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FINAL REPORT ON EXPERT EVALUATION OF TIER 2 ACCURACY LEVEL NATIONAL ACCOUNTING OF POLLUTANTS EMITTED INTO THE ATMOSPEHRE IN FUEL BURNING SECTOR (EXCLUDING TRANSPORT)

Final report

2020

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**ACRONYMS**

|  |  |
| --- | --- |
| EF | Emission factor |
| GB | Guidebook |
| NFR | Nomenclature for reporting |
| EMEP/EEA | European Monitoring and Evaluation Programme / European Environmental Agency |
| CLRTAP | Convention on Long-range Transboundary Air Pollution |
| LRTAP | Long Range Transboundary Air Pollution |
| SNAP | Selected Nomenclature for Air Pollution |
| GHG | Greenhouse gas |
| CHP | Combined Heat and Power |
| PM | Particulate matter |
| Gg | Gigagrams |
| Kt | Kiloton |
| LMT | Lietuvos Mokslo Taryba (Lithuanian Research Council) |
| IPPC | Integrated Pollution Prevention and Control |
| AB / JSC | Akcinė bendrovė (Joint Stock Company) |
| MS | Microsoft |
| EPA | Environmental protection agency) |
| AIVIKS | Aplinkos informacijos valdymo integruota kompiuterinė Sistema / Integrated computer system for environmental information management |

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# Introduction

This report describes the work carried out during the collection of data on emissions in the fuel burning sector (except for transport), the data required for the collection of input data required for the Tier 2 accuracy of national accounting and the data itself. The purpose of the data collection report is to provide input sources for input data, proposed methodologies and additional comments.

The main purpose of the input data was to compare greenhouse gas (GHG) accounting input activity data and to select appropriate types of abatement technologies to improve National annual inventory using the latest EMEP/EEA air pollutant emission inventory guidebook (2016) prepared. The report also identifies sectors for which additional studies, research and preliminary costs are required in order to implement Tier 2 methods.

Taking into account comments provided by Environmental protection agency regarding application of EFs for calculation of NOx emissions the following clarification in provided. It is recommended to use emission factors provided in EMEP/EEA Guidebook 2016 for period of 1990-2012. The aforementioned EFs take into account measurements conducted on global scale and wide range of devices (meaning that not only new but also old devices are taken into account). EMEP/EEA Guidebook 2016 provides EFs refer to researches conducted in 2006, 2010 and even 1998. This allows to conclude that both old and new technologies are included in the emission factors. Furthermore, older versions of EMEP/EEA guidebook have even lower disaggregation of pollutant sources, hence application of older versions would increase the level of uncertainty. During the preparation of GHG inventory same recommendation was applied, which was formulated by Intergovernmental Panel on Climate Change (IPCC) – the EFs provided in the Guidebook should be applied from 1990. GHG inventory not only includes evaluation of CO2, but also CH4 and N2O, which’s EFs are also heavily dependent on the technologies used. However, in order to ensure the consistency of timeseries a strict recommendation to use 2016 EFs from 1990 is applied. The technical advancements are unquestionable, which was shown in LMT project by measurement conducted on devices currently used in Lithuania – in most case the measured EFs are lower than EFs provided in Guidebook 2016. Accordingly it is recommended to use these measured EFs from 2013.

In order to obtain information on sulphur quantity in oil fuel for period of 2018-2019, Department of Ecology of JSC Orlen Lietuva was contacted. The company representatives stated that Environmental Protection Agency already posses said data since it is provided in the table 6 of environmental reports submitted to EPA. Taking that into account as well as the increased data protection regulations on EU scale, the representatives refused to provide said data.

**During the preparation of this report, the following main data collection activities have been carried out:**

* The analyzed pollution abatement technologies are specified in the IPPC applications and permits[[1]](#footnote-1), [[2]](#footnote-2), [[3]](#footnote-3) submitted in 2018-2019 (8 relevant applications / permits analyzed);
* Analyzed and added relevant data from GHG report for 2019;
* The data of Statistics Lithuania have been updated (taking into account the fact that the Department is also adjusting the data of previous periods, this data in the report have also been updated);
* JSC Orlen was contacted regarding acquisition of data.
* Activity data was received from JSC Kauno Stiklas and JSC Panevėžys Stiklas as well as JSC Akmenės cementas[[4]](#footnote-4);
* The calculations in Interim Report III were renewed;
* NFRs 1.A.4.a.i and 1.A.4.c.o were separated into different sheets in the MS excel file attached.
* Corrections were carried out according to comments provided by Environmental Protection Agency.

Activity data collected with respect to the subsectors, economic activities, and abatement technologies in the Technical Guide by NFR codes are provided in the Microsoft Office Excel document (see MS Excel file Fuel\_burning\_Collected\_data\_1990-2019\_EN.xlsx). This document is considered an integral part of this report.

# PUBLIC ELECTRICITY AND HEAT PRODUCTION (NFR 1.A.1.A)

An empirical study of the submitted data was carried out, evaluating the applied abatement technologies in 1.A.1.a sector for boilers with a rated thermal input> = 300 MW and> = 50 and <300 MW (emission factor, EF) according to the reported protocols. Empirical research and calculated EF values are based on the same methods and practice, which is applied abroad and in Lithuania for GHG accounting. The evaluation of 1.A.1.a sector EF is accompanied by an analysis, which is equivalent to the study, and obtained EF values for the key pollutants are considered as the values recommended by the experts and may be used as national values (according to needs).

In order to apply Tier 3 level methodology for 1.A.1.A it is recommended apply recommendations provided in the EMEP/EEA Guidebook 2016 and to differentiate the devices in to into two groups: >=300 MW and >=50 MW to <300 MW. After balancing the data from large emission sources reports and data from Lithuanian Department of statistics and evaluating the amount of fuel not included in previously mentioned groups EMEP/EEA Guidebook 2016 Tier 2 average emission factors should be applied. Sector 1.A.1.A includes public heat and power generation. **In centralized heating boilers with installed power of <1 MW comprises approximately 1% of total installed capacity** (taking into account not only boilers but also heat power plants).

Each sector of economic activity and applicable/collected/calculated input data for 1990-2017 are described below with information which are required for application of **Tables 3.9-3.20** of EMEP/EEA air pollutant emission inventory guidebook (version - July 2017). Links to data collection sources are also provided.

## Table 3.9 Tier 2 EF for 1.A.1.a, dry bottom boilers using coking coal, steam coal and sub-bituminous coal[[5]](#footnote-5)

**1. Areas of use of this type of boilers:** Different types of coal in public electricity and heat production boilers with a rated thermal input of > = 300 MW and> = 50 and <300 MW are not used.

**2. Activity data**: no activity.

**3.** **Additional pollution abatement measures applied in Lithuania and their efficiency:** not used.

## Table 3.10. Tier 2 EF for 1.A.1.a, wet and dry bottom boilers using brown coal/lignite[[6]](#footnote-6)

**1. Areas of use of this type of boilers:** Different types of coal in public electricity and heat production boilers with a rated thermal input of >= 300 MW ir >= 50 ir < 300 MW are not used.

**2. Activity data**: no activity.

**3.** **Additional pollution abatement measures applied in Lithuania and their efficiency:** not used.

## Table 3.11. Tier 2 EF for 1.A.1.a, dry bottom boilers using residual oil[[7]](#footnote-7)

**1. Areas of use of this type of boilers:** Residual fuel oil in public electricity and heat production is burned in stationary boilers with a rated thermal power> = 300 MW and> = 50 and <300 MW from 1990. An analysis of protocols submitted by large point sources for the period 2006-2015 has been carried out to determine the ratio (EF) between emissions of pollutants into the air and fuel combusted. It was found that fuel oil was burned in six combustion plants by SNAP 010101> = 300 MW (Kaunas CHP, Lithuanian PP, Vilnius E-2, Vilnius E-3 and JSC Orlen Lithuania) and 010102> = 50 and <300 MW (Klaipeda CHP) and <50 MW boiler (boiler) processes. The EF comparative analysis study carried out allows national EF values to be applied (according to needs).

**2. Activity data:** In 2018 April report on 1.A.1.a, public electricity and heat production it was recommended to apply T2 (1990-2005): AD - Lithuanian Department of Statistics, EF - EMEP / EEA guidebook 2016 and T3 (since 2006): AD and EF - respective installations level (major pollution sources reports) and to adjust AD data according to the data of the Department of Statistics of Lithuania.

The attached file contains the data of Statistics Lithuania for the period 1990-2018 i.e. fuel consumption in public electricity and heat production (see MS Excel file, FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, PAGE 1.A.1.A).

Since 2006 it is recommended to apply AD and EF at the relevant installation level (based on the high emission reports and in the absence of large emission source reports, activity data for Category 1.A.1.A at the installation level can be collected from the 2016 annual GHG quantity reports). Fuel consumption of all evaluated point sources shall be adjusted and balanced according to the energy and fuel balance data provided by Statistics Lithuania.

After adjusting and balancing the data from the Major Pollutant Reports and the Energy and Fuel Balance Data provided by Statistics Lithuania for the relevant fuel residue, it is recommended that the EMEP / EEA guidebook 2016 Tier 2 medium power units EF would be used.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook (2016) the Tier 2 emission factors (page 26, Tables 3 to 11) are already given including emission reduction (excluding SOx EF). During 1990 - 2005 it is recommended to apply the EF values ​​indicated in the table, while from 2006 - to implement Tier 3 level for pollutants provided in the annual reports of public electricity and heat production companies. During 1990-2005 it is recommended to apply the SOx EF value of 430.21 g/GJ obtained from the comparative analysis of residual fuel oil burning boilers for 010101 (> = 300 MW) and 010102 (> = 50 and <300 MW) SNAP activities, Mean evaluated SOx emission factor base on residual fuel oil provided by power plant (Tier 3 level data) corresponds to the 95% confidence interval for the emission factor specific to the technology envisaged. Since 2006 for heavy metals and POT compounds, EF provided in table 3.11 shall be corrected according to PM using a relative conversion factor (the exact value of the coefficient will be estimated in 2019). Preliminary conversion coefficient for PM10 and PM2.5 emissions from TSP EF values are ~70 and 55%, respectively. **It should be noted that the PM EF depend on the sulfur content of the fuel, so the TSP EF value also varies with the sulfur content. In 2019, the coefficient from 1990 onwards will be assessed taking into account the sulfur content of the fuel oil.** Data on sulfur content of fuel oil in Lithuanian market (JSC Orlen Lietuva) were analyzed.

## Table 3.12 Tier 2 EF for 1.A.1.a, dry bottom boilers using natural gas[[8]](#footnote-8)

**1. Areas of use of this type of boilers:** Natural gas is the main fuel used in the district heating sector in boilers with a rated thermal power of >= 300 MW, > = 50 and <300 MW and in boiler houses (<50 MW). Boilers burning natural gas are stationary. It was determined that natural gas was burned in six CHP by SNAP 010101> = 300 MW (Kaunas CHP, Lithuanian PP, Vilnius E-2 and Vilnius E-3) SNAP 010102> = 50 and <300 MW (Klaipėda CHP and Petrašiūnai CHP), and SNAP 010103 <50 MW (Panevezys CHP) processes. A comparative analysis of the emissions of pollutants into the ambient air (EF) according to the reported protocols is presented in the annual report. The evaluation of EF is accompanied by an analysis, which is equivalent to the study, and obtained EF values for the key pollutants are considered as the values recommended by the experts and may be used as national values ( according to needs).

**2. Activity data:** In 2018 April report on 1.A.1.a, public electricity and heat production it was recommended to apply T2 (1990-2005): AD - Lithuanian Department of Statistics, EF - EMEP / EEA guidebook 2016 and T3 (since 2006): AD and EF - respective installations level (major pollution sources reports) and to adjust AD data according to the data of the Department of Statistics of Lithuania.

The attached file contains the data of Statistics Lithuania for the period 1990-2018 i.e. fuel consumption in public electricity and heat production (see MS Excel file, FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, PAGE 1.A.1.A).

Since 2006 it is recommended to apply AD and EF at the relevant installation level (based on the high emission reports and in the absence of large emission source reports, activity data for Category 1.A.1.A at the installation level can be collected from the 2016 annual GHG quantity reports). Fuel consumption of all evaluated point sources shall be adjusted and balanced according to the energy and fuel balance data provided by Statistics Lithuania.

After adjusting and balancing the data from the Major Pollutant Reports and the Energy and Fuel Balance Data provided by Statistics Lithuania for the relevant fuel residue, it is recommended that the EMEP / EEA guidebook 2016 Tier 2 medium power units EF would be used.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Facility level data (Tier 3) cover all natural gas combustion plants from 2006 for >= 300 MW,>= 50 and <300 MW and <50 MW (boilers). During 1990 - 2005 technology and fuel specific Tier 2 emission factors can be applied based on information provided by EMEP / EEA Environmental Emission Inventory Guidebook 2016 (page 27, Tables 3-12). Emission factors for Tier 2 are given taking into account the applied emission reduction.

## Table 3.13 Tier 2 EF for 1.A.1.a, dry bottom boilers using wood waste[[9]](#footnote-9)

**1. Areas of use of this type of boilers:** From 2012 Alytus and Panevėžys boiler houses (>= 50 and <300 MW) have started using biomass. From 2013 Šiauliai boiler house started to use biomass, and from 2014 biomass was used in Klaipeda boiler house. The EF values shown in the table are only applicable for medium capacity boilers> = 50 and <300 MW.

It should be noted that some information on device level is publicly available. However, taking into account general recommendation for sector 1.A.1.A that devices should be differentiated based on EMAP/EEA guidebook 2016 recommendations into two groups: >=300 MW and >=50 MW to <300 MW, while the for the rest of the devices average Tier 2 EF should be applied. The said public data describes devices below 50 MW of installed power, hence average Tier 2 EF should be applied.

**2. Activity data:** In 2018 April report on 1.A.1.a, public electricity and heat production it was recommended to apply T2 (1990-2005): AD - Lithuanian Department of Statistics, EF - EMEP / EEA guidebook 2016 and T3 (since 2006): AD and EF - respective installations level (major pollution sources reports) and to adjust AD data according to the data of the Department of Statistics of Lithuania.

The attached file contains the data of Statistics Lithuania for the period 1990-2018 i.e. fuel consumption in public electricity and heat production (see MS Excel file, FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, PAGE 1.A.1.A).

Since 2006 it is recommended to apply AD and EF at the relevant installation level (based on the high emission reports and in the absence of large emission source reports, activity data for Category 1.A.1.A at the installation level can be collected from the 2016 annual GHG quantity reports). Fuel consumption of all evaluated point sources shall be adjusted and balanced according to the energy and fuel balance data provided by Statistics Lithuania.

After adjusting and balancing the data from the Major Pollutant Reports and the Energy and Fuel Balance Data provided by Statistics Lithuania for the relevant fuel residue, it is recommended that the EMEP / EEA guidebook 2016 Tier 2 medium power units EF would be used.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Facility-level data (Tier 3) cover all Lithuanian biomass combustion plants >=50 and <300 MW (SNAP 010202) during 2013 – 2015 for <50 MW (boilers) (SNAP 010203).

**Facility level data >=50 ir <300 MW** Facility level data (Tier 3) cover all Lithuanian combustion plants >=50 and <300 MW (SNAP 010202) using biomass during 2012-2015. Analysis of facility-level emissions data showed that TSP emission factors varies between 2.52 g/GJ and 8.78 g/GJ with the average value 5.29 g/GJ. The average value of TSP emission factors of combustion plants >=50 and <300 MW (boiler house) using biomass is lower by more than 30 times in comparison with default technology-specific emission factors (172 g/GJ).

For 1990-2011 and from 2012 technology and fuel specific Tier 2 emission factors can be applied based on information available in EMEP/EEA air pollutant emission inventory guidebook 2016 (last update July 2017 (page 28, Table 3-13; Tier 2 EF are provided taking into account the emission reduction), in order to apply Tier 3 level in parallel with recommended TSP EF values for residual biomass after fuel consumption corrected with Statistics Lithuania, in which heavy metal and POT compound EF values should be adjusted to default EF ratio.

Analysis of Major pollution sources 2005-2015 reports showed that the efficiency of the biomass combustion plant abatement equipment is 98-99 %.

Biofuel plants with a capacity of more than 50 MW have multicyclones are equipped with condensing economizers and their efficiency is 94-99 %. Since 2013 prevalence 100 percent

## Table 3.14 Tier 2 EF for 1.A.1.a, wet and dry bottom boilers using brown coal/lignite[[10]](#footnote-10)

**1. Areas of use of this type of boilers:** In Lithuania, coal is not burned in boilers with a capacity exceeding 50 MW. The activity did not take place at any time.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.15 Tier 2 EF for 1.A.1.a, fluid bed boilers using hard coal[[11]](#footnote-11)

**1. Areas of use of this type of boilers:** In Lithuania, coal is not burned in boilers with a capacity exceeding 50 MW. The activity did not take place at any time.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.16 Tier 2 EF for 1.A.1.a, fluid bed boilers using brown coal[[12]](#footnote-12)

**1. Areas of use of this type of boilers:** In Lithuania, coal is not burned in boilers with a capacity exceeding 50 MW. The activity did not take place at any time.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.17 Tier 2 EF for 1.A.1.a, gas turbines using gaseous fuels[[13]](#footnote-13)

Natural gas burning in gas turbine in Lithuania has been operated since 2006, when cogeneration power plant was installed in JSC Achema and in JSC Lifosa. The large sources of pollution reports do not provide information on any additional abatement equipment installed, but the plant-level emission factors estimated reflect the effective operation of the installation.

In 2012 Lithuania Power Plant started using 455 MW combined cycle gas turbine. Given the turbines power, the device is attributed to devices above 300 MW, hence it is recommended to apply Tier 3 level methodology (from 2006): activity data and emission factors should be taken from large emission sources report as well as emission permit trading reports from Lithuania Power Plant. It should be noted that there is no possibility to identify what part of fuel is burned in the CCGT, and what part in other devices.

## Table 3.18 Tier 2 EF for 1.A.1.a, gas turbines using gas oil[[14]](#footnote-14)

**1. Areas of use of this type of boilers:** In Lithuania, gas oils are not burned in boilers with a capacity exceeding 50 MW. The activity did not take place at any time. Reciprocating engines are used only to meet the needs of energy companies' own needs.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.19 Tier 2 EF for 1.A.1.a, reciprocating engines using gas oil[[15]](#footnote-15)

**1. Areas of use of this type of boilers:** In Lithuania, gas oils are not burned in boilers with a capacity exceeding 50 MW. The activity did not take place at any time. Reciprocating engines are used only to meet the needs of energy companies' own needs.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.20 Tier 2 EF for 1.A.1.a, reciprocating engines using natural gas[[16]](#footnote-16)

**1. Areas of use of this type of boilers:** Reciprocating engines are used in co-generation burning biogas. Biogas in co-generation boilers are used since 2004.

**2. Activity data:** Boilers in this case are below 50 MW, therefore activity data is taken from Lithuanian Department of statistics, Emission factors from EMEP/EEA Guidebook 2016.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant inventory guidebook (2016) Tier 2 level emission factors (36 p. Table 3-20) already include abatement technologies.

## Recommendations

In the 2018 April report on 1.A.1.a, Public electricity and heat production it was recommended for T2 (1990-2005): AD - Lithuanian Department of Statistics, EF - EMEP / EEA guidebook 2016 and T3 (from 2006): AD and EF - at the level of the respective installations (Major Pollutant Reports) and to make adjustments to AD data based on Statistics Lithuania data.

The attached file contains the data of Statistics Lithuania for the period 1990-2018, i.e. fuel consumption in public electricity and heat production. For the period of 1990-2005, It is recommended to apply the following activity data and the corresponding EFs from EMEP / EEA guidebook 2016 (Tables 3-11, 3-12 and 3-13) for the period. The EFs in Tables 3-11, 3-12 and 3-13 include units with power> = 300 MW and> = 50 - <300 MW. The EMEP / EEA guidebook 2016 EF 1.A.1.a is no more differentiated, and the analysis of the major pollution sources reports shows that these units cover almost all of the fuel consumption of 1.A.1.a.

Since 2006 it is recommended to apply AD and EF at the relevant installation level (based on the high emission reports and in the absence of large emission source reports, activity data for Category 1.A.1.A can be collected at the installation level from 2016 onwards at annual GHG quantity report[[17]](#footnote-17)). The fuel consumption of all evaluated point sources shall be adjusted and balanced according to the energy and fuel balance data provided by Statistics Lithuania.

After adjusting and balancing the data from the Major Pollutant Reports and the Energy and Fuel Balance Data provided by Statistics Lithuania for the relevant fuel residue, it is recommended that the EMEP / EEA guidebook 2016 Tier 2 medium power units EF would be used.

The use of emission factors in the EMEP / EEA Emission Inventory Accounting Manual 2016 has been recommended from 1990 to 2012, as the updated information in the manual reflects additional measurements and adjustments for a wide range of installations in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 onwards.

When applying calculated or national emission factors for PM2.5 and PM10 it is required to recalculated the heavy metals EF according to proportions from PM2.5 / PM10 applied in 2016 EMEP / EEA Evaluation Guide.

**Efficiency of abatement measures:** Higher power biofuel plants use multicyclones, i.e., a block of small cyclones, with an efficiency of 85 to 95 % for particles larger than 10 μm. The efficiency of multicyclones is higher than that of cyclones. In this way, PM10 can also be applied at 95 %.

In Biofuel plants with a capacity of more than 50 MW, condensing economizers are installed behind multicyclones and their efficiency is 94-99 %. Since 2013 prevalence is 100 %.

# STATIONARY COMBUSTION IN THE RESIDENTIAL SECTOR (NFR 1.A.4.B.I)

The number of dwellings remains quite stable during last decade and on average there are 1.3 million dwellings in Lithuania.

## Table 3.12 Tier 2 EF for 1.A.4.b.i, fireplaces burning solid fuel (except biomass)

**1. Areas of use of this type of boilers:** In open and closed fireplaces, solid fuels (except biomass) are not combusted. The same results are presented in the IIASA model for 2010 and 2015.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.13 Tier 2 EF for 1.A.4.b.i, fireplaces burning natural gas

**1. Areas of use of this type of boilers:** In the fireplaces, natural gas is burned in partially or completely enclosed fireplaces, but their prevalence is very low. The same results are presented in the IIASA model for 2010 and 2015.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.14 Tier 2 EF for 1.A.4.b.i, stoves burning solid fuel (except biomass)

**1. Areas of use of this type of boilers:** The small combustion installations (stoves) are mainly intended for residential heating, cooking. Tier 2 requires disaggregation of fuel use from national totals down into fuel use by specific technology types. Information on fuel use at this level of aggregation currently is not available in Lithuania. In order to have data at such level of aggregation it is necessary to perform additional surveying. Taking into account limited information on fuel use according to specific technology types it is appropriate to use a default split for residential fuel use covering the main technology types for this sector (fireplaces, boilers and stoves) according to data derived from GAINS model. Results of other available studies can be used for activity data or emission factors cross-check in order to increase higher accuracy of air pollution inventory. The average technology-to-technology ratio in 2010 and 2015 based on the IIASA GAINS model is presented in Figure 1.

**2. Activity data:** A default split for residential fuel use covering the main technology types according to data derived from the Greenhouse gas and Air Pollution Interactions and Synergies (GAINS) model. Solid fuels (excluding biomass) used in the household sector in stoves account for 48%. From 2010 part of the use of solid fuels (excluding biomass) in household stoves has decreased from 48 to 44% (separate breakdown for coke, brown coal and lignite (Figure 1). Various fuel consumption before inventorying calculation with EF need to be aggregated to "solid fuel". Fuel consumption from 1990 are presented by Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b).

Figure 1 Disaggregation of solid fuels (except biomass) use in residential sector across main technology types based on GAINS model

|  |  |  |
| --- | --- | --- |
| **Type of technology** | **2010 m.** | **2015 m.** |
| Fireplaces | 0% | 0% |
| Residential boilers (automatic feed) | 1% | 1% |
| Residential boilers (manual feed) | 51% | 55%; 11%\*; 100%\*\* |
| Stoves | 48% | 44%; 88%\*; 0%\*\* |

\* Coke; \*\*Brown coke, lignite

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) provides emission factors for Tier 2 level (page 49, Tables 3 to 14), taking into account the emission abatement. Additional pollution abatement measures for domestic boilers are not applicable except for better combustion efficiency in newer boilers. But no information available for technology age split. It is recommended to apply the EF values given in the table.

## Table 3.15 Tier 2 EF for 1.A.4.b.i, boilers burning solid fuel (except biomass)

**1. Areas of use of this type of boilers:** Such boilers used in the household for heating. Tier 2 requires further disaggregation of fuel use from national totals down into fuel use by specific technology types (table 3.15, <= 50 kW). Information on fuel consumption at this level of aggregation is currently not available in Lithuania. In order to have data at such level of aggregation it is necessary to perform additional surveying or research. Taking into account limited information on fuel use according to specific technology types it is appropriate to use a default split for residential fuel use covering the main technology types for this sector (fireplaces, boilers and stoves) according to data derived from the Greenhouse gas and Air Pollution Interactions and Synergies (GAINS) model. These data are based on data for 2010 recorded as petajoules of energy and represents a weighted average of the EU28 Member States and for 2015 based on EU-16. Average ratio of technology split across technology types for 2010 and 2015 is based on GAINS model is presented in Figure 1.

**2. Activity data:** The split by technology makes it possible to allocate the total fuel consumption into the fuel consumption by typical types of boilers. Solid fuels (excluding biomass) used in the household sector in boilers account for 51%. From 2015 part of the solid fuels (excluding biomass) consumed in household boilers has increased to 55% (separate allocation provided for coke, brown coal and lignite (Table 2.4 1). Fuel consumption before emission calculation needs to be aggregated into the "solid" group, except for wood. Solid fuel (excluding biomass) consumption is reported by Lithuanian Department of Statistics. (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) provides emission factors for Tier 2 (page 50, Tables 3 to 15), taking into account the emission reduction. It is recommended to apply the EF values given in the table.

## Table 3.16 Tier 2 EF for 1.A.4.b.i, boilers burning natural gas

**1. Areas of use of this type of boilers:** Boilers burning natural gas boilers are used in the household for heating, so the breakdown of fuel consumption down into fuel use by specific technology types is not required.

**2. Activity data:** The percentage split by technology is not required. Consumption of natural gas since 1990 provided by the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) provides emission factors for Tier 2 (page 51, Tables 3 to 16), taking into account the emission reduction. It is recommended to apply the EF values given in the table.

Measurements carried out during the LMT Internal Needs Project showed that modern low-boiler (<50 kW) natural gas boilers have low air pollutant emissions. From 2013 it is recommended to use national emission factor values, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania.

## Table 3.17 Tier 2 EF for 1.A.4.b.i, stoves burning liquid fuels

**1. Areas of use of this type of boilers:** Stoves burning liquid fuels are used for heating.

**2. Activity data:** Fuel consumption before emissions calculation needs to be aggregated to the "liquid fuel" group. Liquid fuel consumption is reported in the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) provides emission factors for Tier 2 (page 52, Tables 3 to 17), taking into account the emission reduction. It is recommended to apply the EF values given in the table.

## Table 3.18 TIER 2 EF for 1.a.4.b.i, advanced stoves burning coal fuels

**1. Areas of use of this type of boilers:** Stoves burning coal is mostly used for heating.

**2. Activity data:** not known.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** The newer type of stove increases efficiency (almost 70% at full load) due to structure compared to conventional. This part is considered to be small.

## Table 3.28 Tier 2 EF for non-residential sources, gas turbines burning natural gas

**1. Areas of use of this type of boilers:** gas turbines for non-household are used for heating, therefore, in 1.A.4.bii household fuel consumption disaggregation from the annual balance of the country according to the type of technologies is not required. EF provided in Table 3.16 (if needed). No activity.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.29 Tier 2 EF for non-residential sources, gas turbines burning gas oil

**1. Areas of use of this type of boilers:** Gas oil in a gas turbine is not used in a household, usually in boilers for the combustion of liquid fuels, and therefore it is recommended to apply liquid fuel EF (Table 3.17).

**2. Activity data:** The use of gas oil for heating is provided by the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b). Fuel amount need to be combined with other liquid fuels.

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**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) provides emission factors for Tier 2 (page 52, Tables 3 to 17), taking into account the emission reduction. It is recommended to apply the EF values given in the table for liquid fuels.

## Table 3.30 Tier 2 EF for non-residential sources, reciprocating engines burning gas fuels

**1. Areas of use of this type of boilers:** natural gas in reciprocating engines in non-residential sources was not burned.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.40 Tier 2 EF for 1.A.4.b.i, conventional stoves burning wood and similar wood waste

With respect to importance of solid biomass combustion in residential sector due to high share of PM emissions in most countries, a specific methodology has been elaborated and included in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017). This methodology provides default technology split in order to apply Tier 2 for solid biomass combustion in Residential sector. Default factors to split the total solid biomass consumption over various appliance types are distinguished according to the data include in the GAINS model. The split is estimated by taking the energy balances as a starting point to split between residential, commercial/institutional and other sectors. The allocation to stoves and boilers were proposed by IIASA and discussed with countries in the country consultations. Disaggregation of biomass use in residential sector across main technology types based on GAINS model are presented in Figure 2.

Figure 2 Biomass use in sector Stationary household combustion breakdown by key technology based on GAINS model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Fireplaces** | **Heating ovens** | **Individual house boiler (automatic feed, <50 kW)** | **Individual house boiler (manual feed, <50 kW)** | **average automatic boiler (1-50 MW)** | **average manual feed boiler (<1 MW)** |
| 2000 | 8% | 47% | 0% | 38% | 4% | 4% |
| 2005 | 7% | 47% | 2% | 39% | 3% | 2% |
| 2010 | 7% | 47% | 3% | 38% | 4% | 2% |

**Notes:** 1) 2016 EMEP / EEA Technical Guidebook for National Emission Accounting. Last Updated in 2017 July. (Pages 76–78, Tables 3.36–3.38).

In order to have more accurate estimation of air pollution from Residential sector it is needed to perform additional residential sector surveys for identification of country specific information on fuel use according to the technology type or perform producers and sellers of heating appliances surveys. Another option is to perform research on detailed energy demand modelling or research on energy conservation or on climate change mitigation studies. The data from different sources should be compared, taking into account their uncertainties in order to obtain the best assessment of appliances used in residential sector. The fuel consumption should be distinguished from the annual balance according to the distribution in Figure 2.

## Table 3.39 Tier 2 EF for 1.A.4.b.i, open fireplaces burning wood

**1. Areas of use of this type of boilers:** Wood is burned in fireplaces, but not considerably.

**2. Activity data:** Wood consumption is reported in the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b). The fuel consumption should be distinguished from the total annual wood balance according to the split provided in Figure 2).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) provides emission factors for Tier 2 (page 82, Tables 3 to 39), taking into account the emission reduction. It is recommended to apply the EF values given in the table for open fireplaces. Table 3-41 should be used to calculate closed-type fireplaces, but the number is not known.

## Table 3.40-42 Tier 2 EF for 1.A.4.b.i, conventional/advanced and ecolabelled/high efficiency stoves burning wood and similar wood waste

**1. Areas of use of this type of boilers:** although the exact distribution is not known, the majority of stoves in Lithuania are considered to be conventional and EF for conventional furnaces can be used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.43 Tier 2 EF for 1.A.4.b.i, conventional boilers < 50 kW burning wood and similar wood waste

**1. Areas of use of this type of boilers:** Wood is widely used in boilers for heating (up to 40 percent).

**2. Activity data:** Fuel consumption before emission calculation needs to be aggregated into a wood group. Consumption of various types of wood is reported in the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.b). In order to have more accurate estimation of air pollution from Residential sector it is needed to perform additional residential sector surveys for identification of country specific information on fuel use according to the technology type or perform producers and sellers of heating appliances surveys. Another option is to perform research on detailed energy demand modelling or research on energy conservation or on climate change mitigation studies. The data from different sources should be compared, taking into account their uncertainties in order to obtain the best assessment of appliances used in residential sector. The fuel amount should be distinguished from the total annual balance according to the split in Figure 2.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** No pollution abatement measures applied except installed in combustion plant itself.

Measurements carried out during the LMT internal needs project showed that low power (<50 kW) biofuel modern boilers have low particulate emissions, especially boilers with flexible control of fuel and air supply. It is recommended to use national emission factor values, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania.

## Table 3.44 Tier 2 EF for 1.A.4.b.i, pellet stoves and boilers burning wood pellets

**1. Areas of use of this type of boilers:** Wood pellets are used in automatic feed boilers.

**2. Activity data:** Fuel consumption 100 percent classified for combustion in automatic feed boilers, but consumption is not reported by the Statistics Lithuania.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Recommendations

It is recommended to apply the emission factors, indicated in EMEP / EEA Technical Manual for the Preparation of National Pollutant Inventory 2016 (last updated July 2017), from 1990 to 2012 as the updated information in the manual reflects additional measurements and adjustments in a wide range of equipment operating in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 onwards.

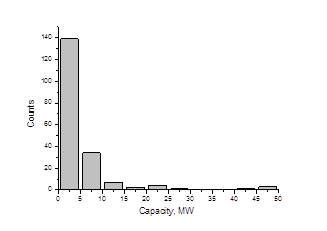
Taking into account the results of the LMT Internal Needs Project, it is recommended that from 2013 onwards. to apply national emission factor values, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania. Experimentally determined emission factors for predominant fuels are well below the standard values for 2016. EMEP / EEA Technical Tier 2 Technical Manual for National Pollution Inventory Development. This is due to the fact that these emission factor values ​​reflect a wide range of age of equipment operating.

# Commercial/institutional: Stationary Combustion (NFR 1.A.4.A.I) and Agriculture/forestry: Stationary Combustion(NFR 1.A.4.C.I)

The sector cover combustion installations activities in the sectors which are considered to have a thermal capacity ≤ 50 MW. The activities essentially cover combustion in smaller-scale combustion units and installations. In the sector the heat generated by the installations is used also for hot water supply. The applications can be conveniently sub-divided considering the general size and the combustion techniques applied: heating — boilers, space heaters (> 50 kW) and smaller-scale combined heat and power generation (CHP).

**1. Areas of use of this type of boilers:** Technologies for institutional stationary combustion and agriculture/forestry sectors comprises of two size categories with a rated thermal input of > 50 kW but less than 1 MW and greater than 1 MW and less than 50 MW.

**2. Activity data:** Based on the results of the analysis of the structure of fuel combustion technologies, it is proposed technology size split: 80% of > 50 kW to < 1 MW and 20% of > 1 MW to < 50 MW. Classification by technology size reflects different emission characteristics for smaller and larger devices.

Various types of fuel consumption are reported in the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.a.i,c.i).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** It is considered as not applicable. Emissions from small combustion boilers into the atmosphere are significant due to the large number of boilers used, it different types of combustion technologies and efficiency. In the case of gas and liquid fuels, emissions to the atmosphere are not significantly higher compared to large installations due to fuel quality and design of boilers.

During the internal needs project of LMT, it was determined that the abatement technologies are used only in stationary plants burning biofuel or coal. Experimental measurements have shown that low-power coal-fired plants have ubiquitous cyclones. Cyclones have no moving parts and filtering surfaces that require constant maintenance. The cyclone operates on the principle of centrifugal force, which causes the coarse particles to settle and the small particles to travel further with the smoke flow. Thus, the disadvantage of the operation of conventional cyclone devices is the inadequate purification of the gas stream from particulate matter of varying dispersion. The use of cyclones effectively precipitates the coarse particles and the fine particles, e.g. less than 10 µm in diameter are not effectively captured.

Low-power biofuel plants also use cyclones. Higher power biofuel plants use multicyclones, i.e., a block of small cyclones, with an efficiency of 85 to 95 percent for particles larger than 10 μm. The efficiency of multicyclones is higher than that of cyclones, which is why multicyclones are widely used due to their high emission reduction efficiency. Usually it is recommended to use these purifiers for pre-smoke purification followed by sleeve or electrostatic filters. Electrostatic precipitators provide up to 98-99 percent solids separation. The cleaning efficiency of these filters is least dependent on the particle size. This is a major advantage over other cleaning methods. However, the overall cost of installing and operating electrostatic precipitators is high [4] and is therefore not widespread. Experimental measurements at the sampled plants show that only cyclones or multicyclones are used for smoke cleaning.

In biofuel plants with a capacity of more than 10 MW, condensing economizers are installed and operated behind multicyclones. The condensing economiser has two functions: firstly, to maximize the efficient use of the heat produced and not to waste it through the chimney; In the economiser, the smoke is sprayed with a water-condensate mixture by means of a nozzle, so the smoke cools down to 45-50 oC and passes through the chimney. The remaining solids settle in the water-condensate mixture, fall into the installed settlers where, over time, all the dirt settles and the purified condensate remains. Mud is pumped out and utilized by pumps. Such a system operates continuously in the boiler room, thus ensuring high and particulate matter reduction efficiency.

**In summary:** Stationary biofuel, peat and coal combustion installations up to 10 MW have cyclones. The spread of cyclones began in 2000 - 20%, 2005 80%, from 2013 - 100% (synergy between GAINS and LMT project results). A major disadvantage of the operation of conventional cyclone devices is the inadequate purification of gas flow from particulates of varying dispersion, especially smaller than 10 μm in diameter. At particle sizes larger than 10 μm, cyclone cleaning efficiency is 80-85%. In this way, PM10 can also be applied at 85%.

Higher power biofuel plants use multicyclones, i.e., a block of small cyclones, with an efficiency of 85 to 95 percent for particles larger than 10 μm. The efficiency of multicyclones is higher than that of cyclones. In this way, PM10 can also be applied at 95%.

Biofuel plants with a capacity of more than 10 MW and above multicyclones are equipped with condensing economizers and their efficiency is 94-99%. Since 2013 prevalence is 100 percent.

## Table 3.20 Tier 2 emission factors for small non-residential sources (>50 kWth to ≤ 1 MWth) boilers burning coal fuels

**1. Areas of use of this type of boilers:** For solid fuel (subbituminous coal) combustion and agriculture/forestry sectors, Tier 2 emission factors are presented in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) page 55, Table 3 - 20 and 56, Table 3 - 21.

## Table 3.21 Tier 2 emission factors for non-residential sources, medium - size (>1 MWth to ≤ 50 MWth) boilers burning coal fuels

**1. Areas of use of this type of boilers:** For solid fuel (subbituminous coal) combustion and agriculture/forestry sectors, Tier 2 emission factors are presented in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) page 55, Table 3 - 20 and 56, Table 3 - 21.

## Table 3.22 Tier 2 EF for non-residential sources, manual boilers <1MW burning coal fuels (advances)

**1. Areas of use of this type of boilers:** Assumed that occurrence is very low.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.23 Tier 2 emission factors for non-residential sources, automatic boilers <1MW burning coal fuels

**1. Areas of use of this type of boilers:** The method can be used for the breakdown by type of fuel feed is provided (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.a.i,c.i).

## Table 3.24 Tier 2 emission factors for non-residential sources, medium - sized (>50 kWth to ≤ 1MWth) boilers liquid fuel

**1. Areas of use of this type of boilers:** Tier 2 emission factors for liquid fuel combustion are presented in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) page 60, Table 3 - 25 and 59, Table 3 - 24.

## Table 3.25 Tier 2 emission factors for non-residential sources, medium sized (>1 MWth to ≤50 MWth) boilers liquid fuel

**1. Areas of use of this type of boilers:** Tier 2 emission factors for liquid fuel combustion are presented in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) page 60, Table 3 - 25 and 59, Table 3 - 24.

## Table 3.26 Tier 2 emission factors for non-residential sources, medium-sized (>50kWth to ≤1 MWth) boilers burning natural gas

**1. Areas of use of this type of boilers:** For natural gas Tier 2 emission factors are presented in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) page 61, Table 3 - 26 and page 62 Table 3 - 27.

## Table 3.27 Tier 2 emission factors for non-residential sources, medium-sized (>1 MWth to ≤50 MWth) boilers burning natural gas

**1. Areas of use of this type of boilers:** For natural gas Tier 2 emission factors are presented in EMEP/EEA air pollutant emission inventory guidebook 2016 (Last update July 2017) page 61, Table 3 - 26 and page 62 Table 3 - 27.

## Table 3.28 Tier 2 emission factors for non-residential sources, boilers burning natural gas, turbine

**1. Areas of use of this type of boilers:** no activity.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.29 Tier 2 EF for non-residential sources, gas turbines burning gas oil

**1. Areas of use of this type of boilers:** no activity. For gas oil emissions are recommended EF for liquid fuels.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.30 Tier 2 EF for non-residential sources, reciprocating engines burning gas fuels

**1. Areas of use of this type of boilers:** no activity.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3.31 Tier 2 EF for non-residential sources, reciprocating engines burning gas oil

**1. Areas of use of this type of boilers:** no activity.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## **Table 3.45** Tier 2 EF for non-residential sources, medium sized (>1 MW to ≤50 MW) boilers wood; **Table 3.46** Tier 2 EF for non-residential sources, medium sized (>50 kW to ≤1 MW) boilers wood (in the absence of information on manual feed

In Tables 3.45 and 3.46, EF can be use if the distribution between the automatic and manual feed is not known in the country. The following EF can be applied to technology distribution suggested in European Commission study[[18]](#footnote-18).

**1. Areas of use of this type of boilers:** Wood is widely used in this type of boiler. At present, the percentage split between manual and automatic feed types is unknown.

**2. Activity data:** Quantity of wood burnt in this type of boiler: Tier 2 requires further disaggregation of fuel use from national totals down into fuel use by technology sizes. Taking into account limited information on fuel use according to specific technology sizes it is appropriate to use technology split proposed in the European Commission’s study. In this study it is proposed technology size split: **80% of > 50 kW to < 1 MW and 20% of >1 MW to <50 MW**. This percentage split by size allow to disaggregate national totals of fuel use into fuel use by specific technology size. In order to have national data at such level of aggregation it is necessary to perform additional surveying or detailed research for Commercial/Institutional sector.

Fuel consumption since 1990 provided by the Department of Statistics (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.a,c).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency**: Only plants burning biofuels and coal have cyclones, i.e. low-capacity devices, while high capacity devices have multicyclones. In biofuel boilers with a capacity of more than 10 MW and above, condensing economizers are installed and operated for multicyclones, condensing economizer performs two functions - firstly, to maximize the use of the heat produced, and secondly to clean up the exhaust fumes, removing volatile ash and small particles.

**In summary:** Stationary biofuel, peat and coal combustion installations up to 10 MW have cyclones. The spread of cyclones began in 2000 - 20%, 2005 - 80%, from 2013 - 100% (synergy between GAINS and LMT project results). A major disadvantage of the operation of conventional cyclone devices is the inadequate purification of gas flow from particulates of varying dispersion, especially smaller than 10 μm in diameter. At particle sizes larger than 10 μm, cyclone cleaning efficiency is 80-85%. In this way, PM10 can also be applied at 85 %.

Higher power biofuel plants use multicyclones, i.e., a block of small cyclones, with an efficiency of 85 to 95 percent for particles larger than 10 μm. The efficiency of multicyclones is higher than that of cyclones. In this way, PM10 can also be applied at 95 %.

Biofuel plants with a capacity of more than 10 MW and above multicyclones are equipped with condensing economizers and their efficiency is 94-99 %. Since 2013 prevalence is 100 percent.

## **Table 3.47** Tier 2 EF for non-residential sources, manual boilers burning wood (<1 MW); **Table 3.48** Tier 2 EF for non-residential sources, automatic boilers burning wood (<1 MW)

The EFs in Tables 3.47 and 3.48 apply if the distribution between automatic and manual loading for boilers <1 MW is known in the country. The following EFs can be applied to technology distribution suggested in European Commission study[[19]](#footnote-19). Taking into account that currently the exact distribution between annual and automatic feed boilers with installed power <1 MW is not known it is suggested to apply EFs provided in Table 3.46.

**1. Areas of use of this type of boilers:** Wood is widely used in this type of boiler. At present, the percentage split between manual and automatic feed types is unknown.

**2. Activity data:** Tier 2 requires further disaggregation of fuel use from national totals down into fuel use by installed power and technology type. Taking into account limited information on fuel use according to specific technology it is appropriate to use technology split proposed in the European Commission’s study[[20]](#footnote-20). In this study it is proposed technology size split: **80% of > 50 kW to < 1 MW and 20% of >1 MW to <50 MW.** This percentage split by size allow to disaggregate national totals of fuel use into fuel use by specific technology. Further disaggregation by technology type for the boilers < 1 MW is carried out according to the proportions provided in Table 3-11 in Chapter 2 (the table contains biomass usage by technology type based IIASA GAINS model). Based on this information it is assumed that 70% of boilers <1 MW used in service sector have automatic feed and 30% manual feed. These assumption were validated in experts of Lithuanian Energy Institute. Fuel consumption since 1990 are provided by the Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.a.c).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency**: Only low-capacity plants burning biofuels have cyclones, while large capacity plants are using multicyclones.

**In summary:** Stationary biofuels, peat and coal combustion installations up to 10 MW have cyclones. The cyclone usage began in 2000. - 20%, 2005 80%, from 2013 - 100% (synergy between GAINS and LMT project results). A major disadvantage of the operation of conventional cyclone devices is the inadequate purification of gas flow from particulates of varying dispersion, especially smaller than 10 μm in diameter. At particle sizes larger than 10 μm, cyclone cleaning efficiency is 80-85%. In this way, PM10 can also be applied at 85%.

## Recomendations

EMEP / EEA Technical Manual for the Preparation of National Pollutant Inventory 2016. (last updated July 2017), it is recommended to apply the emission factors from 1990 to 2012 as the updated information in the manual reflects additional measurements and adjustments in a wide range and age of equipment operating in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 onwards.

Taking into account the results of the LMT Internal Needs Project, it is recommended that from 2013 national emission factor values would be applied, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania. Experimentally determined emission factors for predominant fuels are well below the standard values ​​for 2016. EMEP / EEA Technical Tier 2 Technical Manual for National Pollution Inventory Development. This is due to the fact that these emission factor values ​​reflect a wide range of age of equipment operating.

When applying calculated or national emission factors for PM2.5 and PM10 it is required to recalculate the heavy metals EF according to proportions from PM2.5 / PM10 in 2016. In the EMEP / EEA Evaluation Guide.

# OTHER STATIONARY COMBUSTION (INCLUDING MILITARY), NFR 1.A.5.A

**1. Brief description of processes:** Emissions from fuel combustion in stationary sources are all specified under relevant categories. Data on fuel consumption for military stationary combustion are not available separately. The statistical reports are based on information provided by the fuel suppliers therefore data on fuel used for military stationary combustion is included in Commercial/institutional category. All emissions should be reported as not occurring/not applicable therefore there will be no “not estimated” sector.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# OTHER MOBILE COMBUSTION(NFR 1.A.5.B)

**1. Brief description of processes:** LTO data are not available for military aircraft movements, so a simple approach can be used to estimate emissions from military aviation. A first estimate of military emissions could be made using military fuel consumption data applying Tier 2 EFs for 1990-2015.

**2. Activity data:** the quantity of fuel used is provided by Department of Statistics (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.5.B).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# MOBILE COMBUSTION:SERVICES (NFR 1.A.4.A II), HOUSEHOLDS (NFR 1.A.4.B II), AGRICULTURE (NFR 1.A.4.C II), FORESTRY (NFR 1.A.4.C II), FISHING (1.A.4.C III) and MANUFACTURING (NFR 1.A.2.G VII)

This section contains several mobile combustion sources. The types of equipment in this section are included in the following NFR categories:

* Mobile combustion in the institutional/commercial sector (NFR 1.A.4.a. ii);
* Mobile combustion in households (NFR 1.A.4.b ii);
* Mobile combustion in agriculture, forestry (NFR 1.A.4.c ii);
* Mobile combustion in national fishing (NFR 1.A.4.c iii)
* Mobile combustion in industry (NFR 1.A.2.g vii).

**1. Brief description of processes:** Non-road transport is used in many activities (services, households, agriculture, forestry and fishing, industry). Data on non-road vehicles (quantity, type and age) should be broken down by activity type.

**2. Activity data:** Fuel consumption (since 1990), provided by Statistics Lithuania according to economic activities, and vehicles since 2013 should be further distributed in the Tier 2 and Tier 3 methodologies according to vehicle age and technology, so that appropriate emission factors can be applied.

The data (for all economic activities separately) should be divided by the total fuel consumption according to the engine technology levels (Table 6-1 - 6-5, see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.4.mobile 1.A.2.g,viii) for each year, starting from 2013 (since country-specific vehicle age data are only available from 2013 m.). Tables are input parameters for the algorithm[[21]](#footnote-21):

Where:

* = emission mass of the pollutant over the accounting period;
* = fuel consumption of type j in equipment category C, technology type t;
* = average emission factor for pollutant i in fuel type j, in equipment category C, technology type t;
* i = the type of pollutant;
* j = type of fuel[[22]](#footnote-22);
* t = off-road vehicle technology[[23]](#footnote-23).

## Table 3-2 Tier 2 EF for off-road machinery

When fuel are distributed according to the age of the vehicles by the activities, each technology group is multiplied by EF (2016 EMEP/EEA Manual, page 30 Table 3-2).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: IRON AND STEEL INDUSTRY(nfr 1.a.2.a)

**1. Brief description of processes:** The iron and steel industry occupies a very small part of the Lithuanian manufacturing industry. Lithuanian Statistics Department 1990 - 2007 has included data on these activities in the other unspecified industries and only from 2008 provides data separately to the iron and steel industry. For this reason, emissions from the iron and steel industry are reported in other industries to ensure consistency of time series.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# PETROLEUM REFINING (NFR 1.A.1.B)

JSC ORLEN Lietuva is the only oil refinery in the Baltic States. The refinery processes about 10 million tons of crude oil annually. This company is one of the most important suppliers of petrol and diesel in Lithuania, Latvia and Estonia. The petrol, jet fuel, gas oil, diesel fuel, and liquefied petroleum gas used in Lithuania are produced by JSC ORLEN Lietuva. Imports of all listed fuels represent only a small part of the fuel used in Lithuania.

## **Table 4-4** Tier 2 EF for 1.A.1.b, process furnaces using residual oil; **Table 4-6** Tier 2 EF for 1.A.1.b, process furnaces using natural gas

**1. Brief description of processes:** Mostly burning fuel oil and non-liquefied petroleum gas during the 1.A.2.b processes. The EMEP / EEA Technical Guidebook contains only a few 0103 codes (Figure 3), without activity breakdown.

Figure 3 Device level emissions data is provided according to NFR 1.A.1.b Oil refinery

|  |  |  |  |
| --- | --- | --- | --- |
| SNAP | 1.A.1.b Oil refinery | Fuel | Specified emissions |
| **010301** | Combustion plant >=300 MW | Residual fuel oil / refinery gas | NOx, SOx, CO, TSP, NMVOC |
| **010302** | Combustion plant >=50 ir <300 MW | Residual fuel oil / refinery gas | NOx, SOx, CO, TSP, NMVOC |
| **010303** | Combustion plant <50 MW | Refinery gas | NOx, SOx, CO, NMVOC |

Activity data of facility-level can be obtained through large point sources reports submitted to the EPA. The structure of fuel used in JSC ORLEN Lietuva according to the data presented in a large point source reports are presented in Figure 4. Since 2014 all three types of boilers are using only refinery gas.

Figure 4 The structure of fuel used for 1.A.1.b Petroleum refining, %

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Boilers | Fuel | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Combustion plant >=300 MW | Fuel oil | 36.3 | 39.3 | – | 4.0 | 17.3 | 20.0 | 2.2 | 5.7 | 0 | 0 |
| Not liquefied petroleum gas | 63.7 | 60.8 | – | 96.0 | 82.7 | 80.0 | 97.8 | 94.3 | 100 | 100 |
| Combustion plant >=50 ir <300 MW | Fuel oil | 45.1 | 38.2 | – | 14.0 | 10.6 | 7.8 | 7.3 | 4.9 | 0 | 0 |
| Not liquefied petroleum gas | 54.9 | 61.8 | – | 86.0 | 89.4 | 92.2 | 92.7 | 95.1 | 100 | 100 |
| Combustion u plant nit <50 MW | Fuel oil | – | 20.6 | – | 10.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Not liquefied petroleum gas | – | 79.4 | – | 90.0 | 100 | 100 | 100 | 100 | 100 | 100 |

These activity data must be applied and adjusted in accordance with the energy and fuel balance data provided by Statistics Lithuania [[24]](#footnote-24).

**2. Activity data**: Data provided by Statistics Lithuania since 1990. Since 2006 the Tier 3 accounting level must be applied. Refinery emissions data for sector 1.A.1.b are provided for three types of boilers, but there is no allocation of fuel by type (Refined Petroleum Production Companies: Non-Liquefied Petroleum Gas, Petroleum Coke, Fuel Oil, Natural Gas). Mostly used are Non-Liquefied Petroleum Gas. Fuel consumption since 1990 provided by the Department of Statistics (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.1.b).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** „JSC ORLEN Lietuva has gradually introduced pollution reduction measures. AIVIKS or survey or study that was conducted for ORLEN Emission Calculation is based on Tables 4-4 and 4-6 EF. Since 2006 for heavy metals and POT compounds EF in tables 4-4 and 4-6 shall be adjusted to the calculated aerosol particle number using a relative factor (the exact value of the coefficient will be estimated in 2019).

## Table 4-5 Tier 2 EF for 1.A.1.b, process furnaces using gas oil

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 4-7 Tier 2 EF for 1.A.1.b, stationary engines using natural gas (4-stroke lean burn gas engines)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Tier 2 EF for 1.A.1.b, diesel engines using gas oil (reciprocating Engines (compression injection))

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# FUGITIVE EMISSIONS IN OIL REFINERY (NFR 1.B.2.A.IV)

Emissions data for facility level is sufficient quality are available for subsector 1.B.2.a.iv fugitive emissions from refinery level (Tier 3), which covers processes in the country since 2006. 1990 - 2005 Tier 2 EF can be applied based on EMEP / EEA 2016 Table 3-1 of the Guidebook, although the process would fit in 3-3 Table, but EF is not provided for the pollutants listed in the Tier 3 annual reports. Facility-level reports, along with SNAP codes, are provided by ORLEN Lithuania on demand.

## Table 3-2 Tier 2 EF for 1.B.2.a.iv Refining, storage, Fluid catalytic cracking - CO boiler (not installed)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3-3 Tier 2 EF for 1.B.2.a.iv Refining, storage, Fluid catalytic cracking - CO boiler

**1. Brief description of the processes:** transferred from annual reports except for PCDDF Table 3-3 and only for 040101 and 040102. For other activities (040105), which are listed in the annual reports of JSC Orlen Lithuania until 2005. Tier 1 EF should be used (GB2016 Table 3-1).

**2. Activity data:** Petroleum coke (on the catalyst) is provided by JSC ORLEN Lietuva and Lithuanian Department of Statistics (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.B.2.A.IV).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** The company carries out monitoring and reporting data to EPA, so no adjustment of process emissions is required from 2006 onwards.

## Table 3-4 Tier 2 EF for 1.B.2.a.iv Refining, storage, Fluid coking units

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Table 3-5 Tier 2 EF for 1.B.2.a.iv Refining, storage, Sulphur recovery

**1. Brief description of the processes:** Device Level Tier 2 Accounting Available From 2006 the Sulphur Recovery 040103 process needs to be refined using the mass balance method (study required if Lithuania does not meet the projection limits for 2020 and 2030).

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# FLARE GAS COMBUSTION (NFR 1.B.2.C)

**1. Brief description of the processes:** As reported in the latest study (Expert Assessment of National Accounts for Tier 2 Accuracy in Environmental Accumulation for Volatile Organic Compounds), these emissions are included in sub-sectors 1.B.2.a.iv to avoid double counting.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# STATIONARY COMBUSTION IN IRON AND STEEL INDUSTRY (NFR 1.A.2.a)

**1. Brief description of the processes:** The iron and steel industry occupies a very small part of the Lithuanian manufacturing industry. Lithuanian Statistics Department 1990 - 2007 has included data on these activities in the next unspecified industries and only from 2008 onwards provides operational data separately to the iron and steel industry. For this reason, emissions from the iron and steel industry are reported in other industries to ensure consistency of time series.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# IRON AND STEEL MANUFACTURING (NFR 2.C.1)

## Table 3-12 Tier 2 EF for 2.C.1 Iron and steel production, pig iron production, abated by wSV (medium).

**1. Brief description of the processes**: There were three companies producing cast iron until 2009. Only pig iron scrap was used as raw material. The largest company “Kauno ketaus liejykla” was producing cast iron in induction furnace, but it went bankrupt in 2010. The other two companies are still operating, and one is producing cast iron in blast furnace and the other was producing cast iron in blast furnace until 2011, after 2011 it has been using induction furnace. In the blast furnace cast iron is made by remelting scrap pig iron along with coke and limestone. In the induction furnace only, limestone is added.

**2. Activity data:** Coke consumption and the amount of cast iron produced are provided by the factory (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.C.1).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Enterprises do not carry out continuous monitoring, only the PAV plan with preliminary deductible values is provided, therefore, the average reduction of the EF is to be used until 2011 (Table 3-12) and from 2012 - induction stove EF (Table 3-15).

## Table 3-15 Tier 2 EF for 2.C.1 Iron and steel production, steel making, electric arc furnaces steel plant

**1. Brief description of the processes**: There were three companies producing cast iron until 2009. Only pig iron scrap was used as raw material. The largest company “Kauno ketaus liejykla” was producing cast iron in induction furnace, but it went bankrupt in 2010. The other two companies are still operating, and one is producing cast iron in blast furnace and the other was producing cast iron in blast furnace until 2011, after 2011 it has been using induction furnace. In the blast furnace cast iron is made by remelting scrap pig iron along with coke and limestone. In the induction furnace only, limestone is added.

**2. Activity data:** Coke consumption and the amount of cast iron produced are provided by the factories (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.C.1).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Enterprises do not carry out continuous monitoring, only the PAV plan with preliminary values is provided, so the average reduction of the EF is taken until 2011. (Table 3-12) and from 2012 - induction furnace EF (Table 3-15). Information will be approved by companies in 2019.

# STATIONARY COMBUSTION IN THE NON-FERROUS METALS INDUSTRY (nfr 1.a.2.b)

**1. Brief description of the processes:** There are no Non-Ferrous Metals industries in Lithuania. All emissions are reported as not occurring/not applicable therefore there are no “not estimated” sectors.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# MANUFACTURING OF NON-FERROUS METALS (NFR 2.C.2–2.C.7.C)

## Production of ferro-alloys (NFR 2.C.2)

**1. Brief description of the processes:** Production of ferro-alloys in Lithuania is not carried out, therefore emissions from source category 2.C.2 Iron alloys are not produced and the marking key "NO" is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Aluminum production (NFR 2.C.3)

**1. Brief description of the processes:** Emissions from aluminium production are not occurring in Lithuania so for the category “ source category 2.C.3 Aluminium Production” notation key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Magnesium production (NFR 2.C.4)

**1. Brief description of the processes:** Emissions from magnesium production are not occurring in Lithuania so for the category “ source category 2.C.4 Magnesium Production” notation key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Lead production (NFR 2.C.5)

**1. Brief description of the processes:** Emissions from lead production are not occurring in Lithuania so for the category “ source category 2.C.5 Lead Production” notation key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Zinc production (NFR 2.C.6)

**1. Brief description of the processes:** Emissions from zinc production are not occurring in Lithuania so for the category “ source category 2.C.6 Zinc Production” notation key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Others (NFR 2.C.7)

**1. Brief description of the processes:** Emissions from other production are not occurring in Lithuania so for the category “ source category 2.C.7 Other” notation key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# STACIONARY COMBUSTION IN CHEMICAL INDUSTRY (NFR 1.A.2.C)

**1. Brief description of the processes:** Most of the processes are related to activities in sector 2.B (from conventional combustion in the boiler house to processes using thermal oxidants and process-specific combustion activities (e.g., catalytic oxidation of ammonia during nitric acid production). The chemical industry is one of the largest manufacturing industries in Lithuania. Various products are produced, the most important of which are sulfuric acid, ethyl alcohol, fermented preparations, ammonium nitrate, urea, diammonium phosphate, amino resins, phenolic resins and polyurethanes in primary forms, toilet and washing soaps, hair preparations and cellulose acetate fibres.

Intensive development of this industry has been observed in the last decade, according to the data of 2015, the chemical industry produced 5,882 thousand decaliter of ethyl alcohol, 1,544 tons of hair products, 799,2 thousand tons of diammonium phosphate, 789,5 thousand tons of sulfuric acid and smaller quantities of other chemical materials. This has led to 11.3% of total value added in manufacturing industry.

The main difference in technology is the type of fuel, the type of combustion plant (gas turbine, boiler) and the rated thermal output of the unit (> 50 kW to <1 MW and> 1 MW to <50 MW).

**2. Activity data:** Applying a Tier 3 approach the facility-level data are needed. The facility-level data are available only for two combustion installations (JSC Lifosa and JSC Achema) in Chemical industries through a large point sources reports submitted to the EPA under the Ministry of Environment. Activity data has to be adjusted in accordance to the data provided in the fuel balance[[25]](#footnote-25). Activity data of facility-level (JSC Lifosa and JSC Achema) can be obtained through large point sources reports submitted to the EPA. These activity data it is necessary to adjust and correct according to the data on energy and fuel balance provided by the Lithuanian Statistics (available at: https://osp.stat.gov.lt/). Distribution of boiler type in the chemical industry is presented in Figure 5.

Figure 5 NFR 1.A.2.c Stationary combustion in the chemical industry sector data on potential plant-level emissions

|  |  |  |  |
| --- | --- | --- | --- |
| SNAP | 1.A.2.c Chemical industry | Fuel | Specified emissions |
| **030103** | Combustion plants <50MW | JSC Lifosa | NOx, CO |
| **030104** | Gas turbine | JSC Achema | NOx, CO |

As mentioned above, the fuel costs of the point sources in question should be distinguished from the total costs of this category from the energy / fuel balance.

Facility-level data (JSC Lifosa and JSC Achema) covers about **60% of the total natural gas consumption** in Chemical industries. Taking into account the approximate structure of fuel combustion technologies in Chemical industries using natural gas it can be assumed that **30% of the remaining part of natural gas are burned at the medium size boilers (>1 MW to <50 MW) and 10% - at the boilers size from >50 kW to <1 MW**. Therefore, for estimation of air pollutant emissions from the medium size boilers (>1 MW to <50 MW) using natural gas can be based on Tier 2 emissions factors presented in 2016 m. EMEP/EEA Guidebook 62 p., TABLE 3–27. The estimation of air pollution from the boilers size from >50 kW to <1 MW can be based on Tier 2 emissions factors presented in 2016 m. EMEP/EEA Guidebook 61 p., TABLE 3–26.

For Liquefied petroleum gas (LPG) the same Tier 2 emission factors can be selected as with natural gas. Depending on the approximate structure of combustion technology in the chemical industry, it can be assumed that **90% of liquefied petroleum gas is burned in medium boilers (> 1 MW to <50 MW) and 10% in boilers of> 50 kW to <1 MW**.

Tier 2 emission factors for liquefied petroleum gas (LPG) can be selected the same as for natural gas presented in 2016 m. EMEP/EEA Guidebook 59 p., TABLE 3–24 and 60 p., TABLE 3–25. Taking into account the approximate structure of fuel combustion technologies in Chemical industries it can be assumed that **85% of LPG are burned at the medium size boilers (>1 MW to <50 MW) and 15% - at the boilers size from >50 kW to <1 MW**.

Tier 2 emission factors for solid fuels (Sub-bituminous coal) combusted in Chemical industries are presented in TABLE 3-20 and 56 p., TABLE 3–21. Based on results of performed analysis of the fuel combustion technologies structure it can be assumed that **50% of solid fuels are burned at the medium size boilers (>1 MW to <50 MW) and 50% - at the boilers size from >50 kW to <1 MW**.

Tier 2 emission factors for biomass (wood/wood waste) combusted in Chemical industries are presented in TABLE 3-45 and 95 p., TABLE 3–46. Based on results of performed analysis of the fuel combustion technologies structure it can be assumed that **90% of biomass are burned at the medium size boilers (>1 MW to <50 MW) and 10% - at the boilers size from >50 kW to <1 MW**.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Gas Turbine Emission Levels for New Devices Linked to low NOx.

**Boilers <50 MW**. The comparison of estimated average value of emission factors based on facility-level data (Tier 3) showed that NOx and CO emission factors based on facility-level data (Tier 3) for Chemical industries using natural gas are higher than the default EF. The fuel consumption of considered large point sources should be subtracted from the total consumption of this category which is taken from the energy and fuel balance. In this way, for 1990-2005 for the remaining fuel after balancing with the Statistics Lithuania (since 2006) the values of 2016 EMEP / EEA National Technical Guide on Emission Accounting (July) Page 62, Table 3-27 are recommended;

**Gas turbines.** Analysis of gas turbine (installed at the JSC Achema) emissions data showed that NOx emission factors varies between 39.86 g/GJ and 86.80 g/GJ with the average value 55.41 g/GJ. The average value of NOx emission factors of gas turbine is in the rage of default technology-specific emission factors (95% confidence interval 29-67 g/GJ).. Meanwhile, CO emission factors vary widely (from 4.34 g / GJ to 299.97 g / GJ). 2012 With the introduction of a new, more efficient gas turbine, the CO emission factor decreased almost 20 times. During 2012 – 2015, the average CO emission factor (5.11 g / GJ) for the gas turbine over the period is within the range of the default emission factors 95% confidence limits (1.8 - 42 g/GJ). This confirms that natural gas emissions are more appropriate for estimating the values ​​in the Technical Manual (2016 EMEP / EEA National Emission Accounting Technical Manual. Last update July 2017 (page 63, Table 3–28); Liquefied Petroleum Gas (LPG) can the same Tier 2 emission factors should be selected as for natural gas.

Only plants burning biofuels and coal have cyclones, i.e. low-capacity devices and large multicyclones. In biofuel boilers with a capacity of more than 10 MW and above, condensing economizers are installed and operated for multicyclones, condensing economizer performs two functions - firstly, to maximize the use of the heat produced, and secondly to clean up the exhaust fumes, removing volatile ash and small particles.

## Recommendations

It is recommended to apply emission factors indicated in EMEP / EEA Technical Manual for the Preparation of National Pollutant Inventory 2016 (last updated July 2017) from 1990 onwards as the updated information in the manual reflects additional measurements and adjustments in a wide range and age of operating equipment in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 to 2012.

Taking into account the results of the LMT Internal Needs Project, it is recommended that national emission factor values would be applied from 2013, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania. Experimentally determined emission factors for predominant fuels are well below the standard values ​​for 2016. EMEP / EEA Technical Tier 2 Technical Manual for National Pollution Inventory Development. This is due to the fact that these emission factor values ​​reflect a wide range of age of equipment operating.

# CHEMICALS PRODUCTION (NFR 2.B.1–2.B.10.A)

It is important to note that the manufacture of chemicals must be accompanied by one physical process: fluid flow, heat or mass exchange; thermodynamic or mechanical.

JSC Achema is a leading producer of nitrogen fertilizers and chemical products in Lithuania and the Baltics. Achema is mainly engaged in nitrogen fertilizer, fertilizer blends, liquid fertilizer, ammonia, nitric acid, formalin, urea formaldehyde - melamine resin, polyvinyl acetate dispersion, industrial gas, and aluminium sulphate solution production. Second large nitrogen-phosphorus fertilizers products manufacturer is JSC „Lifosa". The company produces aluminium fluoride, phosphoric acid and technical grade Sulphuric acid (Figure 6).

Figure 6 Industrial activity and air pollutant emissions under NFR 2.B Chemical Industry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NFR | SNAP | Name | Company | Specified emissions |
|  | **0404** |  |  |  |
| **2.B.1** | 040403 | Ammonia production | JSC Achema | NOx, NMVOC, CO, NH3 |
| **2.B.2** | 040402 | Production of nitric acid | JSC Achema | NOx, CO, NH3 |
| **2.B.10.a** | | | | |
|  | **0404** | Other chemical industry |  |  |
|  | 040401 | Sulfuric acid | JSC Lifosa | NOx, SOx, CO, TSP |
|  | 040404 | Ammonium sulfate | – | – |
|  | 040405 | Ammonium nitrate | JSC Achema | NH3 |
|  | 040406 | Ammonium phosphate | – | – |
|  | 040407 | NPK fertilizers | – | – |
|  | 040408 | Urea | JSC Achema | NH3 |
|  | 040409 | Black coal | – | – |
|  | 040410 | Titanium dioxide | – | – |
|  | 040411 | Graphite | – | – |
|  | 040413 | Chlorine production | – | – |
|  | 040414 | Phosphorus fertilizers | JSC Lifosa | NOx, CO, NH3, TSP |
|  | 040416 | Others | JSC Lifosa | NOx, CO, TSP |
|  | 040416 | Other CAN production | JSC Achema | NOx, CO, TSP, NH3 |
|  | **0405** |  | – | NMVOC, SOx, NH3, TSP, PM10, PM2.5, BC |
|  | 040502 | Propylene | – | – |
|  | 040503 | 1,2-dichloroethane (except 04.05.05) | – | – |
|  | 040504 | Vinyl chloride (except 04.05.05) | – | – |
|  | 040505 | 1,2 dichloroethane + vinilchloride (balanced) | – | – |
|  | 040506 | Polyethylene low density | – | – |
|  | 040507 | Polyethylene high density | – | – |
|  | 040508 | Polyvinylchloride | – | – |
|  | 040509 | Polypropylene | – | – |
|  | 040510 | Styrene | – | – |
|  | 040511 | Polystyrene | – | – |
|  | 040512 | Styrene Butadiene | – | – |
|  | 040513 | Styrene-butadiene latex | – | – |
|  | 040514 | Styrene-butadiene rubber (SBR) | – | – |
|  | 040515 | Acrylonitrile butadiene styrene (ABS) resins | – | – |
|  | 040516 | Ethylene oxide | – | – |
|  | 040517 | Formaldehyde | JSC Achema | NOx, CO |
|  | 040518 | Ethylbenzene | – | – |
|  | 040519 | Phthalic anhydride | – | – |
|  | 040520 | Acrylonitrile | – | – |
|  | 040521 | Adipic acid | – | – |
|  | 040523 | Glucosylic acid | – | – |
|  | 040525 | Production of pesticides | – | – |
|  | 040526 | Production of persistent organic compounds | – | – |
|  | 040527 | Other (phytosanitary, ...) | – | – |
|  | 040520 | Propylene | – | – |
|  | 040521 | 1,2-dichloroethane (except 04.05.05) | – | – |
|  | 040523 | Vinyl chloride (except 04.05.05) | – | – |
|  | 040525 | 1,2 dichloroethane + vinyl chloride (balanced) | – | – |
|  | 040526 | Polyethylene low density | – | – |
|  | 040527 | Polyethylene high density | – | – |
|  | **0406** |  |  | – |
|  | 040622 | Manufacturing of explosives | – | – |
| **2.B.10.b** | | | | |
|  | 040415 | Storage and handling of inorganic chemicals | – | – |

## Ammonia production (NFR 2.B.1)

**1. Brief description of the processes:** Ammonia is produced by Achema AB. Ammonia (SNAP 040403)is the most important raw-material for the production of fertilizers. It is obtained from natural gas and air. Some of gas is incinerated to obtain heat and chemical reactions, the other share is purified and turned into liquid and gaseous ammonia via multi-level conversion. Capacity - 1,117 thousand tons per year.

AM-80 AMM technology is analogous to AM-70. The production of ammonia is designed as one technological line of continuous production.

Main stages of production:

* Catalytic purification of natural gas from sulphur compounds;
* Catalytic conversion of methane into water vapor (primary reformer);
* Catalytic conversion of methane into a mixture of air and water vapor (secondary reformer);
* Two-step catalytic conversion of carbon monoxide to water vapor;
* Purification of converted gas from carbon dioxide with methyldiethanolamine solution;
* Catalytic conversion of converted gas from carbon monoxide to dioxane by reduction to methane (methane);
* Synthesis of ammonia and separation of liquid ammonia.

### Table 3-7 Tier 2 EF for 2.B.1 ammonia production, steam reforming[[26]](#footnote-26)

Ammonia synthesis is an exothermic reaction. The selective non-catalytic reduction process is a secondary measure to reduce the nitrogen oxides formed in the combustion gases of the combustion plant. It is recommended to use Table 3-7 EF values.

### Table 3-8 Tier 2 EF for 2.B.1 ammonia production, partial oxidation[[27]](#footnote-27)

The process described in Table 3-7 is used.

**2. Activity data:** Production has been collected from JSC Achema since 1990 (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.B.1).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** JSC Achema is implementing an environmental monitoring program. More than 30 atmospheric emissions from stationary sources are continuously controlled. Control of environmental impact outside the enterprise territory is performed once a week according to JSC Achema environmental monitoring program 2011 - 2015. Airborne concentrations of ammonia, nitric oxide, carbon monoxide, ammonia nitrate, dust, urea and other pollutants are measured. In 2008, the evaluated default emission factor (IEF) value was below the lower 95% confidence limit. This can be explained by the fact that Achema, together with its foreign partners, carried out two joint implementation projects with the aim of completing the project by 2012 reducing nitrogen oxide emissions by 70-80% by the end of the year.

While producing the ammonia, only the NOx content is reduced by the use of selective non-catalytic reduction (SNCR) in the **primary reforming**. Removal of ammonia from purging and volatile (dense) gases.

## Production of nitric acid (NFR 2.B.2)

**1. Brief description of the processes:** There is a single nitric acid production company JSC Achema in Lithuania. Nitric acid (SNAP 040402) is a product mostly used as a composite part of other products. JSC Achema produces 56-59% nitric acid by absorbing nitrogen oxides with water. The subject matter of the production process consists of catalytic oxidation of gaseous ammonia with oxygen to produce nitrogen monoxide which in the course of further process turns to nitrogen dioxide after binding with oxygen. The final product is obtained after cooling the obtained nitrogen oxides and absorbing them with chemically treated water.

### Table 3.9 Tier 2 EF for 2.B.2 Nitric acid production, low pressure process, no abatement

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.10 Tier 2 EF for 2.B.2 Nitric acid production, low pressure process, no abatement

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.11 Tier 2 EF for 2.B.2 Nitric acid production, medium pressure process

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.12 Tier 2 EF for 2.B.2 Nitric acid production, high pressure process

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.13 Tier 2 EF for 2.B.2 Nitric acid production, direct strong acid process

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.14 Tier 2 EF for 2.B.2 Nitric acid production, low, medium and high pressure process, catalytic reduction

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.15 Tier 2 EF for 2.B.2 Nitric acid production, low, medium and high pressure process, extended absorption

The production of nitric acid takes place through the absorption of nitrogen oxides by water. Production is carried out in nine UKL-7 and two Grand Paroisse (GP, GP-2) nitric acid production facilities. The principle of production of nitric acid production UKL-7 and GP is the same, i. Nitric acid is produced by absorbing NO2 in water in an absorption column. NO2 is obtained by oxidizing NO air to oxygen. Nitrogen monoxide (NO) is produced by oxidizing ammonia with oxygen on the catalyst. Productive HNO3 is directed to storage. The production of nitric acid in UKL-7 and GP units differs in that UKL-7 is used in a single pressure (0.73 MPa (7.3 bar)) and in the GP aggregate in two pressures (0.33 MPa and 0.8 MPa, 3), 3 and 8.0 bar, respectively) production scheme.

The nitric acid production process consists of the following main steps:

* preparation of ammonia-air mixture;
* catalytic oxidation of ammonia in the contact apparatus;
* heat recovery of nitro gas;
* absorption of nitrogen oxides by water;
* selective purification of nitrogen oxides from residual gas;
* supply and storage of nitric acid.

It is therefore proposed to apply the EF values of Technical Guidebook in Table 3.15 (page 22).

**2. Activity data:** Activity data received from JSC Achema from 1990 m. (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.B.2).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** From 2015 there is a new nitric acid aggregate (GP-2) that has increased nitric acid production and is more cost-effective. Reduction of NOx emissions: **Selective Catalytic Purification** (SCR) technology, NOx after SCR (NO2) and NH3 after SCR. Reduction of N2O emissions by catalytic N2O decomposition in the reactor chamber.

## Production of adipic acid (2.B.3)

**1. Brief description of the processes:** Emissions of adipic acid in Lithuania are not emitted during production, so for the source category 2.B.3. Production of adipic acid the marking key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Production of caprolactamine, glyoxal and glyoxylic (2.B.4)

**1. Brief description of the processes:** Emissions of caprolactamine, glyoxal and glyoxylic acid in Lithuania are not emitted during production, so for the source category 2.B.4 Production of caprolactamine, glyoxal and glyoxylic acid the marking key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Carbide production (2.B.5)

**1. Brief description of the processes:** Emissions of carbide in Lithuania are not emitted during production, so for the source category 2.B.5. Production of carbide the marking key “NO” is used.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# OTHER CHEMICAL INDUSTRY(NFR 2.B.10.A)

## Urea

### Table 3.29 Tier 2 EF for 2.B.10.a Other chemical industry, urea[[28]](#footnote-28)

**1. Brief description of the processes:** Urea (SNAP 040408) is granular, bulk fertilizers produced of liquid ammonia and carbon dioxide. Urea is also used as an ingredient in the production of other products. Capacity – 785 thousand tons per year (JSC Achema ). In a urea plant, ammonia and particulate matter are the emissions of concern. Ammonia emissions from urea production comprise urea synthesis emissions, (0.1–0.5 kg NH3/t of product), urea concentration emissions (0.1–0.2 kg/t), urea prilling (0.5–2.2 kg/t) and granulation (0.2–0.7 kg/t). The prill tower is a source of urea dust (0.5–2.2 kg urea dust/t of product), as is the granulator (0.1–0.5 kg/t).

**2. Activity data:** Emissions of urea from 1990 to 2005 Tier 2 EF can be considered based on 2016 EMEP / EEA Technical Guidebook 2016 Table 3.29 (page 29). Facility level reports along with SNAP codes since 2006 provided by Achema on request.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Amonio nitratas

### Table 3.27 Tier 2 EF for 2.B.10.a Other chemical industry, ammonium nitrate[[29]](#footnote-29)

**1. Brief description of the processes:** ammonium nitrate (SNAP 040405) – refers to granular bulk fertilizers received by neutralizing nitrogen acid with gaseous ammonia and by adding magnesium nitrate as a stabilizing additive to improve physical properties of the product. Capacity – 561 thousand tons per year. The production of ammonium nitrate yields emissions of PM, ammonia and nitric acid. The emission sources of primary importance are the prilling tower and the granulator.

**2. Activity data:** Ammonium nitrate in 1990-2005 Tier 2 EF can be applied based on EF EMEP/EEA Guidebook Table 3.27 (page 28). Facility level reports along with SNAP codes since 2006 provided by Achema on request.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Sieros rūgštis

Produced from technical melt sulphur double contact using intermediate sulphur trioxide absorption (see Table 3.22).

### Table 3.21 Tier 2 EF for 2.B.10.a Other chemical industry, sulphuric acid production, contact process without inter - mediate absorption (single absorption)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.22 Tier 2 EF for 2.B.10.a Other chemical industry, sulphuric acid production, contact process with inter - mediate absorption (double absorption).

**1. Brief description of the processes:** Sulfuric acid is produced from the technical melting of double sulphur by means of intermediate absorption of sulphur trioxide (double contact and double absorption). Sulfuric Acid 1990-2005 Tier 2 EF can be applied based on Table 3.22 of the 2016 EMEP / EEA Guidebook (page 25). The EF table in the 2016 Technical Guidebook specifies the EF values for the calculation of SOx emissions only, but the installation level reports also include NOx, CO and TSP emissions. From 1990 to 2005 EF can be calculated from reported fuel (natural gas) consumption and applied until 2005.

These pollutants are released into the air during the production process:

* Sulphur dust (solid particles) is released into the environment when off-loading in the storage;
* Sulphur dust (solid particles), sulphur anhydride and hydrogen sulphide enters the environment during melting of sulphur;
* Liquid sulphur combustion generates technological sulphur dioxide gas and combustion products: nitrogen oxides, carbon oxide;
* After double contact and double absorption, unreacted sulphur dioxide and sulfuric acid aerosol enter the environment.

**2. Activity data:** Production data is provided by JSC Lifosa (company provided data for 1999-2005).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** 2014 the refluxing of the sulfuric acid workshop equipment increased the degree of contact and significantly reduced sulphur dioxide emissions to the ambient air. From 2014 there is a Tier 3 accounting method, so no conversion factor is required.

### Table 3.23 Tier 2 EF for 2.B.10.a Other chemical industry, sulphuric acid production, contact process with inter-mediate absorption (double absorption, decomposition plants, spent sulphuric acid).

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.24 Tier 2 EF for 2.B.10.a Other chemical industry, sulphuric acid production, wet contact process (98% and 78 % sulphuric acid)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.25 Tier 2 EF for 2.B.10.a Other chemical industry, sulphuric acid production, wet/dry contact process with intermediate condensation/absorption.

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Black carbon production

### Table 3.30 Tier 2 EF for 2.B.10.a Other chemical industry, carbon black production[[30]](#footnote-30)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Graphite production

### Table 3.31 Tier 2 EF for 2.B.10.a Other chemical industry, graphite production[[31]](#footnote-31)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## CHLORINE PRODUCTION

### Tables 3.32 – 3.34 Tier 2 EF for 2.B.10.a Other chemical industry, chlorine production, mercury cell[[32]](#footnote-32)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## phosphate fertilisers

### Table 3.35 Tier 2 EF for 2.B.10.a Other chemical industry, phosphate fertilisers[[33]](#footnote-33)

**1. Brief description of the processes:** Diamonium phosphate (DAP) - produced by neutralizing the extraction phosphoric acid in ammonia in tubular reactors and granulating the product in drum granulators-dryers. There are three production lines. Monoammonium Phosphate (MAP) is produced by neutralizing sulphated and fluorinated extractive phosphoric acid in gaseous ammonia reactor and crystallization in crystals and drying of product crystals in a boiling layer dryer. Calcium phosphates are produced by mixing fluorinated phosphoric acid with lime and drying the resulting mixture in a dryer. Production is continuous. This produces aerosol particles.

Phosphate fertilizers from 1990 to 2005 Tier 2 EF can be applied based on 2016 EMEP / EEA Technical Guidebook 3.35 Table (page 33). Facility level reports along with SNAP codes since 2006 is provided by JSC Lifosa on request.

**2. Activity data:** The EF table in the 2016 Technical Guidebook specifies the EF values for the calculation of the PM emissions only, but the installation level reports also include NOx, CO and NH3 emissions. From 1990 to 2005 EF can be calculated from reported fuel (natural gas) consumption and applied until 2005.

1990-2005 data provided by JSC Achema on request (company provided data for 1999-2005).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Other products

### Table 3.36 Tier 2 EF for 2.B.10.a Other chemical industry, ethylene and propylene production

**1. Brief description of the processes:** Very small quantities are produced until 2013. In this way, the EF values in the tables are suitable.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Tables 3.37-3.38 Tier 2 EF for 2.B.10.a Other chemical industry, 1,2 dichloroethane + vinylchloride (balanced process, DCE unit) production

**1. Brief description of the processes:** Only polyvinyl chloride is produced in Lithuania (Table 3.41).

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.39 Tier 2 EF for 2.B.10.a Other chemical industry, polyethylene low density[[34]](#footnote-34)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.40 Tier 2 EF for 2.B.10.a Other chemical industry, polyethylene high density[[35]](#footnote-35)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### **Table 3.41** Tier 2 EF for 2.B.10.a Other chemical industry, polyvinylchloride, suspension PVC (S-PVC); **Table 3.42** Tier 2 EF for 2.B.10.a Other chemical industry, polyvinylchloride, emulsion PVC (E-PVC).

**1. Brief description of the processes:** In Lithuania, PVC-U is rigid. Quantities of plasticised PVC provided by the Department of Statistics. It consists of resin, plasticizers and fillers. Produced by exposure to ultraviolet (or benzoyl peroxide) vinyl. Method of production - suspension.

**2. Activity data:** data is provided by Department of Statistics.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.43 Tier 2 EF for 2.B.10.a Other chemical industry, polypropylene[[36]](#footnote-36)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.44 Tier 2 EF for 2.B.10.a Other chemical industry, styrene[[37]](#footnote-37)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.45 Tier 2 EF for 2.B.10.a Other chemical industry, polystyrene, general purpose polystyrene (GPPS)[[38]](#footnote-38)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.46 Tier 2 EF for 2.B.10.a Other chemical industry, polystyrene, high impact polystyrene (HIPS)[[39]](#footnote-39)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.47 Tier 2 EF for 2.B.10.a Other chemical industry, polystyrene, expandable polystyrene[[40]](#footnote-40)

**1. Brief description of the processes:** Not processed, only processing takes place. The main producers of polystyrene foam in Lithuania are: JSC Baltijos Polistirenas, SILIKATAS, JSC Ukmergės gelžbetonis, JSC Kauno šilas, JSC Šilputa, JSC Prokma. During the survey (oral information provided by all manufacturers) information was collected that 100-110 ° C water vapor and / or isobutane, pentane are used in Lithuania during production. The base polystyrene is styrene. During polymerization, styrene molecules bind to each other in chains. In the presence of pentane in polymerization, expanded polystyrene material is obtained. Pentane-impregnated polystyrene beads account for about 6% by weight.

**2. Activity data:** Data are provided by Statistics Lithuania.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.48 Tier 2 EF for 2.B.10.a Other chemical industry, styrene butadiene[[41]](#footnote-41), styrene - butadiene latex[[42]](#footnote-42) and styrene - butadiene rubber (SBR)[[43]](#footnote-43)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.49 Tier 2 EF for 2.B.10.a Other chemical industry, styrene - butadiene latex[[44]](#footnote-44)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.50 Tier 2 EF for 2.B.10.a Other chemical industry, styrene - butadiene rubber (SBR)[[45]](#footnote-45)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.51 Tier 2 EF for 2.B.10.a Other chemical industry, ABS production[[46]](#footnote-46)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Formaldehyde products

### Table 3.52 Urea formaldehyde resins and urea-melamine formaldehyde resins[[47]](#footnote-47)

**1. Brief description of the processes:** Resins(SNAP 040517) produced from formalin, melamine and urea in two steps. In the first stage, the resins are obtained by the polycondensation reaction method, and during the second stage their concentration is increased by vacuum evaporation.

**2. Activity data:** Data is provided by Statistics Lithuania.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.53. Tier 2 EF for 2.B.10.a Other chemical industry, formaldehyde production, silver process, unabated

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.54 Tier 2 EF for 2.B.10.a Other chemical industry, formaldehyde production, oxide process, unabated

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.55 Tier 2 EF for 2.B.10.a Other chemical industry, formaldehyde production, silver process, abated

**1. Brief description of the processes:** Formalin is produced from an air-water-methanol vapor mixture in a contact machine containing a layer of pumice-silver catalyst at a temperature of 600-700 ° C in the contact zone, forms formaldehyde, which is supplied to the standardize and containers and by cooling and absorbing water in the absorption column forms 37% formalin. Formalin is supplied from the standardizer for the production or further storage of urea formaldehyde resin condensate.

**2. Activity data:** The EF table in the EMEP/EEA Guidebook (2016) specifies the EF values for the calculation of CO and NMLO only in the air, but the installation level reports also include NOx emissions. From 1990 to 2005 EF can be calculated from reported fuel (natural gas) consumption and applied until 2005 (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.B.10.a).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.56 Tier 2 EF for 2.B.10.a Other chemical industry, ethylbenzene (040518)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.57 Tier 2 EF for 2.B.10.a Other chemical industry, phthalic anhydride, using o - xylene as feed[[48]](#footnote-48)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.58 Tier 2 EF for 2.B.10.a Other chemical industry, phthalic anhydride, using naphthalene as feed[[49]](#footnote-49)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.59 Tier 2 EF for 2.B.10.a Other chemical industry, acrylonitrile[[50]](#footnote-50)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.60 Tier 2 EF for 2.B.10.a Other chemical industry, glyoxylic acid[[51]](#footnote-51)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.61 Tier 2 EF for 2.B.10.a Other chemical industry, pesticide production[[52]](#footnote-52) and other[[53]](#footnote-53)

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Calcium ammonium nitrate[[54]](#footnote-54)

**1. Brief description of the processes:** Calcium ammonium nitrate (SNAP 040416) is a granular bulk fertilizer. CAN is produced by grinding dolomite and mixing with ammonia nitrate solution. The mix is granulated, dried, sieved, cooled, and conditioned.

**2. Activity data:** Capacity – 450 thousand tons per year (Achema AB).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

## Analysis of chemical substances of the statistics department

Based on this example (code-based orientation), it appears that incorporating all the compounds recommended by EMEP / EEA (2016) and codes starting with 2014, 2016 and 2017 into the accounting for 2.B.10.a is risky in terms of double counting. In this case, it is recommended to include only those compounds listed in the EMEP / EEA Guide 2.B.10.a according to the SNAP codes. After verifying that double counting is not performed, the remaining compounds can be aggregated into a common group and applied to the Tier 1 accounting method and EF (Table 3.6, page 17).

A good example is the production of ethyl alcohol (NACE code 2014740000). Emissions of pollutants (NMO, NOx, KD) into the air during production of this material are classified in sector 2.H.2.

**Production of Ethyl Alcohol (Spirits):** Spirits are produced by the only Obeliai Distillery in Lithuania. Until 2016 only distillation process was carried out at the distillery. During the renovation of the Obeliai distillery a new line of distillation - rectification was built. During the distillation process, the raw material for the production of ethyl alcohol is prepared, and during the rectification this raw material is finally purified - it is pure ethyl alcohol. The new rectification lines, which work continuously around the clock, have a productivity of 30,000 litres of pure ethyl alcohol per day. This alcohol is used not only in the beverage industry, but also in the manufacture of cosmetics and medical products. The alcohol required for household chemistry is further denatured - processed from food to technical.

**Denatured ethyl alcohol** is not accounted for as it is produced from not denatured spirits by pouring denaturants.

**Emission Reduction Effectiveness:** The Company does not release more than 0.578 tonnes of NMVOCs per year in the air. Evaporation of NMVOCs is condensed: in the upper part of the column, the alcohol vapor from the lower portion of the yeast column is concentrated. There are two phases: liquid and vapor-like, which are not uniform in composition. There is more water in the liquid phase, the boiling temperature of which is higher than that of alcohol, and the higher the boiling point of the lower alcohol in the steam. In this way, the alcohol vapor is concentrated by partial condensation. Concentrated vapors containing at least 88% by volume. alcohol, from the column to the deflegmator, phlegm is formed. About 2/3 of the alcohol vapor condenses in the deflator, giving heat to the yeast, and forms a phlegm (fluid flow in the column) that is returned to the top of the alcohol column. The remaining alcoholics (about 1/3) fall into the condenser, cooled. Refrigerated ethyl alcohol at a temperature of 18 to 220 ° C passes through an alcohol filter, a monitoring glass, and a counting counter in an intermediate receiver.

In Lithuania, **synthetic urea resins** were produced in 1958 in woodworking industry. In 1961, the Vilnius Plastic Products Factory (since 1985, Plasta) was launched, in 1965 - Vilnius Polymer Factory (since 1996 Wavin Baltic, manufactures plastic pipes). 1973 Jonava Nitrogen Fertilizer Factory (1979-94 Azot, Achema since 1994) started to produce urea formaldehyde resin (accounting by Tier 3), 1974 - polyvinyl acetate dispersion (PVA adhesive), formaldehyde. After independence, more small plastic companies have emerged. The company Putokšnis (founded in 1994 in Šiauliai) - the largest producer of PET bottles in the Baltic States, Salinta (established in 1996 in Kaunas) produces plastic components for household appliances, the company Komex (founded in 1991 in Panevėžys) - packaging materials made of polyethylene film, V. Juškos įmonė Plastvis (founded in 1995 in Vilnius) - PET bottles, other rain and blown plastic products.

Compounds listed in the Department of Statistics with codes beginning with 2014, 2016 and 2017 to avoid double counting do not include the following compounds:

* 2014611100 Methanal (formaldehyde) (Table 3.55)
* 2014740000 Undenatured ethyl alcohol of an alcoholic strength by volume of 80% vol or higher (important: excluding alcohol duty)
* 2014750000 Denatured ethyl alcohol and other denatured spirits of any strength
* 2014327800 Acetic acid salts

Embedded materials suitable for the EMEP / EEA 2016 Tier 2 method.

* 2016302500 Polyvinylchloride, primary plasticised mixed with other materials (Table 3.42)
* 2016555000 Primary urea resins and thiourea resins (Table 3.52)

## Practice of other countries

Based on the practice of other countries (including Poland, France, Germany and the Czech Republic with deeply diverse industrial traditions), **spirits are not included in sector** 2.B.10.a, only in 2.H.2 to avoid double counting ( emissions from the fermentation process would be estimated twice).

Listed below (Figure 7) are the compounds listed in these countries.

Figure 7 Other country practices

|  |  |
| --- | --- |
| **Country** | **compounds** |
| Latvia | Includes emission from urea and formaldehyde production. Data reported by two operators.. |
| Poland | Carbon black, formaldehyde, Sulfuric acid, Fertilisers, Calcium carbide production, Polyvinylchloride, Polypropylene, Polystyrene, Ethylene, Propylene, Phosphate fertilizers. |
| Norway | Metanol, plastics (ethylene and vinyl chloride, ethylene), explosives, Chloralkali, pigments, soap, varnish. |
| Czech Republic | 1.2 dichlorethane and vinyl chlorides, epichlorhydrine (1-chlorine-2.3-epoypropane) and allyl chloride (1-chlorine-2-propene), polymers on the basis of polyacrylonitrile, 1.2 dichlorethane and vinyl chlorides, synthetic polymers and production of composites, with the exception of composites specified elsewhere, viscose substances, auxiliary preparations, Tar, expanding polystyrene, Acetylene production using the wet method, Chlorine, Hydrochloric acid, Liquid sulfur dioxide, nitric acid and salts, Fertilizer, basic agents to protect plants and biocide production. Explosives, Sulfate process in titanic oxide production, Chloride process in titanic oxide production, Production of other pigments. |
| France | Acide sulfurique, Sulfate d'ammonium, Nitrate d'ammonium, Engrais NPK, Production d’Urée, Noir de carbone, Dioxyde de titane, Chlore, Engrais phosphatés, Ethylène, Propylène, Chlorure de vinyle, Polyéthylène, Polychlorure de vinyle, Polypropylène, Styrène, Polystyrène, Résines butadiène styrène acrylonitrile, Anhydride phtalique, Acide glyoxylique, Autres procédés de la chimie organique (produits phytosanitaires ), Production de produits explosifs. |
| Germany | Acrylonitrile, Ethylbenzene, Ethylene, Ethylene Dichloride Ethylene Oxide, Formaldehyde (Methanal), Methanol, Phthalic Anhydride, Low Density Polyethylene (PE-LD), High Density Polyethylene (PE-HD), Polypropylen (PP), Polystyrene (PS), Polyvinyl Chloride (PVC), Propene, Styrene, Styrene Copolymeres, Vinyl Chloride. |

# STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION: NON-METAL MINERALS (NFR 1.A.2.F)

**1. Brief description of the processes:** Category Stationary combustion in the non-metallic mineral industry includes the production and processing of glass, building materials, clay, ceramics, cement and their products. In 2015, the value added generated by the non-metallic mineral industry was 3.9% of the total value added of manufacturing.

**2. Activity data:** In order to apply the Tier 2 method, activity data and emission factors must be applied according to the country's fuel consumption and combustion technologies installed. The Tier 2 method for calculating emissions from the non-metallic mineral industry, technology-specific emission factors are required. The main difference in technology is the type of fuel, the type of combustion plant (gas turbine, boiler technology) and the size of the technology (> 50 kW and <1 MW and> 1 MW and <50 MW) (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.2.f).

The approximate structure of the fuel combustion technology has been evaluated according to the type and size of the technology, based on reports submitted by the Minister of Environment of the Republic of Lithuania in 2013 April 10 Order Nr. D1-224 "Information on the approval of emission limit values for combustion plants LAND 43–2013", information provided in 2016. The application of Tier 3 method requires device level data. However, there is currently no complete device level data set for at least one company of non-metallic minerals industry.

Since the consumption of fuel for the production of certain products is not known and it would be difficult to break it down (Tables 3-22 - 3-29), the size technology split (analogous to 1.A.2.c) is applied. Based on the results of the fuel combustion technology structure analysis, it can be assumed that **90% of natural gas is burned in medium-sized boilers (> 1 MW and <50 MW) and 10% in boilers of > 50 kW and <1 MW** ( EMEP/EEA air pollutant emission inventory guidebook 2016 (July 2017) Page 61, Table 3–26 and page 62 Table 3–27).

Tier 2 accuracy factors for liquefied petroleum gas (LPG) can be the same as for natural gas (( EMEP/EEA air pollutant emission inventory guidebook 2016 (July 2017), on pages 61, table 3–26 and page 62, table 3-27. Taking into account the approximate structure of combustion technology in the non-metallic mineral industry, it can be assumed that **90% of LPG is burned in medium-sized boilers (> 1 MW and <50 MW) and 10% in boilers. size> 50 kW and <1 MW**.

Tier 2 Emission Factors for Non-Metallic Mineral Oil Burning Fuels (Fuel Oil, Diesel, Petroleum Coke) (EMEP/EEA air pollutant emission inventory guidebook 2016 – (July 2017), page 59, Table 3–24 page 60, Table 3-25). Based on the results of the analysis of the structure of fuel combustion technology, it can be assumed that **85% of liquid fuels are burned in medium-sized boilers (> 1 MW and <50 MW) and 15% in boilers of> 50 kW and <1 MW**.

Tier 2 emission factors for solid fuel burned in the non-metallic mineral industry (sub-bituminous coal, other bituminous coal, anthracite, coke) (EMEP/EEA air pollutant emission inventory guidebook 2016 (July 2017) page. 55, table 3–20 and page 56, table 3-21. Based on the results of the analysis of the structure of fuel combustion technology, it can be assumed that **50% of solid fuel is burned in medium-sized boilers (> 1 MW and <50 MW) and 50% in boilers. size> 50 kW and <1 MW**.

Tier 2 emission factors for biomass (wood / wood waste, other solid biomass) burned in the non-metallic mineral industry ( EMEP/EEA air pollutant emission inventory guidebook 2016 (July 2017) page 95, Table 3–46 and Page 93, Table 3-45. Based on the results of the analysis of the structure of fuel combustion technology, it can be assumed that **90% of biomass is burned in medium boilers (> 1 MW and <50 MW) and 10% in boilers of> 50 kW and < 1 MW**.

Tier 2 pollution factors for peat burning in the non-metallic mineral industry can be chosen the same as for solid fuels. Depending on the approximate structure of fuel combustion technology in the non-metallic mineral industry, it can be assumed that **50% of peat is burned in medium-sized boilers (> 1 MW and <50 MW) and 50% in boilers of> 50 kW and <1 MW**.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Only plants burning biofuels and coal have cyclones, i.e. low-capacity devices and large multicyclones. In biofuel boilers with a capacity of more than 10 MW and above, condensing economizers are installed and operated for multicyclones, condensing economizer performs two functions - firstly, to maximize the use of the heat produced, and secondly to clean up the exhaust fumes, removing volatile ash and small particles.

**In summary:** Stationary biofuel, peat and coal combustion installations have cyclones installations up to 10 MW have cyclones. The usage of cyclones began in 2000 - 20%, 2005 - 80%, from 2013 - 100% (synergy between GAINS and LMT project results). A major disadvantage of the operation of conventional cyclone devices is the inadequate purification of gas flow from particulates of varying dispersion, especially smaller than 10 μm in diameter. At particle sizes larger than 10 μm, cyclone cleaning efficiency is 80-85%. In this way, PM10 can also be applied at 85%.

Higher power biofuel plants use multicyclones, i.e., a block of small cyclones, with an efficiency of 85 to 95 percent for particles larger than 10 μm. The efficiency of multicyclones is higher than that of cyclones. In this way, PM10 can also be applied at 95%.

Biofuel plants with a capacity of more than 10 MW and above multicyclones are equipped with condensing economizers and their efficiency is 94-99%. Since 2013 prevalence is 100 percent.

## Recommendations

It is recommended to apply the emission factors given in EMEP / EEA Technical Manual for the Preparation of National Pollutant Inventory 2016. (last updated July 2017) from 1990 to 2012 as the updated information in the manual reflects additional measurements and adjustments in a wide range of equipment operating in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 onwards.

Taking into account the results of the LMT Internal Needs Project, it is recommended that national emission factor values should be applied from 2013 onwards, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania. Experimentally determined emission factors for predominant fuels are well below the standard values for 2016. EMEP / EEA Technical Tier 2 Technical Manual for National Pollution Inventory Development. This is due to the fact that these emission factor values ​​reflect a wide range of age of equipment operating.

# CEMENT PRODUCTION (NFR 2.A.1)

**1. Brief description of the processes:** In Lithuania, cement production takes place only in one factory. Cement production emits both fuels burning and process emissions. 2006 The company has made significant progress in introducing new 4,500 t / d dry production clinker production lines. From 2014 August the process of using a fully dry process stove was initiated, while until 2014 it was only using wet process furnace in cement production. Fuel combustion emissions are provided in the energy sector (CRF 1.A.2.f i), with the exception of NOX and SO2 emissions provided in sector 2.A.1. The main emissions from cement production are air emissions from the furnace system. Pollutants are emitted from physical and chemical raw material reactions and fuel. The main components of the exhaust gases are nitrogen and excess oxygen from the combustion air stream and carbon dioxide and water from raw materials and the combustion process, which is an integral part of the process. Outgoing gas also has a small amount of air pollutants.

**2. Activity data:** Emissions from the stove are a mixture of combustion and emissions released during the process. The main source of emissions (NOx, SOx, CO, NMVOC and NH3) as well as HM and POP, it mainly originates from the combustion of fuels, therefore these emissions are provided in sector 1A.2.f, which deals with the combustion process in the cement production process because it is not possible to separate process and combustion emissions from cement production. Since emission factors are expressed as mass of clinker produced, activity statistics must be converted from cement to clinker production statistics. Most of the cement produced is Portland cement with an average clinker content of 90-97% (IPCC, 2006). The amount of clinker production was obtained from Akmenės cementas since 1990. Since 2006 equipment level data (Tier 3) covers all cement production plants in Lithuania since 2006. Issue of emissions by 2005 applies to EF EMEP / CORINAIR 2007 (Table 8.1a, Table 8.2b, Table 8.2c), US EPA (2011, Document No: 91127). The main source of emissions is from combustion and is therefore provided in subsector 1.A.2.f.i. Activity is provided in the attached MS Excel file Fuel\_burning\_Collected\_data\_1990-2019\_EN.xlsx, Sheet 2.A.1.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Since 2006 facility level data (Tier 3) includes all pollution efficiency measures. Non-catalytic or catalytic scrubbing technique for wet type of production (until 2014) was not applied.

The reduction of PM and CO emissions is achieved through a combination of measures: electrostatic filters with built-in measurement and control systems to reduce CO emissions and sleeve filters with separate sections and "filled" bag detectors. Process optimization (process control and control, combustion method improvement, fuel selection, combustion cooling) reduces NOx emissions by 10-30 %.

# LIME PRODUCTION (NFR 2.A.2)

**1. Brief description of the processes:** Emissions from the lime production industry include emissions of PM from limestone mining, processing, splitting, sifting and calcination, and emissions of air pollutants from fuel combustion. Since 1999 data on the production of hydrated lime are provided by the Statistics Lithuania. The hydrated lime fraction ranged from 0% to 4%. National statistical data do not include non-commercial data on lime production from sugar undertakings and therefore for the whole period from 1990 onwards the quantities of lime produced were obtained directly from sugar-producing companies (lime deposited and used in agricultural activities).

**2. Activity data:** Emissions from the lime industry are the result of two main processes of lime processing: quarrying, crushing and sizing of minerals; and fuel burning in lime stoves. Emissions from lime production are determined by both processes and fuel combustion. Emissions from combustion are provided in 1.A.2.f.i Stationary combustion in other manufacturing and construction industries. SOx and NOx emissions are provided in (IE) source category 1.A.2.f.i.

### Table 3.2 Tier 2 EF for 2.A.2 Lime production (unabated).

Activities are ongoing. 1990 - 2004 for the assessment of particulate matter and BC emissions over the period 2007-2009, the uncontrolled EF from 2016 EMEP / EEA shall be used. Data is provided by Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.A.2).

### Table 3.3 Tier 2 EF for 2.A.2 Lime production (abated)

Activities are ongoing. Since 2005 particulate matter and BC emission estimation is based on uncontrolled EF from 2016 EMEP / EEA. Data is provided by Statistics Lithuania (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.A.2).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Since 2005 the best available technologies (BAT) have been introduced in the installations, and emissions from the production processes are controlled. Therefore, since 2005, for particulate matters and BC are used for controlled processes EF from EMEP / EEA 2016.

# GLASS PRODUCTION (NFR 2.A.3)

The Tier 2 method is applicable because activity data can be stratified by different types of glass production (hereinafter referred to as "technology" (Tables 3.2, 3.3 and 3.6)) that have been conducted in the country. NOx and SOx emissions are generally considered to be related to combustion and are therefore reported in source category 1.A.2.g.i. JSC Kauno stiklas produces only containers, while cathode tubes are produced by JSC Ekranas. Tables 3.2, 3.3 and 3.6 report only particle emissions. Emissions related to combustion of fuels are reported in the source category 1.A.2.g.i (industrial combustion).

### Table 3.2 Tier 2 EF for 2.A.3 Glass production, flat glass

**1. Brief description of the processes:** Produced in JSC Panevėžio stiklas (JSC Klar Glass). It produces glass sheets and containers. EF is provided with pollution abatement measures, so no additional conversion factor is required.

**2. Activity data:** Activity data for 1990-2017 is provided by producers (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.A.3). At the time of preparation of this report the data for 2018 was not available.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.3 Tier 2 EF for 2.A.3 Glass production, container glass

**1. Brief description of the processes:** Produced by JSC "Kauno stiklas", therefore EF is listed in Table 3.3 since 1990. and additional pollution reduction factor (75% PM filtering (25% and 92% uncertainty limits)).

**2. Activity data:** Activity data for 1990-2017 is provided by producers (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.A.3). At the time of preparation of this report the data for 2018 was not available.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Since 2008 production modernization works started. In this way, for glass containers until 2008 a PM reduction factor is applied (75% for PM detained) and for 2009 - 99% for BC (respectively BC and Pb) indicated in 2016 technical guidebook.

### Table 3.4 Tier 2 EF for 2.A.3 Glass production, glass fibres

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.5 Tier 2 EF for 2.A.3 Glass production, glass wool

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.6 Tier 2 EF for 2.A.3 Glass production, other glass, lead crystal glass

**1. Brief description of the processes:** Production of cathodic tubes was discontinued in 2006. (JSC Ekranas). Tier 2 coefficients are indicated with pollution abatement measures; therefore, no correction coefficient is applied.

**2. Activity data:** Activity data for 1990-2006 is provided by producers (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.A.3).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

### Table 3.7 Tier 2 EF for 2.A.3 Glass production, other glass, water glass

**1. Brief description of processes:** not occurring.

**2. Activity data:** no activity.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied.

# ASPHALT ROOFING (NFR 2.D.3.C)

**1. Brief description of the processes:** There is only one manufacturer in Lithuania (JSC Mida LT), which produce roofing materials: flexible roof tiles with different modifications (different thickness and bitumen flexibility, different geometric shapes) for tiled roofs, as well as membrane coatings for flat roofs.

**2. Activity data:** The manufacturer provided operational data for roofing materials production for 2001-2015 period. Based on the expert judgement presented in the GHG emission inventory (2017), 1990 – 2000 data on the roofing in Lithuania were not received during the period, and the calculations were made on the basis of the average annual costs of bitumen (Statistics Lithuania) and expert judgement (2017 presented by UNFCCC). It was also assumed that between 1990 and 2000 the combustion emissions (e.g. SOx and NOx generated during asphalt coating processes are listed in source category 1.A.2.gi Data compiled in 1990-2016 is provided in MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.D.3.C).

### **Table 3.2** Tier 2 EF for 2.D.3.c, Asphalt roofing, dip saturator; **Table 3.3** Tier 2 EF for 2.D.3.c, Asphalt roofing, spray/dip saturator.

# STATIONARY COMBUSTION IN FOOD, PAPER AND BEVERAGE INDUSTRY (1.a.2.e)

**1. Brief description of the processes:** The food, beverage and tobacco industries have a long tradition in Lithuania. This manufacturing industry consists of important structural parts: production of products; preparation and processing of fish and fish products; preparation, processing and preserving of fruit, berries and vegetables; dairy production; grains; production of strong and soft drinks; tobacco.

**2. Activity data:** The activity data is provided by Statistics Lithuania. Data for 1990-2018 is provided (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 1.A.2.e).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Not applicable (Tier 2 EF to be submitted for pollution reduction). For the assessment of emissions, EF 1.A.4.a. The EFs of sector 1.A.4.a are used to assess emissions. Only low power biofuel plants use cyclones, while higher power biofuel plants use multicyclones. In biofuel plants with a capacity of more than 10 MW, condensing economizers are installed and operated behind multicyclones. The condensing economizer has two functions - firstly, to maximize the efficiency of the heat generated and, secondly, to maximize the purge of exhaust fumes by removing fly ash and fine particulates. In this way, high particulate matter reduction efficiency is assured.

## Recommendations

It is recommended to apply the emission factors given in EMEP / EEA Technical Manual for the Preparation of National Pollutant Inventory 2016 (last updated July 2017) from 1990 to 2012 as the updated information in the manual reflects additional measurements and adjustments in a wide range of equipment operating in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 onwards.

Taking into account the results of the LMT Internal Needs Project, it is recommended that national emission factor values should be applied from 2013 onwards, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania. Experimentally determined emission factors for predominant fuels are well below the standard values for 2016. EMEP / EEA Technical Tier 2 Technical Manual for National Pollution Inventory Development. This is due in particular to the fact that these emission factor values reflect a wide range of equipment operating in all ages of the world.

# STATIONARY COMBUSTION IN OTHER INDUSTRIES (1.A.2.G.VIII)

**1. Brief description of the processes:** In Lithuania Other industries include:

* Production of transport equipment (manufacture of cars, trailers and semi-trailers, as well as manufacture of other vehicles);
* Manufacture of machinery (manufacture of metal products, except machinery and equipment, computer manufacturing, manufacture of electronics and optical products, manufacture of electrical equipment, manufacture of machinery and equipment);
* Mining and quarrying;
* Manufacture of wood and wood products (manufacture of plywood and similar laminated wood products, particle board, manufacture of fiberboards, windows and their frames and doors and their frames);
* Construction;
* Manufacture of textiles and leather goods (manufacture of textiles, clothing, leather and leather products);
* Unmentioned industry (manufacture of rubber and plastic products; manufacture of furniture; manufacture of other goods).

In 2015, in other industries, more than 50% of the total value added generated by the manufacturing industry was created.

**2. Activity data:** The Tier 2 approach to emissions from other industries requires technology-specific emission factors. The main difference in technology is the type of fuel, the type of combustion plant (gas turbine, boiler technology) and the size of the technology (> 50 kW and <1 MW;> 1 MW and <50 MW).

The approximate structure of the fuel combustion technology has been evaluated according to the type and size of the technology, based on information in LAND reports [[55]](#footnote-55). The Tier 3 method requires device level data. However, there is currently no complete device level data set for at least one other industry company.

Data collected in 1990-2016 and provided by MS Excel Kuro deginimas.xls, page 1.A.2.g viii.

Based on the results of the analysis of the structure of fuel combustion technology, it can be assumed that **90% of natural gas is burned in medium-sized boilers (> 1 MW and <50 MW) and 10% in boilers of> 50 kW and <1 MW**.

Considering the approximate structure of fuel combustion technologies in other industries, it can be assumed that **90% of LPG is burned in medium-sized boilers (> 1 MW and <50 MW) and 10% in boilers of> 50 kW and <1 MW.**

Tier 2 emission factors for liquid fuel (fuel oil, gas oil) are given in Tables 2.28-7 and 2.28-8. Based on the results of the analysis of the structure of fuel combustion technology, it can be assumed that **85% of liquid fuels are burned in medium boilers (> 1 MW and <50 MW) and 15% in boilers of> 50 kW and <1 MW.**

Based on the results of the fuel combustion technology structure analysis, it can be assumed that **50% solid fuel is burned in medium-sized boilers (> 1 MW and <50 MW) and 50% in boilers of> 50 kW and <1 MW.**

Based on the results of the fuel combustion technology structure analysis, it can be assumed that **90% of biomass is burned in medium-sized boilers (> 1 MW and <50 MW) and 10% in boilers of> 50 kW and <1 MW**.

Considering the approximate structure of fuel combustion technologies in other industries, it can be assumed that **50% of peat is burned in medium-sized boilers (> 1 MW and <50 MW) and 50% in boilers of> 50 kW and <1 MW**.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Not applicable (Tier 2 EF to be submitted for pollution reduction). For the assessment of emissions, EF 1.A.4.a. is applied. Only plants burning biofuels and coal have cyclones, i.e. low-capacity devices and large multicyclones. In biofuel boilers with a capacity of more than 10 MW and above, condensing economizers are installed and operated for multicyclones, condensing economizer performs two functions - firstly, to maximize the use of the heat produced, and secondly to clean up the exhaust fumes, removing volatile ash and small particles.

## Recommendations

It is recommended to apply the emission factors given in EMEP / EEA Technical Manual for the Preparation of National Pollutant Inventory 2016. (last updated July 2017) from 1990 to 2012 as the updated information in the manual reflects additional measurements and adjustments in a wide range of equipment operating in the world, e.g. not just new devices but old ones as well. The greenhouse gas inventory follows the same recommendation formulated by the Intergovernmental Panel on Climate Change (IPCC) that the emission factors in the latest manual should apply from 1990 onwards.

Taking into account the results of the LMT Internal Needs Project, it is recommended that national emission factor values should be applied from 2013 onwards, which have been determined experimentally and reflect the distribution and age of recent combustion technologies used in Lithuania. Experimentally determined emission factors for predominant fuels are well below the standard values for 2016. EMEP / EEA Technical Tier 2 Technical Manual for National Pollution Inventory Development. This is due to the fact that these emission factor values ​​reflect a wide range of age of equipment operating.

# PULP AND PAPER PRODUCTION (NFR 2.H.1)

**1. Brief description of the processes:** In Lithuania since 1993 pulp is not produced. From 1994 paper and cardboard, used in the production of sanitary and household products, were recycled into secondary raw materials - paper waste. Paper is produced in two Lithuanian companies.

**2. Activity data:** Data provided by IIASA GAINS model (see MS EXCEL FILE FUEL\_BURNING\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, SHEET 2.H.1).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Efficiency was considered to be high and therefore suitable for Tier 1 EF values.

1. <http://gamta.lt/cms/index?rubricId=51785c03-fd6e-4701-86ef-936e4b5ef2b2> [↑](#footnote-ref-1)
2. <http://gamta.lt/cms/index?rubricId=f3ad46c6-97ac-4c90-bf65-869586196586> [↑](#footnote-ref-2)
3. <http://gamta.lt/cms/index?rubricId=89862870-c431-46ac-97dc-76dfef1f0435> [↑](#footnote-ref-3)
4. Data acquisition from JSC Achema and JSC Lifosa was taken over by EPA. [↑](#footnote-ref-4)
5. SNAP 010101, 010102 [↑](#footnote-ref-5)
6. SNAP 010101, 010102 [↑](#footnote-ref-6)
7. SNAP 010101, 010102 [↑](#footnote-ref-7)
8. SNAP 010101, 010102 [↑](#footnote-ref-8)
9. SNAP 010101, 010102 [↑](#footnote-ref-9)
10. SNAP 010101, 010102 [↑](#footnote-ref-10)
11. SNAP 010101, 010102 [↑](#footnote-ref-11)
12. SNAP 010101, 010102 [↑](#footnote-ref-12)
13. SNAP 010104 [↑](#footnote-ref-13)
14. SNAP 010104 [↑](#footnote-ref-14)
15. SNAP 010105 [↑](#footnote-ref-15)
16. SNAP 010105 [↑](#footnote-ref-16)
17. http://klimatas.gamta.lt/cms/index?rubricId=35c6fcad-1114-495d-9926-f40613232509 [↑](#footnote-ref-17)
18. Analysis of the impacts of various options to control emissions from combustion of fuels in installations with a total rated thermal input below 50 MW” (2014) [↑](#footnote-ref-18)
19. Analysis of the impacts of various options to control emissions from combustion of fuels in installations with a total rated thermal input below 50 MW” (2014) [↑](#footnote-ref-19)
20. Analysis of the impacts of various options to control emissions from combustion of fuels in installations with a total rated thermal input below 50 MW” (2014) [↑](#footnote-ref-20)
21. Žemiau pateikiamas bendrasis algoritmas kiekvienai kategorijai naudojant Tier 2 metodologija. [↑](#footnote-ref-21)
22. Diesel, four-stroke petrol, LPG or two-stroke petrol. [↑](#footnote-ref-22)
23. <1981; 1981-1990; 1991-Stage I; Stage I; Stage II; Stage IIIA; Stage IIIB; Stage IV; Stage V. [↑](#footnote-ref-23)
24. <https://osp.stat.gov.lt/> [↑](#footnote-ref-24)
25. <https://osp.stat.gov.lt/> [↑](#footnote-ref-25)
26. SNAP 040403 [↑](#footnote-ref-26)
27. SNAP 040403 [↑](#footnote-ref-27)
28. SNAP 040408 [↑](#footnote-ref-28)
29. SNAP 040405 [↑](#footnote-ref-29)
30. SNAP 040409 [↑](#footnote-ref-30)
31. SNAP 040411 [↑](#footnote-ref-31)
32. SNAP 040413 [↑](#footnote-ref-32)
33. SNAP 040414 [↑](#footnote-ref-33)
34. SNAP 040506 [↑](#footnote-ref-34)
35. SNAP 040507 [↑](#footnote-ref-35)
36. SNAP 040509 [↑](#footnote-ref-36)
37. SNAP 040510 [↑](#footnote-ref-37)
38. SNAP 040511 [↑](#footnote-ref-38)
39. SNAP 040511 [↑](#footnote-ref-39)
40. SNAP 040511 [↑](#footnote-ref-40)
41. SNAP 040512 [↑](#footnote-ref-41)
42. SNAP 040513 [↑](#footnote-ref-42)
43. SNAP 040514 [↑](#footnote-ref-43)
44. SNAP 040513 [↑](#footnote-ref-44)
45. SNAP 040514 [↑](#footnote-ref-45)
46. SNAP 040515 [↑](#footnote-ref-46)
47. SNAP 040517 [↑](#footnote-ref-47)
48. SNAP 040519 [↑](#footnote-ref-48)
49. SNAP 040519 [↑](#footnote-ref-49)
50. SNAP 040520 [↑](#footnote-ref-50)
51. SNAP 040523 [↑](#footnote-ref-51)
52. SNAP 040525 [↑](#footnote-ref-52)
53. SNAP 040527 [↑](#footnote-ref-53)
54. SNAP 040416 [↑](#footnote-ref-54)
55. Submitted by the Minister of Environment of the Republic of Lithuania 2013 April 10 Order Nr. D1 - 244 "Approval of Emission Limit Values for Fuel Combustion Plants LAND 43–2013"". [↑](#footnote-ref-55)