



# Data on the Production of Chemicals

created for the EU Product Environmental Footprint (PEF) pilot phase  
implementation

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## 1. Introduction

The following report serves as a general introduction to the datasets created within the “Data on the Production of Chemicals datasets created for the EU Product Environmental Footprint (PEF) pilot phase implementation 2016-2020” project. Most of the documentation is present directly in the datasets. This report serves only as a summary of the project methods, approaches and as an introduction to the whole set of datasets.

The specifications of the deliverable have been published in the Call for Tenders (ENV.B.1/SER/2016/0038vl), service contract for Provision of “chemicals” process-based product environmental footprint-compliant life cycle inventory datasets.

## 2. Overview of the deliverable

### 2.1. Number of datasets created

The Tender Specifications list 522 datasets to be delivered, representing 261 datasets partially aggregated at level 1 and 261 fully aggregated life cycle inventory datasets (system processes). These datasets represent the production of many different chemical compounds.

The deliverable consists of a mix of updates of data already present in the ecoinvent database and completely new datasets. All datasets are based on a combination of industry data and, to a varying degree, published data on the chemical industry.

There are some cases when duplicate products were listed in the Tender Specifications. Each such case has been discussed with the representatives of the European Commission responsible for managing this project. **Table 1** contains the list of datasets deleted from the list of deliverables.

*Table 1 List of datasets which are not being delivered as they are duplicates of other datasets*

Dataset number	Dataset name	Geography	Motivation
141-142	Carboxymethyl cellulose	World	Duplicate of dataset number 143-144, dataset name: Carboxymethyl cellulose, World
475-476	Sulphite	Europe	Duplicate of dataset number 467-468, dataset name: Sulphite, Europe
401-402	Silicon oil heating agent	EU28+EFTA	This product represents lubricating oil. Lubricating oil is requested in the call for tender dataset number: 289-290.
133-134	Carbon black, deep black pigment	Europe	Duplicate of dataset number 135-136, dataset name: Carbon black, general purposes, Europe
325-326	Nitrogen	Europe	Duplicate of dataset number 328-329, dataset name: Nitrogen liquid

In addition to the datasets requested in the Tender Specification, 12 products have been requested by the representatives of the European Commission responsible for managing this project while data collection was already ongoing. The additionally delivered products are listed in **Table 2**.

*Table 2 List of additional datasets delivered*

<b>Reference product</b>	<b>Geography</b>
styrene	RER
benzene	RER
basic chrome sulfate	ZA
natural tannins extracted from chestnut	RER
oxi-sulphited lard oil	RER
polyacrilates in water solution	RER
sulphated acid esters	RER
sulphonated fish oil	RER
sulphonated rapeseed oil	RER
synthetic tannins and retanning agents	RER
synthetic fatliquors	RER
enzymes	RER

For the full list of datasets listed in the Tender Specifications and the list of datasets delivered see

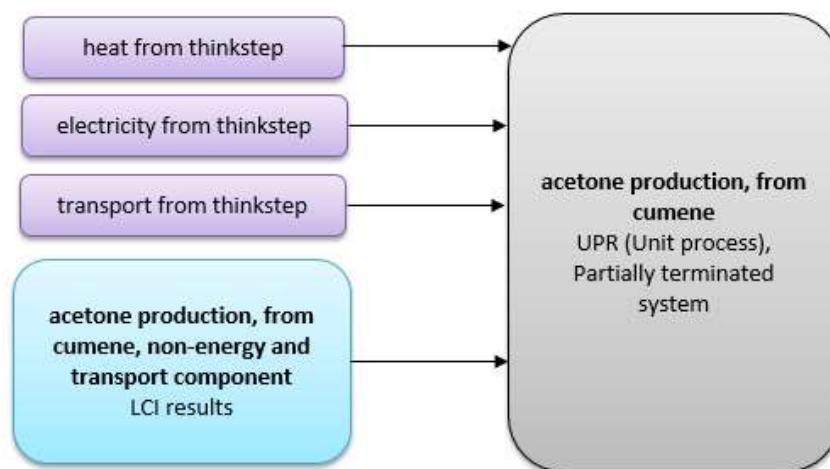
Appendix 1.

## 2.2. The structure of datasets created

For every chemical compound three datasets are created; the unit process (partially terminated system), the non-energy and transport component of the partially terminated system, and the cumulative life cycle inventory dataset (system process). **Figure 1** shows graphically the structure and relationship between the datasets created.

The unit process (partially terminated system) represents the gate-to-gate inventory of production of a specific chemical compound. The transport and the energy (electricity and heat) are listed separately as inputs. These exchanges are supplied by the transport & energy data available through the LCDN node (<http://lcdn.thinkstep.com/Node/>) as requested by the Tender Specifications (European Commission CALL FOR TENDERS ENV.B.1/SER/2016/0038vl SERVICE CONTRACT FOR Provision of "chemicals" process-based product environmental footprint-compliant life cycle inventory datasets).

All other materials and exchanges entering the production are not listed as separate inputs as would be the case for a fully disaggregated unit process dataset. Instead they are all included in the "non-energy and transport component" LCI dataset. At the same time, all the non-energy and transport materials are listed in the dataset documentation (general description of the dataset). This way, all information on the unit process level is documented.



*Figure 1 Structure of the datasets created - an example of acetone production, from cumene*

## 3. Methodology

The delivered datasets are relying on background data that are to a large extent based on ecoinvent version 3.3. The methodology of data collection and their organisation into life cycle inventories (activities) of the background data respects the Data Quality Guidelines for ecoinvent version 3 (Weidema, et al., 2013) and other related literature (Wernet, et al., 2016) (Steubing, et al., 2016). The datasets and the background data of the deliverable respect the methodological requirements defined in the Tender Specifications.

### 3.1. System model; recycled content approach

#### **System model; recycled content approach (cut-off by classification)**

The recycled content approach (cut-off by classification) system model is used as a basis of linking for the datasets supplied in this tender, excepting the energy and transport data from thinkstep which are separately documented on their node. The approach is explained in detail on the ecoinvent website (ecoinvent, 2016).

#### **Allocation**

In case of multi-output activities, the allocation factors are stated in the documentation of the dataset. Allocation in general follows the ISO and ILCD-recommended guidelines for choosing allocation factors.

#### **End-of-life of products**

As the End-of-Life formula present in the Tender Specifications (equation [3], page 27) is not a mandatory requirement for this tender the datasets offered do not include it. The End-of-Life of products supplied in the context of this project follow the rules of the ecoinvent version 3 cut-off system model.

### 3.2. Inclusion of the EF - compliant energy and transport datasets

In the context of the EF pilot phase the European Commission requires that all datasets, i.e. all deliverables from the Call for Tenders opened for this project, to integrate in the background the electricity and transport data provided in the “Provision of Energy and Transport Product Environment Footprint compliant Life Cycle Inventory Data Sets Reference: ENV.A.1/SER/2015/0049v1”.

The existing ecoinvent version 3.3 database was reviewed for datasets that could be replaced by corresponding datasets in the energy and transport deliverable. All such datasets were replaced and the thinkstep data take their place in all supply chains throughout all supply chains in the entire database. The replacement of the energy and transport inputs results in a hybrid database combining foreground data on production of chemicals provided by ecoinvent with the EF-compliant background data on energy and transport. All additional background data are supplied from the ecoinvent version 3.3 database. As stated above, all parts of the supply chains are updated with the EF-compliant data on energy and transport, not only the foreground systems of the chemicals.

### 3.3. ILCD recommended impact assessment methods

Every dataset created includes the LCIA scores for all 15 recommended ILCD methods.

### 3.4. Reporting of data quality

In accordance with the tender, the data quality ratings for the datasets were determined as the average of the 5 individual ratings for Technological Representativeness, Geographical Representativeness, Time-related representativeness, Precision/uncertainty, and implementation of the End of Life Formula. The final scores for these 5 descriptors were determined by the independent, external reviewer after a discussion with the internal reviewers. The basis for this determination was generally a contribution analysis of the material and energy inputs as well as direct resource uses and emissions based on section



2.5 of the original tender specifications. However, the reviewers could adjust the assessment based on their judgment, this is documented in the review reports.

The contribution analysis is based on the most important flows in the dataset, defined in the tender specifications as “the unit processes contributing cumulatively to at least to 80% of the total environmental impact based on characterised and normalised results”. In addition to unit processes, direct emissions also qualified as input exchanges for this approach. For the normalization, the normalisation factors “EC-JRC Global (2010 or 2013), per person” available at [http://eplca.jrc.ec.europa.eu/?page\\_id=140](http://eplca.jrc.ec.europa.eu/?page_id=140) were used as required in the tender. The contribution analysis was carried out before the aggregation of material inputs into the non-energy and transport component as shown in **Figure 1**.

DQR scores for inputs and emissions were determined for each exchange that was deemed relevant according to the contribution analysis. For each parameter, the DQR scores were chosen to best reflect the conditions and quality of the **amount value**, the **appropriateness** of the chosen exchange for the specific needs of the system under analysis, and the quality of the **foreground and background data** for aggregated inputs of exchanges from the technosphere, i.e. not direct emissions or resource uses. The DQR of the energy and transport data takes into account the DQRs stated within their metadata.

The Time-related representativeness of exchanges relevant for the contribution analysis was based on the age of the data or the age of the modelling approach used, or the expert judgment declaration of the validity. Most of the data in this tender were based on either recent industry data or modelling tools developed in 2017 for this project. Some data are based on older measurements and this is reflected in their scores.

The Geographical and Technological representativeness of exchanges relevant for the contribution analysis were scored using expert judgment based on Table 3 of the tender document, taking into account all aspects of data quality listed above that needed to be aggregated into a single score for the purposes of the contribution analysis.

The Precision indicator of exchanges relevant for the contribution analysis was determined based on Table 2 of section 2.5 of the tender document which provides guidance on scoring this indicator.

The End-of-Life formula (formula 3 in the tender document) has not been implemented within this project, so exchanges are scored with a rating of 3 based on Table 3 of the tender document. Third-party data where the End-of-Life formula is included are scored with a 2 in accordance with Table 3 of the tender. Direct emissions within the foreground system, when relevant, are not affected by methodological issues related to End-of-Life modelling and were scored with a rating of 1.

Both the contribution analysis scores and the final review scores are reported within the documentation of the datasets.

## 4. Procedure of data collection and datasets generation

In the context of this project ecoinvent provided both datasets already present in the ecoinvent database as well as new datasets.

The existing datasets have been reviewed and updated to match the time, technology and quality requirements of the PEF project. The update of existing data mainly consisted in checks of the validity of the production route as well as reviews of the bill of materials, exchanges for electricity, compressed air, heat, water, wastewater and nitrogen

as key flows for the majority of products. Any outdated information was updated and the time period was adjusted according to the updates if necessary.

For both the update of existing data and the creation of new datasets the first step was to approach industry partners requesting their collaboration in the provision of data as well as the revision of impact results. Difficulties were encountered in obtaining information from industry for both reasons of time constraints and confidentiality. In general there was a significant interest in both sharing data and supporting the project, but especially the time constraints of the deliver process (3 months) did not allow for sufficient time to get publication clearance for many data sources. We would like to especially thank Guy Castelan, PlasticsEurope, and Thomas Fröhlich, Ifeu, for their help and support.

If no information was available through industries, an extensive literature research was conducted to identify the bills of materials, production routes and energy requirements. When no specific information was found for one or more flows, a model developed internally in ecoinvent was used. The model used for this project evolved from established and published models (Hischier, et al., 2005) (Wernet, et al., 2012) used to produce datasets on production of chemicals in the ecoinvent database until now.

## 5. Handling of electricity and heat inputs in partially terminated systems

In any system where a partially terminated system dataset contains inputs of electricity or heat, these inputs have been listed separately in the dataset. For both product types mixes for use in chemical industry were selected or created. For heat, the distinction of process heat from steam and direct heat was made. Mix datasets were removed during the composition of the partially terminated system datasets and replaced by the individual inputs of heat and electricity to allow the direct linking to the energy and transport deliverable inputs as requested by the tender.

## 6. Data collection approach

In general, primary industry data were given preference over all other data sources. In cases where industry data was not available or outdated, new or newer sources were used and outdated data were updated or replaced. As a second tier, published data and information on industry processes were used.

In cases where process- and product-specific information did not cover all relevant flows and parameters, industry data for chemical production was used to determine process flows for which no specific data were available (Gendorf, 2016) (Gendorf, 2015). This process was applied at a flow-specific level and only applied for those aspects of a dataset for which no specific data were available. The model can cover emissions of reactants and reagents to air and water, including treatment and waste stream processing, use of energy, cooling and process water as well as general reagents and supporting machinery and infrastructure. It is based on several existing models for chemical production, all of which have been reviewed and assessed for their appropriateness. Separate data collection and work have added information to ensure the model is appropriate for the current status of the chemical industry.

All data, including industry data, were subjected to several independent reviews on all relevant levels.

## 7. Supporting activities

The data are available through the ecoinvent LCDN node (<http://ecoinvent.lca-data.com>), all updated datasets and all changes made under maintenance will be available through the mentioned link. Support is available via the email [pef@ecoinvent.org](mailto:pef@ecoinvent.org) and through a discussion forum on the ecoinvent website<sup>1</sup>.

The forum was also created as a space for users to share information, suggestions and questions with other users as well as the ecoinvent staff. The access to the data, maintenance and support are ensured until the 31<sup>st</sup> of December 2020. After this date the use of the data is not permitted unless under a separate agreement with ecoinvent (see EULA).

Datasets are checked yearly to ensure the time representativeness is still valid. This would also result, where necessary, in an update of the data quality ratings. Language quality checks are ensured for all datasets as well. No further checks are foreseen unless errors or defects are found. Users are encouraged to contact ecoinvent in any of these cases and ecoinvent will address the problem in a timely manner. In case of technical problems with the node please contact ecoinvent directly via email and your access to the data will be ensured through other means than the node.

The support service is provided in the English language. Currently, ecoinvent also provides support in: French, German, Spanish, Portuguese, Italian, Czech, Greek and Finnish. Support not in English might require longer waiting time and is not ensured for the full duration of the tender.

## 8. Review and review report

The data provided through the ecoinvent ILCD node is reviewed by 3 reviewers, of which 1 is an independent, external reviewer. The review report is available for each dataset in PDF format. The reviewers ensure the compliancy of the datasets with the ILCD requirements, as well as quality check of the entire dataset, i.e. exchanges and metadata. Reviewers are also responsible to check and review the impact results of the different datasets. Dry mass, wet mass and water in wet mass balances were also reviewed for each dataset.

## 9. Data quality

Data quality was calculated and reviewed based on the Data Quality Rating (DQR) requirements of the PEF project. The DQR covers technological representativeness, geographical representativeness, time-related representativeness, precision/uncertainty and end-of-life methodology. The scores go from 1 to 5 where 1=very good, 2=good, 3=fair, 4=poor, and 5=very poor. The data provided by ecoinvent does not have any individual or overall DQR scores numerically higher than 3.

Existing data quality is also ensured by the extensive and transparent documentation provided by ecoinvent as well as the inclusion, over the year, of feedback from experts and ecoinvent users.

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<sup>1</sup> <http://www.ecoinvent.org/support/ecoinvent-forum/category.html?&cid=140>

## 10. Technical specifications

### 10.1. Data format

The data provided through the ecoinvent LCDN node are in the ILCD format. This includes the use of the provided ILCD elementary flows.

### 10.2. Documentation

The ecoinvent database provides extensive and transparent documentation for its dataset drawing upon multiple sources. The documentation of existing datasets has been updated and extended where required by the ILCD requirements. The same requirements have been followed during the creation of new datasets.

### 10.3. Completeness

The internal ecoinvent guidelines on completeness define in detail the current practice at ecoinvent. The Data Quality Guidelines for ecoinvent version 3 (DQG), chapter 6. Completeness, state clearly what are the mandatory exchanges which need to be present in every activity.

#### Water use

Water use is modelled using separate flows for water withdrawal, water release and water evaporation. The regionalised water flows publish in the official list of approved elementary exchanges are used to report water use.

#### Cut-off

The aim is to provide inventories without doing any cut-offs. In order to be able to say whether the product cut-off is environmentally significant it needs to be present in the inventory in the first place. Once this exchange is present in the inventory - no matter if it is environmentally significant or not - there is no reason to cut it off.

#### Handling multi-functional processes

The following PEF multi-functionality decision hierarchy is be applied for resolving all multi- functionality problems: (1) subdivision or system expansion; (2) allocation based on a relevant underlying physical relationship (substitution may apply here); (3) allocation based on some other relationship.

#### Direct land use change

The GHG emissions from direct LUC is allocated to good/service for 20 years after the LUC occurs, with IPCC default values.

#### Carbon storage and delayed emissions

Credits associated with temporary (carbon) storage or delayed emissions up to 300 years is not considered.

#### Emissions off-setting

Emission off-setting is not included.

#### Capital goods and their End of Life

The capital goods are included. Any eventual exclusion and a justification are clearly documented.

### **System boundaries**

The system boundaries include all processes linked to the product supply chain (e.g. maintenance).

### **Time period**

The emissions and removals are modelled as if released or removed at the beginning of the assessment method (no time discounting).

### **Fossil and biogenic carbon emissions and removal**

The fossil and non-fossil emissions of carbon is modelled according to the Tender Specifications (European Commission CALL FOR TENDERS ENV.B.1/SER/2016/0038v1 SERVICE CONTRACT FOR Provision of "chemicals" process-based product environmental footprint-compliant life cycle inventory datasets, pg.23):

#### *“GHG emissions - fossil*

*These flows account for greenhouse gas (GHG) emissions to any media originating from the oxidation and/or reduction of fossil fuels by means of their transformation or degradation (e.g. combustion, digestion, landfilling, etc.).*

#### *Modelling requirements*

*All GHG emissions from fossil fuels (including peat and limestone) shall be modelled consistently with the most updated ILCD list of elementary flows.*

#### *Carbon emissions and uptakes - biogenic*

*This indicator covers carbon emissions to air (CO<sub>2</sub>, CO, and CH<sub>4</sub>) originating from the oxidation and/or reduction of biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO<sub>2</sub> uptake from the atmosphere through photosynthesis during biomass growth - i.e. corresponding to the carbon content of product and possible biofuel. The CO<sub>2</sub> uptake by a native forest<sup>13</sup> is excluded and not modelled.*

#### *Modelling requirements*

*The flows falling under this definition should be modelled consistently with the most updated ILCD list of elementary flows. The following modelling rules apply:*

- i. The emissions of biogenic methane only shall be modelled.*
- ii. The CO<sub>2</sub> uptake from air and all other biogenic emissions shall not be modelled;*
- iii. When methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and the remaining fossil methane;*
- iv. The biogenic carbon content (at factory gate) shall always be reported as meta-data;*

#### *Carbon emissions and uptakes - land use and transformation*

*These flows account for the carbon uptakes and emissions (CO<sub>2</sub>, CO, and CH<sub>4</sub>) originating from carbon stock changes caused by direct land use change and soil carbon uptake (accumulation) and emissions through land management (land use). Carbon exchanges from deforestation, road construction or other soil activities shall be included, unless they can be excluded based on the 95% cut-off rule. The eventual exclusion has to be clearly documented.*

#### *Modelling requirements*

*The flows falling under this definition should be modelled consistently with the most updated ILCD list of elementary flows<sup>14</sup>. All carbon emissions and uptake shall be modelled*

*separately. The CO<sub>2</sub> uptake by a native forest<sup>15</sup> is excluded and not modelled. The modelling guidelines of PAS 2050:2011 and the supplementary document PAS2050-1:2012 for horticultural products shall be followed. Soil carbon accumulation (uptake) via improved agricultural management shall be excluded from the model and be reported as meta-data.”*

## 11. Data node and contact information

### **Project introduction:**

<http://www.ecoinvent.org/about/projects/pef-chemicals/pef-chemicals.html>

This introduction site will give the users all basic information they need before starting to work with the data as well as link to the LCDN node.

### **LCDN node:**

<http://ecoinvent.lca-data.com/>

Through the node the users gain access to the ecoinvent PEF dataset. The use is granted in accordance with the terms and conditions of the End User License Agreement (EULA).

### **Discussion forum:**

<http://www.ecoinvent.org/support/ecoinvent-forum/category.html?&cid=140>

The discussion forum is publicly available forum for the users working with the data to discuss with each other and with the ecoinvent staff on how to use the datasets.

### **Contact e-mail:**

[PEF@ecoinvent.org](mailto:PEF@ecoinvent.org)

Any potential errors or suggestions for improvement should be reported to this specific e-mail address.

### **General information on the ecoinvent database:**

[www.ecoinvent.org](http://www.ecoinvent.org)

## References

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–. **2016.** *Umwelterklärung 2015*. s.l. : Gendorf, 2016.

**Hischier, Roland, et al. 2005.** Establishing Life Cycle Inventories of Chemicals Based on Differing Data Availability. *International Journal of Life Cycle Assessment*. 2005, pp. 59-67.

**Steubing, Bernhard, et al. 2016.** The ecoinvent database version 3 (part II): analyzing LCA results and comparison to version 2. *International Journal of Life Cycle Assessment*. 2016.

**Weidema, B.P., et al. 2013.** *Data Quality Guideline for the ecoinvent database version 3 - Overview and methodology*. s.l. : ecoinvent Association, 2013.

**Wernet, G., Hellweg, S. and Hungerbühler, K. 2012.** A tiered approach to estimate inventory data and impacts of chemical products and mixtures. *International Journal of Life Cycle Assessment*. 2012.

**Wernet, Gregor, et al. 2016.** The ecoinvent database version 3 (part I): overview and methodology. *Internatinal Journal of Life Cycle Assessment*. 2016.



## Appendix 1

Find in **Table 3** below the list of deliverables, name and geography, with their correspondence to the original list of products provided in the Tender specification (ENV.B.1/SER/2016/0038vl). The list includes the duplicate datasets (see **Table 1**) as well as the additional datasets (see **Table 2**). In accordance with the European Commission, certain products were renamed when deemed appropriate. Additionally, it was agreed to refer to two geographies only, RER and GLO. RER corresponds to Europe and EU28+EFTA, GLO to both Global and World.

In the table below find in the first two columns the list of products as listed in the Tender Specification. In the two adjacent columns, the final name and geography delivered from ecoinvent are listed. Each chemical product is listed once with the understanding that each activity is provided as: unit process (partially terminated system), non-energy and transport component of the partially terminated system, cumulative life cycle inventory dataset (system process). The final number of deliverables is therefore 268 chemical products provided in three different forms.

*Table 3 Correspondence of list of products in Tender Specifications with ecoinvent final deliverables*

CfT Indicative name of the dataset	CfT geography	ecoinvent deliverable name	ecoinvent deliverable geography
1-propanol	Europe	1-propanol production	RER
2,5-Dimethyl-2,5-di(tert-butylperoxy)hexane CAS 78-63-7	World	2,5-Bis(tert-butylperoxy)-2,5-dimethylhexane production	GLO
3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate d'octadecyle CAS 2082-79-3	World	Octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate production	GLO
Acetaldehyde	Europe	acetaldehyde production	RER
Acetic acid	Europe	Acetic acid production	RER
Acetone from cumene	Europe	Acetone from cumene production	RER
Acetone from isopropanol	Europe	Acetone from isopropanol production	RER
Acetylene	Europe	acetylene production	RER
Acrylic acid	Europe	acrylic acid production	RER
Acrylic binder	Europe	Acrylic binder production	RER
Acrylic dispersion	Europe	Acrylic dispersion production	RER
Acrylic filler	Europe	acrylic filler production	RER
Activated bentonite	World/Global	activated bentonite production	GLO
Activated silica	World	activated silica production	GLO
Adipic acid	Europe	adipic acid production	RER
AKD sizer	World	AKD sizer production	GLO
Alcohol ether sulphate (oleo based)	Europe	Alcohol ether sulphate (oleo based) production	RER
Alcohol ether sulphate (petro based)	Europe	Alcohol ether sulphate (petro based) production	RER
AlcoholEthoxylate (oleo), >20 moles EO	Europe	AlcoholEthoxylate (oleo), >20 moles EO production	RER
AlcoholEthoxylate (oleo), 3 moles EO	Europe	AlcoholEthoxylate (oleo) production, 3 moles EO	RER
AlcoholEthoxylate (oleo), 7 moles EO	Europe	AlcoholEthoxylate (oleo) production, 7 moles EO	RER

AlcoholEthoxylate (petro), 3 moles EO	Europe	AlcoholEthoxylate (petro) production, 3 moles EO	RER
AlcoholEthoxylate (petro), 7 moles EO	Europe	AlcoholEthoxylate (petro) production, 7 moles EO	RER
Alkyd paint solvent based	Europe	Alkyd paint solvent based production	RER
Alkyd paint water based	Europe	Alkyd paint water based production	RER
Alkyl amidopropylbetaine	Europe	alkyl amidopropylbetaine production	RER
Alkylbenzene	Europe	Alkylbenzene production	RER
Alkylbenzene sulfonate	Europe	Alkylbenzene sulfonate production	RER
Aluminium chloride	World	aluminium chloride production	GLO
Aluminium oxide	World	aluminium oxide production	GLO
Aluminium sulphate powder	Europe	Aluminium sulphate powder production	RER
Amine oxide	Europe	amine oxide production	RER
Ammonia, as 100% NH3	Europe	Ammonia, as 100% NH3 production	RER
Ammonium bicarbonate	Europe	ammonium bicarbonate production	RER
Aniline	Europe	aniline production	RER
Anionic resin	Europe	anionic resin production	RER
Antifoaming agent, ethoxylate fatty alcohols	World	antifoaming agent, ethoxylate fatty alcohols production	GLO
Antifoaming agent, silicone emulsion	World	Antifoaming agent, silicone emulsion production	GLO
Argon, liquid	Europe	argon, liquid production	RER
Ascorbic acid	Europe	Ascorbic acid production	RER
Azodicarbonamide	Europe	azodicarbonamide production	RER
Barite	World/Global	barite production	GLO
Barium zinc stearate	Europe	barium zinc stearate production	RER
Bentonite	World/Global	bentonite production	GLO
Benzimidazole-compound	World	benzimidazole-compound production	GLO
Benzo[thia]diazole-compound	World	benzo[thia]diazole-compound production	GLO
Benzoic acid	World	benzoic acid production	GLO
Benzyl alcohol	Europe	benzyl alcohol production	RER
Beta-pinene	World	beta-pinene production	GLO
Bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate CAS 52829-07-9	World	Bis(2,2,6,6-tetramethyl-4-piperidyl) sebacate production	GLO
Bisphenol A, powder	Europe	bisphenol A, powder production	RER
Blasting agent glass based	World	Blasting agent glass based production	GLO
Blasting agent silica based	World	Blasting agent silica based production	GLO
Boric acid, powder	Europe	Boric acid, powder production	RER
Butanol	Europe	Butanol production	RER
Butyl acetate	Europe	butyl acetate production	RER
Butyl acrylate	Europe	butyl acrylate production	RER

Butyldiglycol acetate	World	butyldiglycol acetate production	GLO
C12-14 Alkyl sulphate (oleo/petro based)	World	C12-14 Alkyl sulphate (oleo/petro based) production	GLO
C16-18 TEA-Quat (oleo based)	World	C16-18 TEA-Quat (oleo based) production	GLO
Cadmium sulphide	World	Cadmium sulphide production	GLO
Cadmium telluride	World	Cadmium telluride production	GLO
Calcium carbonate	Europe	Calcium carbonate production	RER
Calcium chloride	Europe	calcium chloride production	RER
Calcium hydroxide	Europe	Calcium hydroxide production	RER
Calcium Stearate CAS 1592-23-0	World	calcium stearate production	GLO
Carbon black, deep black pigment	Europe	duplicate dataset (see <b>Table 1</b> )	(see <b>Table 1</b> )
Carbon black, general purposes	Europe	Carbon black, general purposes production	RER
Carbon dioxide, liquid	Europe	carbon dioxide, liquid production	RER
Carbon fibre	World	Carbon fibre production	GLO
Carboxymethyl cellulose	World	Carboxymethyl cellulose production	GLO
Carboxymethyl cellulose	World	Carboxymethyl cellulose production	RER
Carboxymethyl cellulose, powder	Europe	duplicate dataset (see <b>Table 1</b> )	(see <b>Table 1</b> )
Cationic resin	Europe	cationic resin production	RER
Cellulose (excluding blowing)	EU28+EFTA	Cellulose (excluding blowing) production	RER
Chlorine dioxide	World	chlorine dioxide production	GLO
Chromium oxide	Europe	Chromium oxide production	RER
Citric acid	Europe	Citric acid production	RER
Coating powder, exterior	World	Coating powder, exterior production	GLO
Coating powder, interior	World	Coating powder, interior production	GLO
Cocamide diethanolamine (oleo based)	Europe	Cocamide diethanolamine (oleo based) production	RER
Compressed air (10 bar, high efficiency)	EU28+EFTA	Compressed air (10 bar, high efficiency) production	RER
Compressed air (14 bar, high efficiency)	EU28+EFTA	Compressed air (14 bar, high efficiency) production	RER
Compressed air (7 bar, high efficiency)	EU28+EFTA	Compressed air (7 bar, high efficiency) production	RER
Copper oxide	Europe	copper oxide production	RER
Cyclohexane	Europe	cyclohexane production	RER
Cyclohexanone	Europe	cyclohexanone production	RER
Decabromodiphenyl ether	World	decabromodiphenyl ether production	GLO
De-ionised water	Europe	De-ionised water production	RER
Diborane	Europe	diborane production	RER
Dichloromethane	Europe	dichloromethane production	RER
Diethanolamine	Europe	diethanolamine production	RER
Diethylene glycol	Europe	diethylene glycol production	RER
Dihydromyrcenol	World	dihydromyrcenol production	GLO

Dimethyl carbonate	Europe	dimethyl carbonate production	RER
Dimethylacetamide	World	dimethylacetamide production	GLO
Dimethylamine	Europe	dimethylamine production	RER
Dipropylene glycol monomethyl ether	Europe	dipropylene glycol monomethyl ether production	RER
Dispersing agent (unspecific)	World/Global	Dispersing agent (unspecific) production	GLO
EDTA	Europe	EDTA production	RER
Ehtylenediamine	World	Ehtylenediamine production	GLO
Epoxy resin	Europe	epoxy resin production	RER
Erucamide CAS 112-84-5	World	erucamide production	GLO
Ethanol	Europe	Ethanol production	RER
Ethoxylated alcohol (AE7), petrochemical	Europe	Ethoxylated alcohol (AE7) production, petrochemical	RER
Ethyl acetate	Europe	ethyl acetate production	RER
Ethylene	Europe	Ethylene production	RER
Ethylene carbonate	Europe	ethylene carbonate production	RER
Ethylene glycol	Europe	ethylene glycol production	RER
Ethylene oxide	World	ethylene oxide production	GLO
Fatty acid sulphonate derivate	World	Fatty acid sulphonate derivate production	GLO
Fatty alcohols	World	Fatty alcohols production	GLO
Flux	Europe	Flux production	RER
Folpet	World	folpet production	GLO
Formaldehyde	Europe	formaldehyde production	RER
Formic acid	Europe	formic acid production	RER
Glycerine, from palm oil	World	Glycerine, from palm oil production	GLO
Glycerine, from rape oil	World	Glycerine, from rape oil production	GLO
Glycerine, from soybean oil	World	Glycerine, from soybean oil production	GLO
Glycerine, from vegetable oil	World	Glycerine, from vegetable oil production	GLO
Ground calcium carbonate	Europe	Ground calcium carbonate production	RER
HALS HS-944 CAS 70624-18-9	World	Light stabilizer-944 production	GLO
Heat transfer fluid oil	EU28+EFTA	Heat transfer fluid oil production	RER
Hexyl salicilate	World	Hexyl salicilate production	GLO
Hexylcinnamic aldehyde	World	hexylcinnamic aldehyde production	GLO
High temperature lubrication grease	EU28+EFTA	High temperature lubrication grease production	RER
Hydraulic oil	EU28+EFTA	Hydraulic oil production	RER
Hydrochloric acid	Europe	Hydrochloric acid production	RER
Hydrogen	Europe	hydrogen production	RER
Hydrogen fluoride	Europe	hydrogen fluoride production	RER
Hydrogen peroxide, 100%	Europe	Hydrogen peroxide, 100% production	RER
Hydrogen peroxide, 50%	Europe	Hydrogen peroxide, 50% production	RER

Hydrogen sulphide	Europe	Hydrogen sulphide production	RER
Hydroquinone	World	hydroquinone production	GLO
Hydroxylamine	World	hydroxylamine production	GLO
Iron (II) sulphate	Europe	Iron (II) sulphate production	RER
Iron (III) chloride	Europe	Iron (III) chloride production	RER
Isopropanol	Europe	isopropanol production	RER
Kaolin	Europe	kaolin production	RER
Lactic acid	Europe	lactic acid production	RER
Latex	World	Latex production	GLO
Lime	Europe	Lime production	RER
Lithium carbonate	World	lithium carbonate production	GLO
Lithium hydroxide	World	lithium hydroxide production	GLO
Lubricating oil	Europe	lubricating oil production	RER
Magnesium carbonate	Europe	magnesium carbonate production	RER
Magnesium hydroxide	World	magnesium hydroxide production	GLO
Magnesium oxide	Europe	magnesium oxide production	RER
Magnetite	Europe	magnetite production	RER
Maleic anhydride	Europe	maleic anhydride production	RER
Manganese sulphate	World	Manganese sulphate production	GLO
Melamine	Europe	melamine production	RER
Melamine formaldehyde resin	Europe	melamine formaldehyde resin production	RER
Methanol	Europe	methanol production	RER
Methyl ethyl ketone	World	methyl ethyl ketone production	GLO
Methylene diphenyldiisocyanate	World	Methylene diphenyldiisocyanate production	GLO
Methylpyrrolidone	Europe	methylpyrrolidone production	RER
Monoethanolamine	World	monoethanolamine production	GLO
Naphthalene sulfonic acid	Europe	naphthalene sulfonic acid production	RER
Nickel sulphate	Europe	Nickel sulphate production	RER
Nitric acid	Europe	Nitric acid production	RER
Nitrile compounds	Europe	Nitrile compounds production	RER
Nitrogen	Europe	duplicate dataset (see <b>Table 1</b> )	(see <b>Table 1</b> )
Nitrogen gas	EU28+EFTA	Nitrogen gas production	RER
Nitrogen liquid	EU28+EFTA	Nitrogen liquid production	RER
Non-ionic surfactant, ethyleneoxidederivate	World	Non-ionic surfactant, ethyleneoxidederivate production	GLO
Non-ionic surfactant, fatty acid derivate	World	Non-ionic surfactant, fatty acid derivate production	GLO
Octabenzene CAS 1843-05-6	World	Octabenzene production	GLO
Optical brightener, distyrylbiphenyl	World	Optical brightener, distyrylbiphenyl production	GLO
Optical brightener, triazinylaminostilben	World	Optical brightener, triazinylaminostilben production	GLO
Oxygen	Europe	Oxygen production	RER
Ozone	World	Ozone production	GLO

Pentaerythritol	Europe	pentaerythritol production	RER
Pentaerythritol tetrakis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate) CAS NO.6683-19-8	World	Pentaerythritol tetrakis(3,5-di-tert-butyl-4-hydroxyhydrocinnamate) production	GLO
Pentane	Europe	Pentane production	RER
Phenol	Europe	phenol production	RER
Phenolic resin	World	phenolic resin production	GLO
Phosphane	Europe	phosphane production	RER
Phosphoric acid	World	Phosphoric acid production	GLO
Phosphoryl chloride	Europe	phosphoryl chloride production	RER
Poly(4-hydroxy-2,2,6,6-tetramethyl-1-piperidine ethanol-alt-1,4-butanedioic acid) CAS 65447-77-0	World	Poly(4-hydroxy-2,2,6,6-tetramethyl-1-piperidine ethanol-alt-1,4-butanedioic acid) production	GLO
Polyacrylamide	Europe	polyacrylamide production	RER
Polyaluminium chloride	World	polyaluminium chloride production	GLO
Polycarboxylate	Europe	Polycarboxylate production	RER
Polyether polyols (long chain)	Europe	Polyether polyols (long chain) production	RER
Polyether polyols (short chain)	Europe	Polyether polyols (short chain) production	RER
Polyurethane	Europe	Polyurethane production	RER
Polyvinyl Alcohol Granulate (PVAL) mix	World	Polyvinyl Alcohol Granulate (PVAL) mix production	GLO
Portafer	Europe	portafer production	RER
Potassium carbonate	Europe	potassium carbonate production	RER
Potassium hydroxide	World	potassium hydroxide production	GLO
Potassium permanganate	Europe	potassium permanganate production	RER
Potassium sulphate	Europe	Potassium sulphate production	RER
Precipitated calcium carbonate	Europe	Precipitated calcium carbonate production	RER
Propylene glycol	Europe	Propylene glycol production	RER
Propylene oxide	World	Propylene oxide production	GLO
Selenium	Europe	selenium production	RER
Silica sand	Europe	silica sand production	RER
Silicon carbide	Europe	silicon carbide production	RER
Silicon mix	World	Silicon mix production	GLO
Silicon oil heating agent	EU28+EFTA	duplicate dataset (see <b>Table 1</b> )	(see <b>Table 1</b> )
Silicon tetrahydride	Europe	silicon tetrahydride production	RER
Silicon, electronic grade	Europe	Silicon, electronic grade production	RER
Silicon, electronic grade	Europe	Silicon, electronic grade production	RER
Silicon, metallurgical grade	Europe	silicon, metallurgical grade production	GLO
Silicon, metallurgical grade	Europe	silicon, metallurgical grade production	GLO

Silicon, multi-Si, casted	Europe	silicon, multi-Si, casted production	GLO
Silicon, multi-Si, casted	Europe	silicon, multi-Si, casted production	GLO
Silicon, single crystal	Europe	Silicon, single crystal production	GLO
Silicon, single crystal	Europe	Silicon, single crystal production	GLO
Silicon, solar grade	Europe	silicon, solar grade production	GLO
Silicon, solar grade	Europe	silicon, solar grade production	GLO
Soap	Europe	soap production	RER
Soda	Europe	Soda production	RER
Sodium bicarbonate	Europe	sodium bicarbonate production	RER
Sodium chlorate	World	Sodium chlorate production	GLO
Sodium chloride powder	Europe	Sodium chloride powder production	RER
Sodium Cocoamphoacetate	World	sodium cocoamphoacetate production	GLO
Sodium cumenesulphonate	Europe	sodium cumenesulphonate production	RER
Sodium dichromate	World	sodium dichromate production	GLO
Sodium dithionite	Europe	Sodium dithionite production	RER
Sodium formate	Europe	sodium formate production	RER
Sodium hydrogen sulphite	Europe	Sodium hydrogen sulphite production	RER
Sodium hydrosulphide	World	Sodium hydrosulphide production	GLO
Sodium hydroxide	Europe	Sodium hydroxide production	RER
Sodium hypochlorite	Europe	Sodium hypochlorite production	RER
Sodium nitrate	Europe	sodium nitrate production	RER
Sodium percarbonate, powder	Europe	Sodium percarbonate, powder production	RER
Sodium persulphate	World	Sodium persulphate production	GLO
Sodium phosphate	Europe	sodium phosphate production	RER
Sodium pyrophosphate	World	sodium pyrophosphate production	GLO
Sodium silicate powder	Europe	Sodium silicate powder production	RER
Sodium sulphate	Europe	Sodium sulphate production	RER
Sodium sulphite	Europe	Sodium sulphite production	RER
Sodium tripolyphosphate	Europe	sodium tripolyphosphate production	RER
Sulfamic acid	World	sulfamic acid production	GLO
Sulphate pulp	Europe	Sulphate pulp production	RER
Sulphite	Europe	duplicate dataset (see Table 1)	(see Table 1)
Sulphur	Europe	Sulphur production	RER
Sulphur dioxide	World	Sulphur dioxide production	GLO
Sulphuric acid	Europe	Sulphuric acid production	RER
Tetrafluoroethane	World	tetrafluoroethane production	GLO
Tetrafluoroethylene	Europe	tetrafluoroethylene production	RER
Titanium dioxide	Europe	titanium dioxide production	RER
Toluene	Europe	Toluene production	RER

Toluene diisocyanate	Europe	toluene diisocyanate production	RER
Trichloroethylene	Europe	trichloroethylene production	RER
Triethanolamine	World	triethanolamine production	GLO
Triethylene glycol	Europe	triethylene glycol production	RER
Trimethyl borate	Europe	trimethyl borate production	RER
Triphenyl phosphate	World	triphenyl phosphate production	GLO
Tris(2,4-ditert-butylphenyl) phosphite CAS 31570-04-4	World	Tris(2,4-di-tert-butylphenyl) phosphite production	GLO
Trisodium phosphate	World	trisodium phosphate production	GLO
Turpentine	Europe	Turpentine production	RER
Urea-formaldehyde resin	Europe	Urea-formaldehyde resin production	RER
Wax	Europe	Wax production	RER
White spirit	Europe	white spirit production	RER
Xylene	Europe	Xylene production	RER
Zinc monosulphate	Europe	Zinc monosulphate production	RER
Zinc oxide	Europe	zinc oxide production	RER
Zinc sulphide	World	Zinc sulphide production	GLO
additional dataset (see Table 2)	(see Table 2)	Styrene production	RER
additional dataset (see Table 2)	(see Table 2)	Benzene production	RER
additional dataset (see Table 2)	(see Table 2)	basic chrome sulfate production	ZA
additional dataset (see Table 2)	(see Table 2)	natural tannins extracted from chestnut production	RER
additional dataset (see Table 2)	(see Table 2)	oxi-sulphited lard oil production	RER
additional dataset (see Table 2)	(see Table 2)	polyacrilates in water solution production	RER
additional dataset (see Table 2)	(see Table 2)	sulphated acid esters production	RER
additional dataset (see Table 2)	(see Table 2)	sulphonated fish oil production	RER
additional dataset (see Table 2)	(see Table 2)	sulphonated rapeseed oil production	RER
additional dataset (see Table 2)	(see Table 2)	synthetic tannins and retanning agents production	RER
additional dataset (see Table 2)	(see Table 2)	synthetic fatliquors production	RER
additional dataset (see Table 2)	(see Table 2)	enzymes production	RER