LITHUANIA'S INFORMATIVE INVENTORY REPORT 2023

Air Pollutant Emissions 1990-2021

under the UNECE CLRTAP and the EU NECD

Part 6 – WASTE

Lithuanian Environmental Protection Agency

Contents

1. WASTE

In Lithuania emissions from Waste Sector originate from the following sources:

- Biological treatment of waste - Solid waste disposal on land (5.A);
- Biological Treatment of Solid Waste (5.B);
- Incineration and Open Burning of Waste (5.C);
- Wastewater handling (5.D);
- Fires of cars and buildings (5.E).

In early 1990s there were about 1000 landfills and dumps in Lithuania. In late 1990s waste management strategies were developed foreseeing development of waste management infrastructure including construction of new regional landfills complying with EU requirements, closure of existing landfills and dumps, and provision of necessary equipment required for safe and efficient operation of waste management facilities (IIR, 2019).

1.1. Biological treatment of waste - Solid waste disposal on land (5.A)

Overview of the Sector

Solid waste disposal is the main waste treatment operation in Lithuania. Significant amount of landfill gas is emitted annually from waste disposal sites. NMVOC are part of landfill gas. NMVOC emissions relate to methane emissions from solid waste disposal. These emissions mostly relate to disposed waste amount in landfills.

Methodological issues

The calculated NMVOC emissions are based on NMVOC content in landfill gas, and uses CH4 emission ratio per ton of disposed waste (based on the T UNFCCC reporting), converts it into a volume of CH4 per ton of disposed waste (using the molar volume of CH4) and then into a volume of biogas per ton of disposed waste (applying the fraction of CH4 in biogas F = 50%) and then applies the fraction of NMVOC in biogas (5.65 g/m3 NMVOC of landfill gas) as presented in the note at the bottom of table 3-1, chapter 5A of the 2019 EMEP/EEA Guidebook. CH4 generation was evaluated using the FOD model according to Tier 2 approach (2006 IPCC Guidelines). The model calculations were performed using national statistics of landfill site characteristics and amounts of waste fractions deposited each year. This methodology was offered by expert during country review process. PMs calculated based on EMEP/EEA Tier 1 method.

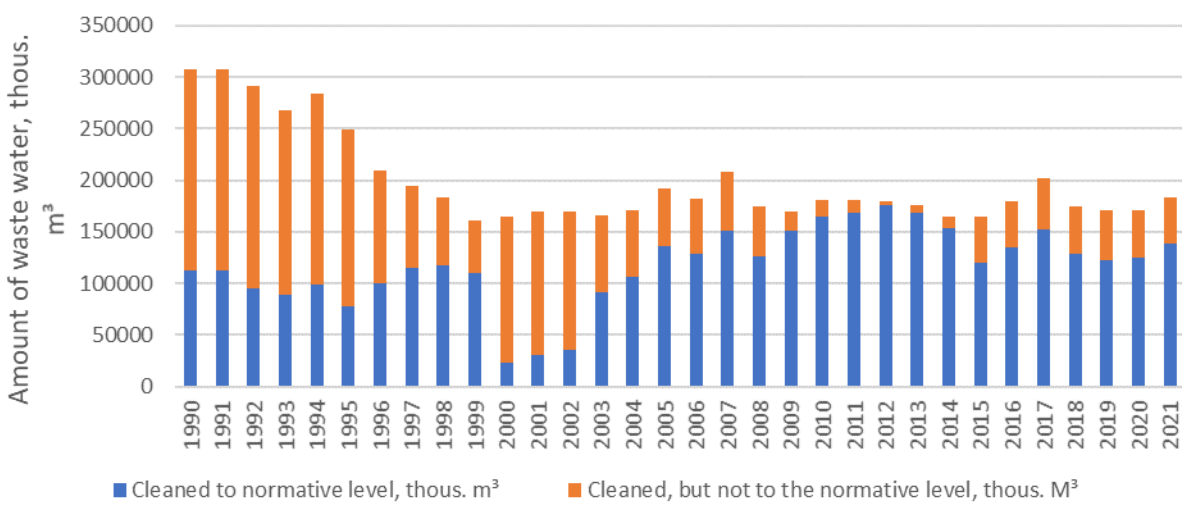

Figure 1-1 Waste management

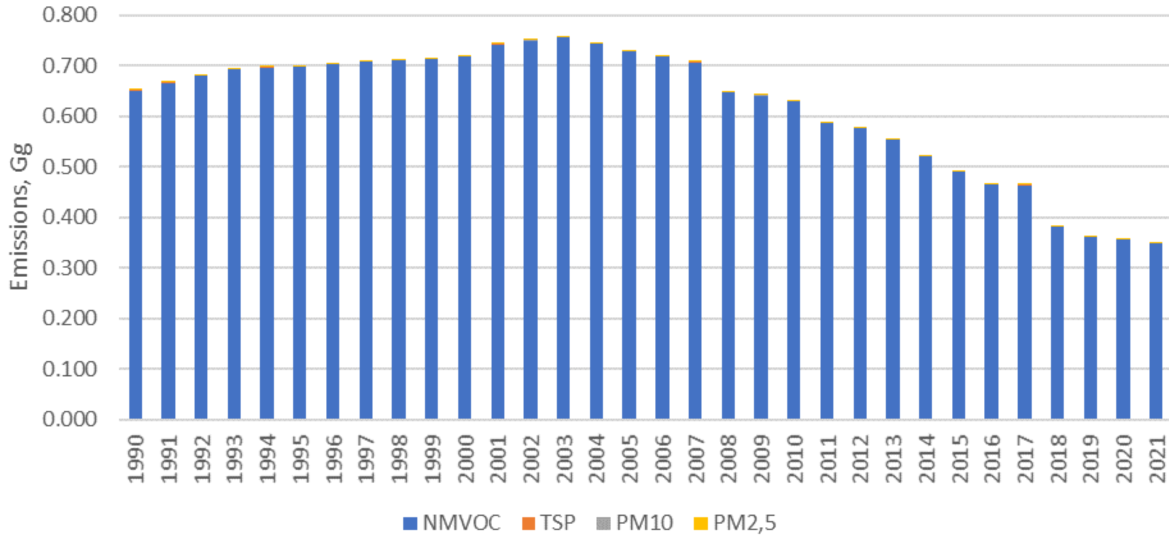

Figure 1-2 Emissions from solid waste disposal on land (5.A)

Uncertainty and time series' consistency

Uncertainty of activity data was assumed to be 30% (2006 IPCC Guidelines, Volume 1, Chapter 3, Table 3.5). Uncertainties of separate input parameters for Tier 1 uncertainty analysis were taken as average values of uncertainties provided in 2006 IPCC Guidelines, Volume 5, Chapter 3, Table 3.5 (Table 7-29). Calculated overall uncertainty of implied emission factor using average CH4 emission values of disposed solid waste and sewage sludge over the period 1990-2021 is 124%. That applied for NMVOC emissions uncertainty.

Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

No source specific recalculations.

Source-specific planned improvements

5.A NMVOC emissions were recalculated based on method proposed by Expert during review in 2022. CH4 activity data was applied from UNFCCC inventory.

	Submission 2022	Submission 2023	**Absolute difference, kt**	**Relative difference, %**
1990	2.264	0.651	-1.613	-71.24
1991	2.267	0.667	-1.600	-70.59
1992	2.305	0.681	-1.624	-70.46
1993	2.059	0.693	-1.366	-66.33
1994	2.079	0.697	-1.382	-66.49
1995	2.270	0.698	-1.572	-69.26
1996	2.248	0.703	-1.545	-68.73
1997	2.246	0.708	-1.538	-68.47
1998	2.254	0.711	-1.543	-68.47
1999	2.275	0.713	-1.562	-68.68

2000	2.538	0.719	-1.819	-71.68
2001	2.248	0.742	-1.506	-66.98
2002	2.223	0.750	-1.473	-66.28
2003	1.793	0.757	-1.036	-57.81
2004	1.909	0.743	-1.166	-61.07
2005	0.729	0.729	0.000	0.03
2006	1.896	0.718	-1.178	-62.13
2007	1.953	0.707	-1.246	-63.81
2008	2.150	0.647	-1.503	-69.91
2009	1.939	0.641	-1.298	-66.95
2010	1.882	0.630	-1.252	-66.51
2011	1.858	0.587	-1.271	-68.42
2012	1.657	0.576	-1.081	-65.23
2013	1.377	0.553	-0.824	-59.84
2014	1.275	0.520	-0.755	-59.20
2015	1.206	0.491	-0.715	-59.27
2016	0.733	0.465	-0.268	-36.57
2017	0.516	0.464	-0.052	-10.03
2018	0.381	0.381	0.000	0.01
2019	0.363	0.363	0.000	-0.09
2020	0.356	0.356		
2020		0.349		

1.2. Biological treatment of waste - Composting (5.B.1)

Overview of the Sector

Biological treatment of waste includes composting and anaerobic digestion. Emissions from biological treatment have increased substantially after establishment of the regional waste management systems in 2011 and once again after implementation of MBT facilities in 2016. Emissions from biological treatment reached ~ 10.5% of the total waste sector emissions. The main part of emissions from biological treatment (about 69%) was generated by composting activities.

Methodological issues

NH_3 emissions from waste composting and manure anaerobic digestion are calculated under this category. Composting is set as one of the priorities in waste treatment in Lithuania. Composting biological degradable waste is useful.

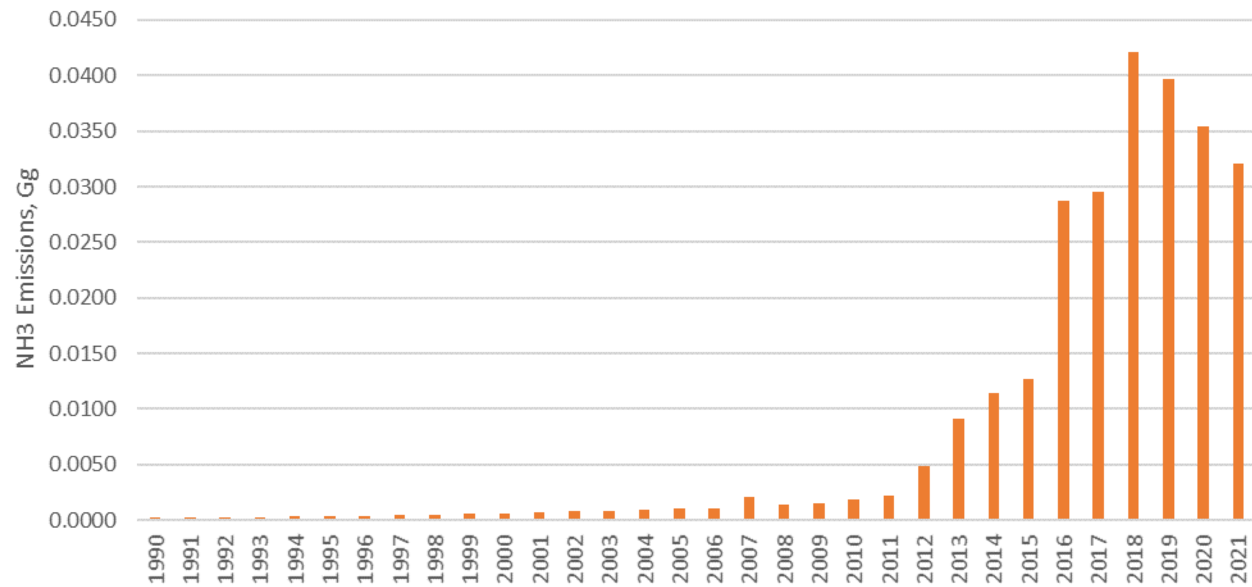

Figure 1-3 Emissions from biological treatment of waste – composting (5.B.1)

For the period 1990-2003 for which statistical data were not available, it was assumed that composting activities were developing the same trend as in 2004 to 2011 (UNFCCC submission).

Uncertainty and time series' consistency

Uncertainty of waste activity data is 5%. Unsertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2019.

Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

Source-specific recalculations

No source specific recalculations.

Source-specific planned improvements

No source-specific improvements.

1.3. Biological treatment of waste - Anaerobic digestion at biogas facilities (5.B.2)

The biogas pradustino involves anaerobic digestion of waste (biomass) with release of methane as major component gas. which after purification and removal of pollutants (e.g.. Sulphur) can be burnt to release energy. Biogas plants. which only collect gas and/or burn it for energy. are included under 1.A.1.a category. Biogas production from anaerobic digestion started in 2002.

Methodology

Information on the biogas production from treatment of agricultural (i.e.. food. manure. slurry. other household and crop) wastes and sewage sludge wastes (such as floatation sludge) can be accessed at the Statistics Lithuania on the fuel balance datasheet. However. no other details (e.g. dry matter in the sludge. nitrogen content and other) are available thus increasing uncertainty and reducing quality of the results. Volumes of biogas produced were gathered from the Statistics Lithuania. Estimation of NH_3 emissions in biogas production from swine manure was taken from the EEA. N-flow tool In order to estimate emissions from the biogas production according to the methodology provided in the 2016 EMEP/ EEA guidebook. the biogas volume was converted to approximate amount of biogenic material. Firstly, the gas volume was converted to the mass of dry matter. For biogas produced from agricultural wastes conversion factors of maize and grass wastes and household wastes were averaged. Averaged value equaled to 0.444 m^3 of biogas/ kg of DM. For sewage sludge averaged conversion factor equaled to 0.635 m^3 / kg of DM and equal to conversion factor of floatation sludge. It was assumed that DM content in the biogenic material is 9% on average which depends on biogas production mechanism. Obtained values were assumed to be equal to the amount of biogenic material and liquid digestate used in the biogas production.

Activity data with 2016 EMEP/ EEA guidebook tier 2 emission factors for storage (before digestion) biogenic material and liquid digestate storage (after digestion) were used. The sum of the mentioned tier 2 emission factors was applied in the following equation:

Equation: EBiogas_NH3 = EFDefault_NH3 x ADTotal Biogas Production x Conversion Factor; Where EBiogas_NH3 is ammonia emissions from biogas production (Gg); EFDefault_NH3 is the sum of the two emission factors from the 2016 EMEP/EEA guidebook; ADTotal Biogas Production is converted activity data from National Statistics.

	Production		
	Landfill biogas, mill. cubic metres	Sludge biogas, mill. cubic metres	Other biogas, mill. cubic metres
2021	11,6	17	55,6
2020	13,7	15	52,1
2019	18,3	14,3	49
2018	20,9	14,5	42,4
2017	10,7	15,2	41,7
2016	17,8	15,8	33,4
2015	17,1	14,7	17,2
2014	16,2	14,5	13,2
2013	15	7,5	10
2012	12,9	6,5	4,8
2011	12,2	6,5	4,5
2010	4,1	6,3	10,5
2009	2,8	4,5	2,5
2008	0,9	3,4	1,9
2007		3,4	1,7
2006		3,1	1,1
2005		2,9	1
2004		2,1	1,3
2003		3,5	0,4
2002		3,1	

Figure 4-3a. Production of biogas.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NH3, Mg	49,8	2	13	13,3	13,6	15,3	14,9	16,6	18,8	19,3	14,3	16,5	35,3	36,5	73,7	78,2	88,8	64,7	63,1	62,4
Part of national total,%:	0,14%	0,01%	0,03%	0,03%	0,03%	0,04%	0,04%	0,04%	0,05%	0,05%	0,04%	0,05%	0,09%	0,09%	0,19%	0,20%	0,23%	0,17%	0,16%	0,16%

Figure 4-3b. Emissions of NH_3 in 5B2 and share of them in national total

1.4. Waste incineration (5.C)

Overview of the Sector

Incineration of municipal waste (5.C.1.a), industrial waste including hazardous waste and sewage sludge (5.C.1.b.i), clinical waste (5.C.1.b.iii) are recorded in the database of the Lithuanian EPA. Cremation (5.C.1.b.v) activity data is provided by company.

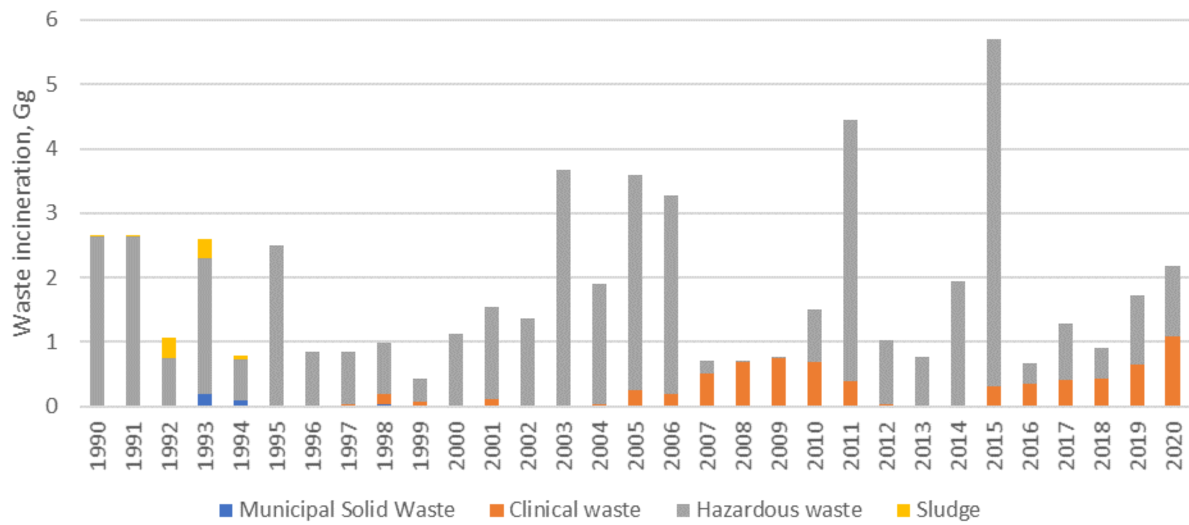

Figure 1-4 Incineration of hazardous waste, clinical waste, sewage sludge and municipal waste (5.C)

Emissions from waste incineration fluctuate quite strongly. There were no dedicated waste incineration facilities in Lithuania until 2006 and waste was incinerated on random basis in existing production facilities, which means that decisions on whether to incinerate or not was taken on ad hoc basis. Incinerated waste included calorific waste such as spent oils used, for example, for heating garages, etc. Hospital waste incineration facility with nominal capacity 200 kg per hour was put in operation in 2006 in Vilnius. There was no energy recovery in hospital waste incineration plant. The hazardous waste incineration facility started regular operation with energy recovery only in 2016 (UNFCCC submission 2020).

Methodological issues

For emissions calculation Tier 2 (Tier 1 *in italic*) EMEP/EEA 2019 methodology was used. The amount of incinerated waste was multiplied with emission factors.

Table 1-1 Tier 2 (Tier 1 *in italic*) EF for waste incineration

	Industrial	Hazardous	Clinical	Cremation	
Nox	1.8	0.87	2.45	*0.825*	kg/Mg
CO	0.7	0.07	0.025	*0.14*	kg/Mg
NMVOC	0.02	7.4	*0.7*	*0.013*	kg/Mg
SO2	1.7	0.047	0.15	*0.113*	kg/Mg
NH3	*3*	NE	NE	NE	g/Mg

TSP	18.3	0.01	0.0378	*38.56*	kg/Mg
PM10	13.7	0.007	NE	*34.7*	kg/Mg
PM2,5	9.2	0.004	NE	*34.7*	kg/Mg
BC	3.5	3.5	*2.3 (% of TSP)*		% of PM2,5
Pb	104	1.3	0.0369	*30.03*	g/Mg
Cd	3.4	0.1	0.0121	*5.03*	g/Mg
Hg	2.8	0.056	0.369	*1.49*	g/Mg
As	2.14	0.016	*0.166*	*13.61*	g/Mg
Cr	0.185	NE	0.0386	*13.56*	g/Mg
Cu	0.093	NE	0.206	*12.43*	g/Mg
Ni	0.12	0.14	0.0179	*17.33*	g/Mg
Se	*11.7*	NE	NE	*19.78*	g/Mg
Zn	0.9	NE	NE	*160.12*	g/Mg
PCB	5.3	NE	*0.02*	*0.41*	mg/Mg
PCDD/F	3.5	10	0.525	*0.027*	mg I-TEQ/Mg
Benzopyrene (a)	4.2	NE	NE	*13.2*	mg/Mg
Benzo(b)	3.2	NE	NE	*7.21*	mg/Mg
Benzo(k)	3.1	NE	NE	*6.44*	mg/Mg
Indeno	*11.6*	NE	NE	*6.99*	microg/Mg
PAH		0.02	*0.04*	NE	g/Mg
HCB	0.002	0.002	*0.1*	*0.15*	g/Mg

Emissions from waste incineration in Lithuania contribute only a small amount of the total pollutant emissions. With no municipal waste incineration, amounts of industrial waste and clinical waste incinerated have decreased resulting in smaller pollutant emissions.

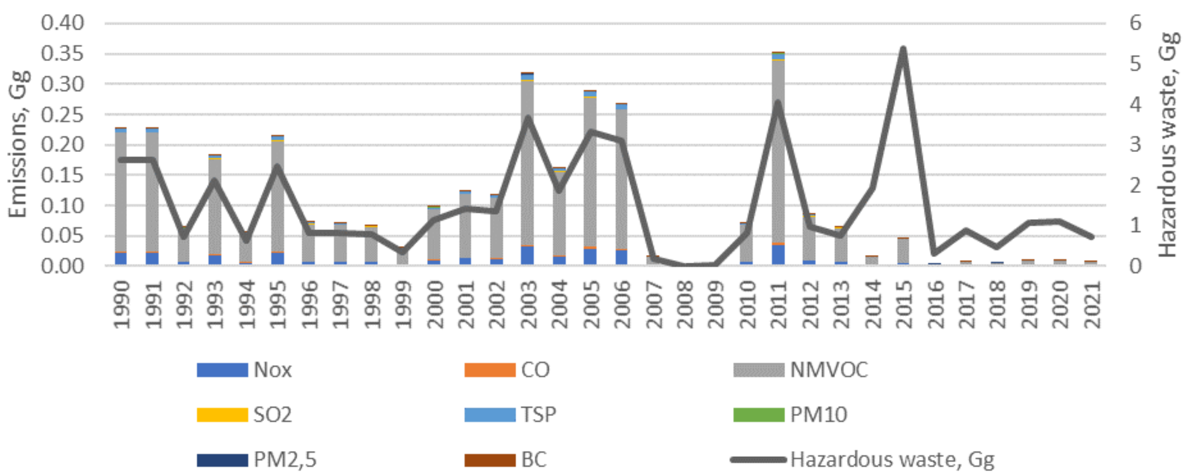

Figure 1-5 Hazardous waste incineration emissions in sector 5.C.1.a

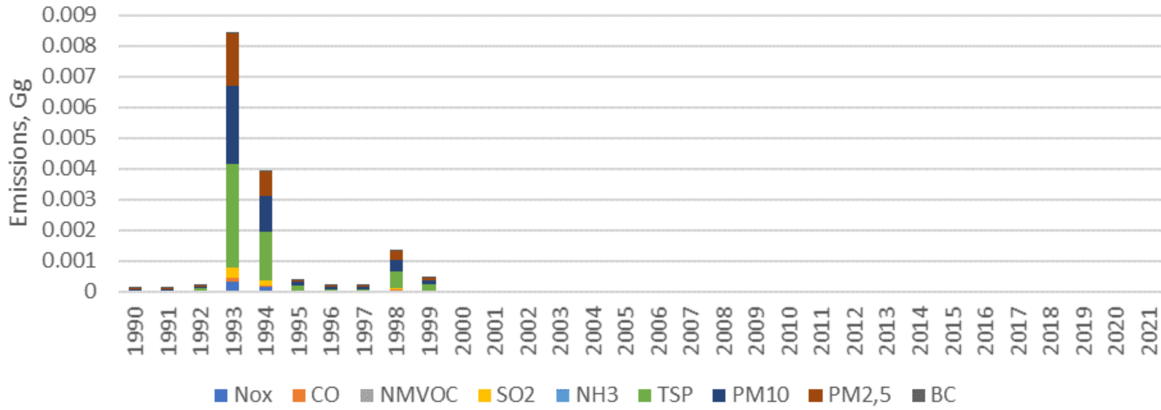

Figure 1-6 Municipal waste incineration emissions in sector 5.C.1.a

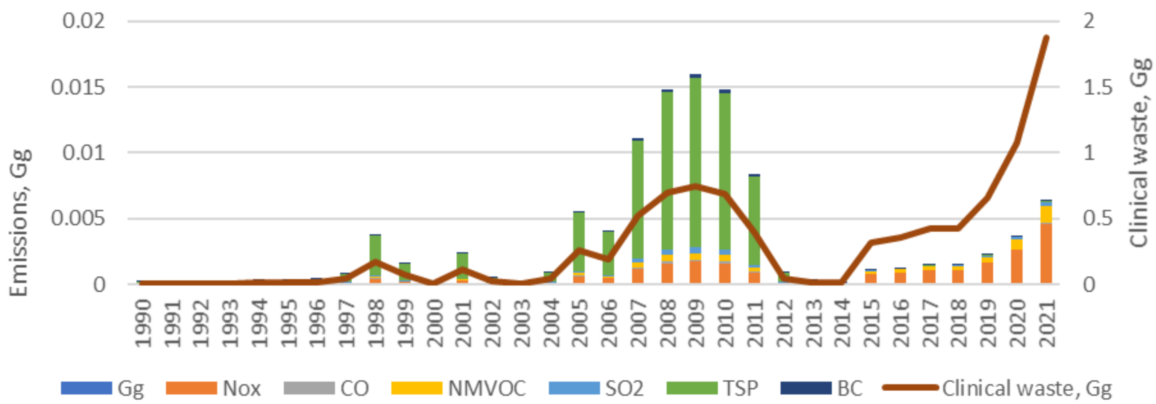

Figure 1-7 Clinical waste incineration in sector 5.C.1.b.iii

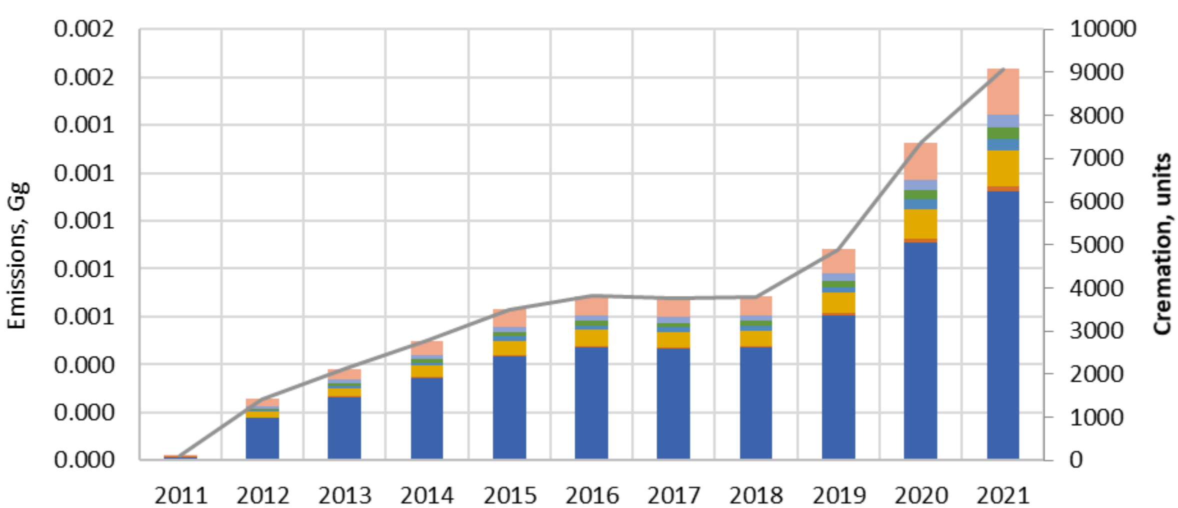

Figure 1-8 Cremation emissions in sector 5.C.1.b.v

Uncertainty and time series' consistency

Uncertainty of waste activity data is 5% (Uncertainty for cremation of bodies is not estimated, because it is correct figure from crematorium). Unsertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2019.

Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

Source-specific recalculations

No source specific recalculations.

Source-specific planned improvements

No source-specific improvements.

1.5. Open burning of waste (5.C.2)

The environment minister's of the Republic of Lithuania legal order no. 269 on Environmental Protection Requirements for Plant (crops) residue burning allows open small-scale incineration of crop residues but forbids any open small-scale incineration of municipal or industrial wastes. This legal order doesn't require any air pollution abatement measures. The emissions from burning of crop residues were estimated on the basis of the propostion that "the average amount of waste burned for arable farmland is estimated to be 25 kg/hectare" (EMEP/EEA guidebook 2019, chapter 5C2). Statistics on arable farmland was taken from the online database of Statistics Lithuania. The emission factors were taken from "Table 3-1 Tier 1 emission factors for source category 5.C.2 Small-scale waste burning" in GB2019.

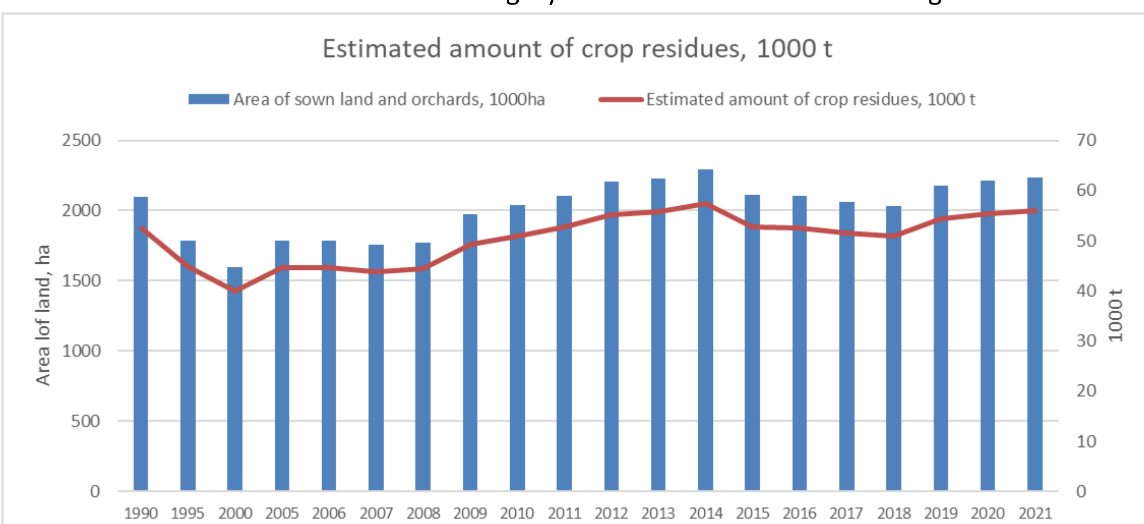

Figure 4-9a. Amount of crop residues

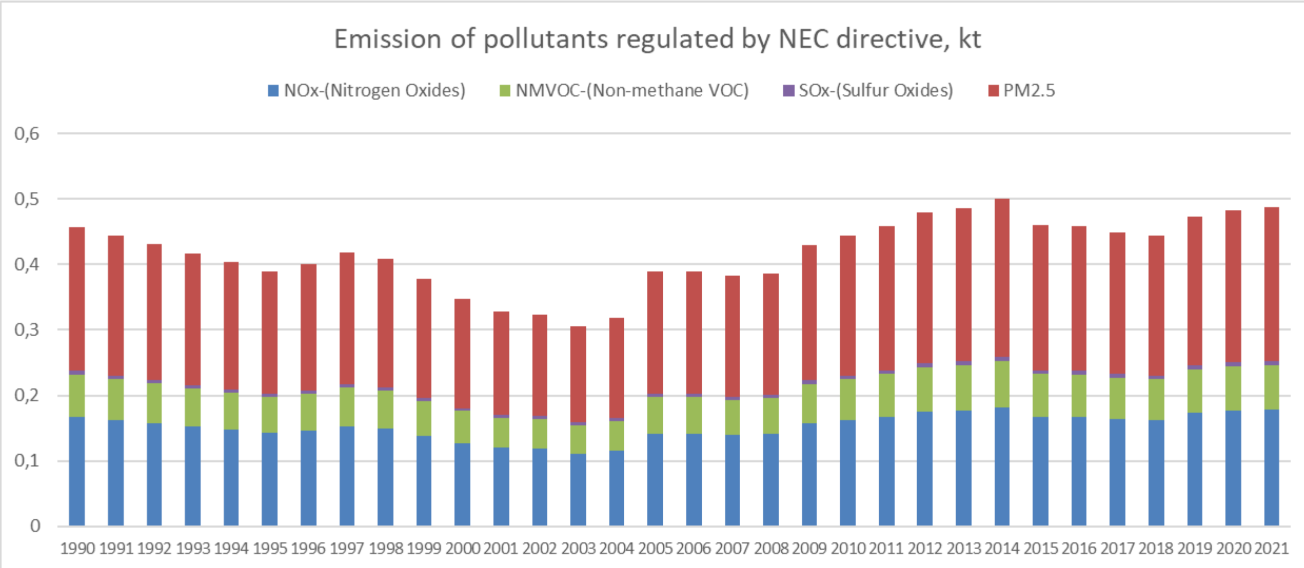

Figure 4-9b. Emission of pollutants regulated by NEC directive, 5C2

1.6. Wastewater handling (5.D)

Overview of the Sector

In most cases in Lithuania industrial wastewater is discharged to centralized municipal sewage collection networks and treated together with the domestic wastewater in centralized municipal treatment plants. Nitrous oxide can be produced as nitrification and denitrification product in both aerobic and anaerobic conditions. Information on wastewater treatment and discharge in Lithuania is collected by the Lithuanian Environmental Protection Agency (EPA).

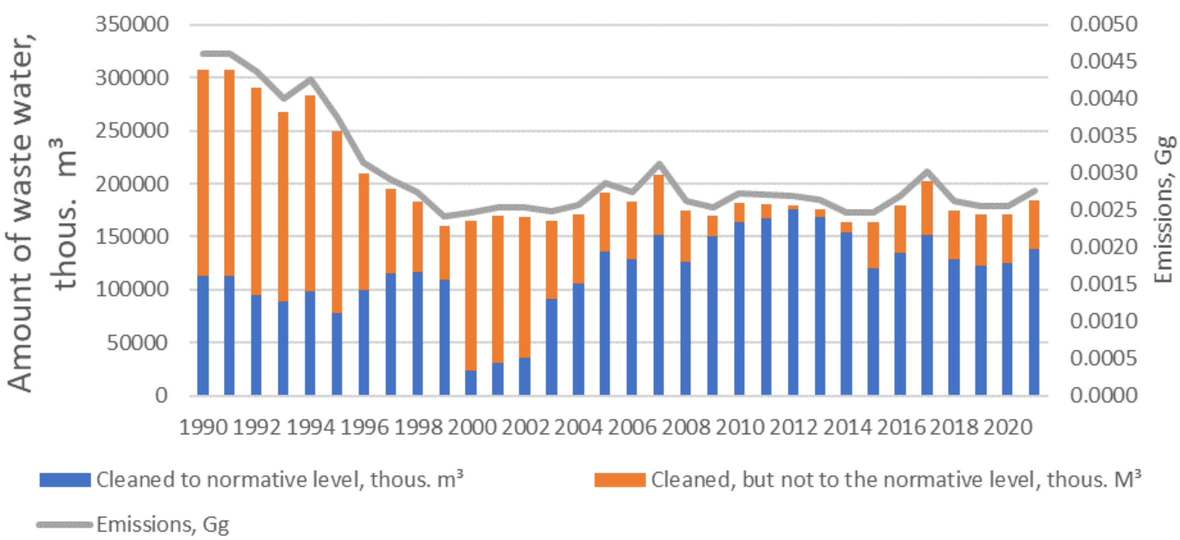

Figure 1-9 Part of population not connected to sewerage

Methodological issues

For emission calculation, EMEP/EEA 2019 was used as the methodology source. According to the methodology, activity data is multiplied by according emission factors to calculate emissions, and for both substances emitted the methodologies are considered to be Tier 2 methods.

Amount of treated waste water (i.e. activity data to estimate NMVOC emissions) provided by Statistics Lithuania were divided into 3 flows: cleaned (municipal waste water collection and treatment), cleaned not to the normative norm and released. Emissions of NH_3, originating only from latrines, are reported under sector NFR 5D1 (domestic waste water).

Table 1-2. Tier 2 EF for wastewater handling

NH3	Population using latrines	1.6	kg/person/year
NMVOC	Amount of waste water produced	15	mg/m^3 waste water

For population having no connection to sewerage networks, it was assumed that septic tanks are used by 75% of population not connected to sewers and about 25% use latrines.

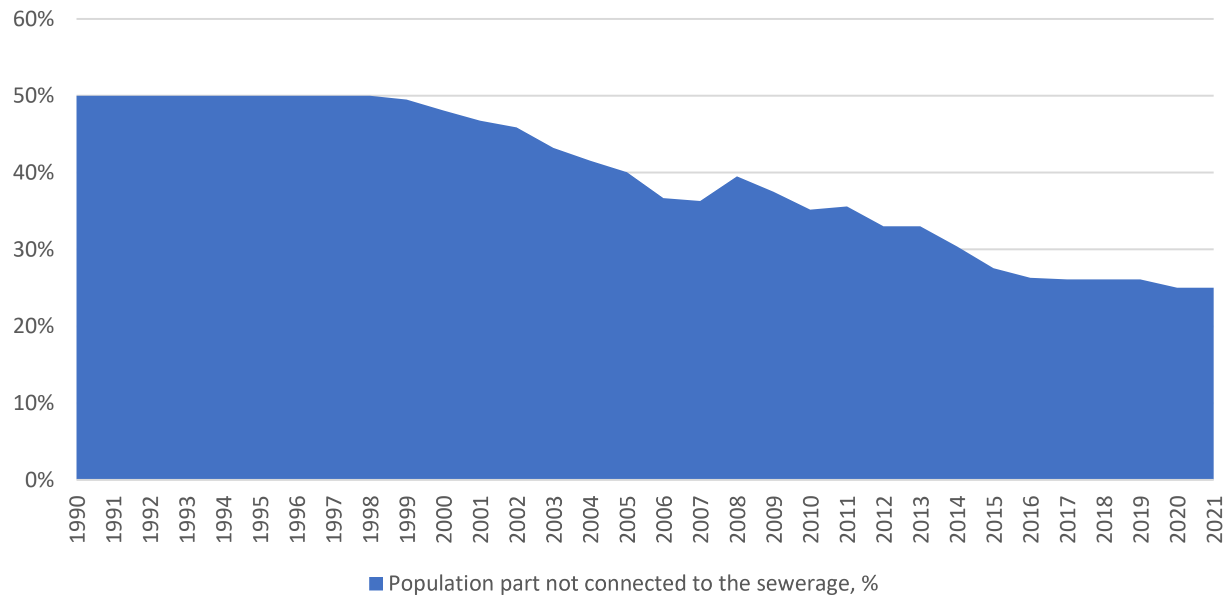

Figure 1-10 Part of population not connected to sewerage

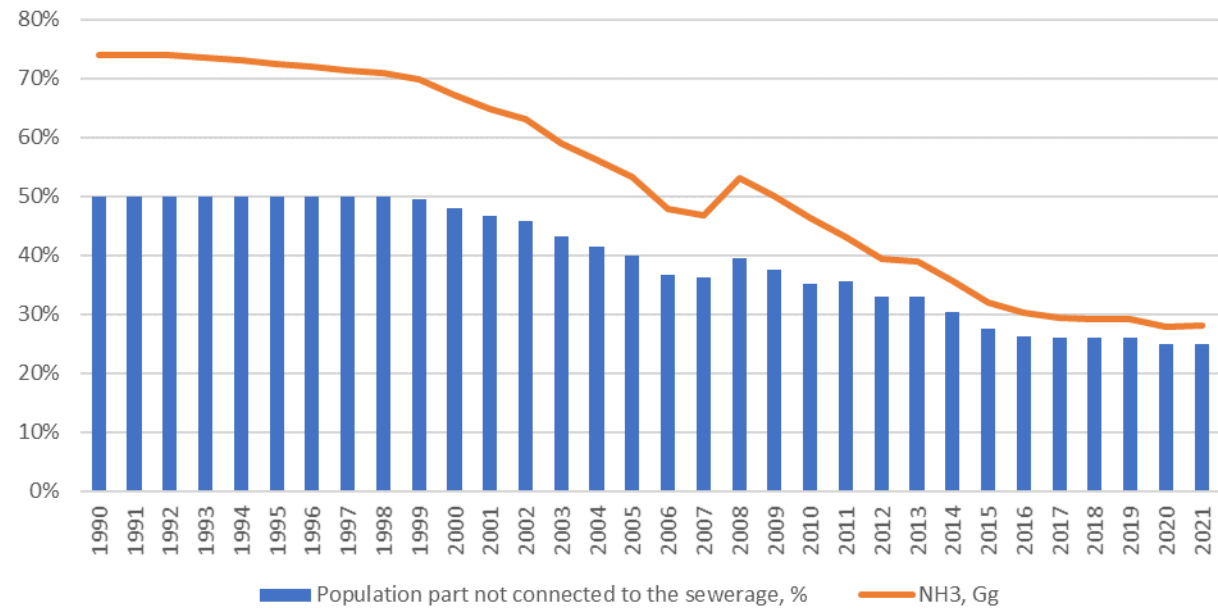

Figure 1-11 Emissions in sector 5.D.2

Uncertainty and time series' consistency

The following uncertainties were assumed for activity data (UNFCCC submission 2020):

- population having no connection to sewerage networks 5%
- fraction of organic component removed as sludge 40%
- aerobic treatment, well managed 66.3%
- primary treatment 65.6%
- anaerobic treatment, shallow lagoon 72.1%
- untreated 82.5%
- septic tanks and latrines 52.2%

Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

Source-specific recalculations

No source specific recalculations.

Source-specific planned improvements

No source-specific improvements.

1.7. Other waste (5.E)

Pollutant emissions those have occured in the accidental fires are covered here. The types of fires concidered here are: car fires, house fires, industrial building fires, farm fires, apartment building fires.

Annual numbers of all fires relevant to the 5E sector in the period 2005-2021 were taken from the data reports of the Lithuanian Fire and Rescue Department, in the period 1990-2004 were derived from the statistics of all fire cases provided by Statistics Lithuania using the average proportion of the relavant fires in all registered fires during 2005-2021.

Annual numbers of the car fires in the period 2005-2021 were taken from the data reports of the Lithuanian Fire and Rescue Department , in the period 1990-2004 were derived from the number of all relevant fire that was obtained by the method described above using the average proportion of car fires in all relevant fires during 2005-2021. For the estimating of pollutant emissions, the emission factors from Table 3-2 „Tier 2 emission factors for source category 5.E Other waste, car fire" (GB2019, chapter 5.E Other waste) were used.

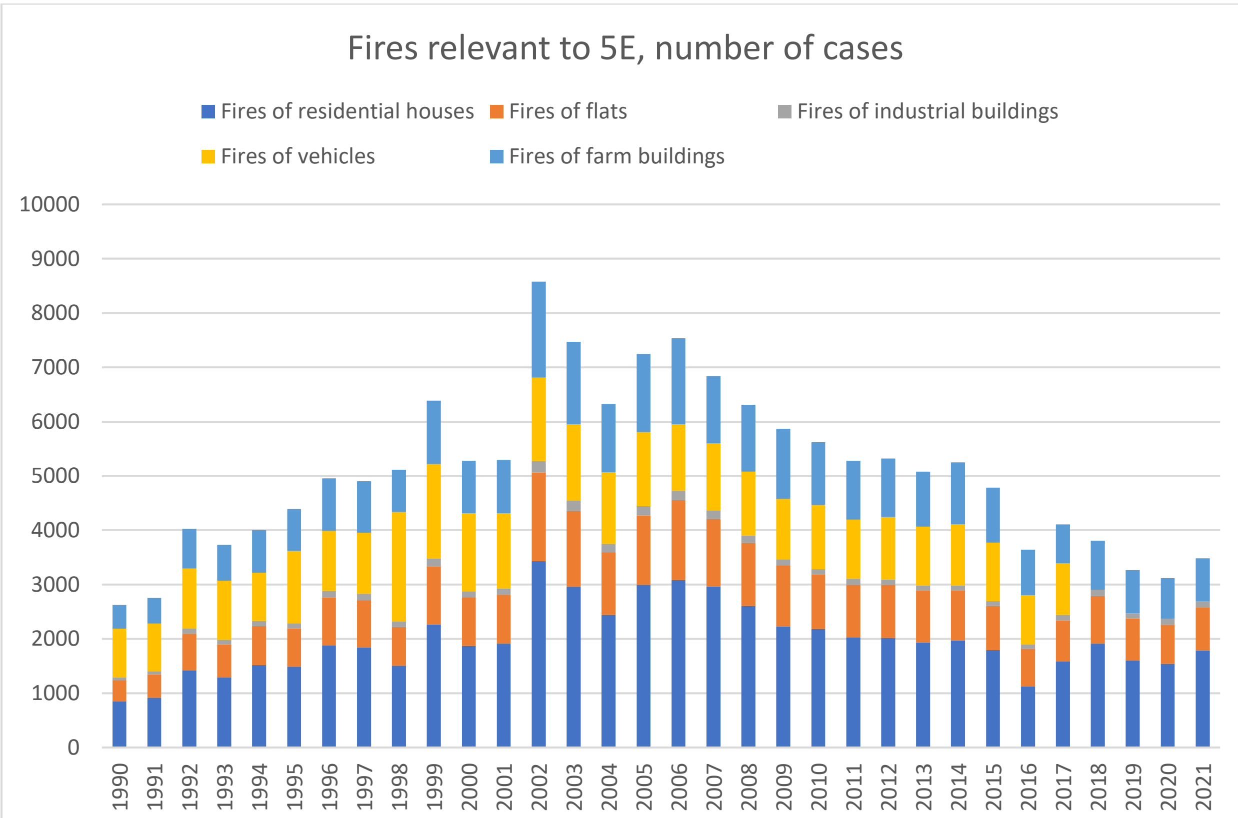

Figure 4-13. Number of fires

Annual numbers of the industrial building fires in the period 2005-2021 were taken from the data reports of the Lithuanian Fire and Rescue Department , in the period 1990-2004 were derived from the number of all relevant fire using the average proportion of industrial building fires in all relevant fires during 2005-2021. For the estimating of pollutant emissions, the emission factors from Table 3-6 „Tier 2 emission factors for source category 5.E Other waste, industrial building fire" (GB2019, chapter 5.E Other waste) were used.

Annual numbers of the farm building fires in the period 2005-2021 were taken from the data reports of the Lithuanian Fire and Rescue Department , in the period 1990-2004 were derived from the number of all relevant fire using the average proportion of industrial building fires in all relevant fires during 2005-2021. For the estimating of pollutant emissions, the emission factors from Table 3-3 „Tier 2 emission factors for source category 5.E Other waste, detached house fire“ (GB2019, chapter 5.E Other waste) were used.

Annual numbers of the apartment building fires in the period 2005-2021 were derived from the data reports of the Lithuanian Fire and Rescue Department , in the period 1990-2004 were derived from the number of all relevant fire using the average proportion of apartment building fires in all relevant fires during 2005-2021. For the estimating of pollutant emissions, the emission factors from Table 3-5 „Tier 2 emission factors for source category 5.E Other waste, apartment building fire“ (GB2019, chapter 5.E Other waste) were used.

Annual numbers of the house fires in the period 2005-2021 were derived from the data reports of the Lithuanian Fire and Rescue Department , in the period 1990-2004 were derived from the number of all relevant fire using the average proportion of house fires in all relevant fires during 2005-2021. For the estimating of pollutant emissions, the average of the emission factors from Tables 3-3, 3-4 (GB2019, chapter 5.E Other waste) were used.

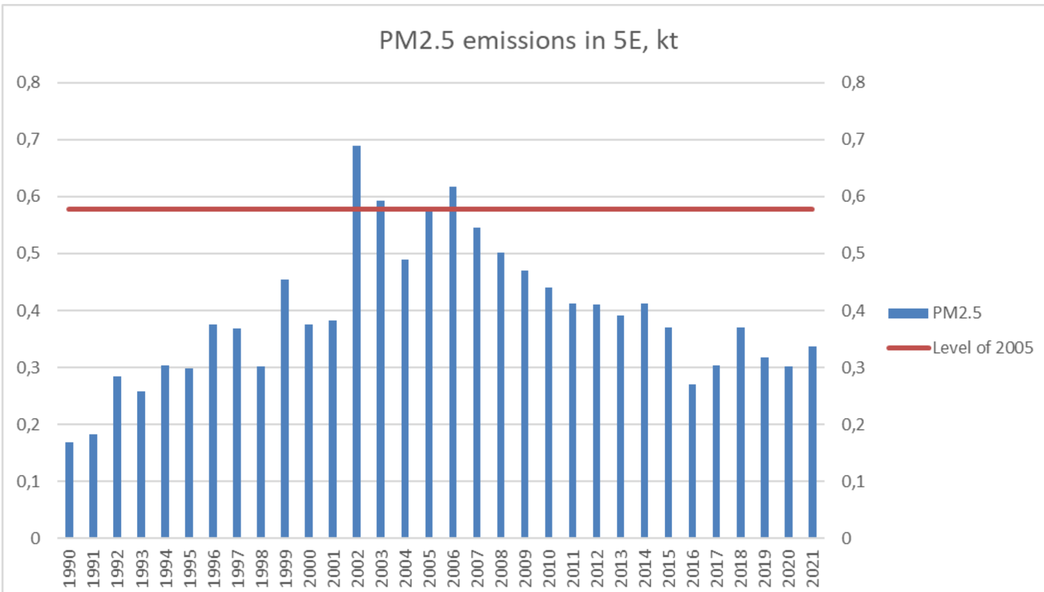

Figure 4-14. PM2.5 emissions in 5E