C:\Users\Administrador\AppData\Local\Microsoft\Windows\INetCache\Content.Word\slash civitta blue.png

NMVOC EMISSIONS ESTIMATION USING TIER 2 METHODOLOGY FINAL REPORT

Final report

2020

This study was carried out by Civitta UAB (project manager Rolandas Gumuliauskas) and dr. Steigvilė Byčenkienė (expert)

**ABREVIATIONS**

|  |  |
| --- | --- |
| 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 |
| VOC | Volatile organic compounds |
| NMVOC | Non-methane volatile organic compounds |
| GHG | Green-house gasses |
| PM | Particulate matter |
| Gg | Gigagrams |
| Kt | Kilotons |
| TIPK | Integrated pollution monitoring and prevention (*lit. Taršos integruota prevencija ir kontrolė*) |
| JSC | Joint stock company (*lit. Akcinė bendrovė*) |
| LLC | Limited liability company (*lit.* *Uždaroji akcinė bendrovė*) |
| MS | Microsoft |
| AAA / EPA | Environmental protection agency (*lit. Aplinkos apsaugos agentūra*) |
| AIVIKS | Integrated Environmental information management system (*lit. Aplinkos informacijos valdymo integruota kompiuterinė sistema*) |
| ESIG | European solvent industry group |

Contents

[1. Introduction 6](#_Toc22821392)

[2. Fugitive emissions oil: Exploration, production, transport (NFR 1.B.2.a.i) 7](#_Toc22821393)

[2.1. Table 4.2.4 Tier 1 EF for fugitive emissions (including venting and flaring) from oil and gas operations in developed countries 7](#_Toc22821394)

[2.2. Table 4.2.5 Tier 1 EF for fugitive emissions (including venting and flaring) from oil and gas operations in developing countries and countries with economies in transition 7](#_Toc22821395)

[3. FUGITIVE EMISSIONS FROM NATURAL GAS (NFR 1.B.2.b) 8](#_Toc22821396)

[4. Distribution of oil products (NFR 1.B.2.a.5) 9](#_Toc22821397)

[5. Domestic solvent use including fungicides (NFR 2.D.3.a) 11](#_Toc22821398)

[5.1. Table 3.2 Tier 2 NMVOC EF for 2.D.3.a Domestic solvent use including fungicides for different solvent types/applications 12](#_Toc22821399)

[5.2. Table 3.4 Tier 2 NMVOC EF for 2.D.3.a Domestic solvent use including fungicides for different products and product types Tier 2 emission 14](#_Toc22821400)

[5.3. Table 3.5 Tier 2 NMVOC EF for 2.D.3.a Domestic solvent use including fungicides for different products and product types 14](#_Toc22821401)

[6. Coating applications (NFR 2.D.3.d) 15](#_Toc22821402)

[7. Degreasing (NFR 2.D.3.e) 16](#_Toc22821403)

[7.1. Table 3-2 Tier 2 EF for 2.D.3.e Degreasing, Open-top degreaser 16](#_Toc22821404)

[7.2. Table 3-3 Tier 2 EF for 2.D.3.e Degreasing, Electronic components manufacturing 16](#_Toc22821405)

[8. Dry cleaning (NFR 2.D.3.f) 18](#_Toc22821406)

[8.1. Table 3-2 Tier 2 EF for 3.B.1 Dry cleaning, Open-circuit machine 19](#_Toc22821407)

[9. Printing (NFR 2.D.3.h) 21](#_Toc22821408)

[9.1. Table 3-2 Tier 2 EF for 2.D.3.h Printing, Heat set offset 21](#_Toc22821409)

[9.2. Table 3-3 Tier 2 EF for 2.D.3.h Printing, Publication gravure 21](#_Toc22821410)

[9.3. Table 3-4 Tier 2 EF for 2.D.3.h Printing, Packaging, Small flexography 21](#_Toc22821411)

[9.4. Table 3-5 Tier 2 EF for 2.D.3.h Printing, Packaging, Large flexography 22](#_Toc22821412)

[9.5. Table 3-6 Tier 2 EF for 2.D.3.h Printing, Packaging, Rotogravure 22](#_Toc22821413)

[10. Chemical products, manufacture and processing (NFR 2.D.3.g) 23](#_Toc22821414)

[10.1. Table 3-2 Tier 2 EF for 2.D.3.g Chemical products, polyester processing 23](#_Toc22821415)

[10.2. Table 3-3 Tier 2 EF for 2.D.3.g Chemical products, polyurethane foam processing 23](#_Toc22821416)

[10.3. Table 3-4 Tier 2 EF for 2.D.3.g Chemical products, polystyrene foam processing 23](#_Toc22821417)

[10.4. Table 3-5 Tier 2 EF for 2.D.3.g Chemical products, rubber processing except tyre production 24](#_Toc22821418)

[10.5. Table 3-6 Tier 2 EF for 2.D.3.g Chemical products, manufacture of tyres 24](#_Toc22821419)

[10.6. Table 3-7 Tier 2 EF for 2.D.3.g Chemical products, pharmaceutical products manufacturing 24](#_Toc22821420)

[10.7. **Table 3-8** Tier 2 EF for 2.D.3.g Chemical products, asphalt blowing, **Table 3-9** Tier 2 EF for 2.D.3.g Chemical products, asphalt blowing, saturant, **Table 3-10** Tier 2 EF for 2.D.3.g Chemical products, asphalt blowing, coating 24](#_Toc22821421)

[10.8. Table 3-11 Tier 2 EF for 2.D.3.g Chemical products, manufacture of paints, inks and glues 25](#_Toc22821422)

[10.9. Table 3-12 Tier 2 EF for 2.D.3.g Chemical products, adhesive tape manufacturing 25](#_Toc22821423)

[10.10. Table 3-13 Tier 2 EF for 2.D.3.g Other product use, manufacturing of shoes 25](#_Toc22821424)

[10.11. Table 3-14 Tier 2 EF for 2.D.3.g Chemical products, leather tanning 25](#_Toc22821425)

[11. Other solvent use (NFR 2.D.3.i) and Other product use (NFR 2.G) 27](#_Toc22821426)

[12. Food and beverages industry (2.H.2) 28](#_Toc22821427)

# Introduction

This report indicates the work carried out during the collection of the activity data and control strategies for calculating the amount of NMVOC emissions on Tier 2 level. The purpose of the data collection report is to distinguish used sources of input data, methodologies and required data.

The structure of this report is in line with emission factor tables provided in the Guidebook. Activity data provided with report is structured accordingly and is connected with the aforementioned EF tables of the Guidebook.

It should also be noted that the published EMEP/EEA Guidebook 2019 doesn’t contain any methodological changes for sector of Non-methane volatile organic compounds[[1]](#footnote-1).

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

* Updated data of Statistics Lithuania, Eurostat and EUROPROM databases (taking into account the fact that statistical data bases are revising the data of previous periods as well, data of previous periods in the report were also updated);
* Activity data from JSC Orlen Lithuania, JSC Energy Distribution Operator (ESO), JSC Litgrid was received;
* Updated data of the IIASA GAINS model, recommendations and insights from sectoral experts were used;
* The calculations made in Interim Report III were extended (e.g. mass balance model);

The activity data collected for Tier 2 level by NFR codes for Fugitive emissions and Other solvent and product use sectors is provided in the attached Microsoft Office Excel document (see MS EXCEL file NMVOC\_Collected\_data\_1990-2019\_EN.XLSX). This document is considered an integral part of this report.

# Fugitive emissions oil: Exploration, production, transport (NFR 1.B.2.a.i)

**1. Activity:** Construction of pipelines in Lithuania started in 1966, with crude oil starting to flow through the pipelines in 1968. In 1992, the company Naftotiekis was established for the operation of Lithuanian pipelines, which later, in 1998, was incorporated into Mazeikiu Nafta in 1998. Currently the Company own and operated about 500 km of the crude oil and petroleum product pipelines in Lithuania.

**2. Activity data**: Based on activity data requirements and availability 1990-onwards, fugitive emissions from sub-sector 1.B.2.a.i Extraction, 1st treatment and loading of liquid (SNAP 050200) can be calculated with Tier 2 EMEP/EEA technology-specific approach by multiplying processes:

* Exploration (drilling, testing, servicing) (Table 4.2.4, p. 4.48);
* Production (fugitive, venting, flaring) (Table 4.2.5, p. 4.50);
* Transport (Table 4.2.5, p. 4.52).

Specific AD stratified according to the different processes with the corresponding IPCC2006 EFs based on data from Department of Statistics is provided (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 1.B.2.a.i).

Below are the Tier 2 tables for 2016 overview of pollutant preparation in technical manual.

## Table 4.2.4 Tier 1 EF for fugitive emissions (including venting and flaring) from oil and gas operations in developed countries

Activity is ongoing in:

* Exploration (drilling, testing, servicing) (TABLE 4.2.4, p. 4.48);
* Production (fugitive, venting, flaring) (TABLE 4.2.4., p. 4.48; 4.50).

## Table 4.2.5 Tier 1 EF for fugitive emissions (including venting and flaring) from oil and gas operations in developing countries and countries with economies in transition

Transportation activity is ongoing via crude oil and petroleum product pipelines) (TABLE 4.2.5, p. 4.52).

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

# FUGITIVE EMISSIONS FROM NATURAL GAS[[2]](#footnote-2) (NFR 1.B.2.b)

**1. Activity**: The transmission system is comprised of gas transmission pipelines, gas compressor stations, gas metering and distribution stations, cathodic protection systems installed to prevent corrosion of the pipeline, remote data transmission and telecommunication systems. Typically, 85–96 % of the emissions consist of methane. Only small amounts of NMVOC are released. In Lithuania, natural gas is transported via gas transmission and distribution systems. The transmission system, operated by JSC Amber Grid is interconnected with the natural gas transmission systems of the Republic of Latvia, Republic of Belarus, Kaliningrad Region of Russian Federation, Klaipeda Liquefied Natural Gas Terminal and distribution systems, operated by the distribution system operators within Lithuania.

**2. Activity data:** Emissions from natural gas transmission and distribution can be calculated on Tier 2 level taking into consideration amount of natural gas leakages in transmission and distribution networks and density of natural gas provided by ESO and Amber Grid AB. Tier 2 for fugitive emissions from natural gas can be applied based on JSC "Lietuvos Dujos" data on natural gas leakages in transmission and distribution networks from 2005. The data on natural gas leakages for the time period 1990-2004 was based on expert judgment (GHG submission, IIR 2017). For the time period 1990-2004 data on natural gas leakages were estimated taking into consideration relation between the total natural gas consumption and leakages in transmission and distribution networks for 2005-2014. Performed analysis showed that leakages accounted about 0.4% in transmission system and about 2% in distribution system from total natural gas consumption in 2005-2014 period. Experts from JSC “Lietuvos dujos” approved that this share can be applied for leakages estimates in 1993-2004 period but recommended to adjust AD for 1990-1992 applying regression analysis. From 2005 CH4 emissions are accounting based on natural gas leakages in transmission and distribution networks and density of natural gas provided by ESO. Conversion Factor: this is the density of CH4 and converts volume of CH4 to mass of CH4. The density taken at 20 C and 1 atmosphere pressure has a value of ~0.67 \* 10-6 Gg m-3 (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 1.B.2.b).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** There is no need for additional application of abatement because the company calculates itself.

# Distribution of oil products (NFR 1.B.2.a.5)

**1. Activity:** Total NMVOC emissions from gasoline distribution come primarily from fugitive emissions released during 1) emissions from bulk storage tanks (refinery dispatch station, border terminals, marketing depots), 2) service station storage tank emissions and 3) transport vehicle filling emissions.

**2. Activity data.**

**Filling Underground Tanks:** It is assumed that since 2005 “bottom loading with vapor return” (Stage IB) for latter recovering (VRU) or destruction (VDU) is used in Lithuania. Before 2005 it is not known in detail share of filling used and it is assumed that 50 % of the service stations had vapor return and 50 % hadn’t the Stage II. So, since 2001-2004, the Stage 1 implemented in 50 %, 2005 – 60 %, 2006 – 70 %, 2007 onwards – 100 %.

**Vehicle Refuelling Operations (Stage II):** Gas station is one of major emission sources of NMVOC. For the calculation of NMVOC emissions from gasoline distribution at service stations AD (amount of delivered gasoline) originate from the ORLEN (www.orlen.lt) and Statistics Lithuania on request. It is assumed that 90 % of service stations had stage IB equipment during 2007-2011 and that 1994-2005 - 10 %. Legislation in place for new stations >100 m3 (>500 m3 in rural areas) applied to all stations by 2007. The share of stage II equipment’s in-service stations is increasing due the new directive (2009/126/EC) implemented in January 2012. So, it was assumed that in 2012 onwards the share of stage II service stations is 30% (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 1.B.2.a.v).

Proposed method was transferred from CONCAWE, 2017[[3]](#footnote-3) report on estimation of fugitive emissions. While in EMEP/EEA, 2016 data from CONCAWE, 2015 are provided.

The definition of the TVP is as follows (EI (2010) Protocol for the estimation of VOC emissions from petroleum refineries and gasoline marketing operations, 2nd edition, London: Energy Institute):

TVP = RVP×10AT+B , where:

* A=0.000007047×RVP+0.01392;
* B=0.0002311×RVP-0.5236;
* T is the temperature (in °C). The annual average loading temperature at terminals can be assumed to equal the average annual ambient temperature;
* RVP is the Reid Vapor Pressure (in kPa).

Tier 2 EF EMEP / EEA Guidebook (2016), CONCAWE and activity data are for gasoline only as it is considered that only NMLO of gasoline evaporates significantly. Accordingly, other fuels are considered to have a low level of evaporation (calculated by Belgium, Denmark, Estonia) and are not evaluated for in the accounts. In Lithuania, storage of raw materials is assessed in sector 1.B.2.a.

**Transportation via pipelines:** Construction of pipelines in Lithuania started in 1966, with crude oil starting to flow through the pipelines in 1968. In 1992, the company Naftotiekis was established for the operation of Lithuanian pipelines, which later, in 1998, was incorporated into Mazeikiu Nafta in 1998.

Currently the Company own and operated about 500 km of the crude oil and petroleum product pipelines in Lithuania:

* Lithuanian section of crude oil pipeline Polotsk – Ventspils — 87.384 km;
* Lithuanian section of product pipeline Polotsk – Ventspils — 87.384 km;
* Lithuanian section of crude oil pipeline Polotsk – Mazeikiai — 225.514 km;
* Crude oil pipeline Mazeikiai – Butinge — 91,5 km.

Until July 2006, Russian crude oil was delivered to Lithuania by two crude oil pipelines via Novopolotsk (Belorussia) to Birzai, from where one 175-km section runs to the Mazekiai Refinery, the other section — to Ventspils.

There are a number of pump stations of various capacities located approximately every 120 kilometres on the crude oil pipeline routes. On the Lithuanian territory, there are three crude oil pump stations. The pipelines have valves installed approximately every 20 kilometres. The valves and pumps of the crude oil stations are controlled at the central control room in Birzai; the valves and pumps of the crude oil pipeline Mazeikiai – Butinge are controlled at Butinge control room. The pipeline pressures are controlled in the similar manner.

**Marine terminal:** The Butinge Terminal is the newest facility of ORLEN Lietuva situated in an all-year-round ice-free area of the Baltic Sea. Its history started in 1995, when the company Butinges Nafta was established for the purpose of constructing and operating the Terminal. In 1998, Butinges Nafta was merged into Mazeikiu Nafta.

The first tanker was loaded in Butinge in the summer of 1999 and took onboard a shipment of YUKOS crude oil. The Terminal can export up to 14 million tons of crude oil a year. As an import and export terminal, it is capable of not only exporting crude oil but also accepting import cargoes.

ORLEN Lietuva is committed to maintaining environmental safety of the Butinge Terminal. Back during the construction of the facility, an environmental monitoring program was introduced that included tests of sea and ground waters. With the start of the terminal operations, a new, expanded environmental monitoring program was launched. The Butinge Terminal applies a number of advanced environmental technologies including a computer-based leak detection system.

The complex of the Butinge Terminal consists of a crude oil pipeline, which connects the facility with the Mazeikiai Refinery, onshore terminal equipment and tanks at Butinge, offshore pipeline, and a

Emissions factors for fugitive process emissions of NMVOC can be expressed as losses per equipment unit per day. As previously discussed, the methods for estimating mass emissions from process equipment leaks range from the use of EFs with equipment counts to comprehensive field measurement techniques.

**Companies operating in oil sector.** The following main companies operate in the country's petroleum sector:

* JSC „ORLEN Lietuva“;
* JSC „Klaipėdos nafta“.

There is a well-developed oil and gas wholesale and retail chain, the main participants of which are:

* LLC „Lukoil Lietuva“;
* LLC „Statoil Lietuva“;
* LLC „Neste Lietuva“;
* LLC „Baltic Petroleum“.

In recent years, the country consumes about 2.4 million. tons oil products. ORLEN Lietuva, an oil producer, dominates the country's market and only a small part of oil products is imported from other countries.

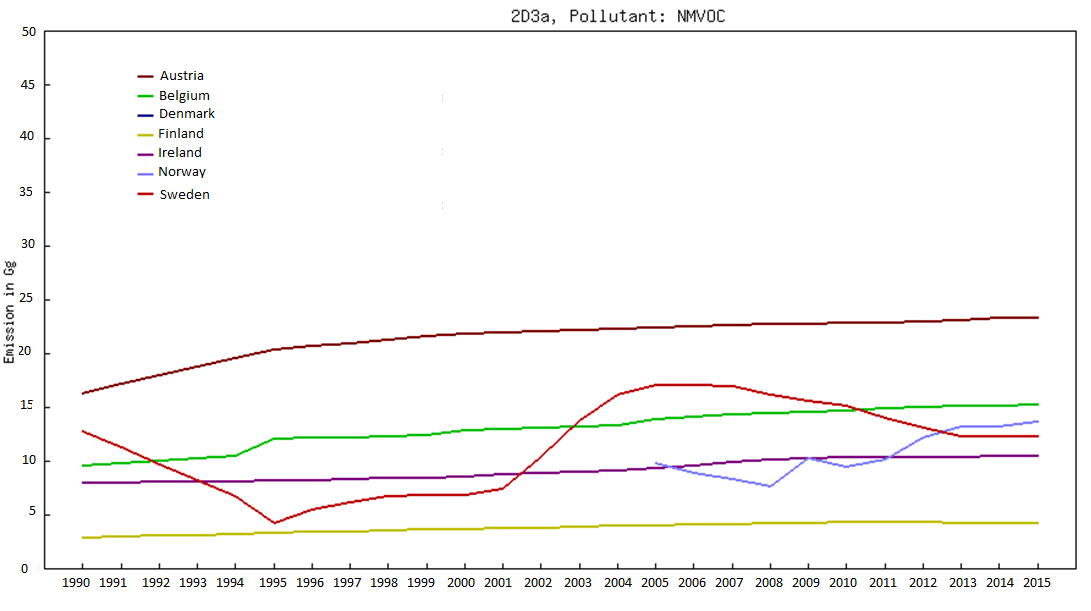
**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Reflected in the EF values provided with and without petrol vapor recovery systems.

# Domestic solvent use including fungicides (NFR 2.D.3.a)

**1. Activity:** Activities are carried out in all countries, including Lithuania (perfume, parfum, lipstick, manicure or pedicure products, shaving, shaving or after shave products (except shaving soaps), creams or makeup, skin care products, make-up treatment, cosmetic powder and talcum powder, shampoos, liquid shampoos, hairspray, etc.

**2. Activity data:** Time series of total emissions for the period 1995–onwards indicate that there is an increasing trend of total residential NMVOC containing products consumption and NMVOC emissions in Europe (see Figure 1). Cosmetics, homeware and DIY, and car care categories are the main contributors in total NMVOC emissions.

Figure 1 NMVOC emissions 1990-2015, Gg



Despite the fact that there are country specific estimation or Tier 2 level implemented in other countries, NMVOC emissions increasing or stabilized over last years. Most appropriate method integrating gradually decreasing EF can be applied based on Estonia practice:

* 1990 – 2000 - 2.59 kg/capita (EMEP/Corinair Emission Inventory Guidebook 2007);
* 2001 – 2.312 kg/capita;
* 2002 – 2.034 kg/capita;
* 2003 – 1.756 kg/capita;
* 2004 – 1.478 kg/capita,
* 2005 and further-on 1.2 kg/capita (ESIG, 2015 m.).

Another alternative method is provided in the initial project report. Below are the Tier 2 tables for 2016 overview of pollutant preparation in technical manual.

Data on the domestic solvent use including fungicides were calculates based on the data provided by Lithuanian department of statistics. The internal consumption was calculated using the general model:

Where:

Cinternal – Internal consumption;

P – Production;

I – Imports

E – Exports.

The input data, calculations as well as internal consumption data is provided in the file attached (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.A).

## Table 3.2 Tier 2 NMVOC EF for 2.D.3.a Domestic solvent use including fungicides for different solvent types/applications

The EF in the table can only be used with detailed information on the amount of solvent consumed in the country. Such information requires research, therefore not recommended. The method may be used as an alternative to Tier 2, but the default values for solvent content in the product must be taken into account (see TABLE 3.3)

ESIG data is not publicly available, although 2016 The EEA / EMEP manual states that the ESIG (European Solvent Industry Group) database is accessible, and ESIG representatives have replied that they cannot disclose the data to third parties. Activity data information prepared by the directly open ESIG group in 2016 The EEA / EMEP Manual is not available for inclusion in the aggregation calculations with all Baltic countries and Finland. Aggregation was done for statistical reasons of confidentiality (emissions in countries with less than 3 markets (5 by 2015)) were grouped by solvent companies (see Table 1).

TABLE 1: SOLVENT EMISSSIONS IN THE BALTICS STATES AND FINLAND IN 2008 and 2013 according to ESIG (2015)

|  |  |  |
| --- | --- | --- |
| **SECTOR** | **VOC SOLVENT EMISSIONS, TONS** | |
| **2008** | **2013** |
| Solvent Distributor / Reseller |  |  |
| Agrochemical use | 87 | 224 |
| Foaming materials | 24 212 | 19 396 |
| Refrigeration | 4 | 3 |
| Binder | 4 | 3 |
| Industrial Cleaning + Skin Processing | 0 | 560 |
| Professional Cleaning | 298 | 262 |
| Coatings-Industrial + Adhesives, Paints | 18 098 | 15 383 |
| Coating-Professional / Consumer + Solvent, paint industry | 2 819 | 3 155 |
| Functional solvents (including those used in chemical processes[[4]](#footnote-4)) | 48 | 50 |
| Use of metalworking / rolling oil / grease | 0 | 0 |
| Oilfield Chemicals - Drilling-Mining-Extraction | 0 | 0 |
| Polymer processing (including tire production) + Industrial resins, synthetic rubber, process | 99 | 86 |
| Roads and construction | 1 076 | 785 |
| fuel / combustion + use of fuel additives | 0 | 2 |
| Water purification | 0 | 236 |
| Other consumables (household, aerosol, cosmetics) | 0 | 319 |
| Pharmaceutical production | 36 | 605 |
| Others - please specify below | 0 | 1 605 |
| *Chemical Industry, Laboratories, Electronic Manufacturing,* |  |  |
| *Reference fluids, chemical raw materials, food extraction,* |  |  |
| *brake fluids / lube oils / jet fuel* |  |  |
| Chlorinated solvents (not ventilated by sector) | 3 673 | 3 232 |
| Total: | **50 454** | **45 906** |

Based on 2016 The ESIG insight provided by the EEA / EMEP Manual revealed that most countries, including Lithuania, reported higher than reported VOC emissions using business activity data provided by companies, which were invited to report on end-use solvent volumes for each of the European countries in 2008 and 2009 (EU-27) and the same process was repeated in 2014 and 2016 (including all solvents per year) (see Table 2).

TABLE 2: AMOUNT OF SOLVENTS IN DIFFERENT YEARS UNDER ESIG ASSESSMENT

|  |  |  |  |
| --- | --- | --- | --- |
| YEAR | ESIG VOC EMISSIONS, kt | EAA STOCKS | ESIG / EAA |
| 2008 | 2159 | 3335 | 65 % |
| 2009 | 1917 | 3050 | 63 % |
| 2013 | 1978 | 2928 | 68 % |
| 2015 | 1981 | 2694 | 74 % |

The trend in the table above shows that the EU hydrogen isotope release solvent has stabilized since 2008 up to ~ 2000 kt. It has been shown that in most countries, including Lithuania, VOC emissions are overestimated by about 30% or more than ESIG forecasts. Given the free movement of goods within the EU, there is no direct activity data on the import and export of solvents in the EU and an assumption can be made in regards to some activity based on CEFIC's Chemicals Export Data (EUROSTAT) assuming that this chemical transfer rate is directly proportional to the percentage of solvent movement.

Solvent emissions are given in the table below (see Table 3).

TABLE 3: EMISSIONS OF SOLVENTS IN THE BALTIC STATES AND FINLAND, TONS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| YEAR | EAA (ibottom – up) | ESIG (TOP-DOWN) | | |
| Before import / export | Import / Export | Total |
| 2008 | 68 | 24.8 | 25.8 | 50.6 |
| 2009 | 59 | 21.5 | 17.6 | 39.1 |
| 2013 | 98.5 | 26.8 | 19.1 | 45.9 |
| 2015 | 20.9 | 31.5 | 54.3 | 49.0 |

It is important to understand that in many Member States and Lithuania, VOC Solvent Emission estimates have been found to be too high due to different Tier levels and assumptions (per capita or product use data). Thus, the first alignment of the ESIG was done by providing an emission factor for the countries / group of countries in their study. For Lithuania in 2009, the projected emission factor for NMVOCs (kg) per capita was 3.9 (as for the other Baltic States and Finland). - 4.6 (total VOC emissions).

Based on the above analysis of ESIG data, solvent emissions / population cannot be considered as simple EU averages and any new EEA emissions guide should help Member States to more realistically estimate their solvent emissions from at least 2010 onwards.

## Table 3.4 Tier 2 NMVOC EF for 2.D.3.a Domestic solvent use including fungicides for different products and product types Tier 2 emission

The EF values provided in Table 3.4 need information on products with solvent. Thus, the consumption of products from different periods would not reflect the decrease in VOC due to chemical composition change, but would only reflect trends in the use of products, and therefore the method is not recommended.

Emissions of Tier 2 NMVOCs from household solvents can be calculated based on the amount of product used (2016 Guide). The bottom-up methodology of 2.D.3.a may be conducted for product groups rather than for each product sold.

It should be noted that the varying percentage of solvents varies due to new laws and production technologies. These changes may be accounted for.

## Table 3.5 Tier 2 NMVOC EF for 2.D.3.a Domestic solvent use including fungicides for different products and product types

The values in table 3.5 provide the NMVOC emission estimation based on per capita consumption of the product. Thus, the consumption of products in different periods would not reflect the decrease of VOC, but showed only trends in the use of products and changes in population, so the method is not recommended.

According to the Guidebook “*Table 3.5 presents additional emission factors for product use. However, these are per-capita emission factors. It is recommended that these be used in only specific cases, for instance if the product statistics for the use of the Tier 2b approach are not complete in terms of the product types covered by domestic solvent use. Table 3.5 Tier 2 NMVOC emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types.*” However, there is no need to apply per-capita EFs, since all of the activities have technology-specific EFs.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** : Emissions of volatile organic compounds into the ambient air are reduced by changing the chemical composition of the products (reducing the VOC content). To determine the gradual VOC composition change in the products of the different groups additional study is needed, hence it is suggested to apply Tier2 methodology (TABLE 3.4).

# Coating applications (NFR 2.D.3.d)

**1. Activity:** Based on EMEP/EEA Guidebook 2016 information and paints sold amount obtained it was concluded that activity data allocation by SNAP categories is needed with different EF implementation. Some paint is used by point sources (private companies) and most of the remaining paint is used for decorative coating application (SNAP 060103, 060104). For Decorative coating application for 1990-2000, Corinair (2000) and EMEP/EEA (2009) EF can be used. Current NMVOC emissions estimation is based on sale data provided by Statistics Lithuania.

**2. Activity data:** IIASA activity data and control strategies, Member States practice and Statistics Lithuania data analysis revealed that 1990 -1999 Corinair (2000) EF can be used. An averaged EF is calculated by taking into account the proportion of solvent borne (SB) and water borne (WB) paints used:

* The NMVOC EF for decorative SB[[5]](#footnote-5) paints (all) is 300-400 g/kg paint applied (average 350 g/kg paint applied can be used);
* The NMVOC EF for decorative WB[[6]](#footnote-6) paints is 33 g/kg paint applied.

Precise division by SB and WB paint production was estimated by production for the year 2000, approximately 55% - SB and 45% - WB and for 1995 – 58% SB and 42% was WB. So, the weighted average EF for the years 1990-1999 can be calculated as follows: (58% x 350 g/kg + 42% x 33 g/kg) / 100% = 217 g/kg paint applied. For 2000-2009, the EMEP Guidebook 2016 Tier 1 EF of 150 g/kg paint can be applied.

For Industrial Coating application for 1990-1999, EMEP GB 2009 Tier 1 EF 600 g/kg. Since 2000 - 400 g/kg paint applied is used for vehicle refinishing. Since 2006, detailed NMVOC emissions from point sources with activity data need to be gathered or IEF applied.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** The Directive (1999/13/EC) was implemented in 2004 (in 2007 for new installations) and aimed to prevent the negative environmental effects of emissions of volatile organic compounds from decorative paints and vehicle refinishing products. For 1990-1995, It is recommended that the value of EF from CORINAIR (2000, 2nd edition) can be used. For the period 1996-2004, values provided in EMEP / EEA Handbook 2009. Alternatively, the operational data of other countries' IEF or IIASA and Lithuanian control strategies can be used (1990-2004).

# Degreasing (NFR 2.D.3.e)

**1. Activity:** Degreasing within the industry is a minor source of NMVOC. The major users of solvent degreasing are the metal-working industries. Solvent degreasing is also used in industries as printing and production of chemicals, plastics, rubber, textiles, glass, paper, and electric power. Also repair stations for transportation vehicles use solvent cleaning part of the time.

**2. Activity data:** During LRTAP in-depth review of national emission inventories in 2017 Solvent Use sector experts Ardi Link and Kristina Saarinen (personal communication) provided organic solvents list need to incorporate to NMVOC emissions evaluation:

* methylene chloride (MC);
* tetrachloroethylene (PER)[[7]](#footnote-7)\*;
* trichloroethylene (TRI) ;
* xylenes (XYL).

The consumption of listed organic solvents can be estimated by the import and export data from Statistics Lithuania (by relevant PRODCOM) or Product Register (by CAS or CN codes). There is no information available regarding production for the years 1990-2001. From 2002 data regarding solvent use for degreasing in point sources is collected into Product Register database in EPA. Emissions from industrial processes are affected by changes in production volumes, changes in the processes or in the use of raw materials and auxiliary chemicals. Estimation of emissions from degreasing is based on the assumption that all chemicals are used during the year of import, even if there is some carryover of stock between years.

An overview of EMEP/EEA (2016) tables showed that additional input data and the extrapolation of historical (1990-2002) data are needed to implement Tier 2 method.

Overview of Tables with Tier 2 EF in 2016 EMEP/EEA Guidebook is provided below.

## Table 3-2 Tier 2 EF for 2.D.3.e Degreasing, Open-top degreaser

Such technology is used.

## Table 3-3 Tier 2 EF for 2.D.3.e Degreasing, Electronic components manufacturing

Such technology is used, however there are no information on solvents consumption (from balance) used in this activity.

In order to verify the proposed NMVOC estimation method on Tier 2 level and historical emission level by integrating pollution abatement technologies, a comparative analysis was performed with the NMVOC emissions estimated by IIASA GAINS model and Tier 1 (see Figure 2).

Figure 2 COmparative analysis of NMVOC emissions based on different methods, Gg

Estimated NMVOC emissions due to degreasing activities in 1990 - 2015 implementing different inventorying methods (Figure 1) in 1990 - 2000 is at the same level, but since 2005 it has decreases due to the introduction of abatement technologies and the change in the chemical composition of solvents (Solvents Emission Directive 1999/13 / EC). This shows that the assumptions made are correct.

Figure 3 NMVOC abatement measures‘ efficiency 1990-2020, %

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Abatement efficiency | | Distribution abatement technology | |
| Semi open-top degreaser and good housekeeping | Sealed chamber system using chlorinated solvents | Semi open-top degreaser and good housekeeping | Sealed chamber system using chlorinated solvents |
| 1990 | 25% | 95% | 100% | 0% |
| 1995 | 25% | 95% | 80% | 20% |
| 2000 | 25% | 95% | 60% | 40% |
| 2005 | 25% | 95% | 40% | 60% |
| 2010 | 25% | 95% | 20% | 80% |
| 2015 | 25% | 95% | 10% | 90% |
| 2020 | 25% | 95% | 0% | 100% |

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** It is very difficult to estimate the prevalence of various degreasing methods. In view of the current situation, the use has led to a phase-out of the open-circuit machine, because their emissions exceed the limits. Depending on the degree of solvent risk, open containers are still allowed) and the use of closed containers allows for better solvent recycling options. The efficiency and implementation of expert-based technologies are presented in the Table 2.

# Dry cleaning (NFR 2.D.3.f)

**1. Activity:** In order to understand the situation, a descriptive interview with the representative of the main dry-cleaning service provider, „confidential“ was carried out. Main findings are:

* Closed-circuit equipment is mainly used;
* Closed-circuit equipment was the main practice in 90‘ties;
* The main cleaning agent is PER;
* Solvent waste (used solvent) is collected and given to hazardous waste companies;
* Dry cleaning services do not have the statistics of cleaned textile, mostly report maximum allowed NMVOC emission for 1 kg cleaned textile..

**2. Activity data:** The sales figures of tetrachloroethylene use in 2.D.3.f in EPA database are obtained each year from operators report from 2002. Control strategies define how the available emission control measures were applied to different emission source categories. Control strategies determine the percentage of activity to which a given control measure were applied from IIASA GAINS model assumption (see Figure 4).

Figure 4 Percentage of activity to which a given control measure were applied 1990 – 2020

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 |
| Dry cleaning | Textiles (clothing) | Conventional closed-circuit machine | 15 | 50 | 90 | 100 | 100 | 100 | 100 |
| Dry cleaning (new installations) | Textiles (clothing) | New generation closed circuit machine | 10 | 20 | 30 | 40 | 50 | 50 | 50 |

In Lithuania all dry cleaning operators declare only NMVOC limits (allowed NMVOC amount due to activity – 20 g/kg cleaned and dried textile) by the order of the Minister of Environment[[8]](#footnote-8) . There are no information on technology used (for new installations 10 g/kg, older up to 30 g/kg). It is assumed (Figure 4) that by 2003 March 13 all dry cleaning technologies are close-circuit (100 %, from which 40-50 % are new generation). Wet cleaning installations are not emitting NMVOC, so are not considered for inventorying.

Figure 5 Proposed mass balance model verification with different methods, Gg

Based on these assumptions, a **mass balance model was developed** to estimate the average amount of cleaned textile in dry cleaning equipment is provided (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.f). The NMVOC emissions were verified with the EF values of the Finnish and Estonian experts and emissions based on Tier 2 and Tier 1 methods provided by EMEP/EEA (2016) (Figure 5). Comparison showed that maximum NMVOCs emissions were inventoried based on Tier 1 and Tier 2 methods provided by EMEP/EEA (2016) (based on population), but perfectly match Estonian and Latvian value levels. Applying the mass balance model in Lithuania, the amount of NMVOC emissions released into the ambient air is slightly higher than that of Estonia and Finland, but this can be explained by a larger population.

Figure 6 Comparative analysis of emissions based on Tier 2 (GB 2016) with abatement and proposed mass balance model, Gg

As shown in Figure 6 the recommended mass balance model for NMVOC emissions due to dry cleaning activities is well corresponding to Tier 2 methods developed by other countries.

Overview of Tables with Tier 2 EF in 2016 EMEP/EEA Guidebook is provided below.

## Table 3-2 Tier 2 EF for 3.B.1 Dry cleaning, Open-circuit machine

The activity is being carried out, reported EF (177 g/kg textiles) has been verified, the analysis showed that this values is not suitable for NMVOC emission in Lithuania.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents is a key policy tool to reduce industrial emissions of NMVOCs in the European Union and ensures that installations comply with the limit values for NMVOC emissions set by the Directive (20 g/kg, expressed as kilogram of solvent emitted per product purified and dried). In all EU Member States, an open-type dry-cleaning system has been eliminated due to the additional emissions limit values of the European Solvent Directive 1999/13/EC. Tetrachlorethylene, a chlorine organic solvent, is not produced in Lithuania.

# Printing (NFR 2.D.3.h)

**1. Activity:** For printing, the two most common technologies are rotogravure with about 50% of the total production and flexography with about 30% of the total production (based on consultation with Vilnius Gediminas Technology University researchers). Hence, these two technologies sum up to the above mentioned 80% of total production that is printed. Other technologies such as lithography or digital printing exist but are hardly used in this sector. Only for samples, very small batches or special materials they might be necessary and applicable. Therefore, they are not in scope of our study and will not be considered in the following. In general, rotogravure is faster and mostly suited for very large batches. Flexography is slightly more flexible and therefore better suited to medium to large batches and more frequent setting-up. Same technology distribution was provided by GAINS model for Lithuania[[9]](#footnote-9).

**2. Activity data:** AD on ink consumed can be evaluated for 2005-2015 from Statistics Lithuania (CN Code 3215). Historical data were obtained by extrapolation as no data for Lithuania for manufacture on printing was provided by Eurostat. As stated in GB2016 „If no direct activity data are available, penetration of different technologies within the printing industry could be estimated from data on capacities, number of employees or other data that reflect the relative size of each of the different technologies“ (see Figure 7) (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.h).

Figure 7 Printing type distribution bY IIASA model

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Printing type |  | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
| Flexography (existing) | % | 50 | 40 | 37.5 | 30 | 30 | 10 |
| Flexography (new) | % | 0 | 10 | 12.5 | 20 | 20 | 40 |
| Rotogravure in publication (existing) | % | 50 | 40 | 37.5 | 30 | 30 | 10 |
| Rotogravure in publication (new) | % | 0 | 10 | 12.5 | 20 | 20 | 40 |

Overview of Tables with Tier 2 EF in 2016 EMEP/EEA Guidebook is provided below.

## Table 3-2 Tier 2 EF for 2.D.3.h Printing, Heat set offset

Technology is rarely used, hence not evaluated.

## Table 3-3 Tier 2 EF for 2.D.3.h Printing, Publication gravure

Technology is rarely used, hence not evaluated.

## Table 3-4 Tier 2 EF for 2.D.3.h Printing, Packaging, Small flexography

50% are considered to be performed by small flexography and 50 percent by large flexography.

## Table 3-5 Tier 2 EF for 2.D.3.h Printing, Packaging, Large flexography

50% are considered to be performed by small flexography and 50 percent by large flexography.

## Table 3-6 Tier 2 EF for 2.D.3.h Printing, Packaging, Rotogravure

The printing method is used in Lithuania. Method prevalence in 1990 - 2015 provided by the IIASA GAINS model and approved by an external expert in this field (VGTU).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** The Solvent Emissions Directive 1999/13/EC entry into force in 1999 March and the emissions of NMVOCs from printing activities have been significantly reduced. EF values are presented in 2016 EMEP/EEA Guidebook by types of printing technologies.

# Chemical products, manufacture and processing (NFR 2.D.3.g)

This sector is not the main source of NMVOC emissions, other countries' practices or IEF values cannot be transferred due to different production and industry characteristics. Overview of Tables with Tier 2 EF in 2016 EMEP/EEA Guidebook is provided below.

## Table 3-2 Tier 2 EF for 2.D.3.g Chemical products, polyester processing

**1. Activity:** In Lithuania, there are production of polyester fibres on a small scale. Polyester is derived from petroleum and the oil. Polyester fibres are formed by extrusion from the polymer melt (polyethylene terephthalate) by air cooling.

**2. Activity data**: Data is provided by Lithuanian Department of Statistics (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** NMVOC emissions are strongly dependent on the system used for the regeneration of ethylene glycol from pre-polymerization and polymerization reactors, resulting in emissions of methanol vapor and NMVOC. The maximum emission release potential is from the cooling tower.

## Table 3-3 Tier 2 EF for 2.D.3.g Chemical products, polyurethane foam processing

**1. Activity:** Production of polyurethane takes place in Lithuania (in closed systems) also it is imported and exported. Emissions of NMVOCs result from the "activation" of foam when the foaming agents evaporate. The majority of fluorinated compounds, butane and pentane are considered to be released.

**2. Activity data**: Data is provided by Lithuanian Department of Statistics (see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g). It is considered that imported and manufactured (except export) polyurethane is proceeded during the reference year.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency**: According to the information provided by the large importing company, part of the blowing gas foam is 7.5% of the total mass. It should be noted that in the EMEP/EEA (2016) Guidebook percentage is 12%, so the EF value should be increased from 120 g/kg to 75 g/kg. A more accurate chemical composition of the polyurethane foam will be revealed in 2020 by ongoing study "Fluorinated greenhouse gas accounting analysis and verification". It is considered that imported and manufactured (except export) polyurethane is proceeded during the reference year.

## Table 3-4 Tier 2 EF for 2.D.3.g Chemical products, polystyrene foam processing

**1. Activity:** The main producers of polystyrene foam in Lithuania are LLC Baltijos Polistirenas, SILIKATAS, Ukmergės gelžbetonis JSC, Kauno šilas LLC, Šilputa LLC, Prokma LLC. During the survey information provided by all manufacturers it was revealed that during foam production 100-110 ° C water vapor and/or isobutane, pentane are used in Lithuania. The base of 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. Pentane treatment is carried out in several stages: heating and mixing with steam, when pentane acts as a blower, expanding the "beads". The highest emissions of NMVOCs occur during polystyrene production (mixing, forming, drying and storage). A more accurate chemical composition of the foam will be revealed in 2020 by EPA (Lithuania) study "Fluorinated greenhouse gas accounting analysis and verification". It is considered that imported styrene is processed during the accounting year.

**2. Activity data:** Data is provided by Lithuanian Department of Statistics(see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency**: Directive 1999/13/EC does not cover polystyrene processing. All pentane used is considered to evaporate. There are 4%-pentane pellets in polystyrene, but low density products (<20-25 kg/m3) cannot be made with %-pentane).

## Table 3-5 Tier 2 EF for 2.D.3.g Chemical products, rubber processing except tyre production

**1. Activity:** Rubber production data in small quantities since 2016.

**2. Activity data:** Data is provided by Lithuanian Department of Statistics(see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g).

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

## Table 3-6 Tier 2 EF for 2.D.3.g Chemical products, manufacture of tyres

Emissions of NMVOCs occur during vulcanization when tire is placed in the melting form and heat initiate melting. When the temperature rises to 150° C, the rubber vulcanization process begins: the sulphur contained in the rubber mixture connects the polymer chains. This makes rubber elastic. In Lithuania, tires are not produced, only restoration is done by vulcanization. **Emissions are not accounted**.

## Table 3-7 Tier 2 EF for 2.D.3.g Chemical products, pharmaceutical products manufacturing

1. **Activity:** Manufacturing of pharmaceutical products has been in operation since 1990, but production volumes are not large. To determine the emissions of NMVOCs, the information on solvents have been used for production need to be identified. Such data are not available..

**2. Activity data:** Data is provided by Lithuanian Department of Statistics(see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Since Statistics Lithuania has been providing data since 2005, manufactures are taking into account stringent requirements, with a maximum of 88% pollution reduction.

## **Table 3-8** Tier 2 EF for 2.D.3.g Chemical products, asphalt blowing, **Table 3-9** Tier 2 EF for 2.D.3.g Chemical products, asphalt blowing, saturant, **Table 3-10** Tier 2 EF for 2.D.3.g Chemical products, asphalt blowing, coating

In order to avoid double counting, bitumen processing activities are included in 2.D.3.b. and 2.D.3.c).

## Table 3-11 Tier 2 EF for 2.D.3.g Chemical products, manufacture of paints, inks and glues

**1.** **Activity:** There are paints manufacturing. Based on the studies carried out, it is proposed to evaluate NMML for the production of paints by codes:

* 24.3 Paints, varnishes and similar coatings, printing and mastics;
* 24.30.11 Paints and varnishes dissolved in aqueous medium;
* 24.30.12 Paints and varnishes dissolved in organic solvents;
* 24.30.22 Other paints and varnishes;
* 24.30.24 Printing inks.

Adhesives are also produced in Lithuania. NMVOCs emissions are only considered to be due to the production of synthetic adhesives. Based on the studies carried out, it is proposed to evaluate NMML for the production of paints by codes:

* 20.52.10.2000 Casein glues (animal origin), (kg);
* 20.52.10.60.00 Glues based on starches, dextrins or other modified starches, (kg) (natural origin);
* 20.52.10.80.00 Prepared glues and other prepared adhesives, n.e.c, (kg) (synthetic);

**2. Activity data:** Data is provided by Lithuanian Department of Statistics(see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** Efficiency is presented in Table 3-11, since the Directive came into force in 2005 and maximum emission reduction techniques can be applied.

## Table 3-12 Tier 2 EF for 2.D.3.g Chemical products, adhesive tape manufacturing

Production not occurring.

## Table 3-13 Tier 2 EF for 2.D.3.g Other product use, manufacturing of shoes

**1.** **Activity:** Manufacturing of shoes are provided since 1990. NMVOC emissions is distinguished by a variety of activities such as thermal and mechanical adhesion of the sole and the upper. Quantities of emissions due to manufacturing of shoes (2.D.3.g) and wearing (2.G) are presented in different sectors. Countries are considering the manufacturing and wear of shoes in various ways. In order to avoiding double accounting only one sector is reported.

**2. Activity data:** Data is provided by Lithuanian Department of Statistics(see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheet 2.D.3.g).

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

## Table 3-14 Tier 2 EF for 2.D.3.g Chemical products, leather tanning

**1.** **Activity:** There are several potential sources of air emissions in the leather tanning industry. Emissions of VOC may occur during finishing processes, if organic solvents are used, and during other processes, such as fat liquoring and drying. If organic degreasing solvents are used during soaking in suede leather manufacture, these VOC may also evaporate to the atmosphere. Many tanneries are implementing water-based coatings to reduce VOC emissions.

**2. Activity data:** From 2016 tanning products were imported: 32021000 Synthetic organic tanning substances, kg and 32029000 -- Other, kg. EMEP/EEA Guidebook (2016) provides EF for raw hides processed, so no information is available until operators will provide information.

# Other solvent use (NFR 2.D.3.i) and Other product use (NFR 2.G)

**1. Activity:** Most countries evaluate emissions from use of tobacco as well as fireworks in this sector. Emissions due to shoe wearing are accounted in 2.D.3.g.

**2. Activity data:** Data is provided by Lithuanian Department of Statistics(see MS EXCEL FILE NMVOC\_COLLECTED\_DATA\_1990-2019\_EN.XLSX, sheetS 2.D.3.I and 2.G).

It should be noted that during the preparation of this report, Statistics Lithuania provided only preliminary data on the number of cigarettes per capita for 2018 (this value is likely to be revised as data collection continues in 2020).

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

# Food and beverages industry (2.H.2)

Current method for NMVOC emissions estimation in Lithuania is fulfilled requirements for Tier 2 methodology for the period 2005 – onwards.

It should be noted that some manufacturers (for example „Pieno zvaigzdes“) report emissions but without activity by process, that make difficult to allocate emissions by NFR codes. Moreover it is assumed that emissions from milk manufactures is negligible. Where meat cooking or putrefaction is not involved, such as the production of fresh and frozen foods, emissions are considered negligible and can be skipped.

Emissions from sugar[[10]](#footnote-10) and beverage[[11]](#footnote-11) production could be obtained directly, as in many cases it is technologically easier to provide NMVOC emissions from fermentation (without combustion-related emissions) from a relatively small number of manufacturers in Lithuania. The above-mentioned interview with the author of EEA / EMEP Manual 2016 (2.H.2)[[12]](#footnote-12) (the email conversation is provided in 13.1) it has been found that since NMVOCs are primarily released during cooking, the amount of food consumed and imported may be more representative.

Technical manual provides two sets of EFs:

* Background, technological process based EF (TABLE 3-2 – TABLE 3-10);
* Proposed default EF (TABLES 3-11 – TABLE 3-32).

Technical manual recommends to apply default coefficients. Furthermore, the activity data for different technological processes is not available. Due to the aforementioned it is suggested to apply EF provided in **TABLES 3-11 – TABLE 3-32.** The analysis of the tables is provided below:

## Table 3-11 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, Bread (typical), Region Europe

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics. An analysis of emission calculation methodologies applied by other countries show that currently only rye bread can be extracted from the activity data provided by Statistics Lithuania (using the Swedish EF). Since it is not possible to apply more detailed analysis of the data provided by the Department of Statistics, EF from this table should be applied for the total quantity provided.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-12 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, Bread (typical), region North America

**1. Activity:** EF from chapter 12.1 (Table 3-11) should be used, since this table is directed for North American region.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-13 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, Sponge-dough

**1. Activity:** EF from chapter 12.1 (Table 3-11) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-14 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, White bread

**1. Activity:** EF from chapter 12.1 (Table 3-11) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-15 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, White bread (shortened process)

**1. Activity:** EF from chapter 12.1 (Table 3-11) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-16 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, Wholemeal bread

**1. Activity:** EF from chapter 12.1 (Table 3-11) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-17 Tier 2 emission factors for source category 2.H.2 Food and beverages industry, Light Rye bread

**1. Activity:** EF from chapter 12.1 (Table 3-11) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-18 Tier 2 EF for 2.H.2 Food and beverages industry, Cakes, biscuits and breakfast cereals

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-19 Tier 2 EF for 2.H.2 Food and beverages industry, Meat, fish and poultry

**1. Activity:** In case of Lithuania meat, poultry and fish meat (cooking of meat, fish and poultry, releasing mainly fats and oils) need to be included, as it is not typical to use the canning process in the manufacturing of meat in Lithuania.

Most of countries don’t report meat emissions at all as it was found that NMVOC emission originates from smoke generators as a result of incomplete combustion and not from the fish processing itself. So no facility level reports is needed in this sector. Therefore, these emissions are different from the calculated NMVOC emission, which primarily occur from the cooking of meat, fish and poultry, releasing mainly fats and oils and their degradation products.

The authors of EEA/EMEP Guidebook 2016 (2.H.2) was interviewed[[13]](#footnote-13) (the email conversation is provided in chapter 13.1). It was provided that since NMVOC are primarily released during cooking, the consumed and imported amount of food is likely to be more representative.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-20 Tier 2 EF for source category 2.H.2 Food and beverages industry, Sugar

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-21 Tier 2 EF for 2.H.2 Food and beverages industry, Margarine and solid cooking fats

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics. Margarine and solid cooking fats should accounted.

**2. Activity data:** Activity data [[14]](#footnote-14) is provided by Lithuanian Department of Statistics (žr. MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by combining data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-22 Tier 2 EF for 2.H.2 Food and beverages industry, Animal feed

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-23 Tier 2 EF for 2.H.2 Food and beverages industry, Coffee roasting

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-24 Tier 2 EF for 2.H.2 Food and beverages industry, Wine

**1. Tokio tipo veiklos sritys:** Activity is occurring, data is provided by Lithuanian Department of Statistics, however there is no way to differentiate between white and red wine. Accordingly, it is proposed to use this table for the calculations.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-25 Tier 2 EF for 2.H.2 Food and beverages industry, Red Wine

**1. Activity:** EF from chapter 12.14 (Table 3-24) should be applied.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-26 Tier 2 EF for 2.H.2 Food and beverages industry, White Wine

**1. Activity:** EF from chapter 12.14 (Table 3-24) should be applied.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-27 Tier 2 EF for 2.H.2 Food and beverages industry, Beer

**1. Activity:** Activity is occurring, data is provided by Lithuanian Department of Statistics.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

Note that product classifications in sub-sectors differ between yearbooks and the departmental database. However, total production in a sub-category can be estimated by aggregating data from these sources into a single time series - methodological differences are considered to be insignificant.

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-28 Tier 2 EF for 2.H.2 Food and beverages industry, Spirits

**1. Activity:** The spirit is produced by the Obeliai distillery. Until 2016 only the distillation process was carried out at the distillery. A new distillation-rectification line was built during the refurbishment of the “Obelių varykla” distillery. The distillation process prepares the raw material for the production of edible ethyl alcohol, and the rectification process results in the final purification of the raw ethyl alcohol. The new rectification line, operating 24 hours a day, has a capacity of 30,000 litres of pure ethyl alcohol per day. This alcohol is used not only in the beverage industry but also in cosmetics and medical products. The alcohol needed for household chemistry is further denatured - from nutritious to technical.

In the upper part of the column, the alcohol vapor exiting the lower part of the yeast column is concentrated. Two phases are formed: liquid and vapor, which are not uniform in composition. The liquid phase contains more water with a higher boiling point than alcohol and the vapor contains more alcohol with a lower boiling point. In this way, by partial condensation, the alcohol vapor is concentrated. Concentrated vapor containing 88% or more by volume of alcohol, from the column to the deflegmator, a phlegm is formed. In the deflegmator, about 2/3 of the alcohol vapor condenses to heat the leaven and forms a phlegm (fluid flow in the column) which is returned to the top plate of the alcohol column. The remaining alcohol vapor (about 1/3) enters the condenser where it condenses and cools. From the refrigerator, ethyl alcohol, 18-220C, flows through the alcohol filters, sight glass and controlling counter to the intermediate receiver.

**2. Activity data:** Activity data is provided by Lithuanian Department of Statistics (see MS Excel prisegtą byla Surinkti duomenys LOJ 2019.xls, lapas 2.H.2).

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-29 Tier 2 EF for 2.H.2 Food and beverages industry, Malt Whisky

**1. Activity:** EF from chapter 12.18 (Table 3-28) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## TABLE 3-30 TIER 2 EF FOR 2.H.2 FOOD AND BEVERAGES INDUSTRY, GRAIN WHISKY

**1. Activity:** EF from chapter 12.18 (Table 3-28) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-31 Tier 2 EF for 2.H.2 Food and beverages industry, Brandy

**1. Activity:** EF from chapter 12.18 (Table 3-28) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** no applied.

## Table 3-32 Tier 2 EF for 2.H.2 Food and beverages industry, Other spirits

**1. Activity:** EF from chapter 12.18 (Table 3-28) should be used.

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

**3. Additional pollution abatement measures applied in Lithuania and their efficiency:** not applied at tier 2 level.

**3.** **Additional pollution abatement measures applied in Lithuania and their efficiency:** EPA authorizes the introduction of new abatement measures in food and beverage production to ensure that emission limits are not exceeded to ensure that, under normal operating conditions, emissions do not exceed a given level in the sector. However, the BAT[[15]](#footnote-15) guidelines only set limits on energy use or waste treatment, and there are no limits on emissions to air.

BAT[[16]](#footnote-16): Describing ways to reduce pollution focuses more on standardized food preparation synergies with energy efficiency improvements, i.e. integrating BAT into the entire cooking process, which reduces emissions to the air through the proper selection and use of materials and other techniques, as well as utilization of contaminants, ensures regulated emissions. Gases and odours are collected and transported to a cleaning or recovery unit (vacuum, cyclone or sleeve filters). In most cases, evaporation or cooking takes place in a vacuum (e.g. industrial sugar production) or in a sealed container. Part of the vapor that cannot be used for heating purposes (large industrial facilities) is condensed in condensers that use water from a circulating system with a coolant, which is added to excess condensate or river water (to large cooking facilities).

Stratification is applied according to PRODCOM codes since 1990 EMEP / EEA Handbook 2016 with possibility to apply 90% efficiency in pollution abatement technologies. However, biofilters are most commonly used to remove odours from wastewater (cooking).

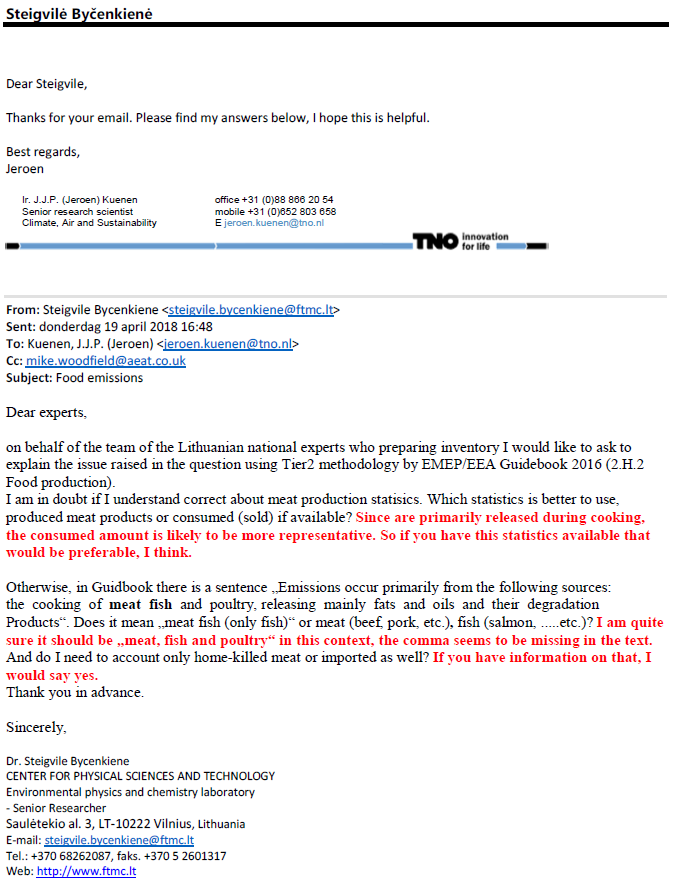
Standard measures for the reduction of NMVOCs are described - VOC degradation (oxidation (thermal or catalytic) and biofiltration). Thermal oxidation occurs through the combustion of exhaust air (fume) and modern thermal oxidizers hold 95-99% of VOC emissions. The catalytic reduction method differs from oxidative only at lower temperatures, when heated air enters the container with the catalyst.

EMEP/EEA 2013, 2016 and 2019 technical manuals provide EF which take abatement technologies into account (technology-specific). However, if additional measures are applied, the emissions can be reduced according to documented percentage. This method is applied in other countries, except instances where data is provided by the companies (tier 3 level).

France, Sweden and Poland 2.H.2 sector activity data and NMVOC EF are provided in annexes (chapter 13.2)

# Annexes

## Email conversation with experts (NFR 2.H.2)



## NMVOC emissions in other countries

Analysis of emissions in France, Germany and Poland shows that the countries are not analysing any additional abatement technologies. NMVOC emissions have been gradually growing over the last decade. Same situation is observed in Lithuania as well.

Figure NMVOC emissions in other countries, gg

According to practices in Poland, when accounting 2.H.2 sectors the EF are assumed stable for period of 1990-2017. That also shows that additional abatement technologies are not evaluated.

Figure Emissions factors applied for 2.H NMVOC in Poland

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NFR code | Emission source | EF unit | EF 1990 | EF 2017 | EF reference |
| 2.H.1 | Chipboards | Mg/m3 | 0.0002 | 0.0002 | PL (IETU) |
| 2.H.1 | Paper pulp (Kraft process) | Mg/Gg | 2 | 2 | EMEP/EEA EIG 2016 |
| 2.H.2 | Bread | Mg/Mg | 4.5 | 4.5 | EMEP/EEA EIG 2016 |
| 2.H.2 | Wine | Mg/hl | 0.000034 | 0.000034 | EMEP/EEA EIG 2016 |
| 2.H.2 | Beer | Mg/hl | 0.00002 | 0.00002 | EMEP/EEA EIG 2016 |
| 2.H.2 | Spirits | Mg/hl | 0.0024 | 0.0024 | EMEP/EEA EIG 2016 |
| 2.H.2 | Sugar | Mg/Gg | 10 | 10 | EMEP/EEA EIG 2016 |
| 2.H.2 | Slaughter products - cattle and calves | Mg/Gg | 0.3 | 0.3 | EMEP/EEA EIG 2016 |
| 2.H.2 | Slaughter products - pigs | Mg/Gg | 0.3 | 0.3 | EMEP/EEA EIG 2016 |
| 2.H.2 | Slaughter products- poultry | Mg/Gg | 0.3 | 0.3 | EMEP/EEA EIG 2016 |
| 2.H.2 | Slaughter products - fish | Mg/Gg | 0.3 | 0.3 | EMEP/EEA EIG 2016 |
| 2.H.2 | Margarine and fat spreads, excluding liquid margarine | Mg/Gg | 10 | 10 | EMEP/EEA EIG 2016 |
| 2.H.2 | Prepared feeds for farm animals | Mg/Gg | 1 | 1 | EMEP/EEA EIG 2016 |
| 2.H.2 | Prepared pet foods | Mg/Gg | 1 | 1 | EMEP/EEA EIG 2016 |

For NMVOC accounting Germany uses default (IPCC and Corinair) and country-specific EF[[17]](#footnote-17).

1. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/emep-eea-guidebook-revision-log/view> [↑](#footnote-ref-1)
2. Exploration, production, processing, transmission, storage, distribution and other [↑](#footnote-ref-2)
3. CONCAWE, 2017. Air pollutant emission estimation methods for E-PRTR reporting by refineries. 2017 edition. Prepared by the Concawe Air Quality Management Group's Special Task Force on Emission. [↑](#footnote-ref-3)
4. e.g., process measures, intermediate products, extraction, deparaffin preparations [↑](#footnote-ref-4)
5. Solvent based. [↑](#footnote-ref-5)
6. Water based. [↑](#footnote-ref-6)
7. As PER is also used for dry cleaning, this is not included as a degreaser. [↑](#footnote-ref-7)
8. Order of the Minister of Environment Nr. 620, 5 of December 2002, the declaration form Annex 5 [↑](#footnote-ref-8)
9. TFTEI technical secretariat 2017 „VOC Abatement: Packaging Printing Industry“ [↑](#footnote-ref-9)
10. LLC "Lietuvos cukrus", JSC "Šiaurės šalių cukrus Kėdainiai" [↑](#footnote-ref-10)
11. JSC Anykščių vynas, JSC "Stumbras", Vilniaus Tauras, Biržų alus, Kalnapilis, Gubernija, LLC "Lietuviškas midus", Rinkuškiai (alaus darykla), Švyturys, Utenos alaus darykla, JSC "Volfas Engelman" [↑](#footnote-ref-11)
12. dr. Ir. J.J.P. (Jeroen) Kuenen, <https://www.tno.nl/en/> [↑](#footnote-ref-12)
13. dr. Ir. J.J.P. (Jeroen) Kuenen, <https://www.tno.nl/en/> [↑](#footnote-ref-13)
14. Butter is not to be included in emissions calculation. [↑](#footnote-ref-14)
15. *BAT - Best available technology* [↑](#footnote-ref-15)
16. European Commission (2006), Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques (BREF) in the Food, Drink and Milk Industries, August 2006. [↑](#footnote-ref-16)
17. J. Theloke, S. Wagner, D. Jepsen, U. Hackmack: Emissionen aus der Nahrungsmittelindustrie", 2008, FKZ 206 42 101/01 [↑](#footnote-ref-17)