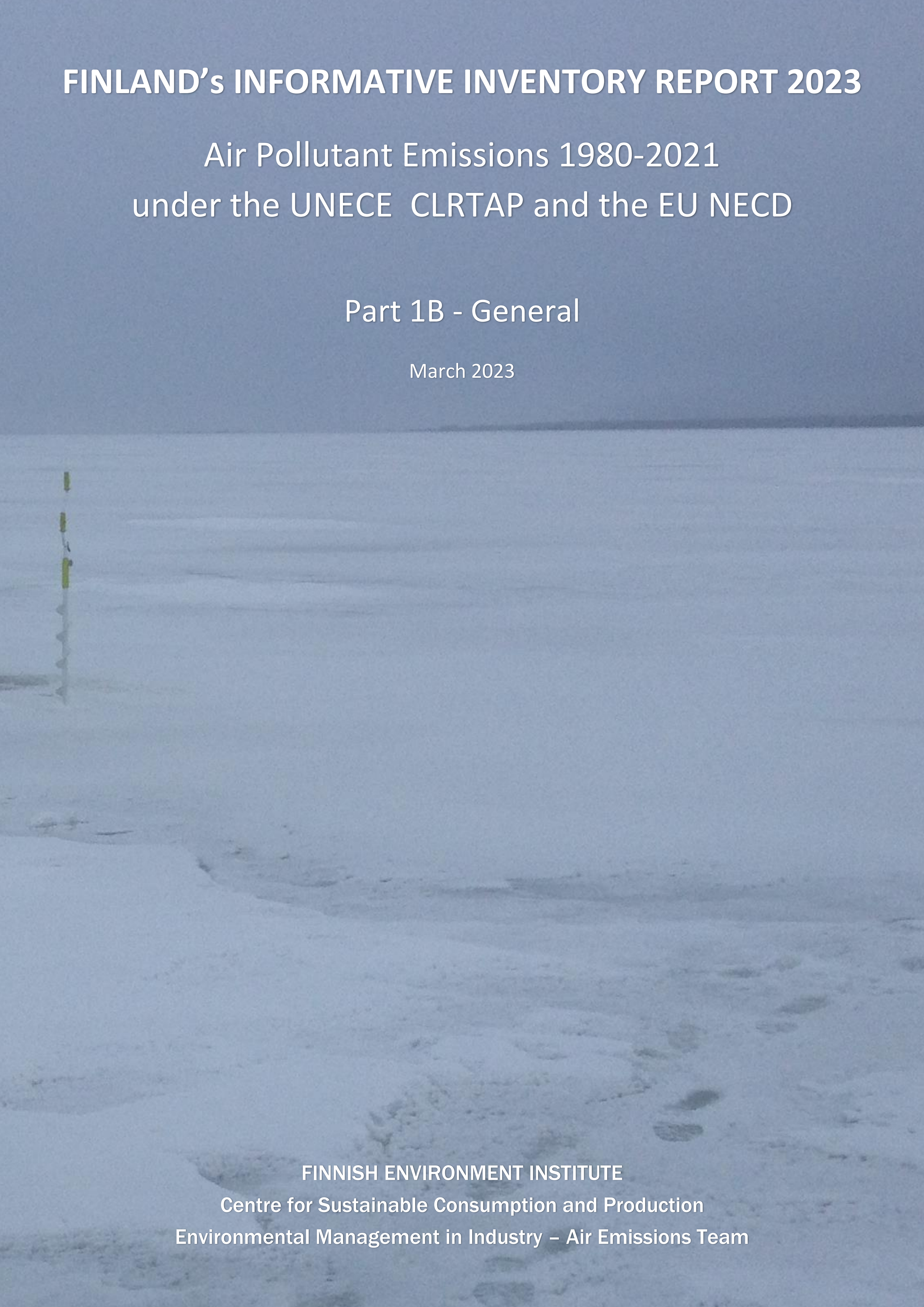


FINLAND's INFORMATIVE INVENTORY REPORT 2023

Air Pollutant Emissions 1980-2021 under the UNECE CLRTAP and the EU NECD

Part 1B - General

March 2023

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

PART 1B - GENERAL

REFERENCES

8.1 RECALCULATIONS AND IMPROVEMENTS

Changes in chapter	
March 2023	KS

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included in the base year but have been added since as well as for sources that were included in the base year and are no longer applicable.

Threre was no obligation to document this information in the early years of reporting air pollutant emission inventories in the 1990's 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 recalcualtions 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 1990's 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 sparce 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.

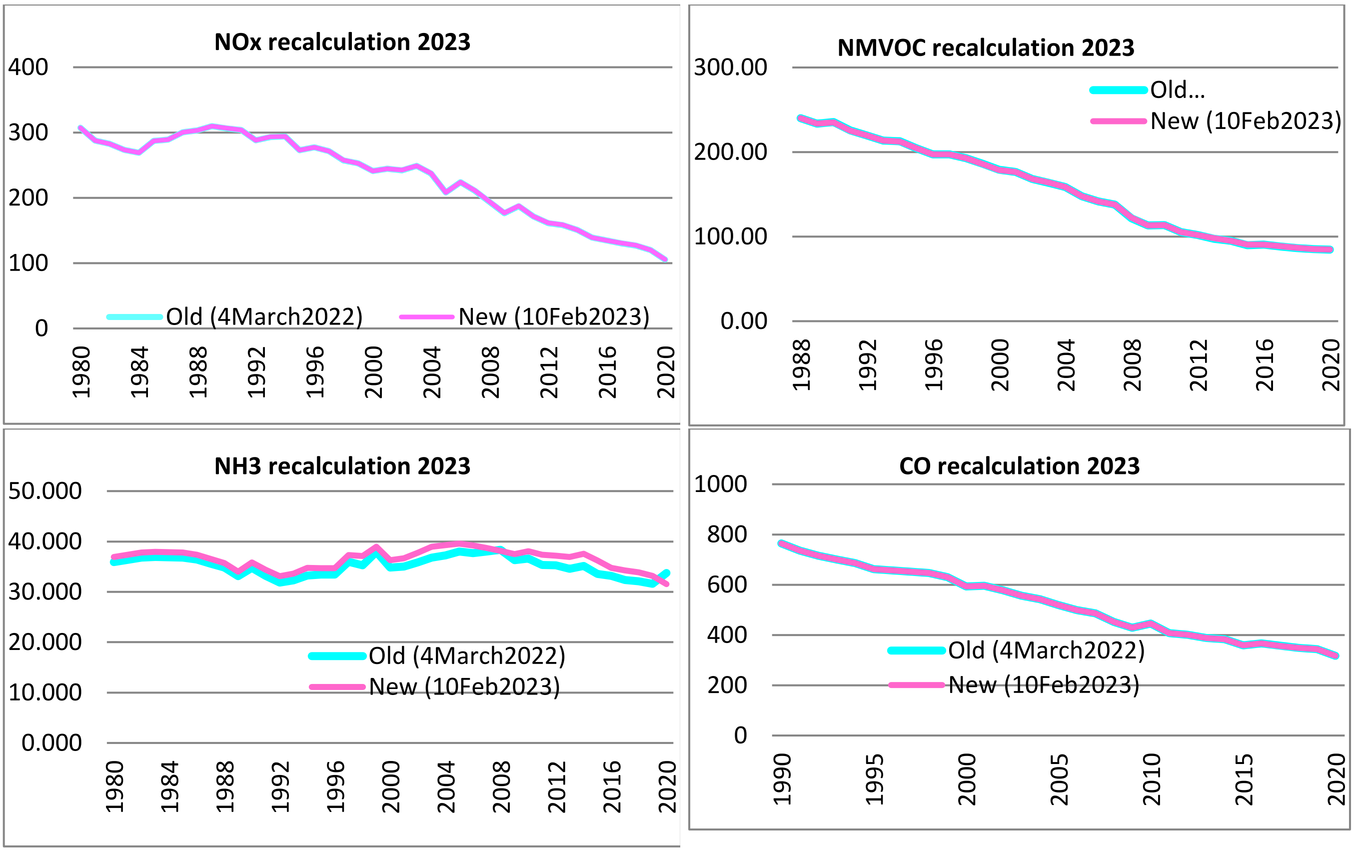
13 Mar 2020 Finland submitted corrections to the submission of 13 Feb 2020 (errors and omissions) due to time constraint caused by unexpected data flows: (1) renewal of the contents of the YLVA database with deletion of technical details used in the energy sector inventory and pre-scheduled initiation 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. The impacts of the recalculations are presented in Chapter 8.2.

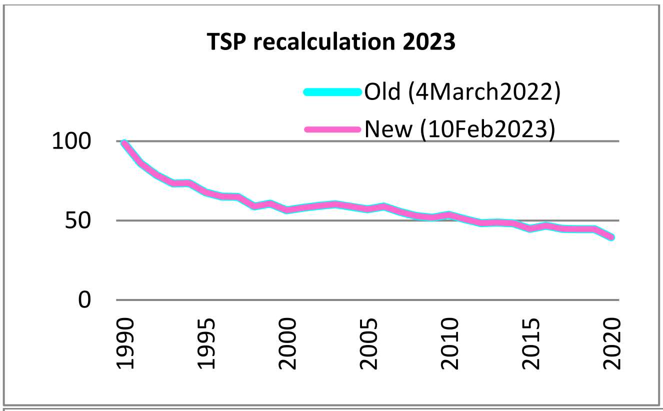
15 Mar 2022 Finland submitted corrections due to errors in NH3 from 5B2 and some AD changes. In addition, the 2019 adjustment values for 2019 were accidentally included for the year 2020 and were removed.

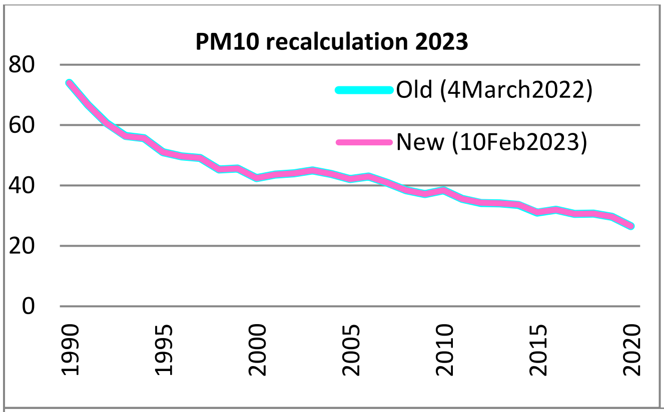
8.1.2 Impacts of recalculations in the 2023 submission

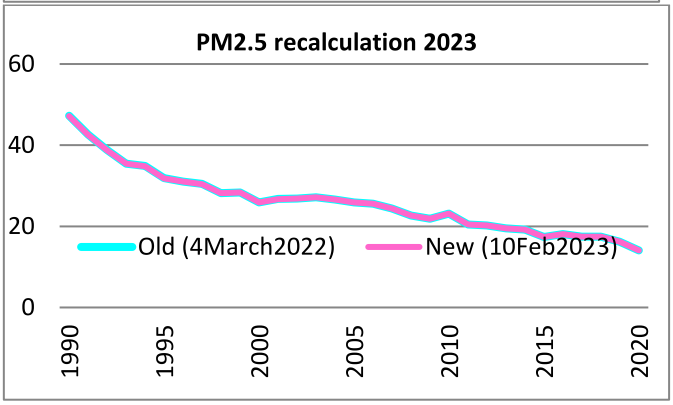
Recalculations to the 2023 submission are explained in detail in the respective IIR chapters (Parts 2-6 of the IIR). Most of the recalculations are due to update of statistical data and in some cases application of new emission factors, or due to new information from the plants.

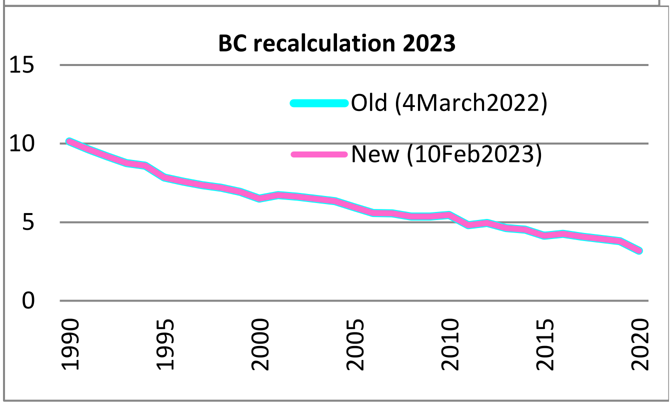
Below is an overview of the impacts of the recalculations to the 2023 submission in Figure 8.1 and Table 8.1.





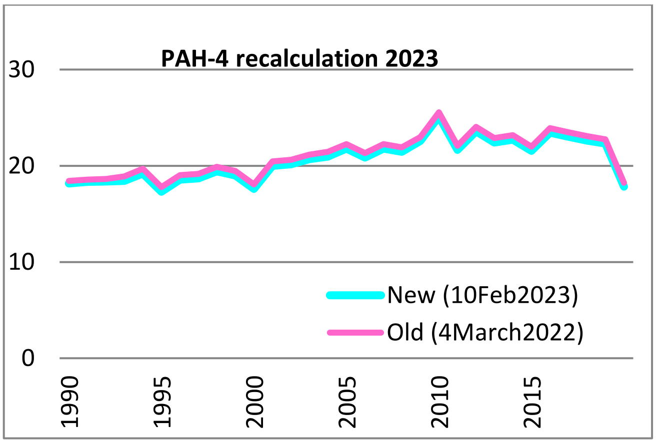


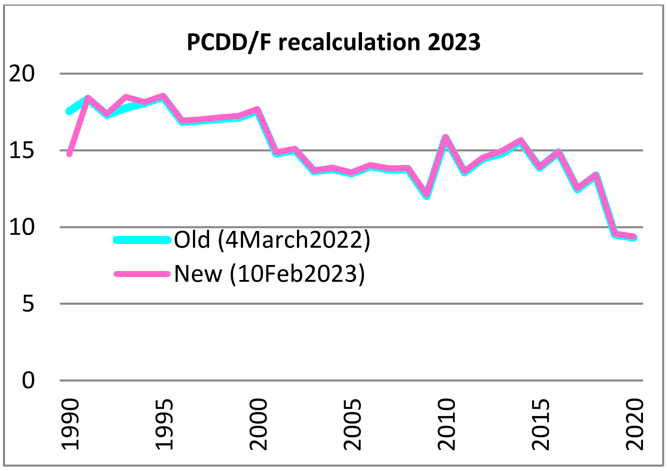




No recalculation for Pb
No recalculation for Hg
No recalculation for Cr
No recalculation for As

No recalculation for Cd
No recalculation for Cu
No recalculation for Ni
No recalculation for Zn





No recalculation for HCB

No recalculation for PCBs

Figure 8.1 Impact of recalculations in the 2023 submission compared to the 2022 submission

Table 8.1 Impact of recalculations in the 2023 submission compared to the 2022 submission

NOx															
	1980	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
4/15 March 2022	307.310	287.732	282.580	273.461	269.288	287.133	288.909	300.330	303.293	309.780	306.550	303.652	288.070	293.281	294.000
10 Feb 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
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028	0.059	0.086	0.108	0.136
%	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
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4/15 March 2022	273.027	277.389	271.555	257.426	252.773	241.124	244.475	242.313	248.767	237.202	208.230	223.853	210.960	193.626	176.458
10 Feb 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
Difference	0.148	0.179	0.162	0.212	0.143	0.184	0.198	0.228	0.257	0.252	0.241	0.301	0.307	0.336	0.232
%	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	0.2	0.1
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**				
4/15 March 2022	187.211	171.310	161.436	158.508	150.832	138.933	134.633	130.379	127.089	119.901	105.392				
10 Feb 2023	187.477	171.623	161.719	158.832	151.163	139.294	134.881	130.693	127.419	120.244	105.614				
Difference	0.266	0.313	0.282	0.324	0.332	0.361	0.248	0.314	0.330	0.343	0.222				
%	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.2				
SOx	**No recalculations**														
NH3															
	1980	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
4/15 March 2022	35.92833	36.33223	36.79751	36.94373	36.86605	36.79542	36.39727	35.5807	34.81443	33.13697	34.73792	33.19021	31.8574	32.28547	33.2658
10 Feb 2023	36.93201	37.35076	37.80853	37.93955	37.87626	37.78855	37.37521	36.52977	35.73182	34.01788	35.62384	34.03729	32.68716	33.13695	34.11939
Difference	1.004	1.019	1.011	0.996	1.010	0.993	0.978	0.949	0.917	0.881	0.886	0.847	0.830	0.851	0.854
%	2.7	2.7	2.7	2.6	2.7	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.6	2.5
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4/15 March 2022	33.42462	33.42462	35.98686	35.25875	37.9425	34.815	35.012	35.854	36.809	37.270	37.996	37.028	36.600	35.757	36.265
10 Feb 2023	34.13693	34.13693	36.74254	36.02992	38.7415	35.656	35.904	36.777	37.735	38.203	38.940	37.978	37.532	36.683	37.186
Difference	0.712	0.712	0.756	0.771	0.799	0.841	0.892	0.923	0.926	0.933	0.943	0.950	0.931	0.926	0.921
%	2.1	2.1	2.1	2.1	2.1	2.4	2.5	2.5	2.5	2.4	2.4	2.5	2.5	2.5	2.5
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**				
4/15 March 2022	36.596	35.345	35.247	34.592	35.150	33.533	33.192	32.331	32.121	31.593	33.740				
10 Feb 2023	37.560	36.324	36.240	35.565	36.089	34.367	34.020	33.142	32.924	32.181	31.529				
Difference	0.964	0.979	0.993	0.973	0.938	0.835	0.828	0.811	0.802	0.588	-2.211				
%	2.6	2.7	2.7	2.7	2.6	2.4	2.4	2.4	2.4	1.8	-7.0				

NMVOC

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
4/15 March 2022	240.04	233.44	235.51	225.78	219.71	213.53	212.71	204.50	197.25	197.30	192.60	186.34	178.98	176.57	167.96
10 Feb 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
Difference	-0.002	-0.002	-0.466	-0.307	-0.147	-0.128	-0.250	-0.122	0.026	-0.197	-0.028	-0.346	-0.162	-0.036	0.041
%	0.0	0.0	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0	-0.2	-0.1	0.0	0.0
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
4/15 March 2022	163.51	158.56	147.66	141.58	137.93	121.78	113.09	113.77	105.20	101.73	97.44	95.11	89.96	90.45	88.36
10 Feb 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
Difference	0.323	0.208	-0.009	0.198	0.088	0.392	0.067	-0.037	0.252	0.285	0.635	0.179	0.622	0.118	0.246
%	0.2	0.1	0.0	0.1	0.1	0.3	0.1	0.0	0.2	0.3	0.6	0.2	0.7	0.1	0.3
	2018	**2019**	**2020**												
4/15 March 2022	86.48	85.12	84.59												
10 Feb 2023	86.630	85.136	84.731												
Difference	0.149	0.014	0.144												
%	0.2	0.0	0.2												

CO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4/15 March 2022	764.457	735.842	715.135	700.247	686.537	661.765	656.805	651.390	646.260	629.839	593.765	596.0479	577.497	556.342	541.870
10 Feb 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
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**
4/15 March 2022	519.417	499.247	486.034	452.015	428.960	446.004	407.362	401.564	388.655	382.571	359.420	366.263	357.159	348.684	343.3928
10 Feb 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
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	-0.093	-0.094	-0.101
%	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														
4/15 March 2022	317.2114257														
10 Feb 2023	317.161982														
Difference	-0.049														
%	0.0														

TSP

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4/15 March 2022	98.90518	86.22526	78.83221	73.58427	73.72423	68.43487	65.81213	65.4201	59.39055	61.11393	56.8545	58.45997	59.63142	60.67307	59.09387
10 Feb 2023	98.73523	86.06132	78.6656	73.40887	73.58643	67.75057	65.16779	64.84385	58.85361	60.67784	56.41023	58.15065	59.32278	60.35906	58.77509
4/15 March 2022	-0.170	-0.164	-0.167	-0.175	-0.138	-0.684	-0.644	-0.576	-0.537	-0.436	-0.444	-0.309	-0.309	-0.314	-0.319

%	1.0	1.2	1.3	1.3	1.8	0.9	1.2	1.2	1.3	1.4	-0.8	-0.5	-0.5	-0.5	-0.5
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4/15 March 2022	57.2283	59.00351	55.60479	52.94356	52.09021	54.36649	51.29598	49.07064	49.00717	48.37681	45.12334	47.39466	45.15251	45.05578	44.51610988
10 Feb 2023	57.07477	58.86147	55.46177	52.78474	51.73366	53.665	50.83512	48.39084	48.7815	48.15705	44.79637	46.78251	44.7083	44.63484	44.52907179
Difference	-0.154	-0.142	-0.143	-0.159	-0.357	-0.701	-0.461	-0.680	-0.226	-0.220	-0.327	-0.612	-0.444	-0.421	0.013
%	-0.3	-0.2	-0.3	-0.3	-0.7	-1.3	-0.9	-1.4	-0.5	-0.5	-0.7	-1.3	-1.0	-0.9	0.0
	2020														
4/15 March 2022	39.48627														
10 Feb 2023	39.49482														
Difference	0.009														
%	0.0														

PM10

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
4/15 March 2022	74.17929	66.8966	60.77715	56.54723	55.8371	51.66347	50.2302	49.68909	45.79967	46.08663	42.93129	43.91933	44.34985	45.32758	44.13141
10 Feb 2023	74.01701	66.74289	60.62126	56.38256	55.7105	51.01051	49.61543	49.12751	45.28756	45.67188	42.50976	43.6275	44.05862	45.03175	43.83072
Difference	-0.162	-0.154	-0.156	-0.165	-0.127	-0.653	-0.615	-0.562	-0.512	-0.415	-0.422	-0.292	-0.291	-0.296	-0.301
%	-0.2	-0.2	-0.3	-0.3	-0.2	-1.3	-1.2	-1.1	-1.1	-0.9	-1.0	-0.7	-0.7	-0.7	-0.7
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4/15 March 2022	42.32309	43.14736	40.98366	38.56066	37.47466	39.05181	36.02412	34.89423	34.33282	33.81448	31.37474	32.57913	30.98986	31.10069	30.03414
10 Feb 2023	42.18123	43.01723	40.85351	38.41577	37.13906	38.38808	35.59344	34.2546	34.12937	33.6176	31.07565	32.00267	30.57583	30.69854	29.61065
Difference	-0.142	-0.130	-0.130	-0.145	-0.336	-0.664	-0.431	-0.640	-0.203	-0.197	-0.299	-0.576	-0.414	-0.402	-0.423
%	-0.3	-0.3	-0.3	-0.4	-0.9	-1.7	-1.2	-1.9	-0.6	-0.6	-1.0	-1.8	-1.4	-1.3	-1.4
	2020														
4/15 March 2022	26.56444														
10 Feb 2023	26.56941														
Difference	0.005														
%	0.0														

PM2.5

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
4/15 March 2022	47.39727	42.77847	38.96607	35.59987	35.02147	32.50242	31.64716	30.95806	28.64718	28.7607	26.32582	26.99546	27.13458	27.43044	26.85738
10 Feb 2023	47.24757	42.62757	38.81473	35.44752	34.86445	31.86712	31.05391	30.43217	28.15488	28.36289	25.92067	26.71772	26.85657	27.14763	26.57184
Difference	-0.150	-0.151	-0.151	-0.152	-0.157	-0.635	-0.593	-0.526	-0.492	-0.398	-0.405	-0.278	-0.278	-0.283	-0.286
%	-0.3	-0.4	-0.4	-0.4	-0.5	-2.0	-1.9	-1.7	-1.7	-1.4	-1.6	-1.0	-1.0	-1.0	-1.1
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4/15 March 2022	26.02572	25.70645	24.54568	22.81868	22.21083	23.79563	20.87371	20.80342	19.69909	19.38443	17.6904	18.60342	17.85298	17.8082	16.62195
10 Feb 2023	25.89589	25.5819	24.42243	22.68034	21.88654	23.15385	20.45866	20.18036	19.50549	19.19845	17.40377	18.04568	17.45406	17.41977	16.20936
Difference	-0.130	-0.125	-0.123	-0.138	-0.324	-0.642	-0.415	-0.623	-0.194	-0.186	-0.287	-0.558	-0.399	-0.388	-0.413

%	-0.5	-0.5	-0.5	-0.6	-1.5	-2.8	-2.0	-3.1	-1.0	-1.0	-1.6	-3.1	-2.3	-2.2	-2.5
	2020														
4/15 March 2022	14.06248														
10 Feb 2023	14.06601														
Difference	0.004														
%	0.0														
BC															
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
4/15 March 2022	10.10017	9.601714	9.151792	8.718234	8.548016	7.956742	7.668376	7.42125	7.246812	6.961374	6.500459	6.673922	6.580453	6.440257	6.295144
10 Feb 2023	10.13737	9.639547	9.189432	8.756007	8.587378	7.846707	7.577087	7.35197	7.190166	6.929695	6.489547	6.715374	6.622459	6.483719	6.33936
Difference	0.037	0.038	0.038	0.038	0.039	-0.110	-0.091	-0.069	-0.057	-0.032	-0.011	0.041	0.042	0.043	0.044
%	0.4	0.4	0.4	0.4	0.5	-1.4	-1.2	-0.9	-0.8	-0.5	-0.2	0.6	0.6	0.7	0.7
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
4/15 March 2022	5.899511	5.527889	5.512307	5.314556	5.314556	5.599238	4.873316	5.088504	4.632816	4.527093	4.152249	4.351033	4.12788	3.979532	3.847619
10 Feb 2023	5.950592	5.576581	5.563682	5.356405	5.356405	5.465733	4.800154	4.959388	4.627451	4.524986	4.130808	4.256194	4.078406	3.92944	3.798568
Difference	0.051	0.049	0.051	0.042	0.042	-0.134	-0.073	-0.129	-0.005	-0.002	-0.021	-0.095	-0.049	-0.050	-0.049
%	0.9	0.9	0.9	0.8	0.8	-2.4	-1.5	-2.6	-0.1	0.0	-0.5	-2.2	-1.2	-1.3	-1.3
	2020														
4/15 March 2022	3.182498														
10 Feb 2023	3.182836														
Difference	0.000														
%	0.0														
All heavy metals	**No recalculations**														
PCDD/F															
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
4/15 March 2022	17.62568	18.4154	17.35114	17.81984	18.16254	18.60414	16.98334	17.05507	17.1707	17.2528	17.68129	14.88651	15.12416	13.70747	13.85224
10 Feb 2023	17.54643	18.3539	17.30663	17.74441	18.08574	18.47767	16.85932	16.93457	17.04031	17.13511	17.58616	14.79949	15.01973	13.63971	13.78918
Difference	-0.079	-0.061	-0.045	-0.075	-0.077	-0.126	-0.124	-0.121	-0.130	-0.118	-0.095	-0.087	-0.104	-0.068	-0.063
%	-0.5	-0.3	-0.3	-0.4	-0.4	-0.7	-0.7	-0.7	-0.8	-0.7	-0.5	-0.6	-0.7	-0.5	-0.5
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4/15 March 2022	13.55029	14.05034	13.81586	13.83801	12.10372	15.91427	13.6386	14.5824	14.83329	15.64955	13.93468	14.94105	12.50627	13.41547	12.13155
10 Feb 2023	13.48914	13.96508	13.74215	13.76279	12.01984	15.80232	13.56094	14.479	14.78034	15.59281	13.88096	14.87612	12.45187	13.36565	9.505828
Difference	-0.061	-0.085	-0.074	-0.075	-0.084	-0.112	-0.078	-0.103	-0.053	-0.057	-0.054	-0.065	-0.054	-0.050	-2.626
%	-0.5	-0.6	-0.5	-0.5	-0.7	-0.7	-0.6	-0.7	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-27.6
	2020														
4/15 March 2022	9.310065														
10 Feb 2023	9.383515														

Difference	0.073
%	0.8

PAH-4

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4/15 March 2022	18.96773	19.12122	19.16386	19.434	20.26539	19.45657	20.62231	20.57398	21.21191	20.57914	18.56488	20.60111	20.76537	21.31431	21.59015
10 Feb 2023	18.42696	18.57417	18.61563	18.88394	19.69175	17.7846	19.04068	19.16366	19.89207	19.46476	18.07227	20.46292	20.6255	21.1691	21.44081
Difference	-0.541	-0.547	-0.548	-0.550	-0.574	-1.672	-1.582	-1.410	-1.320	-1.114	-0.493	-0.138	-0.140	-0.145	-0.149
%	-2.9	-2.9	-2.9	-2.9	-2.9	-9.4	-8.3	-7.4	-6.6	-5.7	-2.7	-0.7	-0.7	-0.7	-0.7
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
4/15 March 2022	22.22801	21.29508	22.22946	21.98663	23.47024	26.14006	22.28911	24.65095	22.52824	22.8106	21.37994	23.82096	23.03498	22.62306	22.30933
10 Feb 2023	22.24609	21.30783	22.23534	21.91236	22.98243	25.55631	22.09924	24.05102	22.86818	23.17876	21.99621	23.91921	23.46506	23.07536	22.75325
Difference	0.018	0.013	0.006	-0.074	-0.488	-0.584	-0.190	-0.600	0.340	0.368	0.616	0.098	0.430	0.452	0.444
%	0.1	0.1	0.0	-0.3	-2.1	-2.3	-0.9	-2.5	1.5	1.6	2.8	0.4	1.8	2.0	2.0
	2020														
4/15 March 2022	18.23854														
10 Feb 2023	17.83787														
Difference	-0.401														
%	-2.2														

HCB and PCBs **No recalculations**

8.2 Improvements and Reviews

Changes in chapter	
March 2021	KS

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

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

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. After the full recalculation of the time series 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

EU Technical Review under the NECD in 2022

Changes in chapter	
March 2023	KS

The improvements made to the 2023 inventory submission in response to the EU Technical Review under the NECD in 2022 are presented in Table 8.2.

UNECE CLRTAP In-Depth Review of Inventories, Stage 3 Review Report 2022

Changes in chapter	
March 2023	KS

The improvements made to the 2023 inventory submission in response to the UNECE CLRTAP In-Depth Review of Inventories (Stage 3) in 2022 are presented in Table 8.2.

Table 8.2. Improvements made in response to UNECE CLRTAP Stage 3 Review in 2022

13. The ERT noted that Finland uses a country specific methodology for the compilation of its emissions in residential sector. 14. The Party uses the same measurement technique in all measurements and provided additional reference in which the measurement method was explained. In addition, Finland provided information that the method is not standardized but is used more than fifteen years successfully in several scientific projects at UEF (University of Eastern Finland, Fine Particle and Aerosol Technology Laboratory (FINE)). **The ERT welcomes the additional information regarding the measurement methods provided by the Party and recommends Finland to include this reference in the next IIR submission.**	The recommended text is included under the respective Energy sector chapter (Small combustion p. 52-53)
15. The measurements technique used by Finland includes condensables in PM2.5 emissions. Finland explained that PM2.5 samples are collected from diluted flue gas at room temperature and thus include the condensable component of particulate matter. 16. The ERT noted that country specific emission factors are calculated as the weighted average of the EF for normal combustion conditions (between 90-100% of total combustion time, defined for each equipment) and the EF for bad combustion conditions (between 0-10%). Furthermore, the Party explained that emission factors are recorded in large database (Starship) which includes results representing the whole combustion cycle (ignition, combustion phase under normal burning conditions, shut down). **The ERT welcomes the explanations provided by Finland and recommends Finland to include this information in the next submission**	The recommended text is included under the respective Energy sector chapter (Small combustion p. 52-53 and p. 55)
18. The emission factors do include the condensable component of PM2.5 emissions for biomass, whereas for other fuels the inclusion of condensables is unknown (Table 1). **The ERT recommends the Party to further investigate for each PM emission factor whether or not condensables are included.**	As stated earlier, EFs for wood combustion cover condensables, the EF for coal combustion is from the Guidebook, which does not implicitely explain if condensables are included. The share of coal combustion in the residential sector is very low in Finland.
20. The ERT noted that Finland uses the following proxy data for spatially distributing emissions: population density and data on all buildings (by count, by floor area, by overall volume, for permanent and temporary residential buildings presented in the National building and dwelling register). Finland plans to improve the proxy data by implementing a model that includes some adjustments on the source material to better estimate small scale wood combustion. The most notable improvement is that the allocation more accurately picks out those buildings where wood is combusted, thus decreasing the rate of wood combustion in the capital region and increasing the rate in	A more detailed plan will be available for future submissions and the impllementation schedule and results will then be described in the IIR. For now, the schedule is not known.

rural areas. **The ERT commends Finland for this improvement plan and recommends including this in the improvement plan with clear steps and schedule and to report on progress of the work in the next submissions.**	

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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.

2022 Review Report Table 4: All findings for NOX, NMVOC, SO2, NH3, PM2.5 and PM10, including those made during the 2022 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 or UPTC in 2021	RE or TC in 2022	Tier 1 used for Key Category
2022 (1)	FI-1A2-2022-0001	No	1A2 Stationary Combustion in Manufacturing Industries and Construction, NH_3, 2005,2018,2019,2020	NA	No	No

Recommendation
For subcategories of 1A2 Stationary Combustion in Manufacturing Industries and Construction, NH_3 and selected years (1A2a: 2018-2020, 1A2c: 2005, 2018-2020, 1A2e: 2005, 2018-2020, 1A2f: 2005, 2018-2020, 1A2gviii: 2005), the TERT noted that NH_3 emissions are reported as 'NA' (not applicable) whilst the 2019 EMEP/EEA Guidebook provide a Tier 1 methodology. In response to a question raised during the review, Finland stated that NH_3 emissions were not detected in measurements, except for SCR/SNCR ammonia slip emissions in some industrial boilers, which are not relevant for this sector. Finland also stated that a current project about emissions from public power and industrial boilers is running and that the result will be considered in the 2023 submission.
The TERT recommends that Finland consider the outcome of the new project and that it makes efforts to estimate NH_3 emissions from biomass burning (other than ammonia slip emissions) in the 2023 submission.

Actions upto March 2023

In an ongoing project 2022-2023 information on possible NH3 emissions have been collected. The preliminary results confirm the earlier information that no ammonia is generated from combustion of wooden fuels. Further information will be included in the 2024 IIR. As also stated in earlier versions of the IIR, ammonia slips may occur when SCR/SNCR are used and these are included in the inventory due to the plant's reporting obligations.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or UPTC in 2021	RE or TC in 2022	Tier 1 used for Key Category
2022 (1)	FI-1A2d-2022-0001	No	1A2d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print, NH_3, 1990-2020	NA	No	No

Recommendation
For 1A2d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print, NH_3 and all years, the TERT noted that NH_3 emissions are reported as 'NA' (not applicable) whilst the 2019 EMEP/EEA Guidebook provide a Tier 1 methodology. In response to a question raised during the review, Finland stated that NH_3 emissions were not detected in measurements, except for SCR/SNCR ammonia slip emissions in some industrial boilers, which are not relevant for this sector. Finland also stated that a current project about emissions from public power and industrial boilers is running and that the result will be considered in the 2023 submission.
The TERT recommends that Finland consider the outcome of the new project and that it makes efforts to estimate NH_3 emissions from biomass burning (other than ammonia slip emissions) for pulp and paper industries in the 2023 submission.

Actions up to March 2023

In an ongoing project 2022-2023 information on possible NH3 emissions have been collected. The preliminary results confirm the earlier information that no ammonia is generated from combustion of wooden fuels. Further information will be included in the 2024 IIR. As also stated in earlier versions of the IIR, ammonia slips may occur when SCR/SNCR are used and these are included in the inventory due to the plant's reporting obligations.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or UPTC in 2021	RE or TC in 2022	Tier 1 used for Key Category
2022 (1)	FI-1A3ai(i)-2022-0001	No	1A3ai(i) International Aviation LTO (Civil), $PM_{2.5}$, 2005	NA	No	No

Recommendation

The TERT noted that for category 1A3ai(i) International Aviation LTO (civil) for pollutant $PM_{2.5}$, the value for 2005 presents a significant jump (i.e., is statistically greater) compared to 2000 and 2010. This trend does not seem to be attributed to increased activity. The IEF also shows a significant jump which is not explained. In response to a question raised during the review, Finland answered that this is due to a possible slight problem of Eurocontrol calculations system for 2005 and suggested two possible solutions: move 3 t of particulate matter emissions from LTO to cruise in 2005 data (in this way total PM emissions would be the same and both time series, LTO and cruise, and also IEF time series would seem smoother); or, add a comment somewhere, without changing the actual figures. The TERT agreed with the first solution, i.e., that Finland in the next submission 2023 moves 3 t of $PM_{2.5}$ from LTO to cruise emissions in 2005 data. It is noted that the impact on national total is 0.01%, i.e., below the threshold of significance.

The TERT recommends that Finland make the suggested correction to $PM_{2.5}$ emissions from category 1A3ai(i) International Aviation LTO (civil).

Actions up to March 2023

Emissions in 2005 and the earlier years are corrected in line with the recommendation.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or UPTC in 2021	RE or TC in 2022	Tier 1 used for Key Category
2022 (1)	FI-2B6-2022-0001	No	2B6 Titanium Dioxide Production, $PM_{2.5}$, 1990-2020	NA	No	No

Recommendation

For 2B6 Titanium Dioxide Production for the years 1990-2020 the TERT noted that the $PM_{2.5}$ emission estimates are equal to the estimates for PM_{10} whilst the 2019 EMEP/EEA Guidebook provides fraction factors. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Finland explained that it did not notice the fractions provided in the guidebook.

The TERT recommends that Finland correct the fraction factors in its 2023 submission.

Action up to March 2023

The estimates have been corrected in line with the recommendation to the 2023 submission.

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or UPTC in 2021	RE or TC in 2022	Tier 1 used for Key Category
2022 (1)	FI-5E-2022-0001	No	5E Other Waste, $PM_{2.5}$, PM_{10}, 2005-2020	NA	No	No

Recommendation

For 5E Other Waste, particulate matter (PM) emissions and all years the TERT noted that only 68% of car fires had been taken into account without any explanation in the IIR (page 37, waste chapter). In response to a question raised during the review Finland clarified that heavy vehicles were not included in the inventory. Finland will correct the calculation in the 2023 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Finland include particulate matter emissions from all vehicle fires in its 2023 submission.

Action up to March 2023

The estimates have been corrected in line with the recommendation to the 2023 submission.

8.2 PROJECTIONS

Changes in chapter	
Update of text March 2023	KS, MS
Update of projections	Every 1-3 years, since 2020 every 2 years

8.2.1 Projections for 2020, 2025, 2030, 2040, 2050

With existing measures (WM) projections

Finland updated the Energy and Climate Strategy – Carbon neutral Finland 2035 – in 2022 (Huttunen 2022[1]). 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 HIISI[2] was commissioned. The HIISI project was succeeded by the HIISI[2] 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, 2019[3]) the First Update Report of the programme (in preparation) 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.

Base years

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

Energy	2019
Transport	2021
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

Projections for 2020, 2025, 2030, 2040 and 2050

Emission projections for 2025, 2030, 2050 and 2050 submitted in 2023 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.

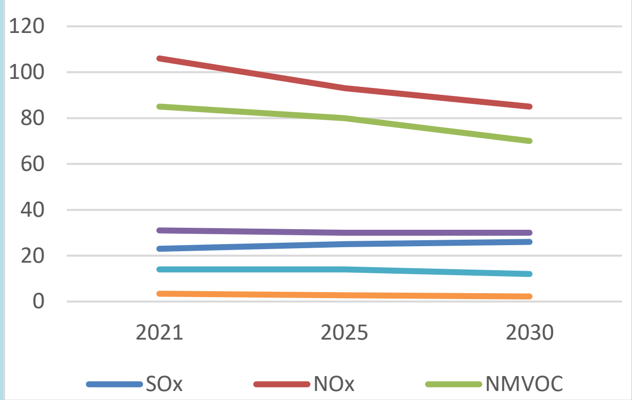
For energy, agriculture and road transport sectors, emission scenarios are available up to 2050. For IPPU, fugitive emissions and waste sector, expert estimates were made also for the years 2040 and 2050 for the 2020 submission, however, these will be further developed in the coming years. The current projected emission values are presented in Table 8.3.

[1] Huttunen R. (Ed.) 202217. 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 Aairs 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

Table 8.3. Projected national total emissions for 2015, 2020, 2030,2040, 2050 as reported on 15 March 2023

Pollutant	Unit	WM projections				
		2021	2025	2030	2040	2050
SO_x	kt	23	25	26	NE	NE
NO_x	kt	106	93	85	NE	NE
NMVOC	kt	85	80	70	NE	NE
NH3	kt	31	30	30	NE	NE
PM2.5	kt	14	14	12	NE	NE
BC	kt	3.4	2.7	2.2	NE	NE



8.2.2. Projections for Energy

Changes in chapter	
Update of text March 2023	MS, KS
Update of projections	Every 1-3 years, since 2020 every 2 years

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 HIISI 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 2008[4]) was used to calculate emission projections for combustion plants and residential combustion. It covers the emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) non-methane volatile organic compounds (NMVOCs) (from residential combustion only) and primary particulate matter (TSP, PM_{10}, $PM_{2.5}$, PM_1 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 NH_3 and NMVOC emissions from the energy sector, 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 lates 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 HIISI 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).

[4] Karvosenoja N. 2008 Emission scenario model for regional air pollution. Morographs Boreal Environ. Res. 32. 2008.

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 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)[5]. 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 questionaries). 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 major 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.

[5] 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

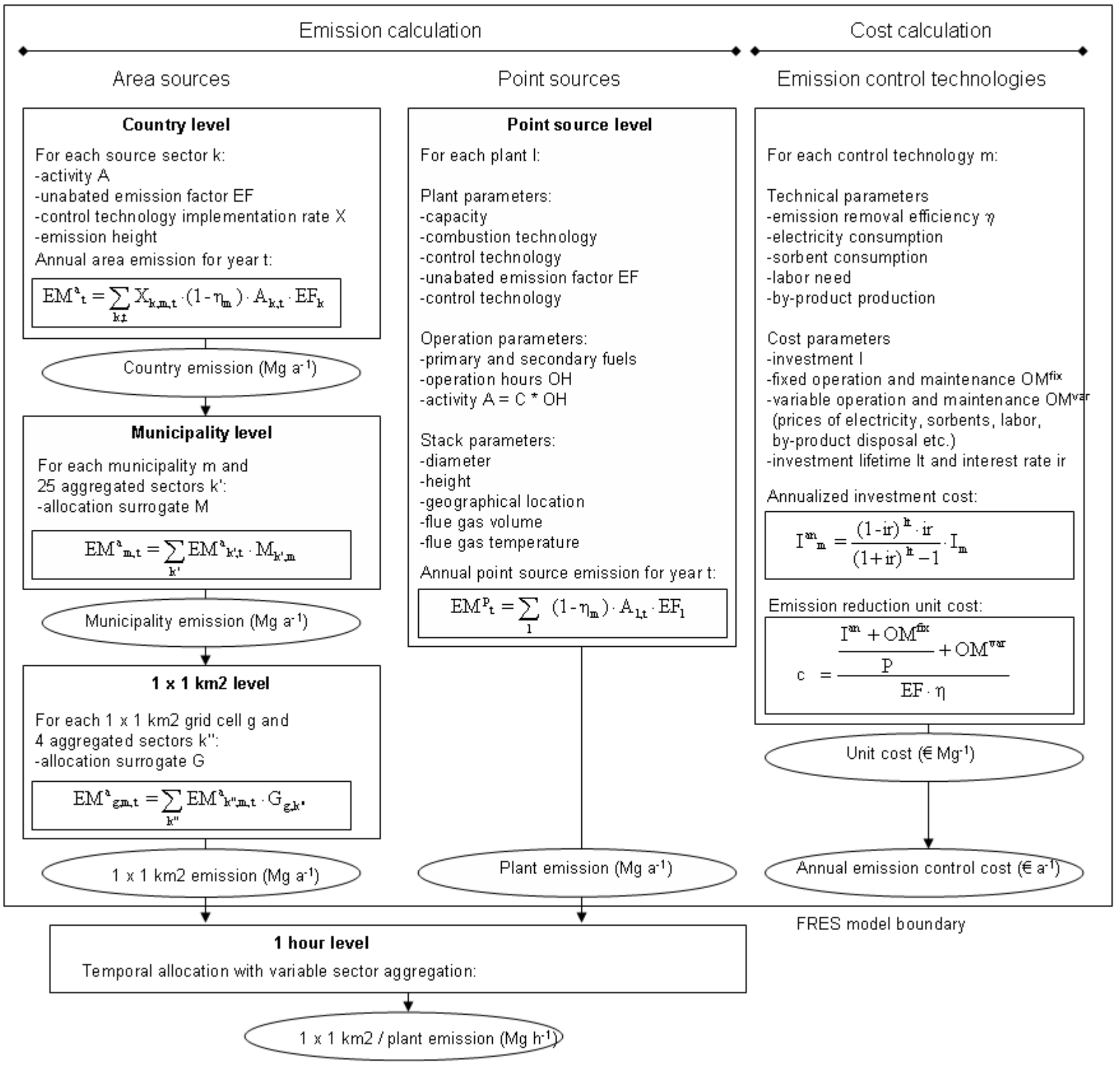


Figure 8.2. Structure of the FRES model.

8.2.3 Projections for Transport

Changes in chapter	
Update of text March 2023	AL, JoMa, KS
Update of projections	Every 1-3 years, since 2020 every 2 years

Projections for the transport sector are presented in Figure 8.3.

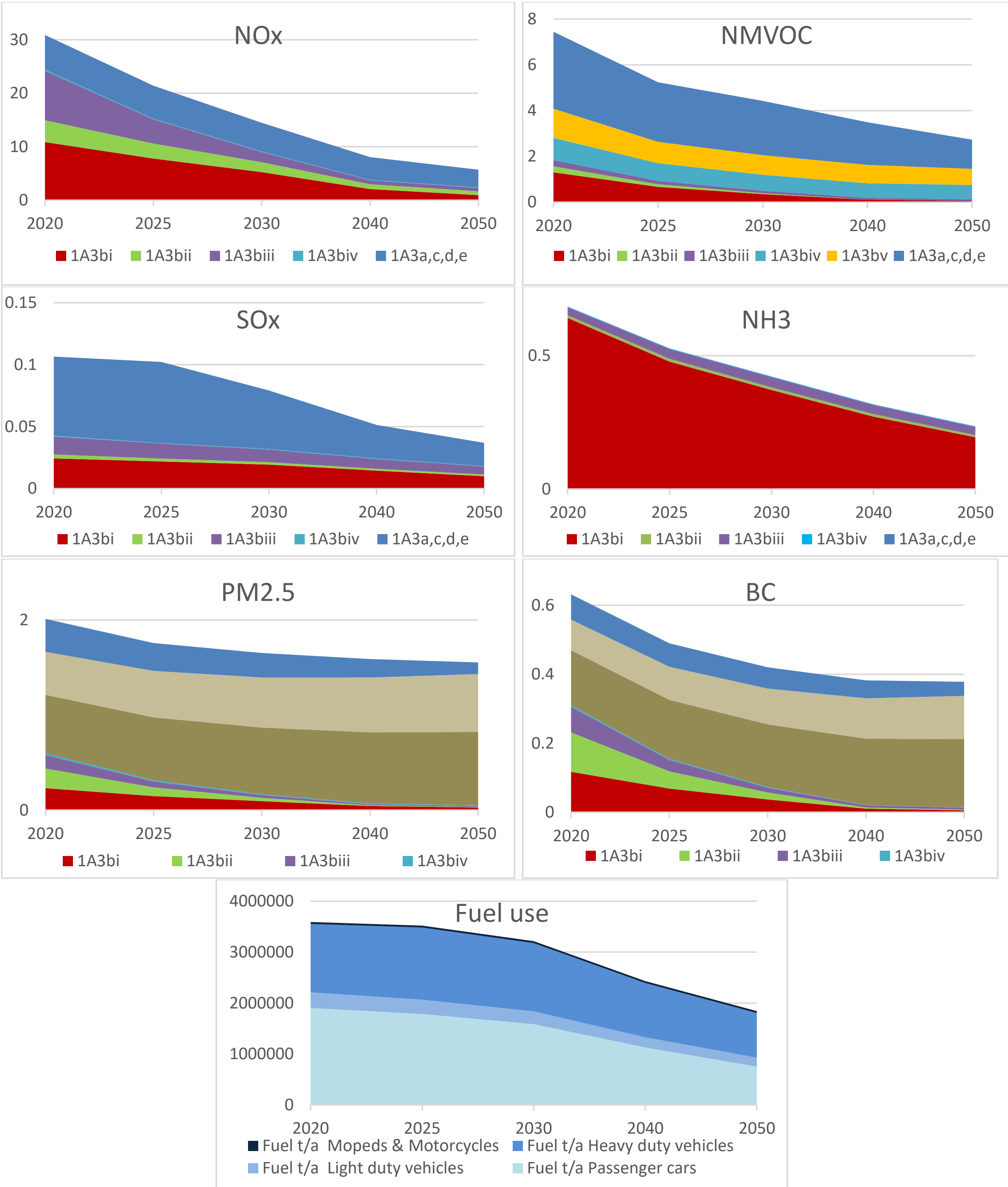


Figure 8.3 Projections for the transport sector

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 2050[6]. 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 model, 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. 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 the vehicles are in line with the CO_2 emission regulation by EU[7,8]. Vast increases in electric and fuel cell vehicle registrations are introduced to the model to simulate the implementation of EU's updated CO_2 emission regulation[9].

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 (flexifuel 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 20 % (by energy content, of annual liquid and gaseous fuel sales) up to 34 % during the period 2020-2030 due to the biofuel obligation in Finland[10]. Biogas and P2X-fuels are included in the obligation since 2022. The model considers also the temporary decrease of biofuel obligation in 2022 and 2023 to 12.0 and 13.5 %, respectively.

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), 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. 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 is high, but a short supply limits the expected pace of the fleet turnover during this decade.

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[6] Finnish Transport and Communications Agency (Traficom). 2021. Tieliikenteen valtakunnallinen ennuste (in Finnish). Available at: https://api.hankeikkuna.fi/asiakirjat/d99a3ae3-b7f9-49df-afd2-c8f2efd3dc1d/5d4db40f-4cf4-4ad5-9e42-99031175f27e/MUISTIO_20210920060527.pdf
[7] 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
[8] Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC
[9] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Regulation (EU) 2019/1242 as regards strengthening the CO_2 emission performance standards for new heavy-duty vehicles and integrating reporting obligations, and repealing Regulation (EU) 2018/956
[10] Finnish Act on biofuels 20.12.2022/1134. Available at: https://www.finlex.fi/fi/laki/alkup/2022/20221134

Ammonia
In transport, most NH_3 emissions originate from passenger cars equipped with catalytic converters. Improvements in technology have substantially reduced NH_3 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 NH_3 emissions are one-tenth of NH_3 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 (PM2.5) 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.

NMVOC
NMVOC 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 NMVOC 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. The proportion of diesel trains has decreased significantly in recent years and they are mainly used in non-electrified, smaller rail sections. The diesel train transport has stabilised, and no major changes 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 focus on experts' (The Finnish Transport Infrastructure Agency's) estimation of the development of port calls. 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 Finland[11]. Evolution of fleet (50 different machine types) is affected by, the penetration of emission standars (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.

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[11] 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%A4%C3%A4st%C3%B6jen-perusennuste-ja-s%C3%A4hk%C3%B6istymisen-vaikutus-p%C3%A4%C3%A4

Aviation

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

8.2.4. Projections for IPPU and Waste

Changes in chapter	
Update of text March 2023	KS, MS
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	NMVOC emissions occur from 2A1 and 3A3 but are minor and are considered to be already included in the uncertainty of the air pollutant emissions from the major IPPU sectors. NOx from 2A2 and 2A3 are included in the energy sector projections as is the case also are in the inventory of historic years. 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 developents 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.
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	NMVOC and NH3 emissions projections are estimated based on the running average of the last three years. NOx from 2C1 is included in the energy sector projections as they also are in the inventory of historic years. 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 developents 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
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	NMVOC and NH3 projections are based on the running average of last three years. No forecast is available for the development of the sector.
2D3c	Asphalt roofing	
2D3d	Coating applications	
2D3e	Degreasing	
2D3f	Dry cleaning	
2D3g	Chemical products	
2D3h	Printing	
2D3i	Other solvent use	
2G	Other product use	IPPU sector emissions are minor and are thus thougt to be included in the uncertainty of the air pollutant emissions from the major sectors. NOx from 2G is included in the energy sector projections as they also are in the inventory of historic years.
2H1	Pulp and paper industry	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 developents 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 NMVOC and NH3 emission projections are based on the running average of last three years.
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)12]
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	251520	45343	3.0
2022	5.6	259186	46658	3.0
2023	5.6	260482	46828	0.5
2024	5.6	264129	47423	1.4
2025	5.6	267827	48030	1.4
2030	5.6	271041	48410	1.2
2040	5.5	272396	49298	0.5
2050	5.5	273758	49564	0.5

[12] Publications by Statistics Finland Tilastokeskus - (stat.fi), Bruttokansantuote ja -tulo sekä tarjonta ja kysyntä, vuosittain muuttujina Taloustoimi, Vuosi ja Tiedot. PxWeb (stat.fi), Pellervo 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

2060	5.3	275127	51921	0.5
2070	5.2			

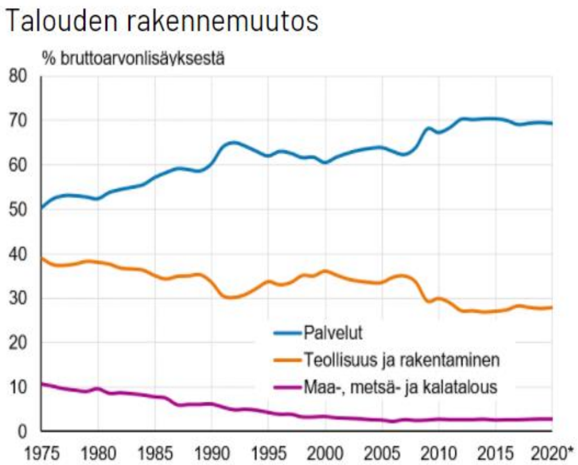


Figure 8.4. Structural changes in economy (% of brutto value addition): Services (blue line), Industry and construction (orange line), Agriculture, Forestry and Fishing industry (red line). Reference: [suomilukuina_tau_kan004.xlsx (live.com)]

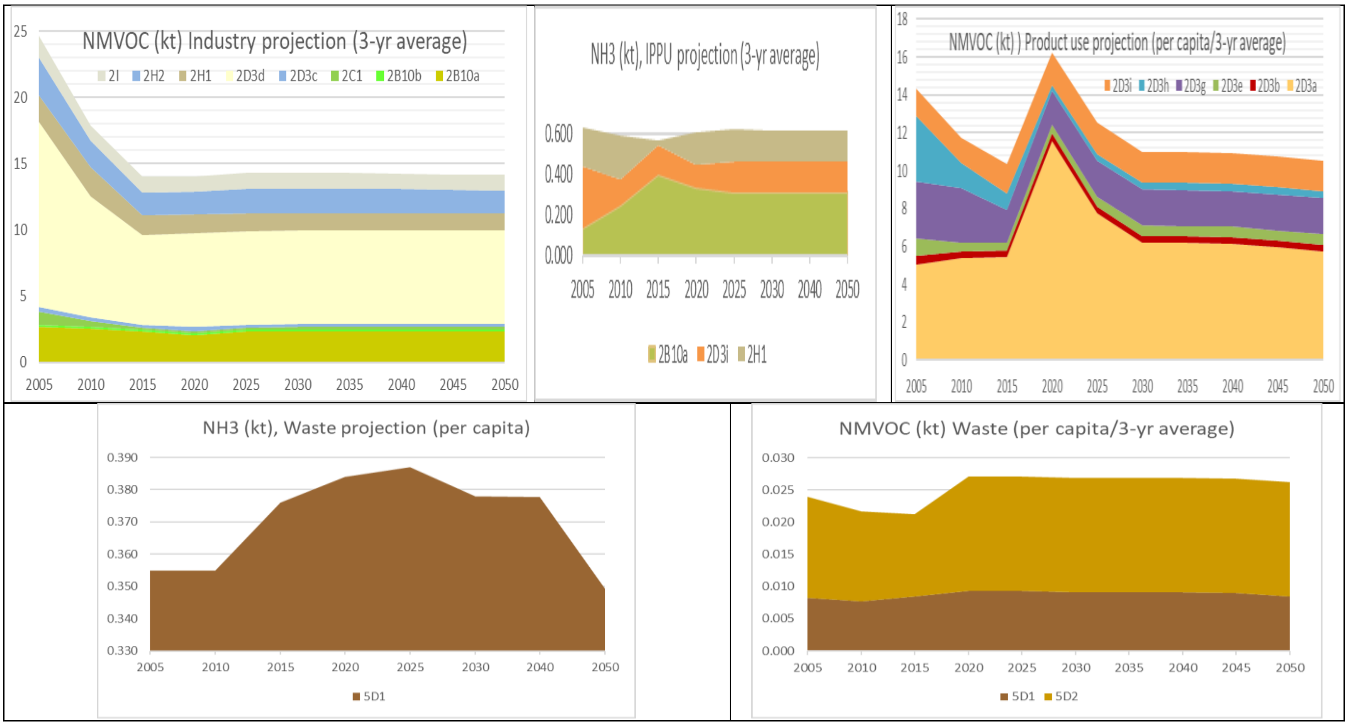


Figure 8.5 Industry, product use and waste projections for NMVOC and NH3 up to 2050

8.2.5 Projections for Agriculture

Changes in chapter	
Update of text March 2022	JG, KS
Update of projections	Every 1-3 years, since 2020 every 2 years

Projections for agriculture are based the national Agriculture sector calculation model available up to 2050. The animal numbers, development of nitrogen excretion and mineral fertilizers and land use areas are forecasts by LUKE 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, 2021[13]).

There are some differences in projected emissions for agriculture compared to the ones presented in the pervious reporting. The reasons for these differences are:

- Changes in animal number and inorganic fertilizer use estimations: for cattle, sheep and goats, animal statistics for 2020 were already available when the projections were calculated and they were used.The numbers of goats and suckler cows are higher compared to the estimated ones, whereas the numbers of all other cattle and sheep are lower. Additionally, the animal number estimations for the other animals groups for 2020 and for all animal groups for the years 2025, 2030, 2040 and 2050 were updated based on the data provided by the Natural Resources Institute Finland (Luke; Lehtonen 2021). Furthermore, the annual inorganic nitrogen fertilizer consumption estimations were updated by Lehtonen (2021). Animal numbers and the use of mineral nitrogen fertilizers are the same as are used in the latest national ghg-emission WEM-scenarios for agriculture.
- Changes in estimated nitrogen excretion rates: nitrogen excretion rates of bulls, dairy cows, heifers, suckler cows and weaned pigs were re-estimated based on the recent development. For all above mentioned animal groups the N excretion rate was estimated to be higher in the projected years than was estimated earlier.
- Changes in manure management:
  - the share of injected slurry was lowered (70% -> 65%) for 2020, based on the most recent knowledge,
  - shares of slurry and urine incorporation methods (for slurry and urine spread on stubble) were corrected for 2025, 2040 and 2050,
  - for pig slurry it was estimated that cooling of slurry channels and increased slurry removal frequency will be more common in the future, due to the implementation of IRPP BAT conclusions in pig production.
- A ban on field burning of agricultural residues from the beginning of 2021, resulting zero emissions for the year 2025 and beyond.

Activity data for agricultural emission projections

- *Animal numbers* and inorganic nitrogen use data used in the emission projections are shown in the tables 8.6-8.19.
- Estimated evolution of *manure management practices* is described in the tables below. Efficiency of the emission abatement measures (as well as the unabated emission factors used) can be found from the Table 5.11 of the Agriculture-chapter of the IIR.
- *Nitrogen excretion rate estimations* are based on the recent development and are shown in in the tables below.

The development of animal numbers, the use of mineral fertilizers and land use areas 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 &

[13] Lehtonen, H. 2021. Personal communication 12.2.2021. Natural Resources Institute Finland (Luke)

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 DREMFIA 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, and because the number of suckler cows is very unlikely to increase due to high dependence on farm subsidies in suckler cow production and non-increasing coupled payments for bovine animal production. 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 forbiddens starting from 1.1.2021*

Table 8.6. Animal numbers and use of inorganic nitrogen fertilisers in 2015-2020 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 | 2015	109 348	306 899	285 147	154 610	58 713	2 084 444	1 026 774	191 100	63 800	10 400	2 100	501 100	345 300	115 800
Finland | 2016	107 786	309 650	282 443	150 158	58 984	2 202 072	1 027 352	191 473	63 800	10 400	1 600	489 200	342 300	108 100
Finland | 2017	110 767	297 334	274 954	150 269	59 854	2 027 757	933 504	193 142	64 000	10 400	1 400	446 900	312 400	99 100
Finland | 2018	105 770	298 882	271 429	146 100	60 096	2 017 309	842 509	184 958	64 000	10 400	1 400	425 000	273 300	95 200
Finland | 2019	104 485	288 066	262 292	142 430	60 349	1 889 369	679 061	188 190	63 900	10 400	1 300	438 600	272 400	92 200
Finland | 2020	98 187	290 199	259 579	136 445	61 975	1 295 961	500 498	188 190	64 000	10 000	1 100	450 600	299 700	88 700
Finland | 2025	93 299	275 717	237 891	129 688	67 659	2 000 000	1 000 000	190 000	70 507	11 493	1 299	394 318	253 570	88 327
Finland | 2030	89 042	263 135	230 504	123 770	61 102	2 000 000	1 000 000	190 000	70 507	11 493	1 266	384 181	247 051	86 057
Finland | 2040	83 406	246 480	207 447	115 936	65 702	2 000 000	1 000 000	190 000	70 507	11 493	1 230	373 448	240 149	83 652
Finland | 2050	79 352	234 501	195 941	110 301	63 933	2 000 000	1 000 000	190 000	70 507	11 493	1 212	368 006	236 649	82 433

	Poultry							**Goat and sheep**		**Inorg. N**
	Broiler breeder hen	Broiler	Laying hen pullet	Cockerel	Laying hen	Other poultry	Turkey	Goat	Sheep	Use of inorganic N-fert. as N (tonnes)
Finland | 2015	548 175	7 827 340	662 228	25 500	3 594 537	23 246	245 906	4 546	155 238	143 479
Finland | 2016	523 216	8 271 563	747 625	26 271	3 598 941	16 930	260 311	4 799	156 496	138 128
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	149 171	139 316
Finland | 2025	544 667	9 109 724	547 638	22 027	3 591 556	20 000	310 293	6 100	140 200	135 280
Finland | 2030	543 312	9 087 055	527 505	21 218	3 459 513	20 000	309 521	6 100	140 200	136 712
Finland | 2040	548 664	9 176 581	491 374	19 764	3 222 560	20 002	312 570	6 100	140 200	137 261
Finland | 2050	549 097	9 183 815	459 876	18 503	3 016 986	20 004	312 817	6 100	140 200	137 691

Table 8.7 Nitrogen excretion rates (kg N/animal place/year) in 2015-2020 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 | 2015	131,910	54,985	40,441	75,669	68,666	31,374	20,562	17,385	9,117	61,913	44,329	7,260	10,700
Finland | 2016	130,419	54,585	40,281	75,028	68,714	32,060	20,558	17,275	9,117	61,987	44,515	7,310	10,700
Finland | 2017	132,830	55,507	40,906	74,877	69,633	31,952	20,813	17,217	9,131	61,972	44,476	7,430	10,700
Finland | 2018	133,374	55,659	41,136	75,303	70,647	32,876	21,025	17,206	9,162	61,898	44,593	7,600	10,700
Finland | 2019	136,712	57,802	42,811	77,276	73,012	32,268	20,941	17,170	9,162	61,769	44,681	7,600	10,700
Finland | 2020	139,062	58,952	43,705	78,355	74,788	33,794	20,692	17,064	9,177	61,664	44,693	7,600	10,700
Finland | 2025	143,000	60,000	44,500	79,000	75,000	32,060	20,558	17,275	9,150	61,987	44,515	7,600	10,700
Finland | 2030	150,000	62,000	46,000	80,500	77,000	32,060	20,558	17,275	9,150	61,987	44,515	7,600	10,700
Finland | 2040	160,000	66,000	50,000	84,000	82,000	32,060	20,558	17,275	9,150	61,987	44,515	7,600	10,700
Finland | 2050	160,000	66,000	50,000	84,000	82,000	32,060	20,558	17,275	9,150	61,987	44,515	7,600	10,700

	Broiler	Broiler hen	Laying hen	Laying hen pullet	Cockerel	Turkey	Other poultry	Fox and racoon	Mink and fitch	Reindeer
Finland | 2015	0,478	0,992	0,623	0,388	0,969	1,629	0,636	3,000	1,305	10,700
Finland | 2016	0,479	0,992	0,615	0,388	0,969	1,629	0,636	3,000	1,305	10,700
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	1,700	0,636	3,000	1,305	10,700
Finland | 2025	0,477	0,992	0,590	0,388	0,969	1,650	0,636	3,000	1,305	10,700
Finland | 2030	0,477	0,992	0,590	0,388	0,969	1,650	0,636	3,000	1,305	10,700
Finland | 2040	0,483	0,992	0,590	0,388	0,969	1,650	0,636	3,000	1,305	10,700
Finland | 2050	0,483	0,992	0,590	0,388	0,969	1,650	0,636	3,000	1,305	10,700

Manure management data for 2020 and as a prediction for 2025, 2030 and 2040 (in most of the cases, values used for 2050 are the same as are 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
Manure management																				
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
Grazing																				
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	Boars	Weaned pigs
	2020	2025	2030	2040	2020-2040	2020-2040	2020-2040
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	Laying hen pullets				Cockerels	Broiler hens	Turkeys	Other poultry
	2020	2025	2030	2040	2020 – 2040	2020	2025	2030	2040	2020-2040	2020 - 2040	2020 - 2040	2020- 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
Animal shelter (% of manure)												
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	-	-	-		-	-	-		-	-	-	-
Manure storage (% of manure)												
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 8.13. Detailed information on deep litter management in animal shelters and manure storages 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>Animal shelter (% of manure)</u>																				
Improved cleaning of surfaces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flushing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increased manure removal frequency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rapid urine separation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or chemical air scrubbers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cooling of manure channels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drying of manure on manure belt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-leaking drinking system	-	-	-	-	-	-	-	-	100	100	100	100	-	-	-	-	-	-	-	-
<u>Manure storage (% of manure)</u>																				
No measures	60	55	45	45	60	55	45	45	41	40	40	40	60	55	45	45	60	55	45	45
Solid manure covering	40	45	55	55	40	45	55	55	59	60	60	60	40	45	55	55	40	45	55	55
Filling of storage from the bottom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Additional information</u>																				
Percentage of deep litter stored after removal from animal shelter	20	20	20	20	20	20	20	20	80	80	80	80	20	20	20	20	20	20	20	20

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 (% 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 (% 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.

	Slurry											
Abatement measures	Cattle				Pigs				Poultry (no slurry systems in 2020 or later)			
	2020	2025	2030	2040	2020	2025	2030	2040	2020	2025	2030	2040
Type of surface for application												
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
Application on arable land												
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
Application on plant covered land												
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
Application on stubble												
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

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.

	Deep litter														
Abatement measures	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 8.18. Detailed information on solid manure (FYM) application in Finland in 2020 and as a prediction for 2025, 2030 and 2040. Unit: percentage of total solid manure per animal species.

	Solid manure (FYM)																	
Abatement measures	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	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	95	95	95
Plant covered land	32	32	32	12	12	12	12	12	12	32	32	32	24	24	24	5	5	5
Stubble	0	0	0	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	0	0	0
Incorp. with ploughing < 4 h	15	15	20	14	15	20	14	15	20	15	15	20	14	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	13	25	20
Incorp. with ploughing 12-24 h	28	15	0	30	15	0	30	15	0	28	15	0	27	15	0	30	15	0
Incorp. with harrowing < 4 h	15	20	30	14	20	30	14	20	30	15	20	30	11	20	30	14	20	30
Incorp. with harrowing < 12 h	3	12	30	14	12	30	14	12	30	3	12	30	14	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	15	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	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.

	Urine						**Dung**					
Abatement measures	Cattle			Pigs			Cattle			Pigs		
	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040	2020	2025	2030, 2040
Type of surface for application												
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	-	-	-	-	-	-
Application on arable land												
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
Application on plant covered land												
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
Application on stubble												
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 Reduction target

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.

NMVOC

NMVOC 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 NMVOC 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 2016[14].

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. (Figure 8.9)

Figure 8.9. Development of NMVOC emissions by sectors according to the baseline

[14] 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 2021 review of projections

In Table 8.20 below recommendations presented in the Review Report of the 2021 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 [15]

Observation	Year	Scenario	KC	Recommendation	Response
FI-0A-2021-0001	2021	WM	n.a	In its response to a question during the review Finland confirmed that it had accidentally copied the formula of 2020 PM2.5 into the years 2025 and 2030 in its reporting file. Finland indicated that this formula error would be corrected for its next submission. **The TRT recommends that Finland include additional checks to ensure similar errors are avoided for future submissions.**	The formula has been corrected.
FI-0A-2021-0003	2021	WM, WAM	n.a	For NH3 in 2020-2029, the TRT notes that under the WM scenario, Finland is predicting to miss the emissions reduction commitment. The TRT further notes that Finland did not include a WAM scenario as part of their projections submission. **The TRT recommends that Finland provides for the necessary additional measures and includes them in its future projections submissions to demonstrate how all emission reduction commitments will be met.**	At the moment, Finland is meeting the reduction commitment. The national air pollution control programme update in 2023 will cover updating the related projections.
FI-1A1-2019-0001	2019	WM	No	For 1A1 and 1A2 PM2.5 emissions, the TRT noted that whilst the FRES model splits 1A1 and 1A2 emissions according to the historical emissions inventory, the differences between the historical emissions inventory latest year (2018) and the 2020 projections for PM2.5 for 1A1 and 1A2 is greater than the sum of the emissions. In response to a question raised during the review, Finland explained that there was an error in the projections submissions and provided the corrected data. **The TRT notes that this issue relates to an over-estimate and recommends that Finland correct the data in the next submission and ensure that appropriate quality control procedures are in place to avoid these errors.**	The error has been corrected.

[15] 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	Year	Scenario	KC	Recommendation	Response
FI-1A3bvii-2019-0001	2020, 2030 2025,	With Measures (WM)	No	For 1A3bvii Automobile road abrasion, $PM_{2.5}$ for 2020, 2025, 2030, the TRT noted that the emissions of $PM_{2.5}$ decrease by around 15 % from 2017 to 2020. $PM_{2.5}$ emissions are kept constant in the projection years. In response to a question raised during the review, Finland explained that no projections have earlier been made for this category (automobile road abrasion). The emissions will be revised as part of the upgraded LIPASTO system and will be included in the next reporting round. **The TRT notes that this issue relates to an underestimate and recommends that revised emissions from the upgraded LIPASTO system will be included in the next emission reporting.**	It was not possible to include the emissions to the 2020 submission due to need to improve the inventory methodology and changes in the organization of the inventory (all transport sector calculations were moved to VTT/Tremo). To the 2021 submission these have been included.
FI-3B-2021-0001	2021	With Measures (WM)	No	The TRT noted with reference to the whole of the agriculture sector (NFR 3) a lack of transparency regarding documentation of projected activity data and emission factors in the IIR. Also, although the external source of projected parameters was quoted in the IIR, this was not accessible to the general public. In response to a question raised during the review, Finland provided additional information on the evolution of key parameters, as well as additional explanation of the rationale for the projected parameters and references with URLs to source material. **The TRT notes that this issue does not relate to an over or under-estimate, and recommends that, to increase transparency, Finland include the main elements of this additional information in the projections chapter of their next IIR submission**. This should include links to the publicly accessible external documentation, as well as summary-level tables or text describing the evolution of important activity data parameters (animal numbers, synthetic fertiliser application, nitrogen excretion, manure management system share, manure spreading techniques) for key categories, to make the reasons for projected trends understandable.	The IIR includes the transparent information.
FI-NATIONAL TOTAL-2019-0001	2019		n.a.	The TRT notes that Finland does not specify the historical year used as the reference year for its projections. During the review, Finland confirmed that it used 2019 from the latest (2021) inventory submission as the reference year for its projections. The TRT commends Finland for providing projections that are fully consistent with the latest historical inventory (2021 submission) despite the reporting requirement allowing projections to be consistent with the previous (2020) inventory submission. **The TRT recommends that Finland clarify the year used and the inventory submission used for its reference year in future projections submissions.**	The year has been inserted in the respective template cell. Finland reports here the last submission values.

Observation	Year	Scenario	KC	Recommendation	Response
FI-NATIONAL TOTAL-2019-0004	2019	With Measures (WM)	n.a.	The TRT noted that very limited information is provided in Finland's IIR on projections. The projection section provides 10 pages of summary information on trends and some limited information on methods data sources and assumptions. Although some information on its projections submitted in 2019 is available in Finland's National Air Pollution Control Programme 20305, Finland has not provided additional information or updates on methods, data sources and assumptions for projections for the 2021 submission. During the review, Finland provided some updates on methods and review of methods in response to a question from the TRT. Finland also indicated that, 'as stated in FI IIR Part 1B Table 4-1 on p. 55, the documentation will be completed to the 2022 IIR after the updating of the scenarios has been completed by the end of 2021.' **The TRT recommends that Finland provides transparent information on its calculation methods, data used with refences to data sources, assumptions, assessment of completeness of projections, applied PAMs/additional PAMs and sensitivity analysis (including info on parameters, variation) in its future submissions**.	The previous documentation has been expanded to the 2022 submission and will be further improved when the air pollution scenarios update has been completed. The update has been postponed to 2023.

Table 8.19 - Review Report Table 4-3 Encouragements from the 2021 projections review

Scenario	Year	Scenario	KC	Encouragement	Response
FI-0A-2021-0003	2021	With Measures (WM)	No	The TRT notes that Finland expects to exceed its 2020 NH3 emission reduction commitment in its WM scenario by a small margin (2.6%) and has not presented a WAM scenario. During the review Finland provided some detailed explanation of policies and measures in place. The TRT also notes that Finland's 2030 emission reduction commitment will be achieved for NH3. **The TRT encourages Finland to review its 2020 estimates and its compliance for NH3 in future submissions.**	In the 2022 submission Finland complies with the ammonia reduction target.
FI-1A3biv-2021-0001	2021	With Measures (WM)	No	For 1A3biv (road transport - motorcycles) for SO2, the TRT noted that the trend for the period 2005-2020 is more than three standard deviations away from the average of the trends of all Member States and that emission estimates increased from 0.0006 kt in 2018 to 0.001 in 2020. In response to a question raised during the review, Finland explained that the projected emission estimates were reported to three decimal places and that the discrepancy was due to rounding. **The TRT notes that this issue does not relate to an over or under-estimate and**	The projections are reported to three decimal places in the 2022 submission. NOTE – reporting to 2 decimal places was originated from the fact that this was the default setting of the template and we

				encourages Finland to report their projected emission estimates to more decimal places in future submissions.	thought that the default should not be touched:=
FI-2A,B,C,H,I,J,K,L-2021-0001	2021	With Measures (WM)	No	For NFR 2, NMVOC, all years, the TRT noted that there was a lack of transparency regarding the allocation of NFR sectors in the projections emissions reported in Annex IV. In response to a question raised during the review, Finland explained that specific industrial processes subcategories within 2G were included in 2A,B,C,H,I,J,K,L (2D3c, 2D3d). **The TRT notes that this issue does not relate to an over or under-estimate and encourages Finland to report IPPU emissions projections according to the Annex IV template.**	The allocation has not yet been changed but we consider changes to the next submissions.

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

Backgound

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 60º and 70º, where one degree corresponds to approximately to a 7 km *7 km area (Figure 8.10)

The presentation of gridded data in the 1º * 1º 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 sparcely 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 classifiactions 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 in their vicinity and especially in the Southern part of Finland. Inside municipalities, population is more and more moving from sparcely 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 sparcely populated areas continue to loose their inhabitants.

Sources included

The reporting of gridded data includes the following pollutants: NO_x (as NO_2), NMVOC, SO_x (as SO_2), NH_3, $PM_{2.5}$, PM_{10}, 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

	Public power and industries*		Other stationary combustion**		Traffic and agriculture***		Products and waste****	
Pollutant	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/Fishing: 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	National building and dwelling register
	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_IntShipping	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 parametres. 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.

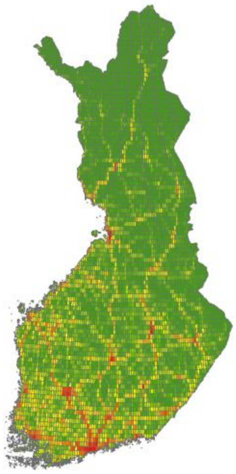
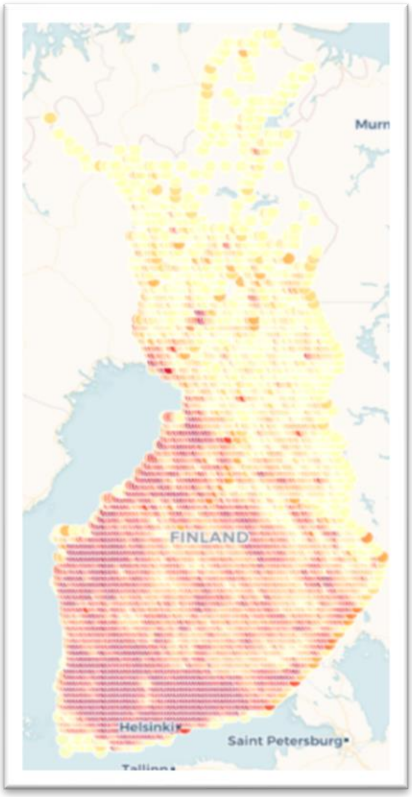


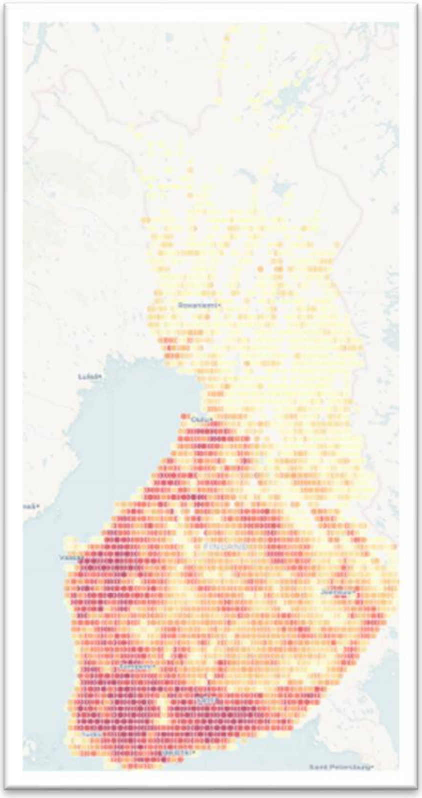
Figure 8.12 - $PM_{2.5}$ emissions of 2013 in the national street system

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://wwwp2.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 D_Fugitive B_Industry	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.
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 H_Aviation F_RoadTransport G_Shipping	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.
E_Solvents M_Other J_Waste	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.
K_AgriLivestock L_AgriOther	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.

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 3.41. 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 1of 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.

Some emissions reported by the facilities for 2020 in the European Environment Agency's (EEA) PRTR database (Industrial Reporting database v5, December 2021) are absent from the LPS data for 2020 set to be reported by 1st May 2022. These include:

- NO_x emissions reported by E-PRTR National IDs 3238 and 11179, SO_x emissions reported by the E-PRTR National ID 100239774 and PM_{10} 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 faclity 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 Multilaterial 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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