LITHUANIA‘S INFORMATIVE INVENTORY REPORT 2023

Air Pollutant Emissions 1990-2022
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)

1.1.1. 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.

1.1.2. Methodological issues

The calculated NMVOC emissions are based on NMVOC content in landfill gas, and uses CH_4 emissions reported on the T UNFCCC and converts it into volume of landfill gas emitted (V_{LG}) using the equation 3 provided in EMEP/EEA Guidebook 2023 chapter „5.A. Solid waste disposal on land“ section 3.3.2.

For particulate matter emissions calculation, the amount of mineral waste generated from construction and demolition, as well as the waste generated from quarrying of minerals were used. Mineral waste data was collected from Lithuanian Environmental Protection Agency (EPA) annual summary of waste generated and managed.

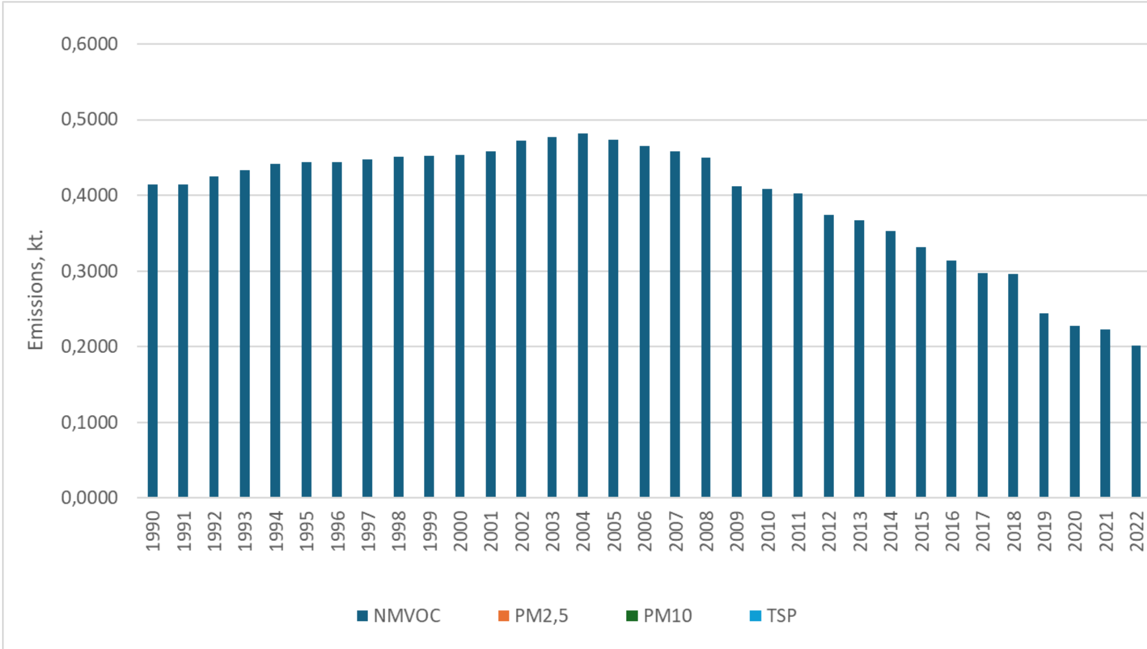

Figure 1-1. Emissions from solid waste disposal on land (5.A)

1.1.3. Uncertainty and time series consistency

Uncertainty of activity data is 5%. Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.1.4. 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.

1.1.5. Source-specific recalculations

NMVOC recalculations were made based on the new emission factors provided in the EMEP/EEA Guidebook, 2023. Particulate matter emissions were recalculated using mineral waste generated from constructuon and demolition, also quarrying of minerals, as stated in the TERT recommendation.

1.1.6. Source-specific planned improvements

No source specific improvements.

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

1.2.1. 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.

1.2.2. 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.

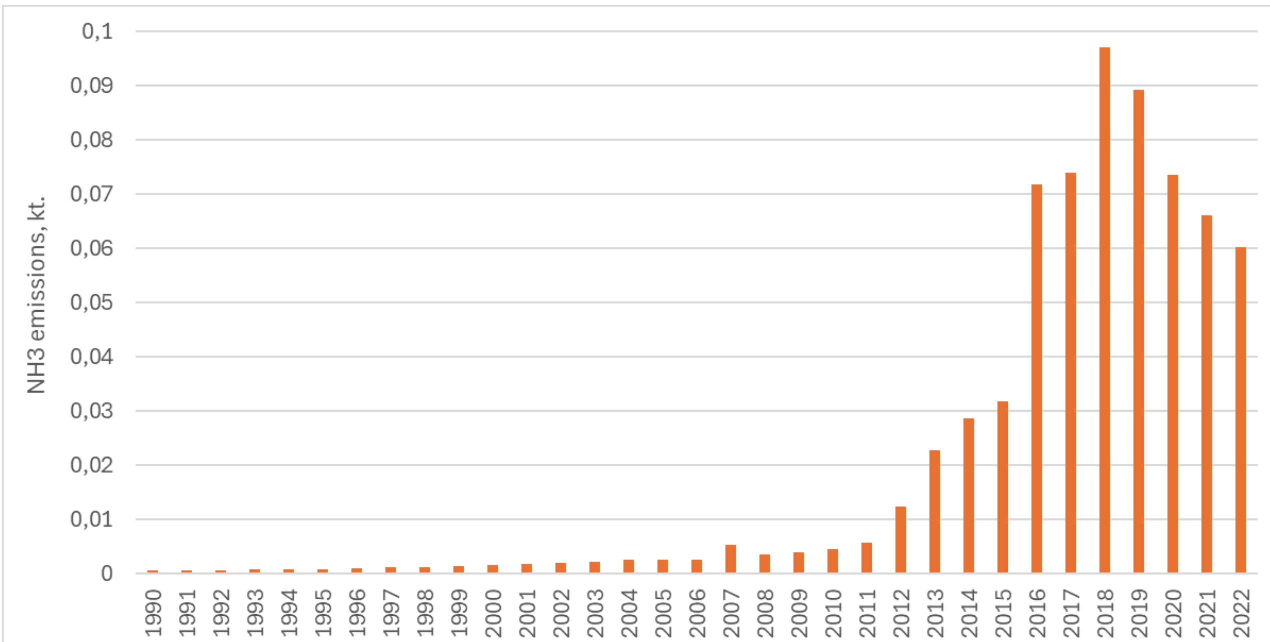

Figure 1-2. Emissions from biological treatment of waste – composting (5.B.1)

1.2.3. Uncertainty and time series consistency

Uncertainty of waste activity data is 5%. Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.2.4. 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.

1.2.5. Source-specific recalculations

5.B.1. sector emissions were recalculated with activity data using wet weight mass instead of dry matter, as recommended by Expert during review in 2023.

1.2.6. Source-specific planned improvements

No source-specific planned improvements.

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

1.3.1. Overview of the Sector

The biogas production 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.

1.3.2. Methodological issues

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 NH3 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 technology. 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) of 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:

$$E_{Biogas\_NH_3} = EF_{Default\_NH_3} \times AD_{Total\_biogas\_production} \times CF$$

Where:

$E_{bBiogas\_NH3}$ – ammonia emissions from biogas production (Gg);

$EF_{Default\_NH3}$ – the sum of the two emission factors from the 2016 EMEP/EEA guidebook;

$AD_{Total\ biogas\ production}$ – converted activity data from National Statistics.

CF – Conversion factor

For more details please refer the annex „NIIR 1990-2022 5B2 calc.xlsx“.

1.3.3. Uncertainty and time series consistency

Uncertainty of waste activity data is 5%. Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.3.4. 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.

1.3.5. Source-specific recalculations

No source-specific planned recalculations.

1.3.6. Source-specific planned improvements

No source-specific planned improvements.

1.4. Waste incineration (5.C)

1.4.1. 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.

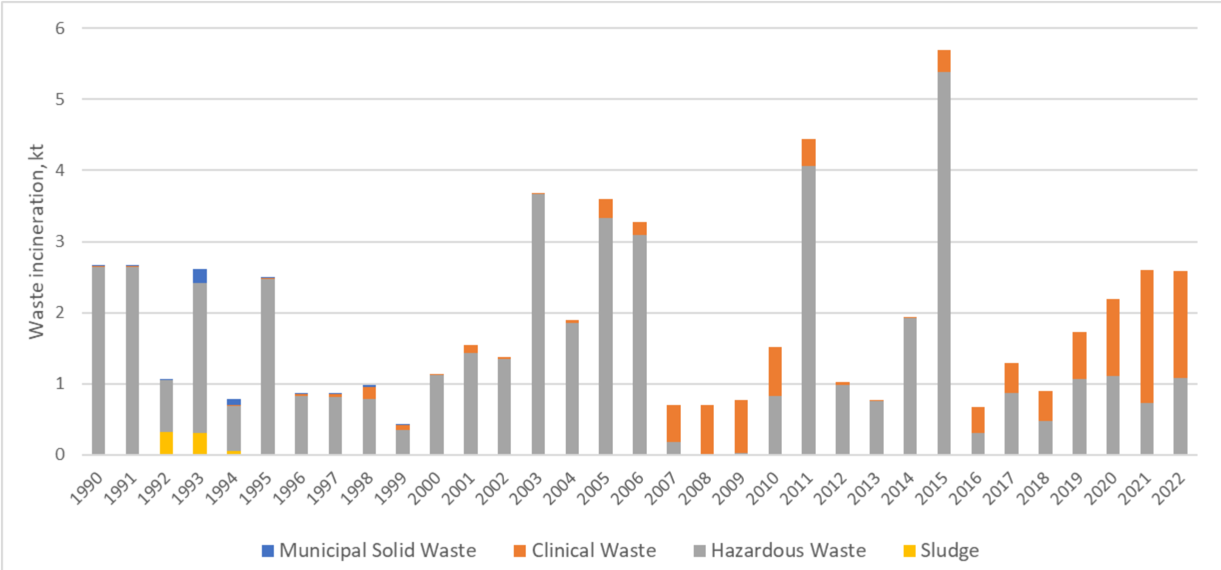

Figure 1-4 . Incineration of hazardous waste, clinical waste, sewage sludge and municipal waste (5.C)

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).

1.4.2. Methodological issues

For emission calculation, facility data were used. For hazardous and clinical waste, activity data was provided by waste management company UAB „Toksika“. Cremation data was obtained throught direct contact with 4 operating crematories.

Tier 2 (Tier 1 *in italic*) EMEP/EEA Guidebook 2023 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

	Municipal	Hazardous	Clinical	Cremation	Unit
Nox	1.8	0.87	1.8	*0.825*	kg/Mg
CO	0.7	0.07	1.5	*0.14*	kg/Mg
NMVOC	0.02	7.4	0.7	*0.013*	kg/Mg
SO2	1.7	0.047	1.1	*0.113*	kg/Mg
NH3	*3*	NE	NE	NE	g/Mg
TSP	18.3	0.01	2.3	*38.56*	kg/Mg
PM10	13.7	0.007	65 (% of TSP)	*34.7*	kg/Mg

PM2,5	9.2	0.004	43 (% of TSP)	*34.7*	kg/Mg
BC	3.5	3.5	2.3 (% of TSP)	NE	% of PM2,5
Pb	104	1.3	36	*30.03*	g/Mg
Cd	3.4	0.1	3	*5.03*	g/Mg
Hg	2.8	0.056	54	*1.49*	g/Mg
As	2.14	0.016	0.1	*13.61*	g/Mg
Cr	0.185	NE	0.4	*13.56*	g/Mg
Cu	0.093	NE	6	*12.43*	g/Mg
Ni	0.12	0.14	0.3	*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	0.2	*0.41*	mg/Mg
PCDD/F	3.5	10	NE	*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	0.04	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. The amounts of hazardous waste and corpses incinerated have increased in 2022, resulting in higher pollutant emissions. In clinical waste sector, there was a decrease in amount of waste incinerated in 2022, therefore smaller pollutant emissions in this sector were observed.

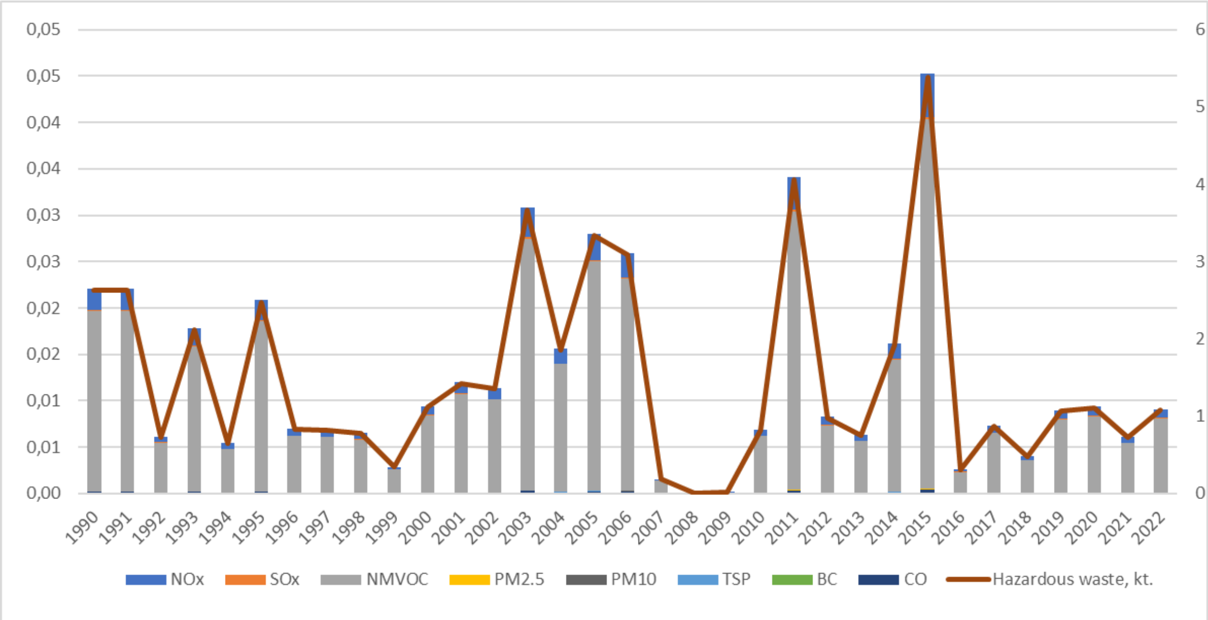

Figure 1-5. Hazardous waste incineration emissions in sector 5.C.1.b.i.i.

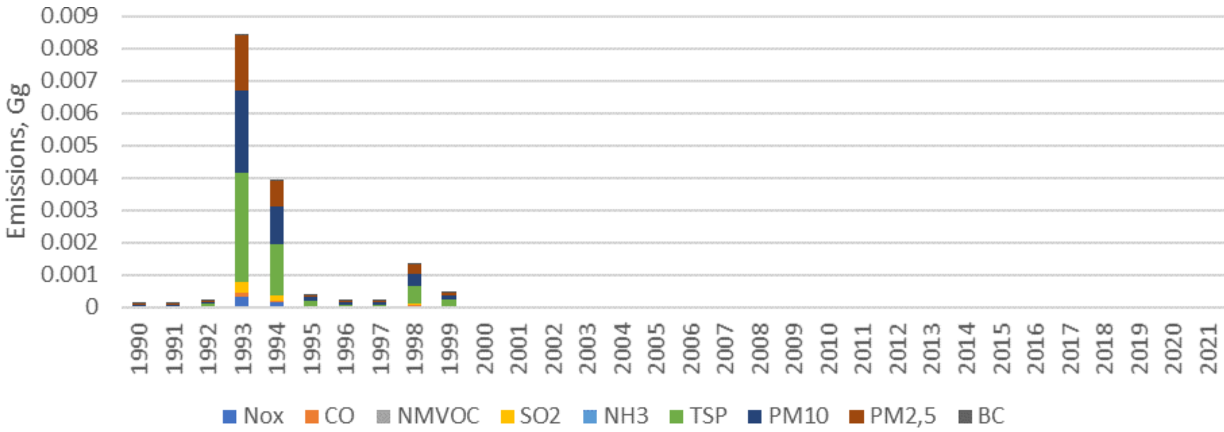

Figure 1-6. Municipal waste incineration emissions in sector 5.C.1.a

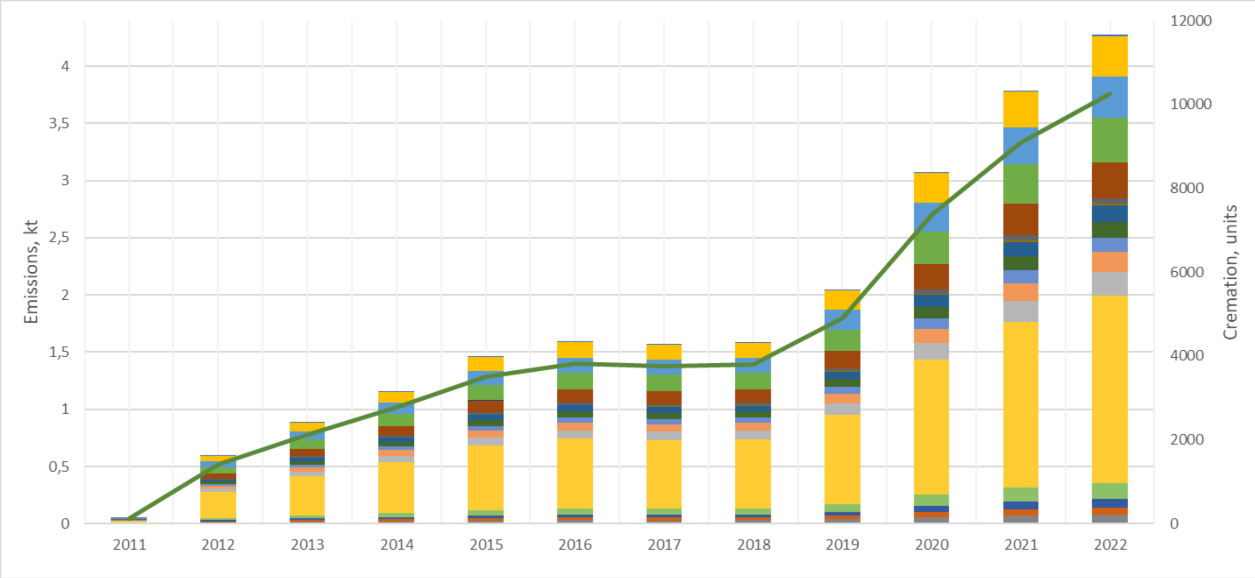

Figure 1-7. Cremation emissions in sector 5.C.1.b.v

1.4.3. 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). Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.4.4. 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.

1.4.5. Source-specific recalculations

Emission from sector 5C1bv Cremation recalculations were made using Tier 1 emission factors provided in EMEP/EEA Guidebook 2023, Table 3-1.

1.4.6. Source-specific planned improvements

No source-specific planned improvements.

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

1.5.1. Overview of the Sector

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. The legal order no. 269 does not regulate a burning of forest residues and the national circumstances make open burning of forest residue unlikely (small part of forest residues are gathered and used for energy recovery in the heating plants. The biggest part of these residues remains in the forests. More information about the situation in Lithuania regarding this issue is provided below.

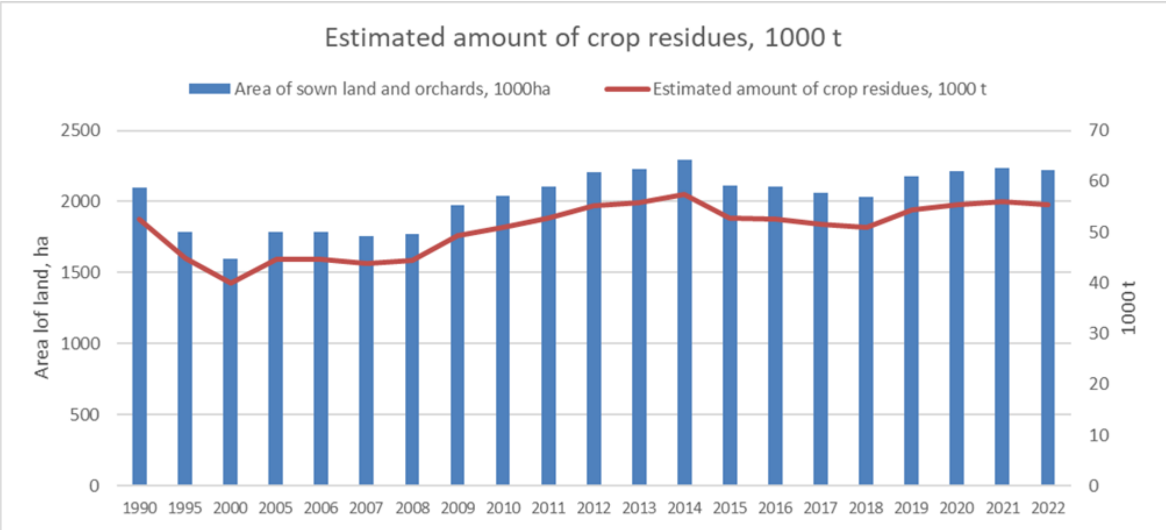

Figure 1-8. Amount of crop residues

1.5.2. Implementation of TERT recommendation

Observation LT-5C2-2023-0002; recommendation „The TERT recommends that Lithuania apply a Tier 2 estimate in the next submission, elaborating carefully on national circumstances having an impact on activity data, especially regarding forest residues and provide publication/documentation supporting that there is no open burning of forest residues.“

Publication/documentation supporting that there is no open burning of forest residues. Information of Energy ministry 2021-11-08. Ministry urges municipalities to increase the use of logging waste for heat production

The Ministry of Energy has appealed to municipalities to increase the use of local logging residues for heat production - the cheapest biofuel from wood chips. According to the Ministry's estimates, this would reduce the final price of heat for consumers by more than 10%, as well as stimulate local business and reduce the import of forest biomass from third countries.

Increasing the supply of domestic biofuels is one of the solutions the Government is taking to mitigate the resulting increase in the prices of heating, natural gas and electricity for household consumers in response to the significant increase in the price of raw materials on the world market. In order to promote the increased use of sustainably produced local biofuels, such as logging residues, amendments to legislation have been made on behalf of the Government to increase the quantities and supply of logging residues on the market, and to simplify and improve the conditions for the acquisition of logging residues.

Currently, about 75% of district heating in Lithuania is produced from biofuels, but the share of local forest residues in heat production decreased significantly in 2019-2020, when the fall in biofuel prices allowed heat producers to choose cheaper, higher quality biofuels. By comparison, according to the biofuel exchange Baltpool, in 2018 heat supply companies used around 30% more local forest residues than in this heating season.

By adjusting the methodology for the preparation of logging residues and simplifying the conditions for the acquisition of these residues, the State Forest Enterprise has increased the volume of logging residues planned for sale to 400 000 m3. In comparison, in 2020, the State Forest Enterprise sold 240 000 m3 of logging residues.

This is expected to encourage heat producers to increase the use of forest residues in heat production. "We can see from the trade statistics that heat producers could already today use significantly more forest residues, but this requires decisions by municipally-owned heat supply companies to choose biofuel produced in Lithuania and to adapt their boilers to the use of this biofuel," says Minister of Energy Dainius Kreivys. - Increased use of sustainably produced local forest residues would reduce the final price of heat by more than 10%, stimulate local business and reduce the impact of Belarusian forest biomass imports on heat prices in Lithuania".

The Ministry of Energy also points out that the EU is tightening its requirements for the sustainability of biofuel production, promoting the use of ecologically and sustainably produced and supplied biofuels, and requiring sustainability throughout the entire biofuel production and supply chain. It is likely that, as the sustainability and CO2 reduction requirements for biofuels become more stringent, only low-quality biofuels will be allowed to be burned, i.e. logging residues that cannot be used for any other higher value-added production.

1.5.3. State Forest Service information

Deadwood resources shall be determined by direct tree measurements during the NMI and

assessing their condition prior to the complete decomposition of the tree stem. The dead trees are classified as liquid and illiquid (in financial sense). The latter are not suitable for economic use. In their forests, approximately twice as many as liquid tree hollows. Since 2003, the amount of liquid drywood has been almost doubled from 6.43 m^3/ha to 10.9 m3/ha in the country's forests - from 12.97 million m3 to 23.37 million m3 (counting only stem wood without branches, stump and roots).

Together with non-liquid deadwood, the amount of dead wood stems (solid part) per ha in the country's forests currently amounts to 14.2 m^3/ha [in Europe (excluding Russia) this figure is 11.5 m^3/ha].

Taking into account the total dead wood resources in the country's forests (i.e. dry wood of varying degrees of decomposition and all its parts), it is estimated that these resources in the country's forests have increased from about 33 million m^3 to about 61 million m^3. Dead wood (stems, branches, roots) of dead trees in forests represents more than 10% of the volume of (green) tree stems in forests.

Dead wood resources in forests earmarked for the restoration of property rights (average 1 ha) were about 30% higher than in the remaining forests (due to the absence of economic activities). Although the deadwood stock in the country's forests is steadily increasing with the addition of new tree mortality, the amount of deadwood is also reduced each year by the decomposition processes that are taking place, which

The intensity of dead wood is estimated at 1.03 m^3/ha/m (equivalent to ⅓ of the wood stored in the stand)

1.5.4. Renewable wood resources use for energy

Share of renewables in the country's total energy balance in 2019 was around 20.2 %, with wood accounting for the largest share. The use of firewood and wood residues for fuel and energy production was about 6.37 million m^3 of wood (equivalent to 1.25 million tonnes of wood and woodfuel. TNE, or 5.7 million tonnes of CO2 eq.). For comparison in 2010, this volume was around 4.8 million tonnes of wood.

State Forest Enterprise intensifies the collection of logging residues and sale on the market from 2010. The quantities of logging residues sold during this period have fluctuated in the range of 150-260 thousand m^3. The most recent sale was around 200 thousand m^3 of logging residues.

1.5.5. Uncertainty and time series consistency

Uncertainty of waste activity data is 5%. Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.5.6. 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.

1.5.7. Source-specific recalculations

No source-specific planned recalculations.

1.5.8. Source-specific planned improvements

No source-specific planned improvements.

1.6. Wastewater handling (5.D)

1.6.1. 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).

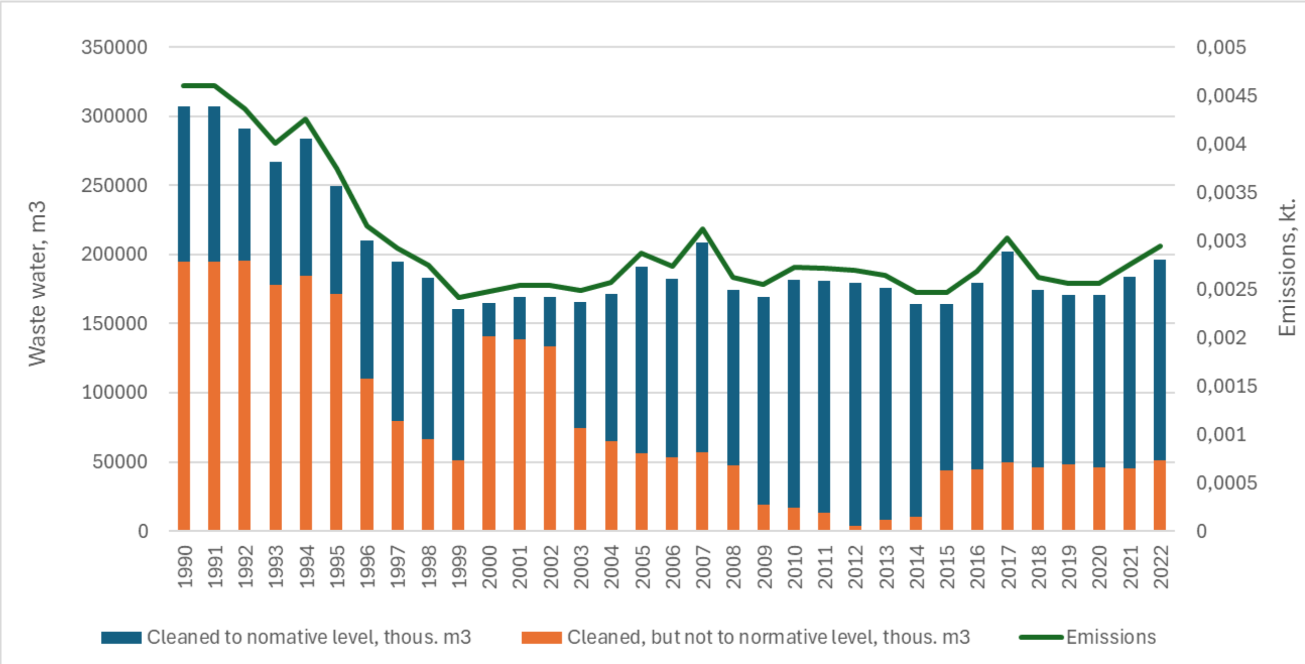

Figure 1-9. Waste water management in period 1990 – 2022

1.6.2. Methodological issues

For emission calculation, EMEP/EEA 2023 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 were estimated using resident population data at the beginning of the year. The data for population, not connected to sewerage networks were used as reported on T UNFCCC. 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. The population using latrines were estimated for the evaluation of NH_3 emissions. Both NMVOC and NH_3 emissions are reported under sector NFR 5D1 (domestic waste water handling).

Table 1-3. Tier 2 EF for wastewater handling.

NH_3	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.

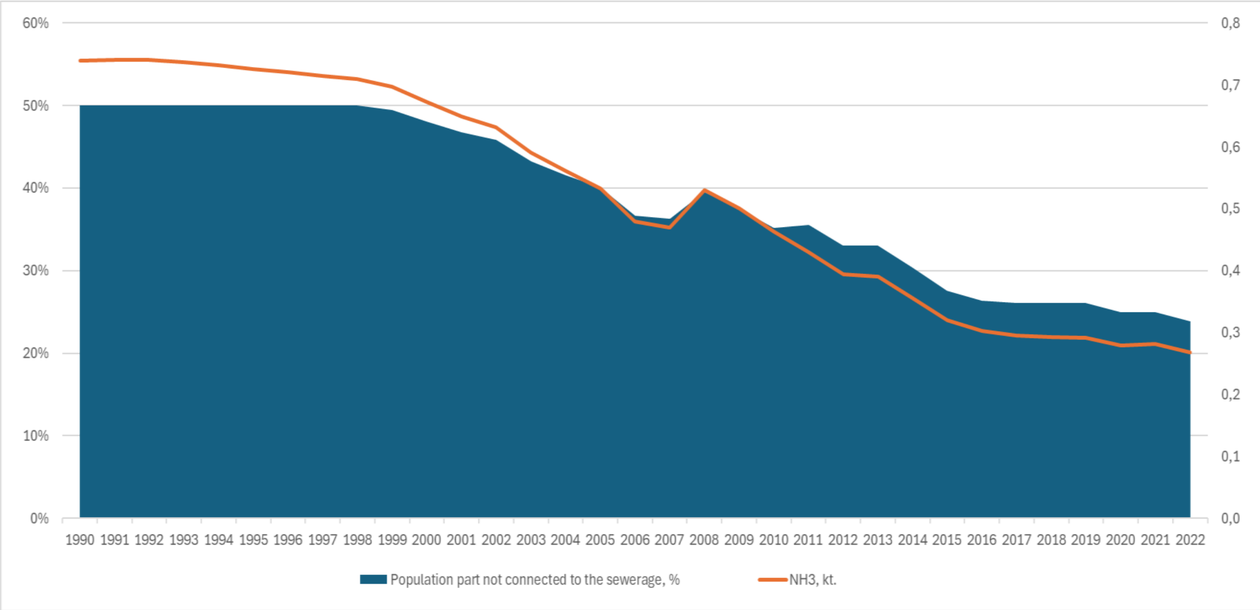

Figure 1-10. Part of population not connected to sewerage

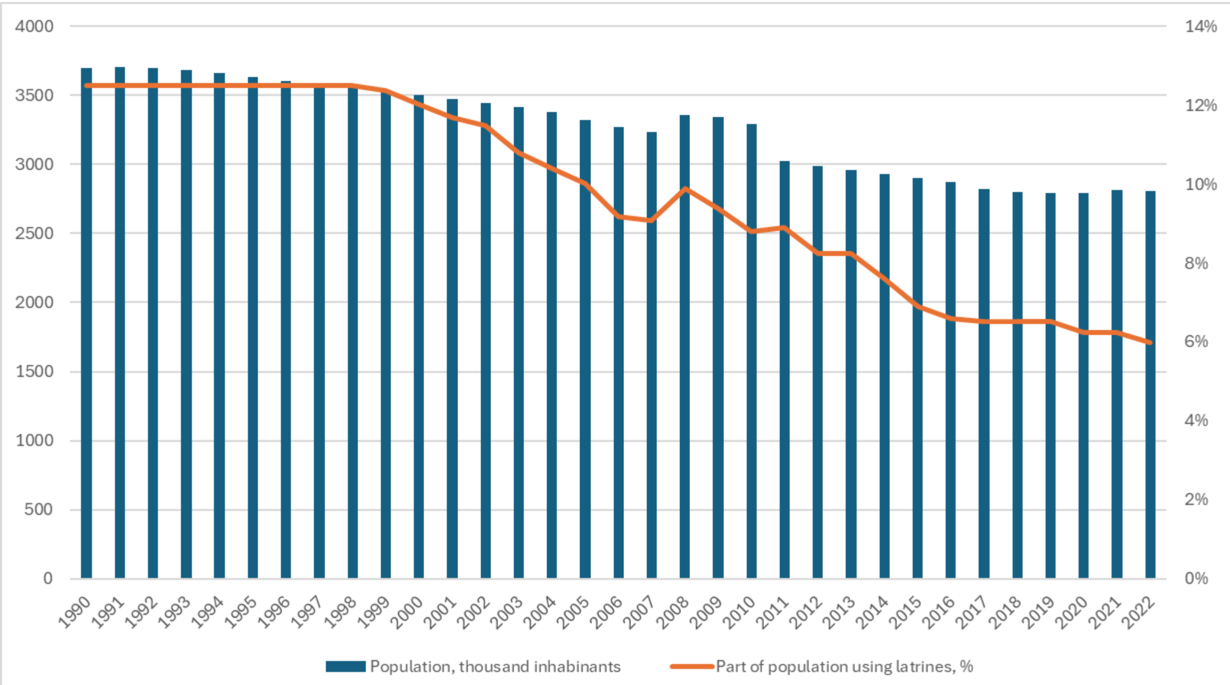

Figure 1-11. Part of population using latrines

1.6.3. 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%

1.6.4. 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.

1.6.5. Source-specific recalculations

No source specific recalculations.

1.6.6. Source-specific planned improvements

No source-specific improvements.

1.7. Other waste (5.E)

1.7.1. Overview of the Sector

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 2005-2022 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 2005-2022.

Annual numbers of the car fires in the period 2005-2022 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 2005-2022. 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.

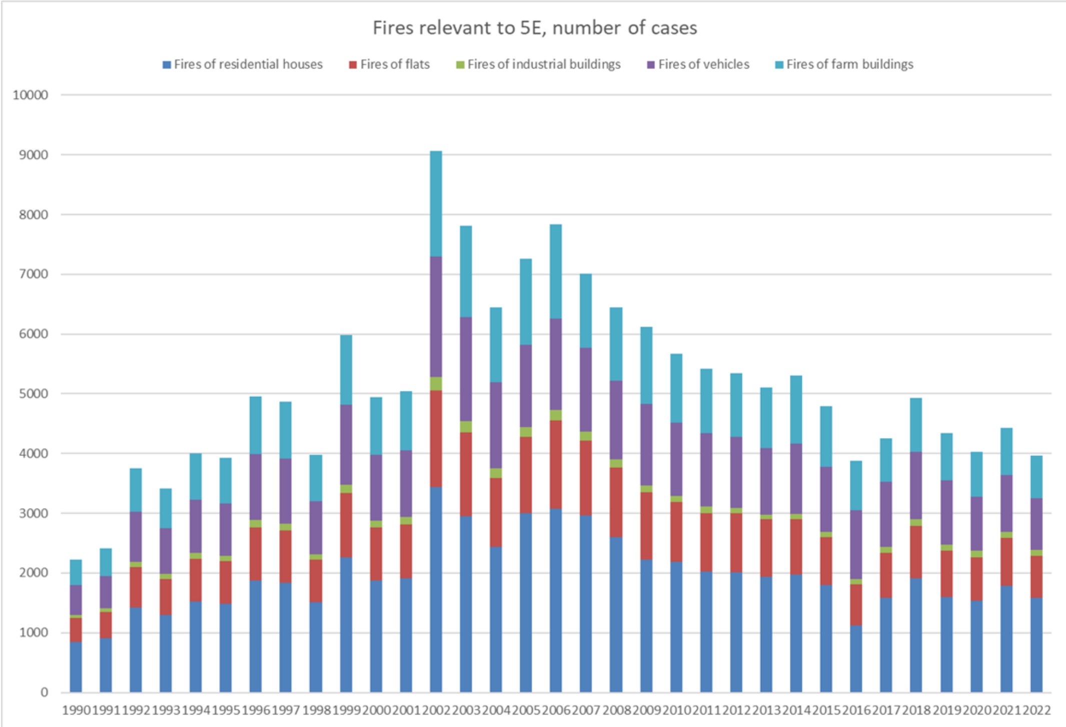

Figure 1-12. Number of fires

1.7.2. Methodological issues

Annual numbers of the industrial building fires in the period 2005-2022 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 2005-2022. 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 2005-2022 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 2005-2022. 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 2005-2022 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 2005-2022. 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 2005-2022 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 2005-2022. 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.

1.7.3. Uncertainty and time series consistency

Uncertainty of waste activity data is 5%. Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.7.4. 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.

1.7.5. Source-specific recalculations

No source-specific planned recalculations.

1.7.6. Source-specific planned improvements

No source-specific planned improvements.

1.8. Other (included in national total for entire territory) (6.A)

1.8.1. Overview of the Sector

In this section NH_3 emissions from the domestic cats and dogs manure are estimated according to the methodology provided in the GB2023.

1.8.2. Methodological issues

Numbers of cats and dogs for years 2010, 2014, 2020, 2021, 2022 were taken from the bulletin of the "FEDIAF • The European Pet Food Industry". Activity numbers for all other years from 2005 were estimated by the number of inhabitants using dogs per capita and cats per capita variables. Emission factors used are provided in Table 1-4:

Table 1-4. Tier 1 EF for domestic cats and dogs manure.

Dogs	0.74	kg/dog/year
Cats	0.13	kg/cat/year

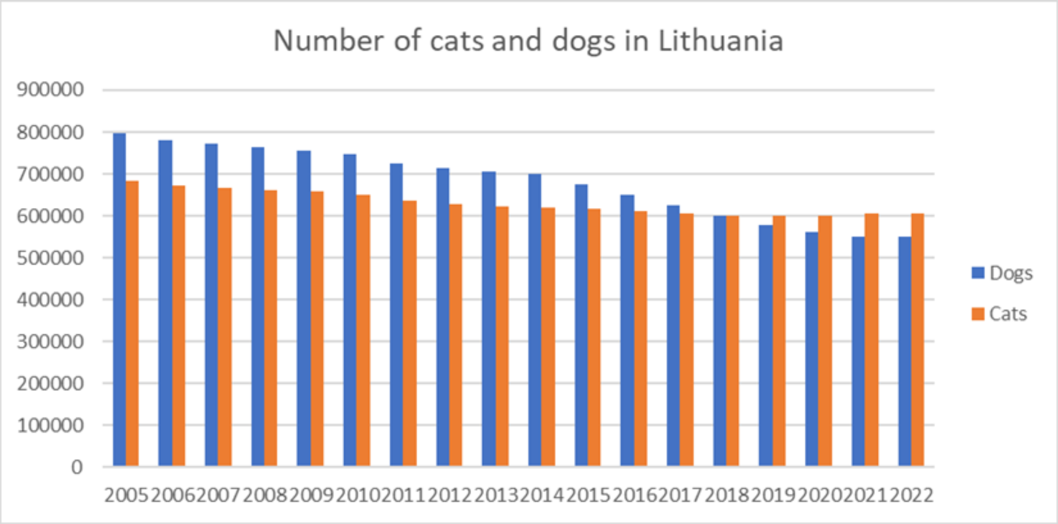

Figure 1-13. Activity data for sector 6.A.

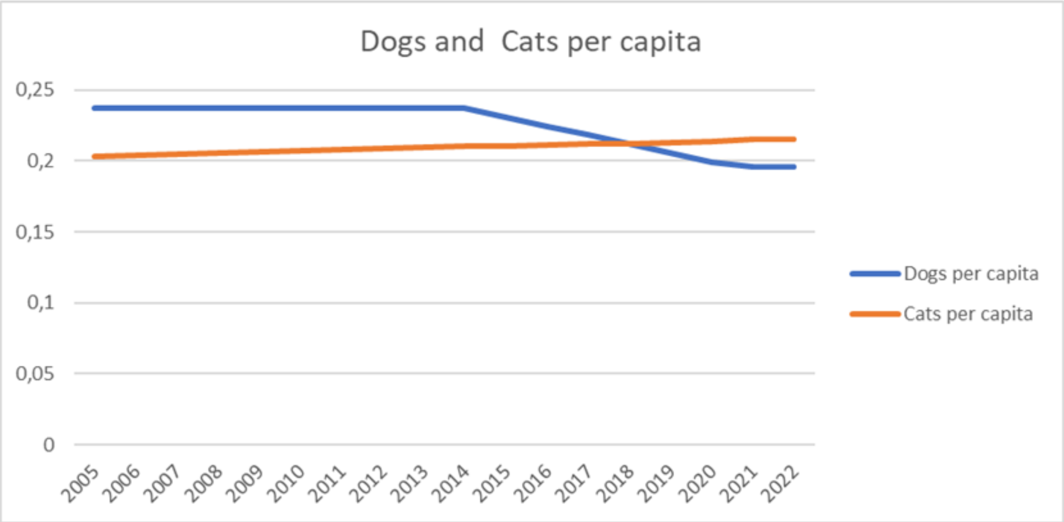

Figure 1-14. Emissions from sector 6.A.

For the details please refer “NIIR 6A cats dogs.xlxs”.

1.8.3. Uncertainty and time series consistency

Uncertainty of waste activity data is 5%. Uncertainty of EF with 95% confidence interval is provided in EMEP/EEA, 2023.

1.8.4. 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.

1.8.5. Source-specific recalculations

No source-specific planned recalculations.

1.8.6. Source-specific planned improvements

No source-specific planned improvements.