for different purposes. For example for categories of product use the it can be assumed that the activity rate is more connected to the count of households rather than volumetric parameters. For emissions resulting from heating, the overall volume gives a better estimate as the amount of energy required correlates with building volume. The inventory of 2022 will substitute the previous model with a more detailed model, both of which are based on the data above.

National road and street information system (Digiroad)

Digiroad is the national road- and street information system which contains the centre line geometry data for all known streets. The activity rate is also available for most main roads as vehicles per day. The following activities are extracted for use as proxies:

- Highways
- Roads
- Streets
- Private streets
- All combined

Activity rate is introduced with the following formula:

$$E_{cell} = \frac{E_{total}}{n_{total}} * n_{cell}$$

where

- E_{cell} = Emission value in a cell
- E_{total} =Sum value of emissions
- n_{total} =Vehicles per day (total national)
- n_{cell} =Vehicles per day (cell)

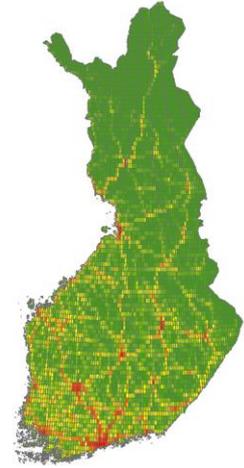


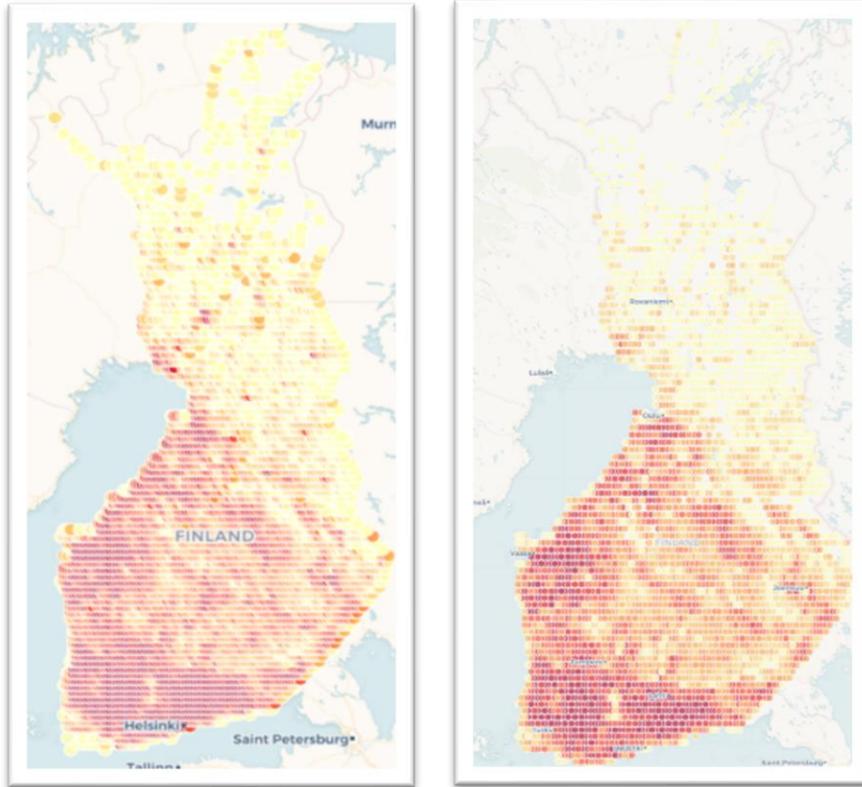
Figure 8.12 illustrates the resulting map after applying the methodology.

Figure 8.12 - PM_{2.5} emissions of 2013 in the national street system

Other sources

In the Finnish emission inventory crematoria, small breweries and wineries are calculated as diffuse sources. It is however possible to collect the location data for most of these based on various public listings. The data extracted in this manner is geocoded based on publicly available addresses and emissions are assigned to the corresponding cells. The method does not take the rate of activity within the locations into account.

For agricultural emissions a pre-existing proxy containing information about field distribution is used. This proxy is used for GNFR L_AgriOther under which Finland reports the following activities: indirect emissions from managed soils, urine and dung deposited by grazing animals, inorganic N-fertilizers, on-field burning of stubble, use of pesticides, animal manure applied to soils, sewage sludge applied to soils and farm-level agricultural operations. Spatially these emissions are estimated by fields and built agricultural land. Agricultural activities concentrate on the south-west of Finland and there is a notable amount of fields in the vicinity of the largest cities. To illustrate further, the images below present an image of the distribution of emissions before and after reconfiguring the proxies for the 2020 submission as a response to observation FI-GRID-L-2020-0001. Figure 8.14 presents the registered fields for Southern Finland (as listed by the Finnish Food Authority).



Initial submission Revised estimate



Registered fields in the registry of Finnish food authority

Figure 8.13. Maps above: Distribution of emissions before and after reconfiguring the proxies for the 2020 submission as a response to observation FI-GRID-L-2020-0001. Map below: Registered fields for Southern Finland (as listed by the Finnish Food Authority) marked in pink colour.

Public viewing tool for spatial distribution of emissions

A viewing tool of the spatial distribution of emissions within the inventory can be found at: <https://www.p2.ymparisto.fi/paastotkartalla/?lang=en>. The viewing tool aggregates GNFR sectors as presented in Table 8.25.

Table 8.25 – Description of the aggregation of GNFR classes for public viewing.

GNFR	Aggregate class	Description of sources
A_PublicPower	Public power and industries	Energy production and industrial processes covers emissions from electricity production and district heating, manufacturing and handling of fuels as well as from industrial processes and industrial boilers. Emissions which can not be allocated to geographical locations are evenly distributed on the map on industrial areas.
D_Fugitive		
B_Industry		
C_OtherStationaryComb	Other stationary combustion	Other stationary combustion includes such small scale furnaces and heat sources. Most of these are heat sources for housing, but also included are sauna stoves, fireplaces and stoves using wood or biomass as the primary fuel. The category also includes emissions from known fuel consumption that can not be allocated to a known facility.
I_Offroad	Transport	Transport category includes emissions from road and rail transport, navigation, aviation, non-road and working machinery. Regarding road transport emissions from tyre, brake wear and road abrasion as well as gasoline evaporation are included. The mapping has been carried out using data on road network, starting points of navigation and aviation without route data.
H_Aviation		
F_RoadTransport		
G_Shipping		
E_Solvents	Products and waste	Product use and waste includes use of products and solvents in industry and households. Emissions from landfill, composting and wastewater treatment are included, as well as e.g. house and car fires.
M_Other		
J_Waste		
K_AgriLivestock	Agriculture	The emissions from agriculture consists of such activities as animal husbandry and manure management, fertilizing and the use of pesticides. Also field burning of agricultural residues and other field operations are listed under agricultural emissions.
L_AgriOther		

Methodological issues

Changes in chapter	
March 2021	JM

Overview of the calculation of emissions

Gridded emissions contain all of the emissions of the air emission inventory including point sources and non-point sources. The national emission values are distributed to the cells with the following generalized equation.

$$E_{cell} = \frac{E_{total}}{n_{total}} * n_{cell}$$

Where

- E_{cell} = Emission value in a cell
- E_{total} = Total emission value
- n_{total} = Rate of activity, national total
- n_{cell} = Rate of activity in a cell

The methodology is constructed by the instructions of *Spatial mapping of emissions* of EMEP/EEA Guidebook 2013. As of the latest methodology of Guidebook 2019, the following steps are included in the methodology:

- Key category analysis to identify the most important sources is used.
- Existing spatial datasets are preferred.
- GIS tools are used to improve the proxies.
- Proxy data that is judged to most closely represent the spatial emissions patterns and intensity, and which is applicable with available resources, is selected.
- Spatial datasets that are complete are preferred.
- New data is available rarely. The currently gridded data uses spatial proxies which are set to describe land use of the year 2010.
- Issues relating to non-disclosure may be encountered but have not been observed to date.
- Aggregation is done in the EMEP 0.1 x 0.1 degree longitude/latitude grid but the methodology of creating proxies is applicable to higher levels of detail when needed

Disaggregating diffuse emissions.

The methodology to create proxies follows the basic principles as presented in the Guidebook 2019 where applicable, with modifications based on source content. Point sources are gridded based on chapter 3.4.1. Area sources are gridded based on chapter 3.4.2, however in many cases the material is first converted into points of certain density within the area. This commonly takes place with rasterized data sources that do not allow spatial analysis with the available toolset. Line sources are gridded according to chapter 3.4.3. Converting spatial projections is done where needed.

Uncertainty and time series' consistency

No evaluation of uncertainty has been done for gridded data. The methodology is prone to uncertainty especially in the temporal scale, as spatial disaggregation is done only for the target year 2010.

Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. Visual inspection for all GNFR sectors.

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

2020

- Update of methodology and inclusion of new inspection tools.
- Correction of geographical allocation issues: FI-GRID-L-2020-0001, FI-GRID-C-2020-0001, FI-GRID-B-2020-0001
- Update of coordinates to selected power plants (in response to FI-GRID-A-2020-0001)

2021

- Rewritten documentation of gridded emissions (in response to *Notes on reporting of air pollutant emissions from Large Point sources and emissions gridded data under the NECD*)
- Improved accuracy in facility coordinates
- Facility locations unified with LPS

2022

- The proxy data used for small scale wood combustion have been updated to more detailed data regarding the location of different building types (Finnish Regional Emission Scenario, FRES).

Source-specific planned improvements

None.

8.3.2 LPS data, sources, geographical coordinates and emissions

Changes in chapter	
March 2022	TF
Change in method	none

According to the 2014 CLRTAP Reporting Guidelines (ECE/EB.AIR/125), large point sources (LPS) are defined as facilities whose combined emissions, within the limited identifiable area of the site premises, exceed the pollutant emission thresholds identified in table 1 of the reporting guidelines. In the Finnish inventory, LPS facilities are identified as facilities that have at least one E-PRTR installation at their site premises. All emissions from all installations of these facilities, that are located at their site premises and exceed the pollutant emission thresholds identified in the reporting guidelines, are included in the LPS reporting data.

The emission data from LPS facilities are either reported by the facilities according to the environmental monitoring requirements in their environmental permits, and available from the YLVA system, or calculated at SYKE. Always when facility reported emission data are available, it is used in the reporting. All the reported LPS emission data is also included in the national inventory.

The emission data reported by Finland under the E-PRTR regulation is extracted from the YLVA system. This emission data is also included in the national inventory and LPS emission data. The differences in the emission data of individual facilities reported under the E-PRTR and LPS reporting are usually due to the inclusion of all installations from the site premises of the facilities to the LPS reporting. The E-PRTR reporting comprise only E-PRTR installations. Furthermore, in some cases, the LPS reporting data may also contain emissions calculated at SYKE in addition to the emissions reported by the facility to the YLVA system. Sometimes, erroneous emission data of E-PRTR installations is detected from the YLVA system (e.g. emissions reported in a wrong unit). When detected, these are corrected to the inventory data extracted from YLVA. The facility supervisors from the Centres for Economic Development, Transport and the Environment are informed of these data. If these data are not corrected to the E-PRTR reporting, this causes also differences between inventory/LPS data and E-PRTR data.

E-PRTR reporting includes ammonia emissions from a large number of agricultural operators. In the Finnish inventory, these facility reported emissions are not taken into account in the inventory reporting (and hence LPS reporting), since all the ammonia emissions in the inventory are calculated in a separate calculation model for agricultural emissions.

Note that the inventory is built up from boiler/process level data and default LPS emissions are calculated as part of the inventory, however, replaced by the reported data in the YLVA system, whenever these data are available and their correctness is checked.

The incorrect coordinates detected in the 2020 NECD review have been corrected to the latest LPS data sets.

The differences between the latest E-PRTR and LPS reporting data sets are described in the IIR. The differences for the year 2020 are listed below. The list will be completed with a description of the differences in more recent years' data sets in submission 2025.

Some emissions reported by the facilities for 2020 in the European Environment Agency's (EEA) PRTR database (Industrial Reporting database v5, December 2021) were absent from the LPS data for 2020 reported in submission 2022. These included:

- NO_x emissions reported by E-PRTR National IDs 3238 and 11179, SO_x emissions reported by the E-PRTR National ID 100239774 and PM₁₀ emissions reported by E-PRTR National ID

1913. In these cases the 2020 emissions are below the reporting threshold from LPS when the emissions are split between the different stack heights in the LPS reporting.

- NO_x emissions reported by E-PRTR National ID 100131111. The emission data in the reported in the PRTR database for this facility includes emissions also from the fuel use in off-road working machines. In the air pollutant emission inventory, all emissions from off-road working machines are calculated in the LIPASTO (explained in a more detailed level in the IIR/Part 3 – Transport) calculation system. To avoid double counting, none of the emissions of working machines reported by the facilities themselves are taken into account.
- PCDD/F emissions reported by E-PRTR National ID 1172. These emissions are incorrect in the PRTR database. The emissions are 1000 times too high in the database. The emissions have been corrected to the air pollutant emission inventory and the correct emissions are below the reporting threshold from LPS.
- PCDD/F emissions reported by E-PRTR National ID 3653. The emissions reported by the facility for the first time for 2020 in the PRTR database will be investigated thoroughly with the facility during 2022. Based on this work the possible inclusion of these emissions will be decided for submission 2023.

Data on Finnish LPSs has been submitted annually under the CLRTAP and since 2002 under the NECD.

Uncertainty and time series' consistency

No separate evaluation of uncertainty has been done for LPS data. However, all LPS data are included in the inventory data, for which an uncertainty analysis has been carried out.

Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out.

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

2012

- The definition of the set of Finnish Large Point Sources (LPS) was revised to correspond to the definition of E-PRTR installations. as defined in the revised UNECE Reporting Guidelines (ECE/EB.AIR/97).
- During the preparation of the 2012 submission, it was observed that the conversion of nationally used coordinates into the coordinates in the CLRTAP reporting did not work as believed. A new method to convert the coordinates was introduced.

2017-2018

- The geographical coordinates used in national reporting for point sources is EUREF-FIN and there was a need to carry out a conversion between the level and geographical coordinates. The additional functionality challenges were resolved to the 2019 submission.

2021

- Rewritten documentation
- Correction of some coordinates
- VAHTI-based coordinates updated to more accurate YLVA coordinates.
- Facility locations unified with gridded data.

2022

- Inclusion of a description of the differences between the latest E-PRTR and LPS reporting data sets.

Source-specific planned improvements

None.

8.4 MEMO ITEMS

Changes in chapter	
Update of text	March 2020 KS
Change in methodology	
Other (e.g. language, layout)	

Overall description and methodologies

1 A 3 ai(ii) International aviation cruise

See IIR Part 2 Energy under Aviation.

1 A 3 aii(ii) Domestic aviation cruise

See IIR Part 2 Energy under Aviation.

1 A 3 dii(i) International maritime navigation

See IIR Part 2 Energy under Navigation.

1 A 5 c Multilateral operations

Included under 1A5 (IE)

1 A 3 Transport (fuel used)

.Not applicable (NA). The inventory is based on fuels sold.

6 B Other not included in national total of the entire territory

Not occurring (NO) in Finland.

11 A Volcanoes

There are no volcanoes in Finland.

11 B Forest fires

Not estimated (NE).

11 C Other natural emissions

Not applicable (NA).

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