SOLVENT VOC EMISSION INVENTORIES 2023

March 2025

ESIG has finalised its 2023 solvent volatile organic compounds (VOC) emission inventories with 2023 data. As there was a decline in sales due to the economic situation in Europe, we also see a decline in the calculated VOC emissions.

General trend and comparison (amounts in kilotons)

year	ESIG VOC emissions	ESIG VOC emissions with ethanol	EEA inventories*	EEA vs ESIG difference
2008	2159	NA	3369	36%
2009	1917	NA	3029	37%
2013	1775	2323	2706	16%
2015	1842	2366	2632	11%
2016	1628	2002	2617	30%
2017	1613	1980	2678	34%
2018	1813	2145	2644	22%
2019	1765	2120	2589	21%
2020	1538	2263	2751	19%
2021	1663	2207	2692	18%
2022	1470	1816	2494	37%
2023	1350	1741		

** based on reporting in 2024*

Both the ESIG and EEA data indicate relatively stable emission levels in the late 2010s, with divergences between the two datasets reaching over 30%. However, since 2018, the discrepancy in solvent reporting has decreased to slightly over 20%. In 2020, ESIG VOC emissions declined, likely due to reduced production and sales attributed to the Covid-19 crisis. Conversely, ethanol consumption increased due to its use in hand sanitizers, leading to an overall rise in VOC emissions compared to previous years. In 2021, this elevated ethanol usage persisted, albeit at a lower level than in 2020. In 2022 and 2023, there was a decline, likely influenced by the economic situation.

In 2023, overall VOC emissions saw a 4% reduction from 2022. Ethanol emissions increased by 13%, while VOC emissions from ESIG solvents alone showed an 8% decrease, in line with the drop in solvent sales reported by ESIG members in 2023. This represents the lowest absolute VOC emissions, both with and without ethanol, in the inventory's history for the second year in a row. While the exact cause of this decline remains unclear, the influence of solvent sales data contributes to the uncertainty of the results. Despite

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

improvements in methodology over time, uncertainties continue in estimating import and export figures and ethanol use, adding to overall uncertainty.

The emissions across various segments have shown diverse trends from 2015 to 2023. Some segments exhibited a general downward trend, while others experienced fluctuations or even increases. Overall, there have been notable changes in recent years, attributable to various economic and industrial factors.

The segment that contributed the most to the development of emissions is "Coatings-Industrial + adhesives, resins, inks, refining and blending + reprographics." Emissions in this segment showed a continuous decline from 2015 to 2018. This downward trend persisted from 2019 to 2023, reflecting a consistent reduction in emissions over the years.

Key trends include lower emissions in 2016 and 2017 compared to 2013 and 2015, with a notable increase in 2018. The sharp rise in emissions during 2020 and 2021 is attributed to increased ethanol use for hand sanitizers during the COVID-19 pandemic. In 2022, VOC emissions dropped by 18% due to a 36% reduction in ethanol consumption as pandemic-related demand decreased. This marked the lowest emissions level in the inventory's history. In 2023, VOC emissions continued to decline by 4%, driven by an 8% decrease in ESIG-reported emissions and a 13% increase in ethanol use. The exact reasons for the decline in VOC emissions over the past two years remain unclear, possibly due to a decrease in industrial solvent production in the EU

The ESIG solvents emission inventories have been conducted with the support of TNO.

SOLVENT VOC EMISSION INVENTORIES 2023

March 2025

ESIG Solvent VOC Emissions Numbers 2023 per country

Summary of results for aggregated country groups applied by ESIG 2023

Countries	TOTAL EMISSIONS BY COUNTRY OF PRODUCTION Hydrocarbon + Oxygenated solvents (kiloton/country)	IMPORT/EXPORT Corrections	Ethanol emissions	Emissions NMVOC in kiloton/country
Austria	24.98	7.18	6.88	39.05
Belgium + Luxembourg	97.04	-72.33	9.38	34.08
Bulgaria + Romania	4.17	34.87	19.28	58.33
Croatia	2.14	16.75	2.91	21.80
Cyprus + Greece + Malta	10.25	14.74	8.98	33.97
Czech Republic	15.40	27.64	8.19	51.23
Denmark	19.04	-2.45	4.49	21.07
Estonia + Latvia + Lithuania	5.64	20.06	4.62	30.32
Finland	7.49	8.94	4.21	20.64
France	151.85	1.67	51.54	205.06
Germany	358.61	-231.88	63.78	190.50
Hungary	8.98	16.00	7.26	32.24
Ireland	12.24	-1.08	3.99	15.14
Italy	171.70	43.49	44.60	259.79
Netherlands	159.31	-97.28	13.47	75.49
Poland	43.46	49.25	27.79	120.50
Portugal	10.12	32.52	7.95	50.59
Slovakia	1.84	24.69	4.10	30.63
Slovenia	10.59	-1.08	1.60	11.10
Spain	104.77	64.30	36.35	205.42
Sweden	27.45	7.38	7.95	42.78
United Kingdom	102.61	36.65	52.16	191.42
Total EU-27+UK	1 349.66	**0.00**	391.46	1 741.12

Import and export data for 2016 and 2017 were based on adjusted 2015 figures from J. Pearson. From 2018 onwards, estimates were adjusted annually for changes in VOC emissions. In 2021, estimates were revised for consistency across all years, affecting country-level data but not EU28 totals. Solvent trade within the EU was analysed using import/export shares from 2013 and 2015. Adjustments ensured each country's per capita solvent use stayed within double the EU average. From 2018, import/export estimates were based on extrapolated 2013 data, with annual adjustments to align with solvent sales fluctuations. Caps on yearly percentage changes managed these shifts, varying by year to reflect changes in EU27+UK solvent usage.

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

SOLVENT VOC EMISSION INVENTORIES 2023

March 2025

The emissions data from 2015 to 2023 show significant changes in various European countries. Notably, there has been a significant reduction in emissions in Germany, France, and Italy. Spain and the United Kingdom also recorded a decrease in emissions. Overall, the data reflect a positive trend towards reducing emissions in Europe.

ESIG Solvent VOC Inventories for the EU – a top-down approach[1]

The ESIG VOC inventory methodology involves several key steps to ensure accurate and comprehensive data collection and analysis of solvent emissions across Europe. The process includes collecting solvent sales data, applying emission factors, and making necessary import/export corrections. Here is a detailed breakdown of each step:

Data Collection:

- **Solvent Sales Data**: Solvent sales data, representing the majority of Europe's solvent production, is collected from ESIG member companies. This data is categorized by country and REACH end-use sector. The sales numbers cover about 90% of all oxygenated and hydrocarbon VOC solvents manufactured and sold in the European Union, making them highly confidential. Cefic collates and analyses these data carefully and confidentially.
- **Intermediary Sales**: When solvents are sold to intermediaries, such as distributors or resellers, their final use becomes uncertain. These intermediary sales are proportionally distributed across REACH end-use sectors, including an additional 'other' category to account for unspecified uses.

Assumptions and Estimations:

- **Annual Usage Assumption**: The inventory assumes that solvent sales are equal to annual usage, meaning there is no change in stock levels. This assumption simplifies the calculation by disregarding any net solvent imports or exports for the EU27+UK as a whole.
- **Solvent Destination Estimation**: Given the mobility within the European market, solvents sold in one Member State may be used in another. Due to the lack of comprehensive European tracking data, the solvent destination is estimated. Import and export proportions from 2013 and 2015 are extrapolated to subsequent years to refine these estimations.

[1] For more information on the method used, former technical papers can be consulted: https://www.esig.org/wp-content/uploads/2018/03/201802_ESVOC_techncial-paper-solvent-VOC-emisisons-2015_final-1.pdf
https://www.esig.org/wp-content/uploads/2019/03/Atmospheric-Environment-John-VOC-article-201903.pdf

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

Ethanol Usage:

- **Inclusion of Ethanol**: Ethanol has been included in the inventory since 2016, with data extended back to 2013 to maintain consistency over the reporting period. Estimated ethanol usage as a solvent is based on data from the European Renewable Ethanol (ePure).
- **Revised Distribution**: The distribution of ethanol use over individual Member States has been revised. The old distribution was based on a Eurostat indicator for the use of personal care products, where some countries were missing and therefore received no emissions related to ethanol. Given the COVID-19 pandemic, ethanol has become a significantly more important source of emissions, and the products are used by the general population. Therefore, a distribution proportional to the total population in each year has been assumed in the new inventory.

Emission Factors:

- **Application of Emission Factors**: A consistent set of emission factors is applied to estimate the percentage of VOCs emitted into the air. These factors depend on two parameters: the final end-use of the solvent and the type of solvent. Emission factors are based on realistic data and assumptions from environmental safety assessments.
- **VOC Classification**: Not all solvents are VOCs, and not all VOCs are solvents. Their respective properties, such as boiling point range and molecular weight, determine whether they are classified as VOCs. For example, a C6 hydrocarbon solvent (Hexane) is a VOC, whereas a heavier C14-C19 hydrocarbon solvent is not.

Import/Export Corrections:

- **Estimation of Import/Export Data**: Due to the free flow of goods in the EU, there is no direct data for the import and export of solvents within the EU member states. Cefic uses Eurostat data to calculate net chemical transfer for each Member State. By assuming that the percentage of chemical transfer is directly proportional to the percentage of solvent movements, an estimate of solvent import/export related to downstream activities is made for each country.
- **Adjustments for Smaller Countries**: For the 2021 ESIG emissions, the import and export assumptions have been reassessed, with adjustments made especially for smaller countries to ensure accurate estimates.

Confidentiality and Grouping:

- **Data Grouping:** Solvent sales data by Member State is grouped to comply with competition laws. Since 2020, the following country groupings have been used: Belgium and Luxembourg, Bulgaria and Romania, Cyprus, Greece and Malta, and Estonia, Latvia and Lithuania. This grouping helps maintain confidentiality and comply with statistical rules.

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

Per capita emissions (kg/person) derived for the year 2015 for all sectors and for NFR category 2D3a only

all sectors					
per capita all sectors	2015 - 2017	2018 - 2020	2021 - 2023	2015 - 2023	change 2023 vs 2013
AT	5,73	6,24	5,13	5,70	-28%
BE	3,74	3,37	3,05	3,39	-45%
BG	2,47	2,33	2,11	2,31	-31%
HR	5,73	6,05	5,54	5,77	423%
CY	2,74	2,75	2,41	2,63	-21%
CZ	4,94	4,94	4,74	4,88	-9%
DK	3,68	3,70	3,71	3,70	-19%
EE	5,08	5,42	4,67	5,05	-7%
FI	5,08	5,21	4,34	4,88	-22%
FR	3,53	3,80	3,43	3,59	-33%
DE	3,68	3,18	2,62	3,16	-44%
GR	2,95	3,19	3,13	3,09	-8%
HU	3,09	3,58	3,41	3,36	0%
IE	3,50	3,30	3,17	3,32	-43%
IT	5,87	5,95	4,90	5,58	-31%
LV	5,08	5,51	6,22	5,60	28%
LT	5,08	5,62	5,03	5,24	-5%
LU	3,74	3,61	3,13	3,50	-45%
MT	2,66	2,94	2,38	2,66	-37%
NL	5,16	5,68	4,83	5,22	-9%
PL	3,51	3,71	3,58	3,60	-22%
PT	5,32	5,35	5,18	5,28	-15%
RO	2,47	2,87	2,54	2,62	-21%
SK	4,94	5,57	5,53	5,35	8%
SI	5,73	6,49	5,95	6,06	-12%
ES	5,32	5,46	4,66	5,15	-24%
SE	4,48	4,81	4,49	4,59	-43%
UK	3,39	3,61	3,14	3,38	-19%
average	4,16	4,24	3,73	4,04	-27%

The emissions per capita in various European countries also showed a general downward trend, while some countries (LV, SK) even recorded increases.

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

petrochemicals europe

SOLVENT VOC EMISSION INVENTORIES 2023

March 2025

In 2020, there was a significant spike in VOC emissions, with a smaller increase in 2021, reflecting the widespread use of ethanol-based hand sanitizers during the COVID-19 pandemic. By 2022, ethanol values returned to pre-pandemic levels. In 2023, ethanol values increased by 13%, driven by a 17% rise in industrial ethanol production in the EU, with imports contributing only a 1% increase.

2D3a only					
	2015 - 2017	2018 - 2020	2021 - 2023	2015 - 2023	change 2023 vs 2013
AT	1,29	1,95	1,45	1,56	-13%
BE	1,28	1,27	1,26	1,27	-21%
BG	1,03	1,20	0,97	1,07	-26%
HR	1,26	1,51	1,65	1,47	48%
CY	0,98	1,19	1,05	1,07	-3%
CZ	1,59	1,75	1,56	1,63	-7%
DK	1,71	2,09	1,91	1,90	-28%
EE	1,40	1,85	1,74	1,66	-3%
FI	1,31	1,85	1,66	1,61	45%
FR	1,16	1,55	1,53	1,41	-25%
DE	1,24	1,33	1,14	1,24	-30%
GR	1,12	1,28	1,15	1,18	-29%
HU	1,39	1,42	1,48	1,43	-1%
IE	1,07	1,16	1,25	1,16	-13%
IT	1,30	1,52	1,41	1,41	-17%
LV	1,40	1,72	2,74	1,95	128%
LT	1,29	1,66	1,51	1,49	2%
LU	0,93	1,37	2,26	1,52	56%
MT	1,00	1,38	1,14	1,17	-3%
NL	1,44	1,70	1,69	1,61	20%
PL	1,07	1,31	1,24	1,20	-13%
PT	1,43	1,82	1,79	1,68	27%
RO	0,93	1,09	1,05	1,02	-20%
SK	1,42	3,71	1,52	2,22	18%
SI	1,09	1,38	1,79	1,42	51%
ES	1,47	1,97	1,75	1,73	-6%
SE	1,19	1,58	1,50	1,42	-14%
UK	1,17	1,46	1,45	1,36	-16%
average	1,25	1,53	1,42	1,40	-14%

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

When examining emissions 2.D.3.a (Domestic solvent use including fungicides) per capita, many European countries have made progress in reducing their emissions. Austria, Belgium, Germany, France, and Italy have all seen decreases in emissions per capita. Conversely, Latvia, Slovakia, Slovenia, Lithuania, and Luxembourg have experienced increases in emissions per capita.

How to access and use ESIG data?

The ESIG inventories are an accepted Tier 2a method according to the EMEP/EEA air pollutant emission inventory guidebook, however, the top-down approach using REACH end uses and confidentiality considerations make it difficult to use the data when establishing the country inventories.

Due to the high confidentiality of sales data, Cefic statistics impose certain rules. When there are fewer than 3 original entries there is no show of data for a category. In a few cases, countries are grouped to allow to display at least some numbers. Here again, population numbers could serve to split between countries to get some results.

Thanks to efforts done by the UK, a table is added as an annexe to the EMEP/EEA air pollutant emission inventory guidebook 2019, chapter 2.D.3.a.Domestic solvent use mapping the NFR categories against Reach end-use sectors showing where and when ESIG data can be used (see table below). For instance, for INDUSTRIAL CLEANING: 100% is attributed to 2D3e, so in case of no own activity data the ESIG number can be used instead.

Since ESIG data are based on real data from EU solvent manufacturers, the ESIG emission inventories remain a valuable source of information and can also be used for comparisons.

Member States can obtain more information upon request for full details per REACH category provided data is not confidential. Additionally, based on the mapping, ESIG can per member state, provided no confidentiality claims apply, provide a reattribution to the NFR categories.

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

REACH end-use categories & Emission Factors

	End-use	Release to air	Remarks
1	Agrochemical uses	100%	assumed to be completely released into the atmosphere and utilize solvents that are VOC
2	Blowing Agents	100%	
3	De-Icing	100%	
4	Binder and Release Agents	100%	
5	Industrial Cleaning	70%	Cleaning agents used industrially are mostly handled in a closed system and are partially released into the atmosphere.
6	Professional & Consumer Cleaning	50%	There are two types of products in this category: dry cleaning agents used by professionals that have a very low release percentage and other cleaning agents used by consumers that are completely released into the atmosphere. Therefore, an average 50% emission factor is applied.
7	Industrial, Professional and Consumer Coatings	75%	The emission factor of the entire coatings industry is a combination of consumer and professional paint for the decorative market which has an emission factor of 100% and the industrial paints where the solvents are mostly regenerated resulting in an emission factor assumed to be 10%. Therefore, a conservative emissions factor of 75% is applied.
8	Functional Solvents	10%	include solvents used in chemical processes including intermediates, polymerization and extraction resulting in a low emission factor of 10%.
9	Metal working/Rolling Oils/ Lubricant uses	0%	taken over from ATIEL, the Technical Association of the European Lubricants Industry
10	Oil field chemicals-Drilling-Mining-Extraction	0%	Solvents used are mostly heavy and non-VOC
11	Polymers Processing (incl. rubber-tyre production)	10%	Value from ESIG GES/SpERCs
12	Road and Construction	95%	Value from ESIG GES/sPERCs
13	Use as Fuel/Combustion	0.25%	Combustion solvents are burnt, generating water and carbon dioxide and therefore do not produce any VOC in the atmosphere. A conservative emission factor of 0.25% has been applied to take into account possible leaks.
14	Water Treatment	5%	Value from ESIG GES/SpERCs
15	Other Consumer uses (household, aerosols, cosmetics)	90%	Solvents used by consumer in household and aerosol applications are completely released into the atmosphere. Solvents used in cosmetic applications are heavy and non-VOC products. Therefore, an estimated 90% emission factor has been applied.

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

petrochemicals europe

16	Pharmaceuticals Manufacturing	30%	Value from ESIG GES/sPERCs

.

Table annexed to the EMEP/EEA air pollutant emission inventory guidebook 2019, chapter 2.D.3.a.Domestic solvent use

REACH end-use sector	2D3a	2D3b	2D3c	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i
Agrochemical uses	100%								
Binder and Release Agents									100%
Blowing Agents									100%
Cleaning Industrial + Leather treatment, electronics, semiconductor					100%				
Cleaning-Professional Consumer	100%								
Coatings-Industrial + adhesives, resins, inks, refining and blending + reprographics				80%				15%	5%
Coatings-Professional/Consumer + Thinners, paint industry + emulsions + automotive	30%			70%					
De-Icing	50%								50%
Functional Solvents (inc. solvents used in chemical processes, e.g. process aids, intermediates, extraction, dewaxing agents)							100%		
Metal working/rolling oils/Lubricant uses									100%
Oil field chemicals-drilling-mining-extraction									100%
Other consumer uses (household,aerosols,cosmetics)	100%								
Pharmaceuticals manufacturing							100%		
Polymers Processing (inc.rubber-tyre production) + Industrial resins, synthetic rubber, process							100%		
Road and construction		100%							
Use as Fuel/Combustion + Fuel additives									100%
Water Treatment									100%
Others	100%								

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90

SOLVENT VOC EMISSION INVENTORIES 2023

March 2025

ESIG (European Solvents Industry Group)
Rue Belliard 40 b.15 B-1040 Brussels Belgium

esig@cefic.be **www.esig.org**

A sector group of Cefic
European Chemical Industry Council - Cefic aisbl
EU Transparency Register n° 64879142323-90