LITHUANIA‘S INFORMATIVE INVENTORY REPORT 2024

Air Pollutant Emissions 1990-2022

under the UNECE CLRTAP and the EU NECD

Part 3 – ENERGY

Lithuanian Environmental Protection Agency

Contents

List of abbreviations

CHP – Combined Heat and Power Plants

ELV – Emission limit value

GB2019 - EMEP/EEA air pollutant emission inventory guidebook 2019

HM – Heavy metals

HP – Heating plants

LCP – Large combustion plant

LCPD- Large combustion plant directive

LPG – Liquified Petroleum Gases

MCP – Medium combustion plant

MCPD - Medium combustion plant directive

POP – Persistent Organic Pollutants

STATIONARY FUEL COMBUSTION (NFR 1.A.1-2-4)

This group comprises the following NFR sectors: 1.A.1.a "Public electricity and heat production", 1.A.1.b "Petroleum refining", 1.A.1.c "Manufacture of solid fuels and other energy industries", 1.A.2.a "Stationary combustion in manufacturing industries and construction: Iron and steel", 1.A.2.b "Stationary combustion in manufacturing industries and construction: Non-ferrous metals", 1.A.2.c "Stationary combustion in manufacturing industries and construction: Chemicals", 1.A.2.d "Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print", 1.A.2.e "Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco", 1.A.2.f "Stationary combustion in manufacturing industries and construction: Non-metallic minerals", 1.A.2.g.viii "Stationary combustion in manufacturing industries and construction: Other", 1.A.4.a.i "Commercial/Institutional: Stationary", 1.A.4.b.i "Residential: Stationary", 1.A.4.c.i "Agriculture: Stationary".

The Statistics Lithuania fuel balance was used as the activity data for calculation of the historical emissions (1990-2022).

General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants

NOx and PM emission factors for "new" MCP. According to the Medium Combustion Plant Directive (MCPD), for combustion plants 1-50 MW which are installed after 20th December 2018, following ELV (Emission Limit Values, mg/m3) are set:

Pollutant	Solid biomass 1-5 MW	Solid biomass 5-50 MW	Natural gas 1-50 MW
NOx ELV (mg/m3)	500	300	100
NOx EF (g/GJ)	140	84	28

Figure 1. NOx ELV and corresponding EF for MCP installed after 20.12.2018

NOx emission factors were evaluated using the methods provided in Appendixes B and C of EMEP/EEA air pollutant emission inventory guidebook 2019, chapter 1A4. For burning wood in old devices, Lithuanian national ELV (mg/m3) for NOx is 750; corresponding EF value was selected as 210 g/GJ (Table 3.45, GB2019, 1A4). For MCPD ELV equal 500, corresponding EF was derived by formula EF =210*(500/750), for MCPD ELV 300, by formula EF =210*(300/750). For natural gas, NOX EF was taken from Table C3.2 (GB2019, 1A4).

Pollutant	Solid biomass 1-5 MW	Solid biomass 5-20 MW	Solid biomass 20-50 MW
TSP ELV (mg/m3)	50	30	20
TSP EF (g/GJ)	12,3	7,4	4,9
PM10 EF (g/GJ)	11,1	6,6	4,4
PM2.5 EF (g/GJ)	9,5	5,7	3,8

Figure 2. PM ELV and corresponding EF for MCP installed after 20.12.2018

TSP emission factors were evaluated using the methods provided in Appendixes B and C of EMEP/EEA air pollutant emission inventory guidebook 2019, chapter 1A4. For old devices burning wood installed before 01.07.1998 with capacity 1-20 MW, Lithuanian national ELV (mg/m3)

for TSP is 700; corresponding EF value was selected as 172 g/GJ (Table 3.13, GB2019, chapter 1A1). For MCPD ELV equal 50, corresponding EF was derived by formula EF =172*(50/700), for MCPD ELV 30, by formula EF =172*(30/700), for MCPD ELV 20 EF=172*(20/700). Proportion of PM10 and PM2.5 was taken from Table 3.13 (GB2019, chapter 1A1).

Proportion of fuel combustion in MCP installed after 20.12.2018.

This proportion was evaluated by the LEPA experts in cooperation with the experts of Environment Ministry. It was applied for wood and natural gas combustion.

Scenario:	Historical	Historical	Historical	WEM	WEM	WEM	WEM	WEM	WAM	WAM	WAM	WAM	WAM
Years:	2019	2020	2021	2025	2030	2035	2040	2050	2025	2030	2035	2040	2050
Proportion, %:	10	15	20	35	55	80	95	100	35	55	80	95	100

Figure 3.Proportion of fuel combustion in MCP installed after 20.12.2018

NOx and PM emission factors for "old" MCP.

Tables below provides ELV and EF for medium combustion plants that were installed before 20.12.2018 ("old" devices) and MCP directive is not implemented so far:

Pollutant	Solid biomass 1-50 MW	Natural gas 1-50 MW
NOx LT national ELV (mg/m3)	750	350
NOx EF (g/GJ)	210	89

Figure 4. NOx LT national ELV and corresponding EF for MCP installed before 20.12.2018 ("old" MCP)

Pollutant	Solid biomass 1-20 MW (installed before 01.07.1998)	Solid biomass 1-20 MW (installed after 01.07.1998)	Solid biomass 20-50 MW (installed before 01.07.1998)	Solid biomass 20-50 MW (installed after 01.07.1998)
TSP LT national ELV (mg/m3)	700	400	500	300
TSP EF (g/GJ)	172	98,3 (=172*(400/700))	122,9 (=172*(500/700)	73,7 (=172*(300/700))
PM10 EF (g/GJ)	155	88,6 (=155*(400/700))	110,7 (= =155*(500/700))	66,4 (=155*(300/700))
PM2.5 EF (g/GJ)	133	76 (=133*(400/700))	95 (=133*(500/700))	57 (= 133*(300/700))

Figure 5. PM LT national ELV and corresponding EF for MCP installed before 20.12.2018 ("old" MCP) when MCP directive is not implemented.

From 2019 for the above mentioned group of boilers, particulate matter emission factors were derived from the Lithuanian national EF research 2018-2019 results and are equal to particulate matter emission factors provided in the Table 3.49 (GB2019, chapter 1A4).

NOx and PM emission factors for "old" MCP from 01.01.2025 and 01.01.2030.

For boilers with capacity 5-50 MW those were installed before 20.12.2018, the following ELV (and corresponding EF) must be implemented from 01.01.2025:

Pollutant	Solid biomass 5-50 MW	Natural gas 5-50 MW
NOx ELV (mg/m3)	650	200
NOx EF (g/GJ)	182 (=210*(650/750))	51 (=89*(200/350))

Figure 6. NOx ELV and corresponding EF (from 01.01.2025) for MCP 5-50 MW installed before 20.12.2018

Pollutant	Solid biomass 5-20 MW	Solid biomass 20-50 MW
TSP ELV (mg/m3)	50	30
TSP EF (g/GJ)	12,3	7,4
PM10 EF (g/GJ)	11,1	6,6
PM2.5 EF (g/GJ)	9,5	5,7

Figure 7.PM ELV and corresponding EF (from 01.01.2025) for MCP 5-50 MW installed before 20.12.2018

For boilers with capacity 1-5 MW those were installed before 20.12.2018, the following ELV (and corresponding EF) must be implemented from 01.01.2030:

Pollutant	Solid biomass 1-5 MW	Natural gas 1-5 MW
NOx ELV (mg/m3)	650	250
NOx EF (g/GJ)	182 (=210*(650/750))	63,6 (=89*(250/350))

Figure 8. NOx ELV and corresponding EF (from 01.01.2030) for MCP 1-5 MW installed before 20.12.2018

Pollutant	Solid biomass 1-5 MW
TSP ELV (mg/m3)	50

TSP EF (g/GJ)	12,3
PM10 EF (g/GJ)	11,1
PM2.5 EF (g/GJ)	9,5

Figure 9. PM ELV and corresponding EF (from 01.01.2030) for MCP 1-5 MW installed before 20.12.2018

There is possibility for the enterprises in Lithuania to get funding for implementation of the MCP directive in advance.

HM and POPs emission factors for wood combustion in MCP

Wood combustion emissions of heavy metals and persistent organic pollutants are attached to the particulate matter emissions. Abatement of particulate matter emissions also reduces the HM and POPs. GB2019 provides HM and POPs emission factors for wood combustion in MCP in the Table 3.45, GB2019, chapter 1A4. This table lacks information what was particulate matter concentration in the combustion plants where HM and POPs measurements were performed. So it was problematic to evaluate the effect of PM abatement required in the Lithuanian standards and in the MCPD on the emissions of HM and POPs and emission factors for HM and POPs were used as they are in the Table 3.45 without any abatement.

CO, NMVOC, SO2, NH3 emission factors for wood combustion in MCP

Emission factors from the Table 3.45, GB2023, chapter 1A4 were used.

Fuel combustion in the 1A1a (Public electricity and heat production)

1.1.1. Activity data

The following chapters of the fuel balance by Statistics Lithuania were used as the activity data for calculation of the historical emissions (1990-2022): Transformation in public CHP plants, Transformation in autoproducer CHP plants, Transformation in public heat plants, Transformation in autoproducer heat plants, Transformation in geothermal plants.

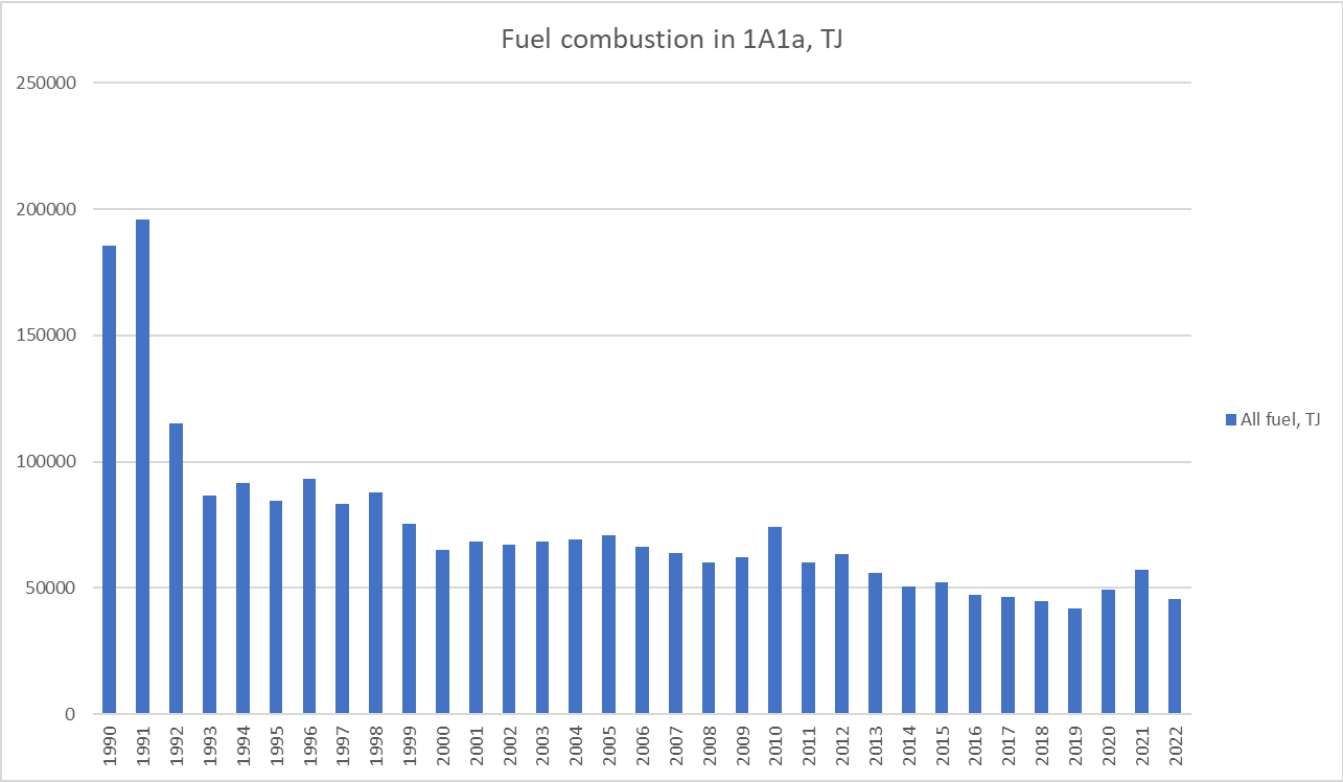


Figure 10. Fuel amount, 1A1a

RECALCULATIONS

The pollution permits of energy plants which were in force in 2022, were investigated. The purpose was to estimate more exactly the distribution of wood and natural gas combustion devices, in the terms of combusted fuel, by the required NOx emission limit values. Also, the bigger emission factors were applied to biogas combustion. All these circumstances lead to recalculations of emissions.

1.1.2. Heavy fuel oil combustion and air pollutant emission factors

Categories of heavy fuel oil used in Lithuania in the 1A1a (1990-2022) are residual fuel oil (mazut), orimulsion and emulsified vacuum residue. Mazut was combusted in the Combined Heat and Power (CHP) Systems in the LCP (boilers > 50 MW) and in the Public Heating Plants (MCP (boilers 1-50 MW)). Mazut that was combusted in the petroleum refinery power plant in 1990-2004 is included in the 1A1a, from 2005 it is included in the 1A1b sector. Orimulsion and emulsified vacuum residue was used in the Combined Heat and Power (CHP) Systems in the LCP (boilers > 50 MW) until 2008.

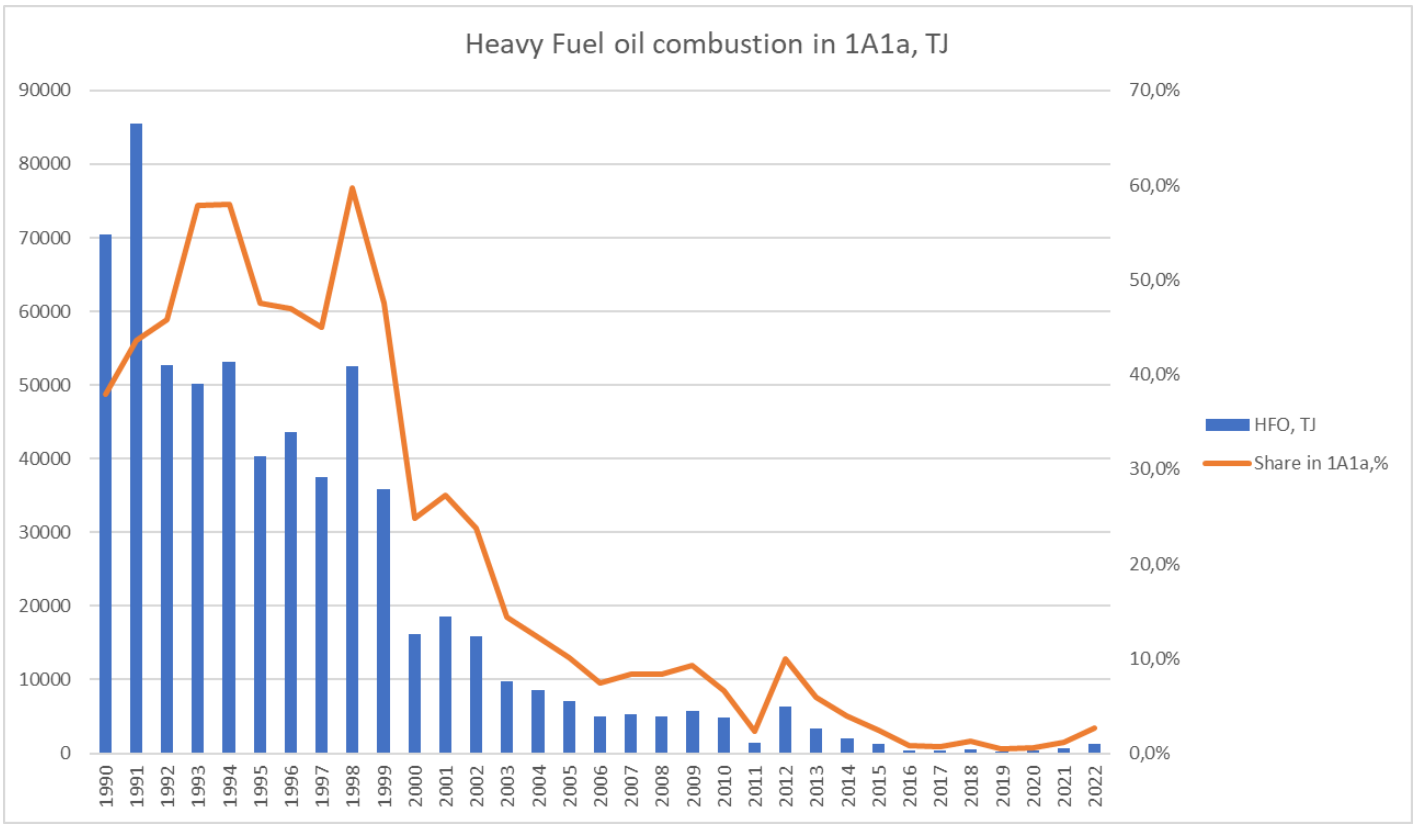


Figure 11. Heavy Fuel Oil amount, 1A1a

SO2 emissions from heavy fuel oil combustion. Data on SO2 emissions were taken from the combustion plant operators air pollution reports.

NOx emission factors for heavy fuel combustion in period 1990-2022 for large combustion plants are adjusted according to the former Large combustion plant directive requirements. For years 1990-1998 emission factor (g/GJ) value 142 was taken from the Table 3-11 (GB2019, Chapter 1A1a). For later years the following values were applied: 1999-2003 120, 2004-2007 95, from 2008 80. NOx emission factors for mazut combustion in the medium combustion plants were taken from the Table 3-25 (GB2019, Chapter 1A4).

PM emission factors for heavy fuel combustion in period 1990-2022 are adjusted according to the former Large combustion plant directive requirements.

Pollutant	*1990-2007*	*2008-2018*	*from 2019*
TSP	35,4	14,2	8,9
PM10	25,2	10,1	6,3
PM2.5	19,3	7,7	4,8

Figure 12. PM emission factors (g/GJ) for heavy fuel combustion.

Heavy fuel combustion in LCP PM emission factors for period 1990-2007 were taken from the Table 3-11 (GB2019, Chapter 1A1a); for MCP PM emission factors were taken from the Table 3-25 (GB2019, Chapter 1A4).

Emission factors of other pollutants for heavy fuel combustion in LCP were taken from the Table 3-11 (GB2019, Chapter 1A1a), for combustion in MCP - from the Table 3-25 (GB2019, Chapter 1A4) and applied without any abatement.

1.1.3. Light fuel oil combustion and air pollutant emission factors

Light fuel oil (diesel, gasoil, shale oil) mainly was used in 1990-1999. From 2000, usage is insignificant. Emission factors from the Table 3-24 (GB2019, Chapter 1A4) (SO2 - Table 4.1 , GB2019, chapter 1A4) were used to evaluate emissions from this source.

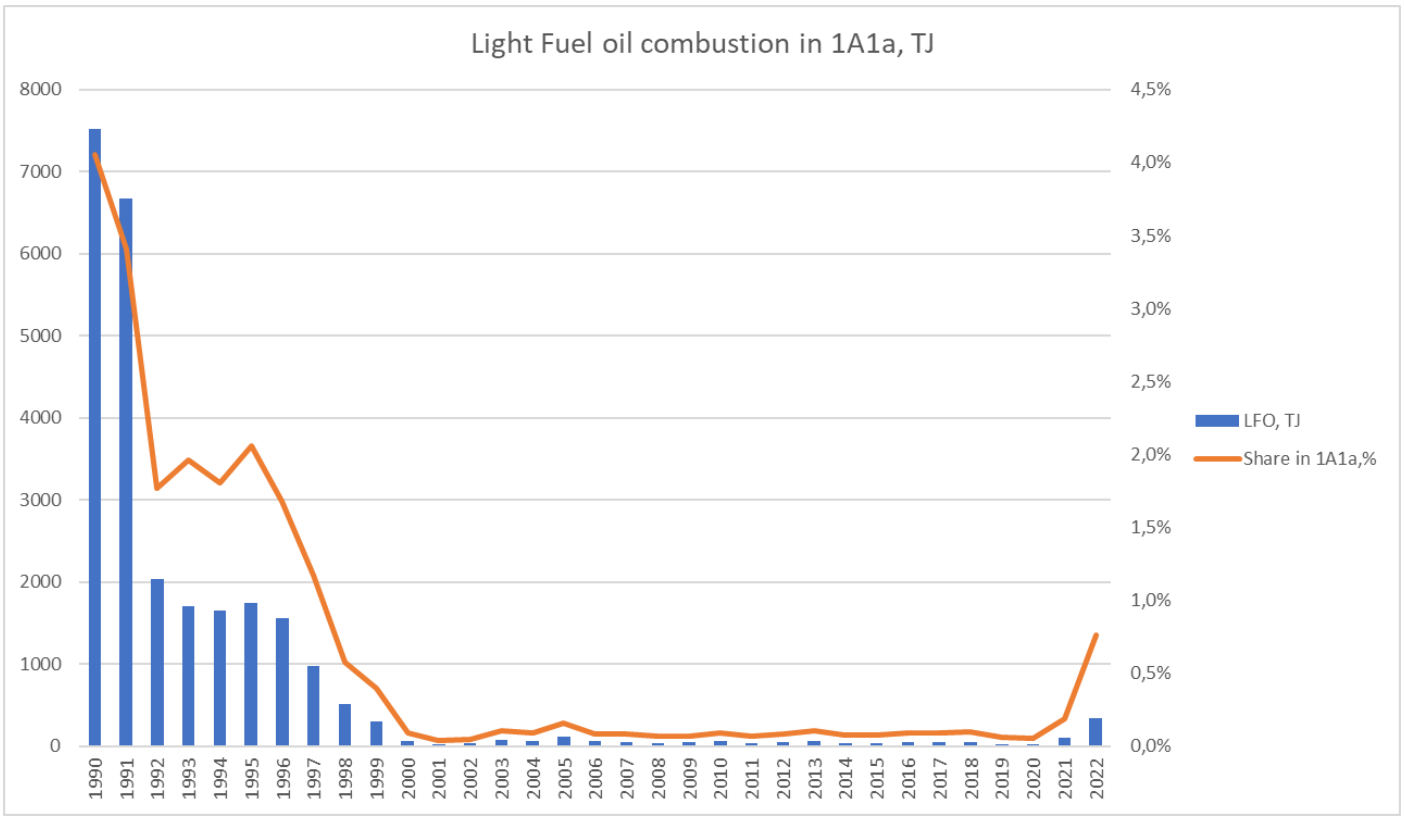


Figure 13. LFO in 1A1a, TJ

1.1.4 Coal and peat fuel combustion and air pollutant emission factors

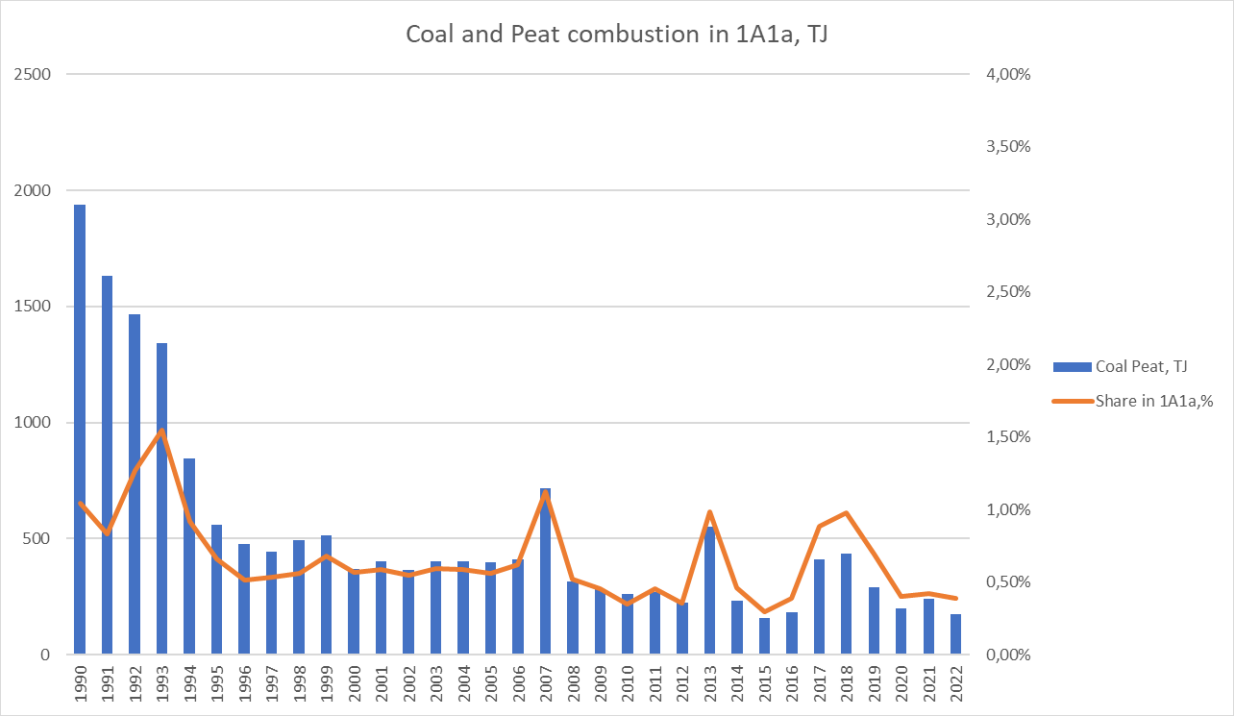


Figure 14. Coal and Peat in 1A1a, TJ

Emissions of pollutants (except SO2, NH3) for the period 1990-2017 were estimated using the emission factors from the Table 3.22 "Tier 2 emission factors for non-residential sources, manual boilers burning coal fuels" (GB2019, chapter 1A4). From 2018, the emission factors from the Table 3.23 "Tier 2 emission factors for non-residential sources, automatic boilers burning coal fuels" (GB2019, chapter 1A4) were used following the recommendations of the national emission factors research. Emissions of NH3 were not estimated, because the newest version of the EMEP/EEA Guidebook 2023 do not provide EF for NH3 . SO2 emission factor for peat was 300 g/GJ (Lithuania's national EF), for coal were as follows:

Fuel:	*Bituminous coal*	
	1990-2002	from 2003
Sulfur,%	1,82	0,3
Calorific value, GJ/tonne	25	25
SO2 EF, g/GJ	1449	239
Fuel:	*Subbituminous coal*	
	1990-2002	from 2003
Sulfur,%	1,82	0,3
Calorific value, GJ/tonne	23	23
SO2 EF, g/GJ	1604	264

Figure 14a. SO2 emission factors for coal.

The method described in the GB2019, chapter 1A4, page 100, was used to evaluate the SO2 EF.

1.1.5 Biogas combustion and air pollutant emission factors

Biogas combustion in the 1A1a sector started in 2002. This fuel is used in the stationary internal combustion engines of the small-scale Combined Heat and power systems. Usage of biogas has grown rapidly from 2010.

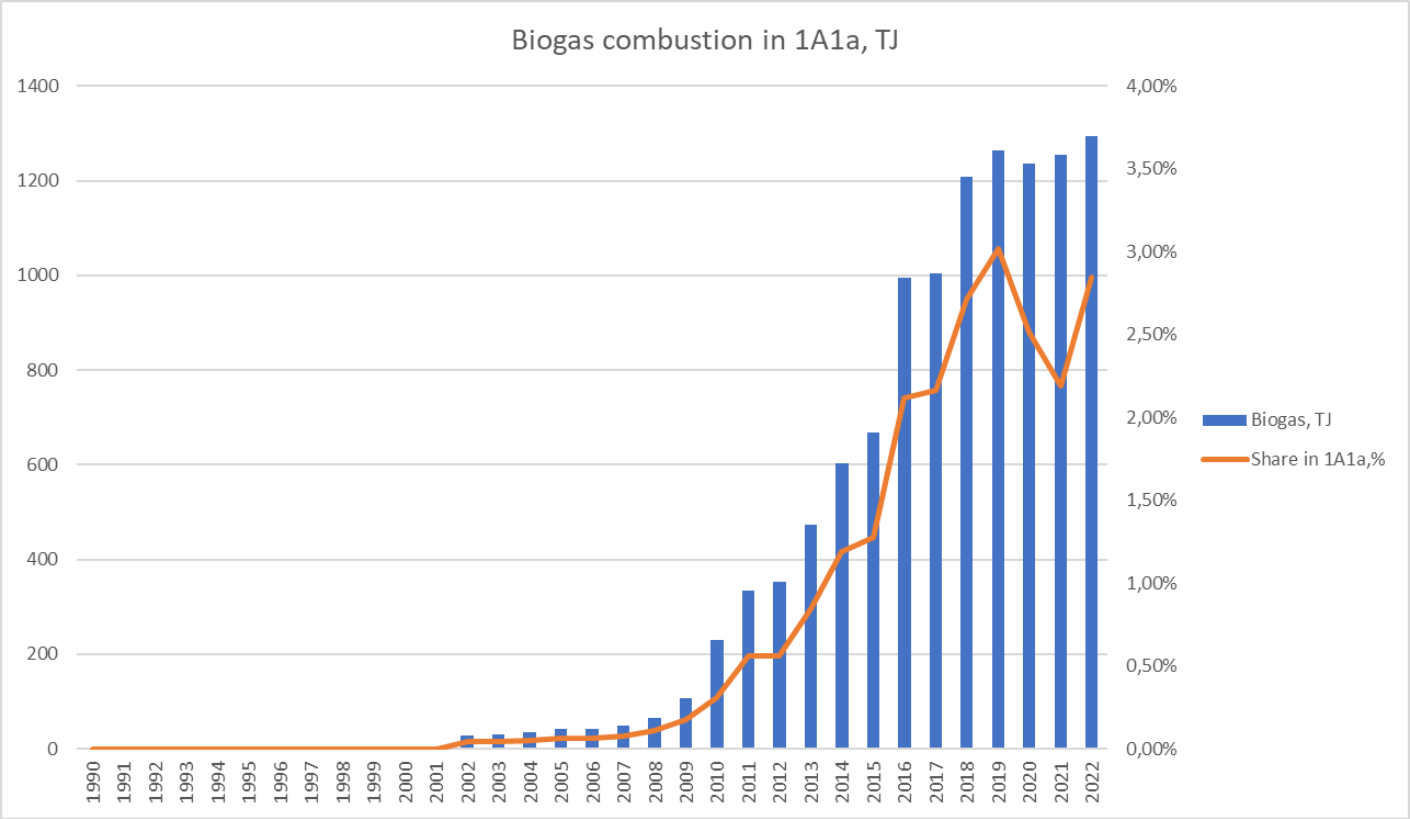


Figure 15. Biogas combustion in 1A1a, TJ

The emission factors from the Table 3.9 „Tier 1 emission factors for source category 1.A.1.a using biogas“ (GB2023, chapter 1A1) were used for calculation of air pollutant emissions.

1.1.6. Solid biomass combustion and air pollutant emission factors

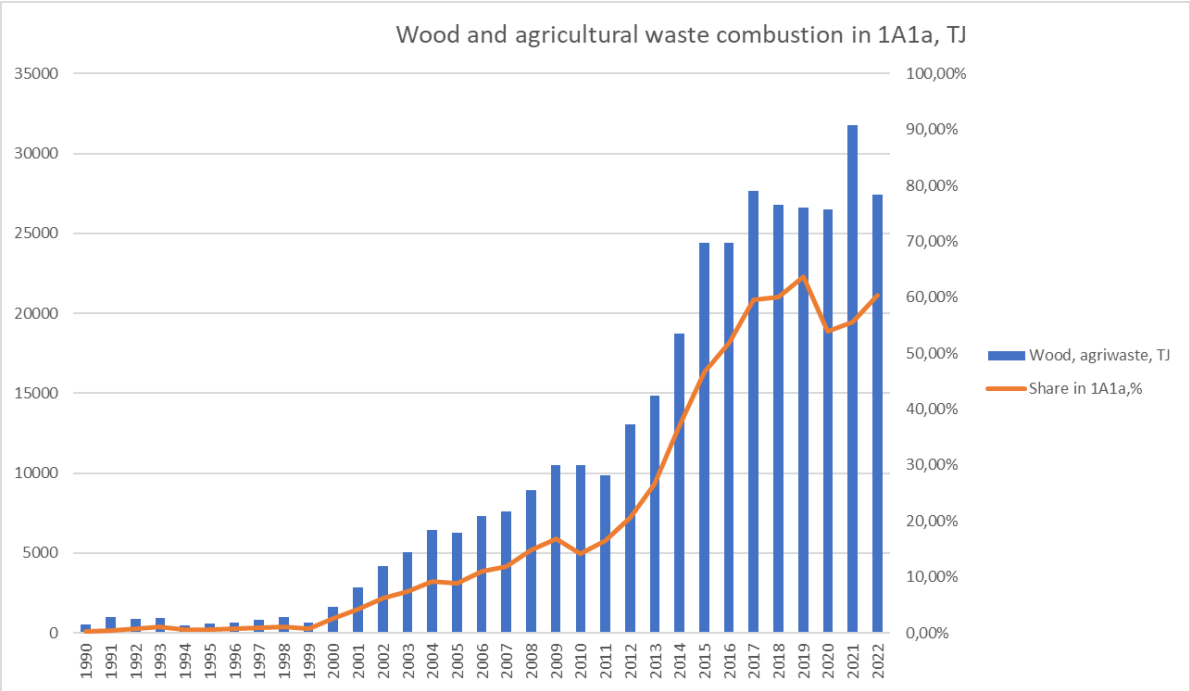


Figure 16. Solid biomass combustion in 1A1a, TJ

It was estimated that about 10-12% of wood in 2019-2022 was combusted in the large combustion plants. The former LCP directive regulates NOx and PM emission standards for this group of boilers. According to the Pollution Permits, NOx emission limit values till 2019 were 400 mg/m3 (corresponding EF was 108 g/GJ), from 2019 ELV are 300 mg/m3 (corresponding EF is 81 g/GJ); TSP emission limit values till 2019 were 50 mg/m3 (corresponding TSP EF was 6.88 g/GJ, PM10 EF was 6.2 g/GJ, PM2.5 EF was 5.32 g/GJ,), from 2019 ELV are 30 mg/m3 (corresponding TSP EF is 3.44 g/GJ, PM10 EF was 3.1 g/GJ, PM2.5 EF was 2.66 g/GJ). These NOx and PM emission factors were derived according to the methods provided in Annex D and Annex E (GB2019, chapter 1A1a). The emission factors of CO, NMVOC, SO2, POPs were taken from the Table 3-13 „Tier 2 emission factors for source category 1.A.1.a, dry bottom boilers using wood waste“ (GB2019, Chapter 1A1a) The emission factors of heavy metals provided in the above mentioned table were reduced according to particulate matter abatement efficiency.

It was estimated that about 65% of wood in 2019-2022 was combusted in the medium combustion plants. The details on emission factors are provided in the paragraph “General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants”.

It was estimated that about 25% of wood in 2019-2022 was combusted in the boiler with capacity less than 1 Mw. The emission factors for 0,05-1 MW boilers (except NOx) were taken from the Table 3.46, GB2019, chapter 1A4. NOx EF was

taken from the Table 3.45, GB2019, chapter 1A4, because in Lithuania NOx ELV for 0,05-1 MW boilers is the same as for the 1-50 MW boilers.

LPG (Liquified Petroleum Gas) combustion and air pollutant emission factors

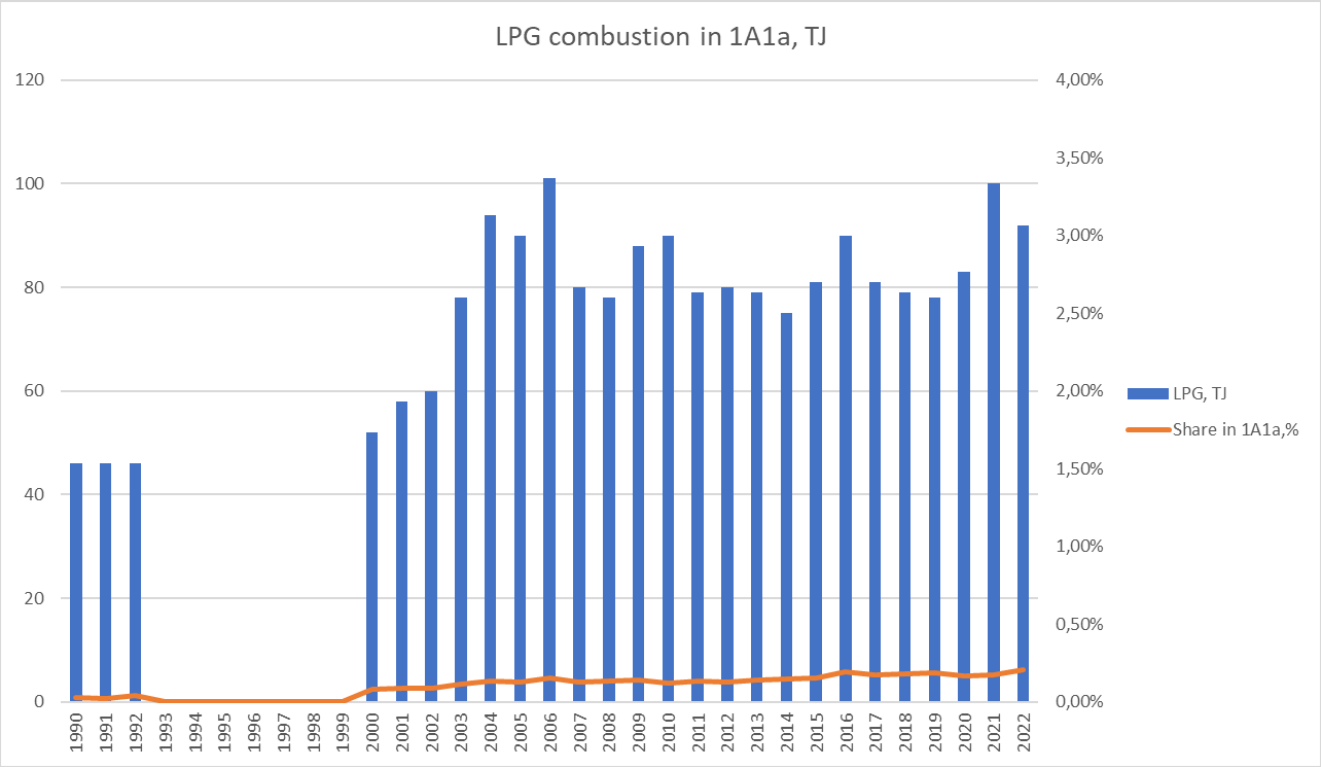


Figure 19. LPG (Liquified Petroleum Gas) combustion in 1A1a, TJ

Emission factors from the Table 3.26 “Tier 2 emission factors for non-residential sources, medium-sized (> 50 kWth to ≤ 1 MWth) boilers burning natural gas” (GB2019, chapter 1A4) were used.

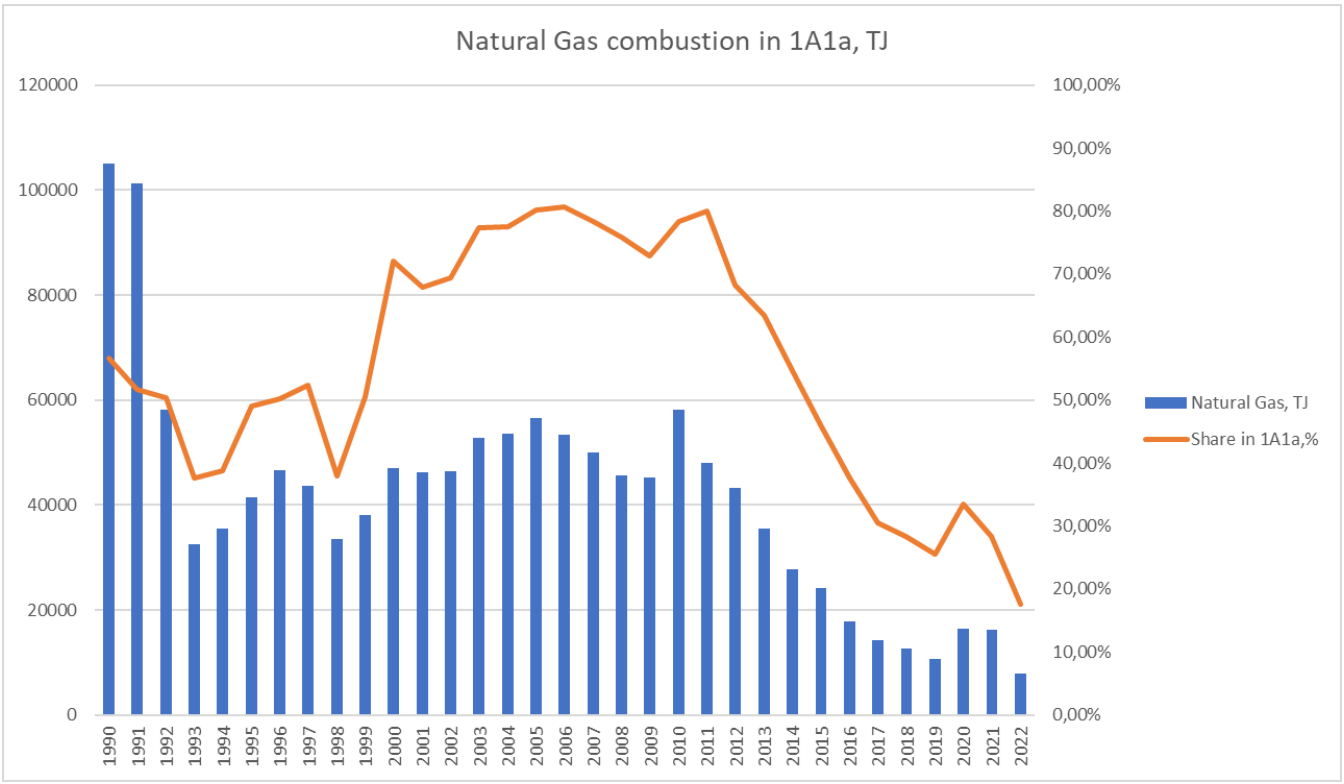


Figure 20. Natural Gas combustion in 1A1a, TJ

Natural gas in the geothermal plants were combusted in the stationary reciprocating engines. Emission factors from the Table 3.30 "Tier 2 emission factors for non-residential sources, reciprocating engines burning gas fuels" (GB2019, Chapter 1A4) were used.

The former LCP directive regulates natural gas NOx emission standards for boilers with capacity > 50 MW. According to the Pollution Permits, NOx emission limit value till 01.01.2008 was 350 mg/m3 (the corresponding EF was 89 g/GJ), in the period 01.01.2008-01.01.2019 ELV was 300 mg/m3 (EF was 76 g/GJ), from 01. 01.2019: ELV is 100 mg/m3 (EF is 25 g/GJ). These NOx emission factors were derived according to the methods provided in Annex D and Annex E (GB2019, chapter 1A1a). The emission factors of PM, CO, NMVOC, SO2, POPs, HM were taken from the Table 3-12 „Tier 2 emission factors for source category 1.A.1.a, dry bottom boilers using natural gas" (GB2019, Chapter 1A1a)

According to the LCP directive, NOx emission standard (ELV) for gas turbine with capacity > 300 MW is 50 mg/M3 (EF is 43 g/GJ). This NOx EF value was obtained from the Table D4 in GB2019, chapter 1A1, page 86. Emissions of other air pollutants from natural gas combustion in gas turbine with capacity > 300 MW were calculated on the basis of emission factors taken from the Table 3-17 „Tier 2 emission factors for source category 1.A.1.a, gas turbines using gaseous fuels" (GB2019, chapter 1A1).

Natural Gas combustion in 1A1a Heating plants occured in 0,05-50 MW boilers. From the data obtained from Environmental information system (in lith. AIVIKS) natural gas distribution by boiler capacity was estimated: 5% in boilers 0,05-1 MW, 50% in boilers 1-5 MW, 45% in boilers 5-50 MW. NOx emissions were estimated on the basis of the principles in the „General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants". The emission factors for other pollutants were taken from the Table 3.27 "Tier 2 emission factors for non-residential sources, medium sized (> 1 MWth to ≤ 50 MWth) boilers burning natural gas" (GB2019, chapter 1A4).

Waste combustion and air pollutant emission factors

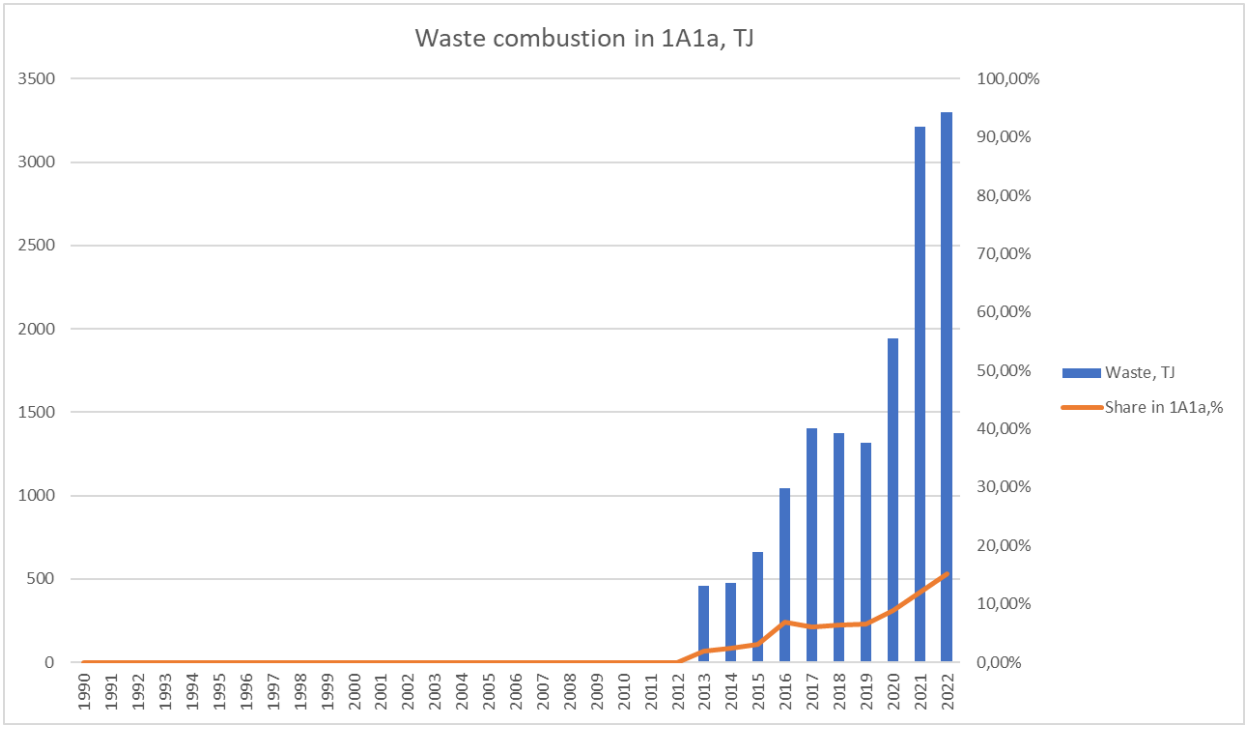


Figure 23. Waste combustion in 1A1a

NOx average emission limit value (ELV, mg/m3) in the pollution permits for waste combustion in 2013-2020 was 190 mg/m3 (corresponding EF was 1017 g/Mg waste), in 2021 emission limit value (ELV, mg/m3) was 170 (corresponding EF was 910 g/Mg waste). These NOx EF values were derived from the Table 3-1 "Tier 1 emission factors for source category 5.C.1.a

Municipal waste incineration" (GB2019, chapter 5.C.1.a Municipal waste incineration), assuming that NOx EF value provided in this table corresponds to the ELV (mg/m3) 200. Emission factors for other pollutants were taken from the same table.

Planned improvements to the sector 1A1a

To investigate the implemented NOx emission limit values in the terms of concentrations according to the real-life measurement reports. This issue was raised during TAIEX workshop in May, 2023.

Fuel combustion in the 1A1b (Petroleum refining)

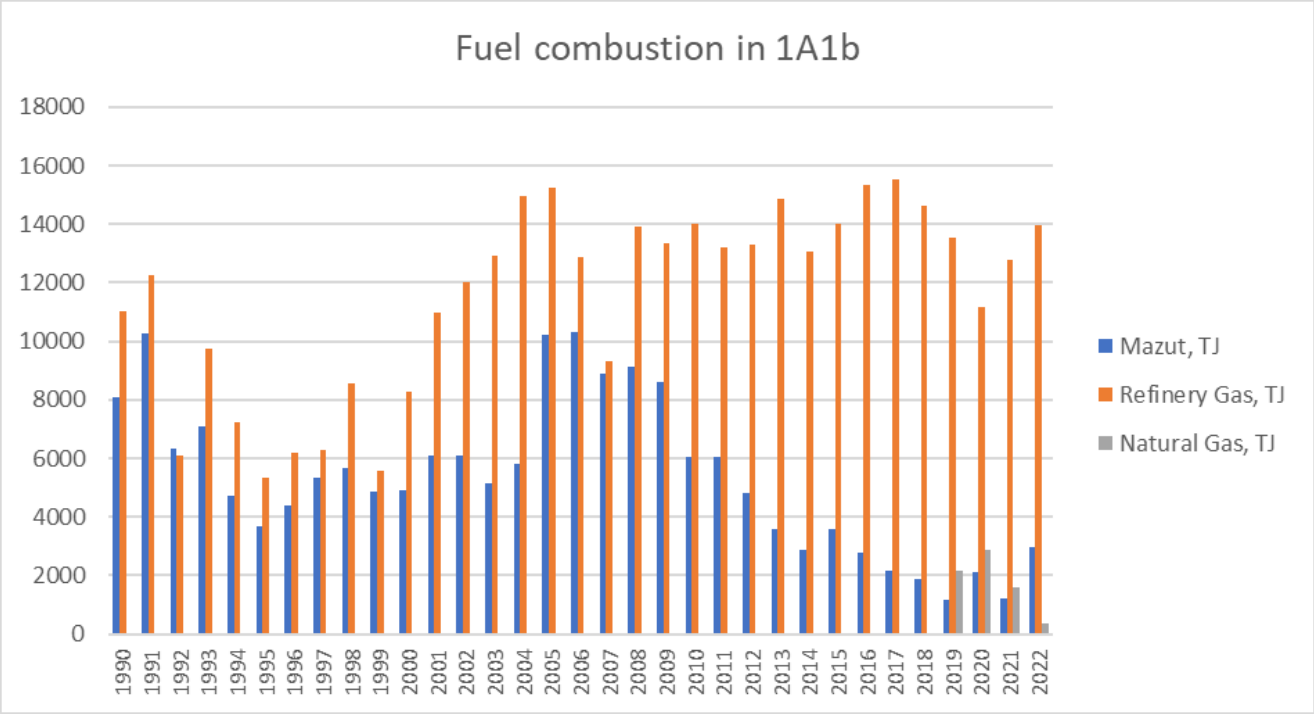


Figure 29. Fuel combustion in 1A1b

From 2005, fuel combusted in the oil refinery power plant is included in 1A1b (1990-2004 it was included in the 1A1a). Natural gas from 2019 is used in the oil refinery power plant.

Emissions of NOx, SO2, PM were taken from the refinery plant operator reports. Emissions of other pollutants (CO, NMVOC, POPs, HM) were calculated by the following method:

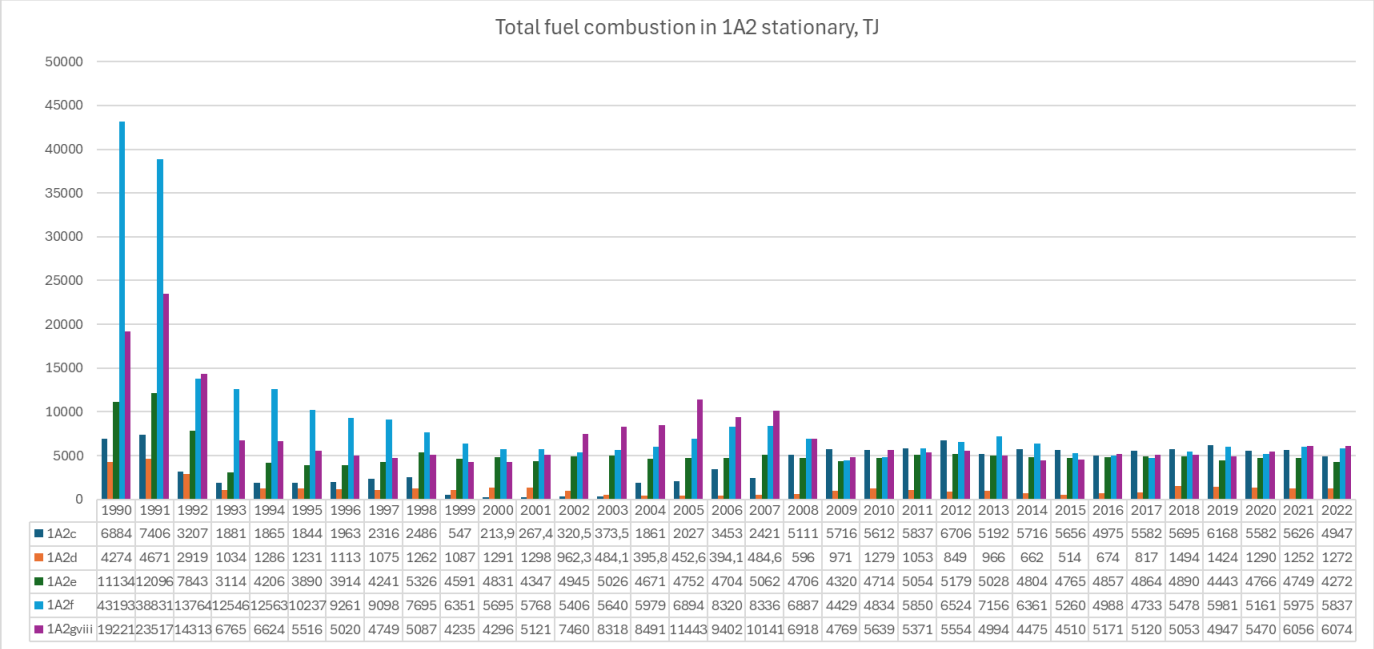
Fuel	***Industrial process***	***EF Table***
Residual fuel oil	Combustion in refinery power plant	GB2019, chapter 1A1, Table 3-11 "Tier 2 emission factors for source category 1.A.1.a, dry bottom boilers using residual oil"
Residual fuel oil	1A1b Process Furnaces, Heaters and Boilers	GB2019, chapter 1A1, Table 4-4 "Tier 2 emission factors for source category 1.A.1.b, process furnaces using residual oil"
Natural gas	Combustion in refinery power plant	GB2019, chapter 1A1, Table 3-12 "Tier 2 emission factors for source category 1.A.1.a, dry bottom boilers using natural gas"
Refinery gas	Combustion in refinery power plant; 1A1b Process Furnaces, Heaters and Boilers	GB2019, chapter 1A1, Table 4-2 "Tier 1 emission factors for source category 1.A.1.b, refinery gas"

Manufacture of solid fuels and other energy industries (1A1c)

Combustion of diesel oil in the off-road machinery in peat mining and combustion of natural gas in the stationary reciprocating engines and boilers in the Floating Storage Regasification Unit (FSRU) at the Liquefied Natural Gas (LNG) terminal in Klaipeda Sea Port were the main sources of air pollution in this NFR sector.

Stationary fuel combustion in the 1A2 (Manufacturing industries and construction)

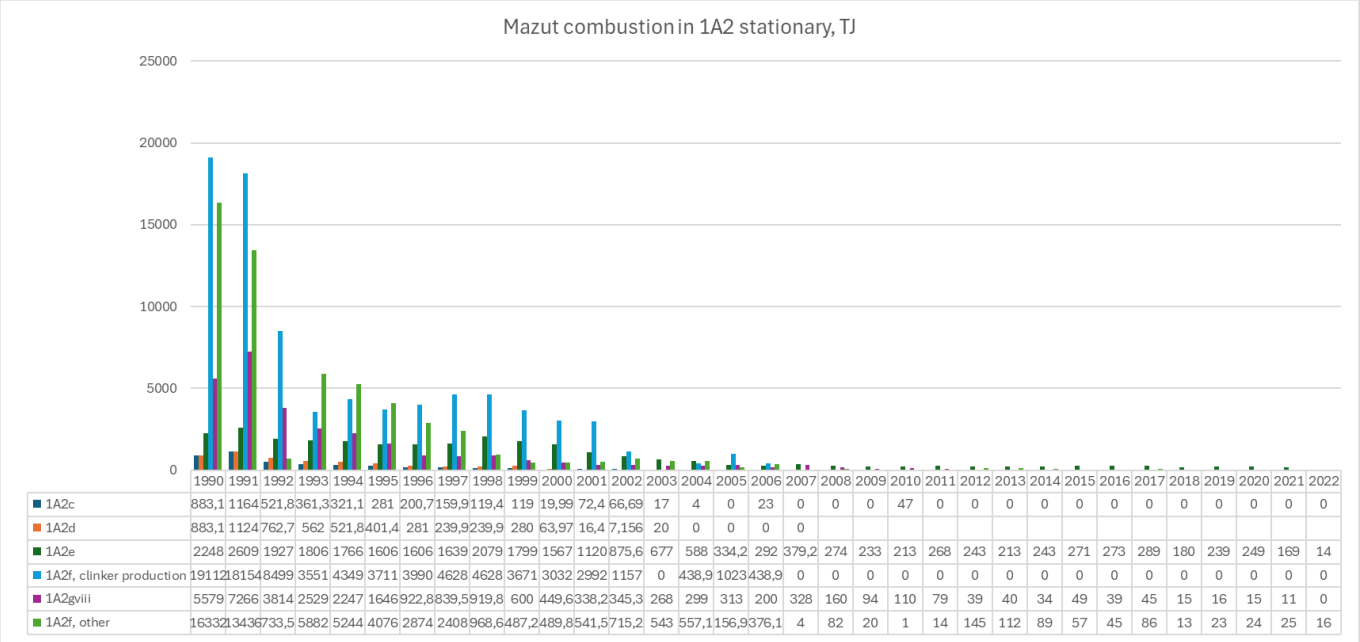
The Statistics Lithuania fuel balance was used as the activity data for calculation of the historical emissions (1990-2022).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1A2c	6884	7406	3207	1881	1865	1844	1963	2316	2486	547	213,9	267,4	320,5	373,5	1861	2027	3453	2421	5111	5716	5612	5837	6706	5192	5716	5656	4975	5582	5695	6168	5582	5626	4947
1A2d	4274	4671	2919	1034	1286	1231	1113	1075	1262	1087	1291	1298	962,3	484,1	395,8	452,6	394,1	484,6	596	971	1279	1053	849	966	662	514	674	817	1494	1424	1290	1252	1272
1A2e	11134	12096	7843	3114	4206	3890	3914	4241	5326	4591	4831	4347	4945	5026	4671	4752	4704	5062	4706	4320	4714	5054	5179	5028	4804	4765	4857	4864	4890	4443	4766	4749	4272
1A2f	43193	38831	13764	12546	12563	10237	9261	9098	7695	6351	5695	5768	5406	5640	5979	6894	8320	8336	6887	4429	4834	5850	6524	7156	6361	5260	4988	4733	5478	5981	5161	5975	5837
1A2gviii	19221	23517	14313	6765	6624	5516	5020	4749	5087	4235	4296	5121	7460	8318	8491	11443	9402	10141	6918	4769	5639	5371	5554	4994	4475	4510	5171	5120	5053	4947	5470	6056	6074

Figure 33. Fuel consumption by industry branch

Heavy fuel oil combustion and air pollutant emission factors

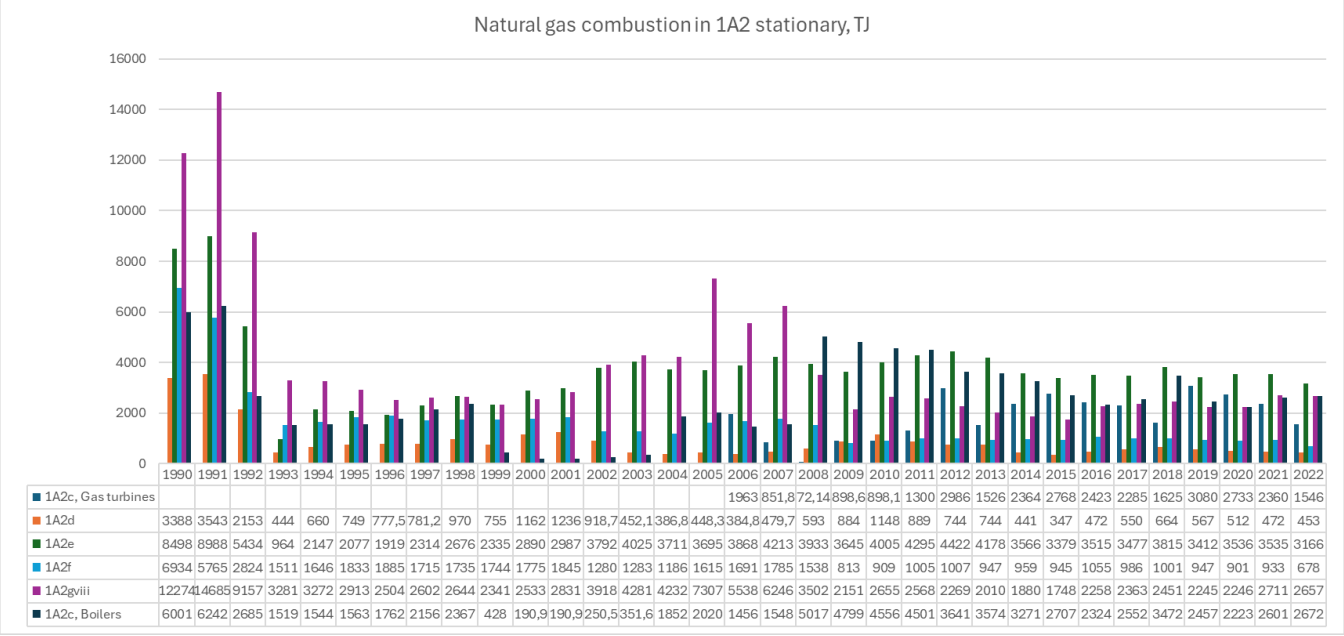


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1A2c	883,1	1164	521,8	361,3	321,1	281	200,7	159,9	119,4	119	19,99	72,4	66,69	17	4	0	23	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0
1A2d	883,1	1124	762,7	562	521,8	401,4	281	239,9	239,9	280	63,97	16,4	7,156	20	0	0	0	0															
1A2e	2248	2609	1927	1806	1766	1606	1606	1639	2079	1799	1567	1120	875,6	677	588	334,2	292	379,2	274	233	213	268	243	213	243	271	273	289	180	239	249	169	14
1A2f, clinker production	19112	18154	8499	3551	4349	3711	3990	4628	4628	3671	3032	2992	1157	0	438,9	1023	438,9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1A2gviii	5579	7266	3814	2529	2247	1646	922,8	839,5	919,8	600	449,6	338,2	345,3	268	299	313	200	328	160	94	110	79	39	40	34	49	39	45	15	16	15	11	0
1A2f, other	16332	13436	733,5	5882	5244	4076	2874	2408	968,6	487,2	489,8	541,5	715,2	543	557,1	156,9	376,1	4	82	20	1	14	145	112	89	57	45	86	13	23	24	25	16

Figure 34. Heavy fuel oil consumption by industry branch

For heavy fuel oil combustion (apart clinker production) the emission factors were taken from the Table 3-25 " Tier 2 emission factors for non-residential sources, medium sized (> 1 MWth to ≤ 50 MWth) boilers liquid fuels "(GB2019, Chapter 1A4).

Gaseous fuel combustion and air pollutant emission factors



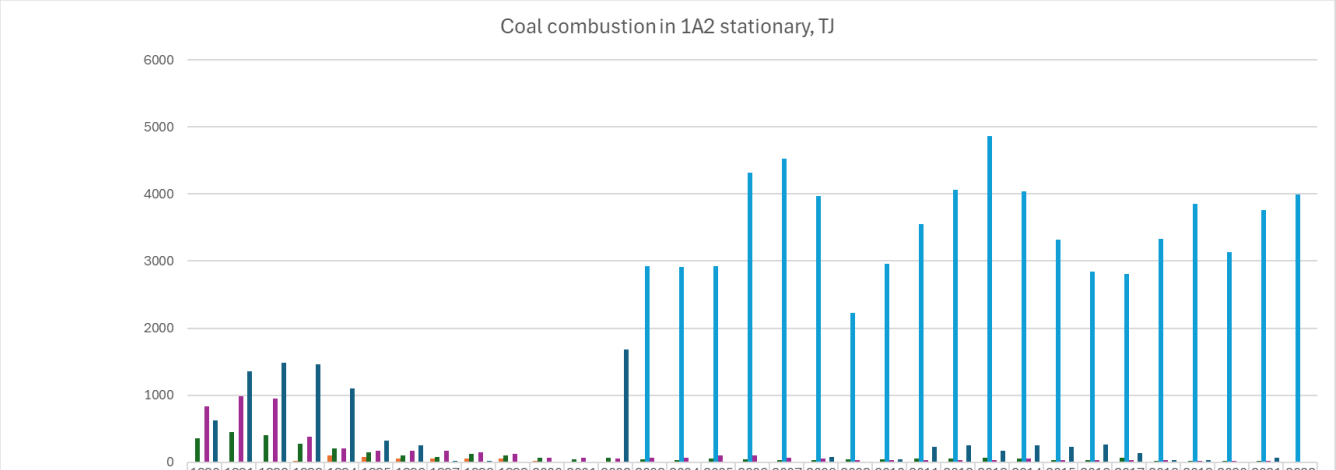
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1A2c, Gas turbines																	1963	851,8	72,14	898,6	898,1	1300	2986	1526	2364	2768	2423	2285	1625	3080	2733	2360	1546
1A2d	3388	3543	2153	444	660	749	777,5	781,2	970	755	1162	1236	918,7	452,1	386,8	448,3	384,8	479,7	593	884	1148	889	744	744	441	347	472	550	664	567	512	472	453
1A2e	8498	8988	5434	964	2147	2077	1919	2314	2676	2335	2890	2987	3792	4025	3711	3695	3868	4213	3933	3645	4005	4295	4422	4178	3566	3379	3515	3477	3815	3412	3536	3535	3166
1A2f	6934	5765	2824	1511	1646	1833	1885	1715	1735	1744	1775	1845	1280	1283	1186	1615	1691	1785	1538	813	909	1005	1007	947	959	945	1055	986	1001	947	901	933	678
1A2gviii	12274	14685	9157	3281	3272	2913	2504	2602	2644	2341	2533	2831	3918	4281	4232	7307	5538	6246	3502	2151	2655	2568	2269	2010	1880	1748	2258	2363	2451	2245	2246	2711	2657
1A2c, Boilers	6001	6242	2685	1519	1544	1563	1762	2156	2367	428	190,9	190,9	250,5	351,6	1852	2020	1456	1548	5017	4799	4556	4501	3641	3574	3271	2707	2324	2552	3472	2457	2223	2601	2672

Figure 35. Natural gas consumption by industry branch

For natural gas combustion in gas turbines, EFs from Table 3.28 „Tier 2 emission factors for non-residential sources, gas turbines burning natural gas“ (GB2019, chapter 1A4) were used.

Natural Gas combustion in 1A2 also was performed in 0,05-50 MW boilers. From the data obtained from Environmental information system (in lith. AIVIKS) natural gas distribution by boiler capacity was estimated: 5% in boilers 0,05-1 MW, 50% in boilers 1-5 MW, 45% in boilers 5-50 MW. NOx emissions were estimated on the basis of the principles in the „General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants”. The emission factors for other pollutants were taken from the Table 3.27 “Tier 2 emission factors for non-residential sources, medium sized (> 1 MWth to ≤ 50 MWth) boilers burning natural gas” (GB2019, chapter 1A4).

Coal combustion and air pollutant emission factors

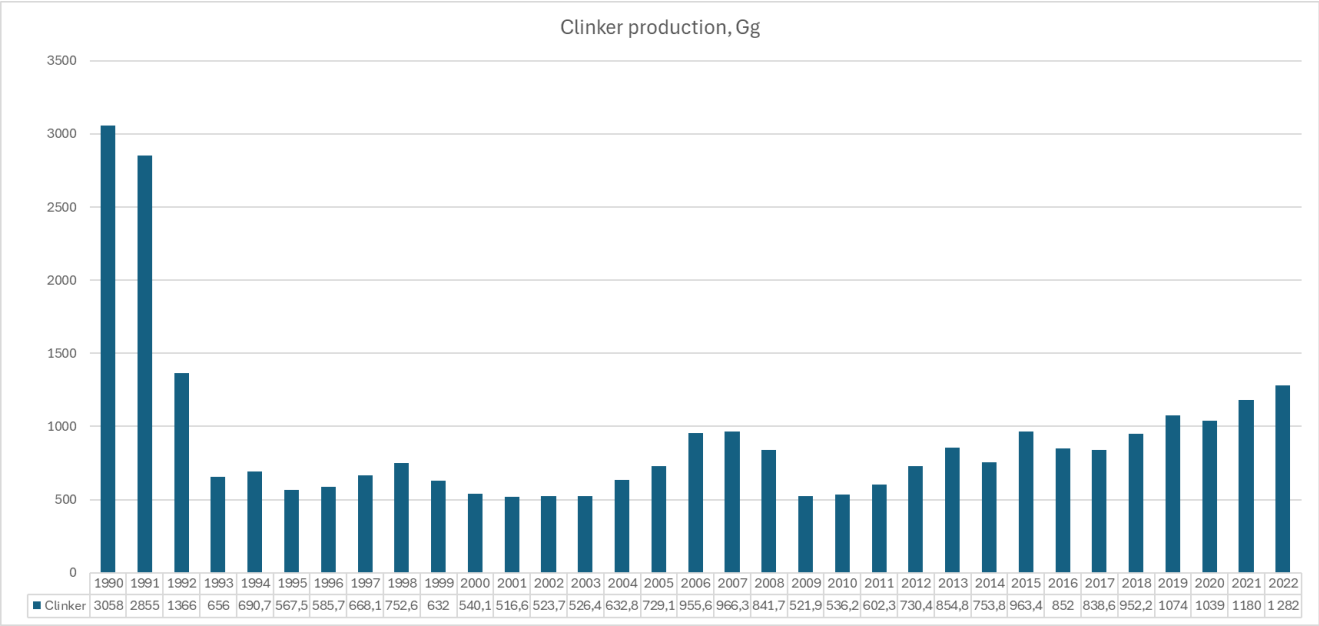


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1A2d	0	0	0	25,12	100,5	75,36	50,24	50,4	50,24	50,24	17,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1A2e	351,7	452,2	401,9	276,3	201	150,7	100,5	76	125,6	100,5	67,5	37,68	61,29	40,86	34,05	49,62	41	36	32	43	41	56	56	66	57	36	33	66	24	15	16	17	5
1A2f, clinker production	0	0	0	0	0	0	0	0	0	0	0	0	0	2920	2909	2924	4323	4523	3965	2230	2962	3552	4067	4863	4035	3320	2846	2809	3327	3858	3138	3758	3997
1A2gviii	829,3	980,4	954	376,6	201,3	175,4	176,1	175,5	151	125,3	63,46	70,81	58,71	66,14	63,27	102,9	96,4	64,28	50	29	35	35	33	36	53	27	31	36	29	25	18	16	9
1A2c	0	0	0	0	0	0	0	0	0	0	0	2,512	2	0	0	0,386	0	0,318	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1A2f, other	628	1356	1482	1457	1105	326,6	251,2	25,12	25,12	0	7,536	0	1682	0	0	0	4,145	3,065	75,97	3,184	37,52	226,2	248,7	171,5	248,1	224,7	265,8	137,6	27,43	26,2	0,141	71,06	2

Figure 36. Coal fuel consumption by industry branch

For solid fuel combustion (apart clinker production) the emission factors were taken from the Table 3.21 “ Tier 2 emission factors for non-residential sources, medium-size (> 1 MWth to ≤ 50 MWth) boilers burning coal fuels “(GB2019, Chapter 1A4). For SO2 emissions from stone wool production, abatement installed in the plant was applied.

Clinker production and air pollutant emission factors

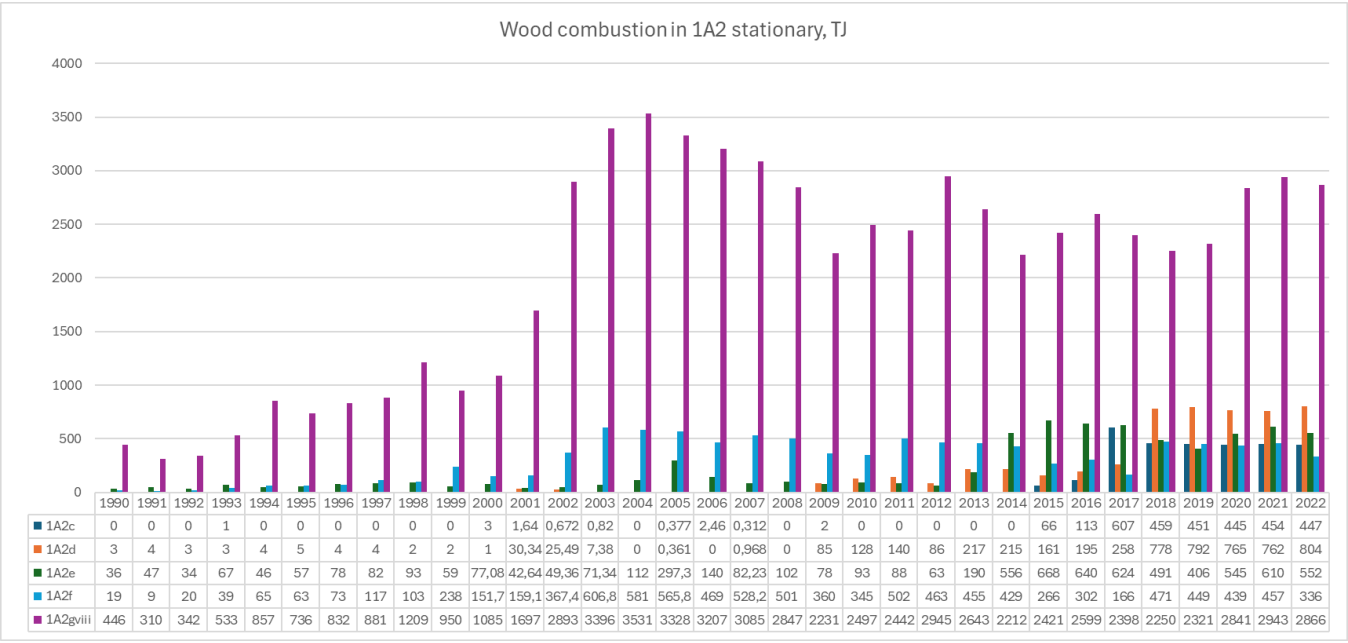


Emissions of NOx and SO2 were provided by the cement plant operator. Emissions of other pollutants were estimated using EFs from the Table 3-24 "Tier 2 emission factors for source category 1.A.2.f.i, Cement production" (GB2019, chapter 1.A.2).

Implementation of TERT recommendation LT-1A2f-2023-0001

Evaluation of SO2 emissions in the production of clinker will be performed applying the appropriate EF for fuels combusted during clinker production. The obtained results will compared with data of cement plant and with estimation obtained using EF suggested by GB2023. On the basis of such comparison, solution for this issue will be done.

Biomass combustion and air pollutant emission factors



All wood in 1A2 was burned in boilers 0,05-50 MW. Details on EFs are provided in the paragraph “General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants”.

Light fuel oil combustion and air pollutant emission factors

Emission factors from the Table 3-24 “Tier 2 emission factors for non-residential sources, medium-sized (> 50 kWth to ≤ 1 MWth) boilers liquid fuels” (GB2019, Chapter 1A4) (SO2 - Table 4.1 , GB2019, chapter 1A4) were used to evaluate emissions from this source.

Stationary fuel combustion in the 1A4ai,Commercial/Institutional: Stationary

Activity data were taken from fuel balance chapter “Fuel consumption in sector of services”. Regarding emission factors please refer to “General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants”

RECALCULATIONS

SO2 emissions were corrected (in the 2023 submission, amount from coal combustion was included twice)

Stationary fuel combustion in 1A4bi (residential)

IIASA GAINS model and IIASA TSAP 16 Underlying assumptions - GAINS details.xlsx database suggested fuel distribution by device type was used. The share of pellet boilers and other wood combustion devices from 2014 was reestimated on the basis of the database of the national Certification center of construction products. Data on PM2.5 condensables is located in the annex “NIIR 1990-2022 Annex PM fractions in 1A4bi.xlsx”. Lithuania does not include this fraction in the PM2.5 national inventory. For mobile combustion in households activity data (40 TJ) proposed by IIASA GAINS model was used.

RECALCULATIONS

The share of pellet boilers and other wood combustion devices from 2014 was reestimated on the basis of the database of the national Certification center of construction products.

Stationary fuel combustion in 1A4ci (agriculture)

Activity data were taken from fuel balance chapter “Fuel consumption in agriculture”. Regarding emission factors please refer to “General methodological issues for stationary non-residential fuel combustion in Medium Combustion Plants”

Fugitive emissions from the fuels (1B)

Coal mining and handling (1.B.1.a)

Overview of the sector

In Lithuania, companies using coal as fuel or companies selling coal, have two kinds of coal – washed and unwashed. Washed coal has less dust than unwashed coal, so storage of washed carbon, unlike the storage of non-washed carbon, is attributed to controlled coal storage. On the other hand, companies storing unwashed coal are classified as uncontrolled carbon storage companies.

Methodological issues

PM emissions from coal public storage were estimated from the amount of coal for the non-industrial use taken from the fuel balance of Statistics Lithuania. Coal for industrial use is stored in the covered premises and do not emmit PM to the atmosfere.

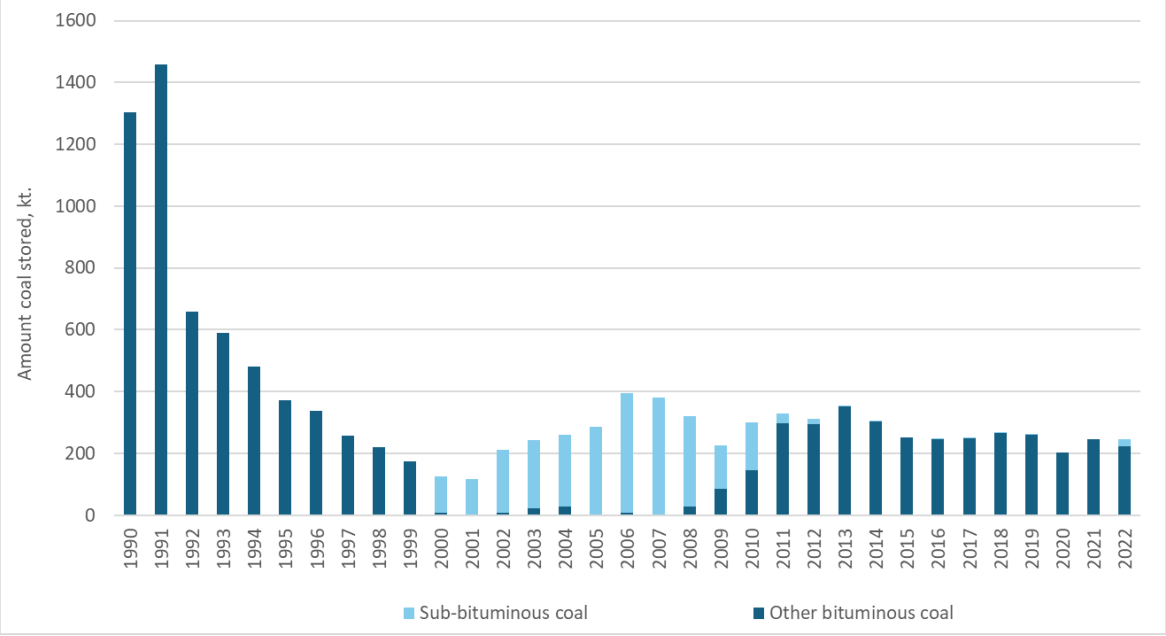


Figure 2-37. Trends in amount of stored coal in the period 1990-2022

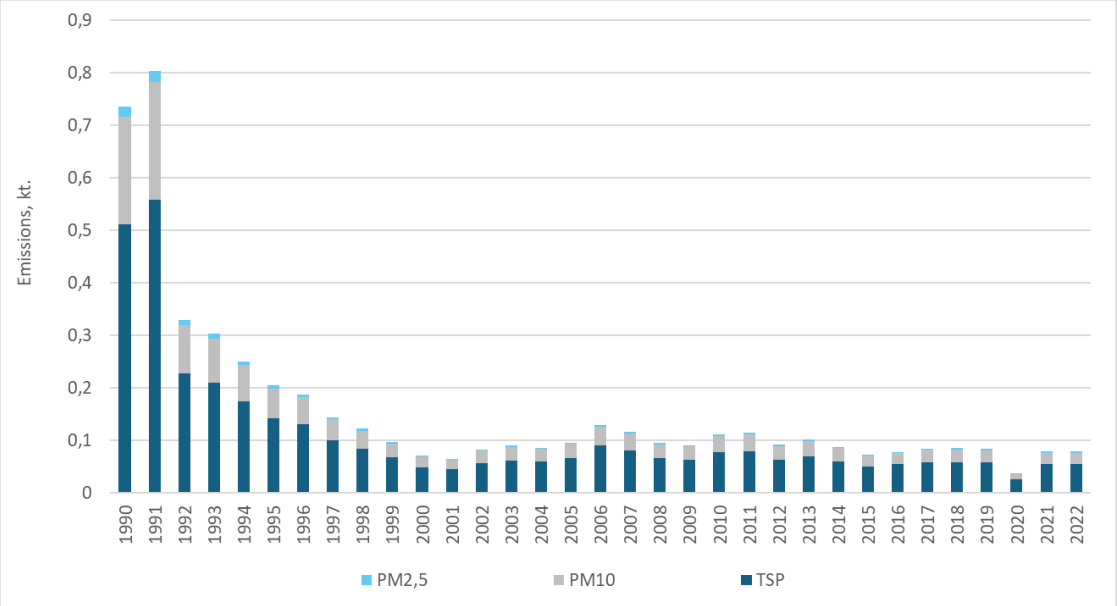


Figure 2-38. Pollutant emissions in sector 1.B.1.a Coal mining and handling in the period 1990-2022

The emission factors from the Table 3-4 „Tier 2 emission factors for source category 1.B.1.a Coal Mining and Handling, Storage of coal, uncontrolled“ (GB2023, chapter 1.B.1.a Fugitive emissions from solid fuels: coal mining and handling) were used.

$$E_{Pollutant} = AR_{production} \times EF_{pollutant}$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant

$AR_{production}$ – the activity rate for the coal mining,

$EF_{pollutant}$ – the emission factor for this pollutant

Uncertainties and time-series consistency

The uncertainty of activity data is 2%. The EF uncertainty range is provided in EMEP/EEA, 2023 Guidebook.

Source-specific QA/QC 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 planned improvements .

Exploration, Production and Transport of Oil (1.B.2.a.i)

Overview of the sector

In this sector, NMVOC emissions from crude oil production were estimated.

Methodological issues

Crude oil production activity data are taken from fuel balance by Statistics Lithuania, emission factors were used from the Table 3-7 „Tier 2 emission factors for source category 1.B.2.a.i Exploration, Production and Transport of Oil, Facilities producing oil only“ (GB2023, chapter B.2.a.i Oil – exploration, production, transport; and 1.B.2.b Natural gas) were used.

$$E_{Pollutant} = AR_{production} \times EF_{pollutant}$$

Where:

$E_{pollutant}$ – the emission of the specified pollutant

$AR_{production}$ – the activity rate for the exploration/production of oil,

$EF_{pollutant}$ – the emission factor for this pollutant

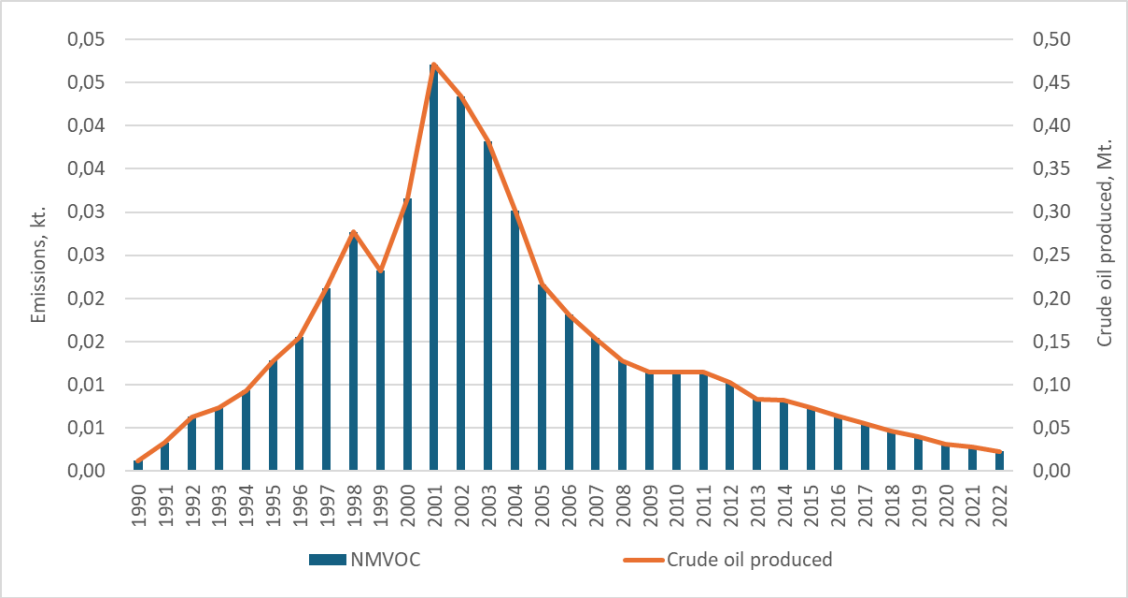


Figure 2-40. NMVOC emissions and crude oil production in the period 1990-2022

Source-specific QA/QC 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 planned improvements .

1B2b Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)

Data on gas leakage from the pipelines are taken from the GHG inventory. Chemical composition of natural gas are provided by the gas transmission system operator and looks like this:

Eil. Nr.	Komponentė	Žymėjimas	Vidutinė vertė	Matavimo vnt.
1	Metanas	CH_4	96,1910	% molio
2	Etanas	C_2H_6	2,5844	% molio
3	Propanas	C_3H_8	0,4041	% molio
4	i-Butanas	C_4H_{10}	0,0675	% molio
5	n-Butanas	C_4H_{10}	0,0602	% molio
6	neo-Pentanas	C_5H_{12}	0,0017	% molio
7	i-Pentanas	C_5H_{12}	0,0096	% molio
8	n-Pentanas	C_5H_{12}	0,0059	% molio
9	C_6 plus	C_{6+}	0,0184	% molio
10	Azotas	N_2	0,4948	% molio
11	Anglies dioksidas	CO_2	0,1624	% molio

Methan, Carbon 6, Nitrogen, CO2 are excluded from leakage.

1B2aiv Fugitive emissions oil: Refining and storage

SO2, NMVOC, NOx emission are provided by the refinery plant. Emissions of NMVOC from 1A1b also were added here, according to the GB2023 methodology. The plant performed methodological improvements in NMVOC leakage accounting (more direct measurements were implemented) in 2022.

Implementation of TERT recommendations LT-1B2aiv-2021-0001

When assessing emissions from the oil refining sector, emissions data from one company (JSC ORLEN Lietuva (hereinafter - the Company)) operating in the refining sector are used. In 2005, the Company (then JSC Mažeikių Nafta), in accordance with the legal requirements in force at that time, reported, after assessing the Company's refinery production processes at that time, that it had emitted 10,11 kt (the amount declared in the Company's annual report) of volatile organic compounds (VOCs) into the air. The amount of VOCs emitted from fugitive sources (open surfaces, pipelines, couplings, flanges, etc.) was estimated using a national methodology approved in 2003 (the methodology of the Lithuanian Energy Institute "Methodology for the assessment of air pollution with organic compounds at the Mažeikiai Oil Refinery", based on the recommendations of the American Petroleum Institute). Calculations according to this methodology are based on fixed emission factors (coefficients). The Environmental Protection Agency considers that the national methodology is the most appropriate for estimating the amount of VOCs emitted by the Company in 2005. Due to changes in legal requirements, between 2006 and 2020, the Company implemented the abatement measures foreseen in the 2003 and 2014 information documents on the Best Available Techniques of Production in the oil and gas industry, but continued to use the above-mentioned national methodology for the estimation of VOC emissions from fugitive sources, which is not able to assess the impact of the implemented abatement measures on the emission of pollutants. An inventory of ambient air pollution sources and their emissions was carried out at the Company in 2022. The inventory aimed at changing the methodology for the assessment of VOCs, i.e. to apply an integrated determination of emissions of NMVOCs: instrumental measurements and calculation. For 2022, the amount of NMVOC emissions declared in the Company's annual report decreased to 7.88. In 2023, the Company applied integrated measurement of NMVOC emissions: instrumental measurement and calculation.

Emission of heavy metals and PAHs were evaluated applying

Table 3-2 Tier 2 emission factors for source category 1.B.2.a.iv Refining, storage, Fluid catalytic cracking - CO boiler (not installed)

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.B.2.a.iv	Fugitive emissions oil: Refining / storage			
Fuel	NA				
SNAP (if applicable)	040102	Fluid catalytic cracking - CO boiler			
Technologies/Practices	Catalytic Cracking unit regenerators Partial burn without CO boiler				
Region or regional conditions					
Abatement technologies	Cyclone systems installed internally within the regenerator				
Not applicable	HCB, PCB				
Not estimated	PCDD/F				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NO_x	0.2	kg/m3 fresh feed	0.12	0.29	CONCAWE (2015A)
CO	39	kg/m3 fresh feed	24	55	CONCAWE (2015A)
NMVOC	0.63	kg/m3 fresh feed	0.38	0.88	CONCAWE (2015A)
SOx	1.4	kg/m3 fresh feed	0.85	2	CONCAWE (2015A)
NH_3	0.16	kg/m3 fresh feed	0.093	0.22	CONCAWE (2015A)
TSP	0.7	kg/m3 fresh feed	0.05	2	Environment Australia, 1999
PM10	0.55	kg/m3 fresh feed	0.18	1.6	CONCAWE (2015A)
$PM_{2.5}$	0.24	kg/m3 fresh feed	0.08	0.5	1)
BC[(a)]	0.13	% of PM2.5	0.05	0.2	2)
Pb	0.32	g/m3 fresh feed	0.11	0.96	CONCAWE (2015A)
Cd	0.063	g/m3 fresh feed	0.021	0.19	CONCAWE (2015A)
Hg	0.07	g/m3 fresh feed	0.023	0.21	CONCAWE (2015A)
As	0.014	g/m3 fresh feed	0.0046	0.042	CONCAWE (2015A)
Cr	0.33	g/Mg coke burned	0.1	1	Bertrand & Siegell, 2002; CONCAWE (2015A) [(b)]
Cu	0.14	g/m3 fresh feed	0.046	0.42	CONCAWE (2015A)
Ni	0.61	g/m3 fresh feed	0.2	1.8	CONCAWE (2015A)
Se	0.014	g/m3 fresh feed	0.005	0.042	CONCAWE (2015A)
Zn	0.12	g/m3 fresh feed	0.039	0.35	CONCAWE (2015A)
Benzo(a)pyrene	0.71	mg/Mg coke burned	0.4	1.4	CONCAWE (2015A)
Benzo(b)fluoranthene	1.2	mg/Mg coke burned	0.6	2.4	CONCAWE (2015A)
Benzo(k)fluoranthene	0.82	mg/Mg coke burned	0.4	1.6	CONCAWE (2015A)
Indeno(1,2,3-cd)pyrene	0.62	mg/Mg coke burned	0.3	1.2	CONCAWE (2015A)

Amount of coke burned was taken from the fuel balance, feed was estimated on the basis of the refinery continuous air pollution monitoring reports.

Recalculations

Emissions of NMVOC from 1A1b also were added here, according to the GB2023 methodology.

1B2av Distribution of oil products

Source category description In Lithuania, oil terminals and service stations must have permits with overload >100 m3 per year. Two complementary directives aim jointly to reduce NMVOC emissions from the storage and distribution of petrol: • Directive 94/63/EC concerning emissions of NMVOCs from the storage of petrol and distribution from terminals to service stations (the VOC-I Directive), which covers refineries and the delivery of petrol to service stations; • Directive 2009/126/EC concerning petrol vapor recovery during refueling of motor vehicles at service stations (the VOC - II Directive). Since 1 January 2004 requirements entered into force in major installations: terminals with an annual gasoline turnover of more than 50 000 tons per year, and in terminals where gasoline is transported to railway tanks, tank-vehicles and/or vessels with an annual petroleum turnover of more than 150 thous. tons per year, as well as petrol stations with a petrol turnover of 1000 m3 per year, as well as in petrol stations in cities.

Methodological issues. The calculation of the NMVOC time series for fugitive emissions from gasoline distribution, can be based on methods given by CONCAWE, including annual national gasoline consumption and assumptions on the share of gasoline evaporated at different stages of the handling procedure, as well as effects of applied abatement technology at gasoline stations. Algorithms are provided for the following sources: • Storage tanks; • Automobile refueling. Gasoline vapor emissions at service stations can be controlled using “vapor balancing” techniques: Storage tank filling: When the storage tank is filled the vapors normally vented to atmosphere can be fed back into the tanker cargo tank (compartment) from which the gasoline is being offloaded. This technique is called “Stage 1B” vapor balancing.