Documentation of Changes Implemented in the ecoinvent Database v3.12 (2025.11.05)

Stoikou N., FitzGerald D., Vadenbo C., Sonderegger T., Symeonidis A., Fazio S., Treichel A., Ioannou I., Bonanno E., Kaarlela O., Anagnostou A., Beckert P., Bichot L., Bohara K., Cassar C., Cirone F., Clementi M., Giakoumatos A., Hoxha E., Jensen S., Kunde S., Polimeno A., Savant S., Smith G., Superti V., Valente A., Moreno Ruiz E.

ecoinvent
Technoparkstrasse 1
8005 Zürich, Switzerland
+41 44 500 42 58
info@ecoinvent.org

ecoinvent.org

ecoinvent

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1 Introduction to the New Version

This report covers the changes to the ecoinvent database between version 3.11, released in 2024, and version 3.12, released in 2025. It describes both database-wide changes, as well as the specific changes in different sectors. These changes consist of the addition of new datasets, the deletion of outdated ones, and the updating of others.

All changes described in this report potentially affect or modify impact assessment results, even when they seem as minor as changing an activity link. The description of the changes has been provided to help the users with the interpretation and understanding of the possible changes in results they might encounter when comparing version 3.11 with version 3.12.

For a full comparison at the exchange level, between the versions of the database, the Change Report Annex can be downloaded as an Excel file from the “Files” section of ecoQuery, accessible only to license holders. This file lists all datasets available in versions 3.11 and 3.12 with indication of the changes between versions. Changes that may affect the LCIA scores are reported.

The Correspondence File, which is available on the ecoinvent Knowledge Base, provides a mapping of datasets for each system model between versions 3.11 and 3.12, indicating which new datasets are available in cases where datasets in the previous version have been deleted or replaced.

More information about the technical background of the sectors can be found in the dedicated sectorial pages on the ecoinvent Knowledge Base.

The main updates introduced with v3.12 include the following:

— Fuels: The new version delivers an update for data on the extraction or production of crude petroleum oil and natural gas, with a geographical coverage of 40 countries for onshore production and 36 countries for offshore production, based on the reference year of 2023. Additionally, natural gas liquids production and fractionation were regionalized, adding 18 new geographies covering 95% of global natural gas liquids production and subsequent fractionation.

— Chemicals and Plastics: We’ve updated key chemical precursors, plastics, and auxiliary chemicals. The outputs of steam cracker and key downstream processes were regionalized, and new data on plastic processing was added. A product portfolio expansion has also been implemented, covering a diverse selection of chemicals and plastics. Additionally, we introduced new flows of grouped organic compounds to be used when specific chemicals are not available.

— Energy: We updated electricity market mixes for all countries with 2022 data, and China, India, Brazil, Switzerland, Canada, and the U.S. have been updated with 2023 data.

— Batteries & Electronics: We further refined this sector through a series of technical corrections by replacing proxy input materials with the exact substances used, updates in energy inputs, clarifications on manufacturing scrap, etc. New chemical components relevant to battery applications were also introduced.

— Metals: We enriched this sector with important updates on aluminium production and on aluminium electricity supply mixes. New data was also added covering zamak production and steel alloys manufacturing.

— Waste Management & Recycling: We implemented several updates and corrections, such as integrating recyclable polymers in their production activities, updating chromium emissions of electric arc furnace slag landfilling, aligning ISIC classifications and EN15804 waste inventory indicators, etc.

— Forestry & Wood: We expanded the geographical coverage of the sector through the introduction of Finnish forestry data. The new data focuses on pine, spruce, and birch, covering 97% of the annual harvested area in Finland. Furthermore, the product naming conventions across the sector were harmonized.

— Agriculture, Fishery and Animal Husbandry: ecoinvent v3.12 focuses on several refinements through technical corrections to improve the quality of the data inside the sector, such as crop yield adjustments, properties updates, and harmonization of emissions to air and water, etc.

— Textiles: Version 3.12 introduces new hemp production datasets in France, representative of over 98% of national French production, and remodels the existing European flax datasets to enhance the accuracy of the data.

— Transport: We've updated the seagoing vessels data by refining the production, maintenance, and use-phase of the ships, while adapting the new emission limits. Moreover, corrections were implemented to road transport regarding brake wear of lorries and passenger cars.

— Life Cycle Impact Assessment Methods: For the new version, we implemented several minor fixes for the IPCC and EF methods. A unit error in the USEtox method was corrected, and characterization factors (CFs) for new elementary flows were added.

2 Database-wide Changes

2.1 Renamed Activities

Several activities were renamed for version 3.12. The changes are listed in **Table 1**.

Table 1. Activities renamed for v3.12. Most of the activity name changes aim at better defining the scope of the activity. More details of some changes are given in the corresponding chapters.

Activity Name v3.11	Activity Name v3.12
4-methyl-2-pentanone production	methyl isobutyl ketone production, one-step process, from acetone and hydrogen
bark chips, wet, measured as dry mass to generic market for residual hardwood, wet	bark chips, green, measured as dry mass to generic market for residual hardwood, green, measured as green volume
butadiene purification, extractive distillation of crude butadiene	butadiene purification, extractive distillation of C4 hydrocarbon mixture
market for 4-methyl-2-pentanone	market for methyl isobutyl ketone
market for bark	market for bark, green, measured as dry mass
market for bark chips, wet, measured as dry mass	market for bark chips, green, measured as dry mass
market for bundle, energy wood, measured as dry mass	market for bundle, energy wood, green, measured as dry mass
market for butadiene, crude	market for C4 hydrocarbon mixture
market for chemical, organic	market for chemical, organic, basic precursors and materials
market for cleft timber, measured as dry mass	market for cleft timber, green, measured as dry mass
market for pulpwood, hardwood, measured as solid wood under bark	market for pulpwood, hardwood, with bark, green, measured as green volume under bark
market for pulpwood, softwood, measured as solid wood under bark	market for pulpwood, softwood, with bark, green, measured as green volume under bark
market for residual hardwood, wet	market for residual hardwood, green, measured as green volume
market for residual softwood, wet	market for residual softwood, green, measured as green volume
market for residual wood, dry	market for residual wood, dry, measured as dry volume
market for sawdust, loose, wet, measured as dry mass	market for sawdust, green, loose, measured as dry mass

market for sawdust, wet, measured as dry mass	market for sawdust, green, collected, measured as dry mass
market for sawlog and veneer log, azobe, debarked, measured as solid wood	market for sawlog and veneer log, azobe, debarked, green, measured as green volume
market for sawlog and veneer log, azobe, measured as solid wood under bark	market for sawlog and veneer log, azobe, with bark, green, measured as green volume under bark
market for sawlog and veneer log, eucalyptus ssp., measured as solid wood under bark	market for sawlog and veneer log, eucalyptus, with bark, green, measured as green volume under bark
market for sawlog and veneer log, hardwood, measured as solid wood under bark	market for sawlog and veneer log, hardwood, with bark, green, measured as green volume under bark
market for sawlog and veneer log, meranti, debarked, measured as solid wood	market for sawlog and veneer log, meranti, debarked, green, measured as green volume
market for sawlog and veneer log, meranti, measured as solid wood under bark	market for sawlog and veneer log, meranti, with bark, green, measured as green volume under bark
market for sawlog and veneer log, paraná pine, measured as solid wood under bark	market for sawlog and veneer log, paraná pine, with bark, green, measured as green volume under bark
market for sawlog and veneer log, softwood, debarked, measured as solid wood	market for sawlog and veneer log, softwood, debarked, green, measured as green volume
market for sawlog and veneer log, softwood, measured as solid wood under bark	market for sawlog and veneer log, softwood, with bark, green, measured as green volume under bark
market for shavings, hardwood, loose, measured as dry mass	market for shavings, hardwood, dry, loose, measured as dry mass
market for shavings, hardwood, measured as dry mass	market for shavings, hardwood, dry, collected, measured as dry mass
market for shavings, softwood, loose, measured as dry mass	market for shavings, softwood, dry, loose, measured as dry mass
market for shavings, softwood, measured as dry mass	market for shavings, softwood, dry, collected, measured as dry mass
market for slab and siding, hardwood, wet, measured as dry mass	market for slab and siding, hardwood, green, measured as dry mass
market for slab and siding, softwood, wet, measured as dry mass	market for slab and siding, softwood, green, measured as dry mass
market for waste wood, post-consumer	market for waste wood, post-consumer, measured as dry mass
market for wood chips and particles, willow	market for wood chips and particles, willow, dry, measured as dry mass
market for wood chips, from post-consumer wood, measured as dry mass	market for wood chips, from post-consumer wood, dry, measured as dry mass

market for wood chips, wet, measured as dry mass	market for wood chips, green, measured as dry mass
market for wood pellet, measured as dry mass	market for wood pellets, dry, measured as dry mass
pulpwood, softwood, measured as solid wood under bark, import from Europe without Switzerland	pulpwood, softwood, with bark, green, measured as green volume under bark, import from Europe without Switzerland
sawdust, wet, measured as dry mass to generic market for residual softwood, wet	sawdust, green, measured as dry mass to generic market for residual softwood, green, measured as green volume
sawlog and veneer log, azobe, debarked, measured as solid wood, import from CM	sawlog and veneer log, azobe, debarked, green, measured as green volume, import from CM
sawlog and veneer log, hardwood, measured as solid wood under bark, import from Europe without Switzerland	sawlog and veneer log, hardwood, with bark, green, measured as green volume under bark, import from Europe without CH
sawlog and veneer log, meranti, debarked, measured as solid wood, import from MY	sawlog and veneer log, meranti, debarked, green, measured as green volume, import from MY
sawlog and veneer log, softwood, measured as solid wood under bark, import from Europe without Switzerland	sawlog and veneer log, softwood, with bark, green, measured as green volume under bark, import from Europe without CH
shavings, hardwood, measured as dry mass to generic market for residual wood, dry	shavings, hardwood, dry, measured as dry mass to generic market for residual wood, dry, measured as dry volume
shavings, softwood, measured as dry mass to generic market for residual wood, dry	shavings, softwood, dry, measured as dry mass to generic market for residual wood, dry, measured as dry volume
slab and siding, hardwood, wet, measured as dry mass to generic market for residual hardwood, wet	slab and siding, green, measured as dry mass to generic market for residual hardwood, green, measured as green volume
slab and siding, softwood, wet, measured as dry mass to generic market for residual softwood, wet	slab and siding, green, measured as dry mass to generic market for residual softwood, green, measured as green volume
suction, sawdust	suction, sawdust, at sawmill
treatment of waste polyester, industrial, from textile produ ction, hydrothermal treatment	treatment of waste polyester, industrial, from textile production, hydrothermal treatment
yarn production, cotton, ring spinning, for knitting	yarn production, cotton, spinning, for knitting
yarn production, cotton, ring spinning, for weaving	yarn production, cotton, spinning, for weaving

2.2 Exchanges

2.2.1 Renamed Exchanges

Some intermediate exchanges were renamed to be more specific or to correct mistakes. **Table 2** contains all intermediate exchanges that were renamed for version 3.12.

Table 2. Intermediate exchanges renamed for version 3.12.

Intermediate exchange name in v3.11	Intermediate exchange name in v3.12
4-methyl-2-pentanone	methyl isobutyl ketone
bark	bark, green, measured as dry mass
bark chips, wet, measured as dry mass	bark chips, green, measured as dry mass
bundle, energy wood, measured as dry mass	bundle, energy wood, green, measured as dry mass
butadiene, crude	C4 hydrocarbon mixture
chemical, organic	chemical, organic, basic precursors and materials
cleft timber, measured as dry mass	cleft timber, green, measured as dry mass
pulpwood, hardwood, measured as solid wood under bark	pulpwood, hardwood, with bark, green, measured as green volume under bark
pulpwood, softwood, measured as solid wood under bark	pulpwood, softwood, with bark, green, measured as green volume under bark
residual hardwood, wet	residual hardwood, green, measured as green volume
residual softwood, wet	residual softwood, green, measured as green volume
residual wood, dry	residual wood, dry, measured as dry volume
sawdust, loose, wet, measured as dry mass	sawdust, green, loose, measured as dry mass
sawdust, wet, measured as dry mass	sawdust, green, collected, measured as dry mass
sawlog and veneer log, azobe, debarked, measured as solid wood	sawlog and veneer log, azobe, debarked, green, measured as green volume
sawlog and veneer log, azobe, measured as solid wood under bark	sawlog and veneer log, azobe, with bark, green, measured as green volume under bark
sawlog and veneer log, eucalyptus ssp., measured as solid wood under bark	sawlog and veneer log, eucalyptus, with bark, green, measured as gree n volume under bark

sawlog and veneer log, hardwood, measured as solid wood under bark	sawlog and veneer log, hardwood, with bark, green, measured as green volume under bark
sawlog and veneer log, meranti, debarked, measured as solid wood	sawlog and veneer log, meranti, debarked, green, measured as green volume
sawlog and veneer log, meranti, measured as solid wood under bark	sawlog and veneer log, meranti, with bark, green, measured as green volume under bark
sawlog and veneer log, paraná pine, measured as solid wood under bark	sawlog and veneer log, paraná pine, with bark, green, measured as green volume under bark
sawlog and veneer log, softwood, debarked, measured as solid wood	sawlog and veneer log, softwood, debarked, green, measured as green volume
sawlog and veneer log, softwood, measured as solid wood under bark	sawlog and veneer log, softwood, with bark, green, measured as green volume under bark
shavings, hardwood, loose, measured as dry mass	shavings, hardwood, dry, loose, measured as dry mass
shavings, hardwood, measured as dry mass	shavings, hardwood, dry, collected, measured as dry mass
shavings, softwood, loose, measured as dry mass	shavings, softwood, dry, loose, measured as dry mass
shavings, softwood, measured as dry mass	shavings, softwood, dry, collected, measured as dry mass
slab and siding, hardwood, wet, measured as dry mass	slab and siding, hardwood, green, measured as dry mass
slab and siding, softwood, wet, measured as dry mass	slab and siding, softwood, green, measured as dry mass
waste wood, post-consumer	waste wood, post-consumer, measured as dry mass
wood chips and particles, willow	wood chips and particles, willow, dry, measured as dry mass
wood chips, from post-consumer wood, measured as dry mass	wood chips, from post-consumer wood, dry, measured as dry mass
wood chips, wet, measured as dry mass	wood chips, green, measured as dry mass
wood pellet, measured as dry mass	wood pellets, dry, measured as dry mass

The names of several elementary exchanges were changed to improve consistency of naming. The renamed exchanges are listed in **Table 3**.

Table 3. Elementary exchanges renamed for version 3.12.

Elementary exchange name in 3.11	Elementary exchange name in 3.12

4-Methyl-2-pentanone	Methyl isobutyl ketone
4-Methyl-2-pentanone	Methyl isobutyl ketone
4-Methyl-2-pentanone	Methyl isobutyl ketone
Ferrocyanide	Ferrocyanide

2.3 Properties

As part of our ongoing commitment to data quality and consistency, ecoinvent has completed a review of the Lower Heating Values (LHV) property across the database. This update aims to ensure alignment with current scientific literature and improve consistency in how thermal energy values are reported for materials and products within the ecoinvent database. The project for the update of LHV is currently ongoing and will affect future versions of the ecoinvent database with new updates. The main objective is to have LHV values that are internally consistent, appropriately sourced, referenced, and clear to our users. This initial revision prioritizes transparency by updating LHV values with clear sources and explanatory comments that distinguish between measured values, calculated values based on carbon content, and assigning a null LHV value for non-combustible materials. Where applicable, moisture content considerations are explicitly documented to provide users with complete context for thermal energy calculations. As a result, in some cases the properties of fossil carbon content, non-fossil carbon content, dry mass, water content, water content in wet mass, and wet mass are also added or updated.

2.3.1 New Properties

The current revision adds LHV values for exchanges introduced in the previous database release. Many non-combustible materials (e.g., minerals, metals, inorganic compounds) now explicitly show LHV = 0 MJ/kg with appropriate documentation while other non-null LHV values have been updated and reported in **Table 4**.

Table 4. Exchanges with new properties. The newly added properties include LHVs, fossil carbon content, non-fossil carbon content, dry mass, water content, water in wet mass, and wet mass.

Exchange Name	Property Name	Amount	Comment
adobe brick	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
aluminium in car shredder residue	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
antimony slag, desulfurised	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
antimony slag, water-quenched	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).

ash from deinking sludge	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
basic oxygen furnace waste	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
blast furnace dust, for recovery	heating value, net	10.1	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
blast furnace sludge, for recovery	heating value, net	5.48	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
clay	heating value, net	0	Not combustible
coating from waste cathode ray tube display	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
containerboard, unspecified	heating value, net	15.92	Assumed equal to "waste paperboard"
copper in car shredder residue	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
copper slag	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
decarbonising waste	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
diethyl carbonate	heating value, net	25.66	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
diisopropyl ether	heating value, net	37.97	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
disodium phosphate	heating value, net	0	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
dolomite	heating value, net	3.95	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
H3PO4 purification residue	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
hard coal ash	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
jatropha seed	heating value, net	0	Estimated value: based on the carbon content of jatropha oil (76% C) and press cake (48.5%) and the mass ratio of press cake to oil of 3:1.
lead in car shredder residue	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
lead smelter slag	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).

lightweight concrete block, polystyrene	heating value, net	38.67	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
lime, from liquid packaging board production	heating value, net	0	Not combustible
lithium aluminium hydride	heating value, net	12.77	LHV is calculated based on the elemental composition of the substance with the chemical formula: $LiAlH_4$, (PubChem 2020).
lithium hydride	heating value, net	15.25	LHV is calculated based on the elemental composition of the substance with the chemical formula: LiH, (PubChem 2020).
methyldiethanolamine	heating value, net	28.49	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
mill scale	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
m-toluidine	heating value, net	33.95	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
o-toluidine	heating value, net	33.95	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
packaging, for fertilisers	heating value, net	25.01	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
packaging, for fertilisers or pesticides	heating value, net	27.31	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
packaging, for pesticides	heating value, net	25.97	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
palm fruit bunch	heating value, net	0	Literature Value: Carbon content on a fresh matter basis [kg C /kg FFB]
peracetic acid	heating value, net	15.94	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
pollutant from rail ballast	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
polyurethane adhesive	carbon content, fossil	0.72	fossil carbon content on a dry matter basis
polyurethane adhesive	carbon content, non-fossil	0	biogenic carbon content on a dry matter basis
polyurethane adhesive	dry mass	1	
polyurethane adhesive	water content	0	water content on a dry matter basis

polyurethane adhesive	water in wet mass	0	water content on a wet matter basis
polyurethane adhesive	wet mass	1	
printed paper	carbon content, fossil	0.032530991	fossil carbon content on a dry matter basis
printed paper	carbon content, non-fossil	0.247	biogenic carbon content on a dry matter basis
printed paper	dry mass	0.945	
printed paper	water content	0.058201058	water content on a dry matter basis
printed paper	water in wet mass	0.055	water content on a wet matter basis
printed paper	wet mass	1	
p-toluidine	heating value, net	33.95	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
refractory spent pot liner from Al electrolysis	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
residual fuels	heating value, net	41.2	Proxied with the LHV of heavy fuel oil.
residue from Na-dichromate production	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
residue from rutile production, synthetic, 56% water	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
residue from TiO2 production, sulfate process	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
salt tailing from potash mine	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
silky fibre	heating value, net	12.12	LHV is calculated based on the Carbon content of the product. More details can be found in the respective documentation.
sludge, NaCl electrolysis	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
sludge, NaCl electrolysis Hg	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
spent catalyst base from ethyleneoxide production	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
spent Formox catalyst base from formaldehyde production	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
steel in car shredder residue	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).

sugarcane	heating value, net	0	Literature value: nitrogen uptake of sugarcane [kg N kg fresh matter] based on the SQCB background report - Table 8-3.
tin slag	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
used liquid crystal display module	heating value, net	2.66	
used metallurgical coke	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
used window frame, aluminium	heating value, net	0	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
waste aluminium	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
waste cement, hydrated	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
waste cement-fibre slab, dismantled	heating value, net	5.39	
waste copper	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
waste frit from cathode ray tube production	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
waste mix of pitch and coke, from graphite block forming	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
waste paper, unsorted	water content	0.111111111	
waste paper, unsorted	wet mass	1	
waste paper, unsorted	dry mass	0.9	
waste paper, unsorted	carbon content, fossil	0	
waste paper, unsorted	carbon content, non-fossil	0.448888889	Biogenic carbon content on a dry mass basis is based on carbon content of wood fiber source (0.494 kg C/kg dry wood, taken from ecoinvent v2.2 report 6_IX and report 9) considered to be the only source of the carbon in the waste paper/pulp.
waste paperboard, sorted	dry mass	0.804	
waste paperboard, sorted	carbon content, non-fossil	0.483258929	C content was calculated for 1 kg DM, using data in Tab A.3, ecoinvent v2.2 report 13_I.
waste paperboard, sorted	wet mass	1	
waste paperboard, sorted	water in wet mass	0.196	water content on a wet matter basis

waste paperboard, sorted	water content	0.243781095	water content on a dry matter basis
waste paperboard, sorted	carbon content, fossil	0	fossil carbon content on a dry matter basis
waste polyethylene, for recycling, sorted	carbon content, fossil	0.829	
waste polyethylene, for recycling, sorted	carbon content, non-fossil	0	
waste polyethylene, for recycling, sorted	dry mass	0.994	
waste polyethylene, for recycling, sorted	water content	0.006036217	
waste polyethylene, for recycling, sorted	water in wet mass	0.006	
waste polyethylene, for recycling, sorted	wet mass	1	
waste steel	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
waste tin sheet	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
water pump operation, diesel	heating value, net	43.2	Literature. net (lower) heating (calorific) value for diesel in MJ/kg
zinc in car shredder residue	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).
zinc slag	heating value, net	0	Non-combustible products are assumed to have an LHV equal to zero (0).

2.3.2 Updated Properties

This revision standardizes LHV values to align the ecoinvent database with available references. It also ensures consistent LHV values for each specific intermediate exchange within the database. Among the consulted sources are the PubChem database for chemical compounds and their compositions, Phyllis2 database, IPCC Guidelines, and peer-reviewed literature for specific materials, while certain exchanges were updated considering their specific composition and adapting the LHV accordingly. Key updates affect waste plastics, several bio-based products, biomethane, and sewage sludge variants. All revised values are presented in **Table 5** with corresponding source documentation.

Table 5. Exchanges with updated properties. The updated properties include LHVs, and water in wet mass

Exchange Name	Property Name	Previous Amount	New Amount	New Comment

[sulfonyl]urea-compound	heating value, net	4.965568958	4.97	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (), the chemical formula of the substance is found to be: C2H4N4O6S2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
[thio]carbamate-compound	heating value, net	7.96769793	7.97	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (), the chemical formula of the substance is found to be: CH2NOS-, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
1-methoxy-2-propanol	heating value, net	29.59873164	29.6	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000107-98-2), the chemical formula of the substance is found to be: C4H10O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
1-methylcyclopropene	heating value, net	40.35331317	40.35	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (003100-04-7), the chemical formula of the substance is found to be: C4H6, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
1-naphthylacetic acid	heating value, net	29.96059982	29.96	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000086-87-3), the chemical formula of the substance is found to be: C12H10O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
6-benzyladenine	heating value, net	25.30527474	25.31	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001214-39-7), the chemical formula of the substance is found to be: C12H11N5, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
acetamide-anillide-compound, unspecified	heating value, net	24.8118311	24.81	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (60-35-5), the chemical formula of the substance is found to be: CH3CONH2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
aclonifen	heating value, net	20.62149103	20.62	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (074070-46-5), the chemical formula of the substance is found to be: C12H9ClN2O3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

acrylonitrile-butadiene-styrene, flakes, recycled	heating value, net	35.58311932	35.58	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (009003-56-9), the chemical formula of the substance is found to be: C15H17N, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
acrylonitrile-butadiene-styrene, pellets, recycled	heating value, net	35.58311932	35.58	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (009003-56-9), the chemical formula of the substance is found to be: C15H17N, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
adiponitrile	heating value, net	29.1556698	29.16	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000111-69-3), the chemical formula of the substance is found to be: C6H8N2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
amidosulfuron	heating value, net	13.78857678	13.79	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (120923-37-7), the chemical formula of the substance is found to be: C9H15N5O7S2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
ascorbic acid	heating value, net	17.9022209	17.9	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000050-81-7), the chemical formula of the substance is found to be: C6H8O6, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
atrazine	heating value, net	21.36419116	21.36	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001912-24-9), the chemical formula of the substance is found to be: C8H14ClN5, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
bamboo culm	heating value, net	9.870979558	9.87	LHV is calculated based on Carbon and water in wet mass content.
barium carbonate	heating value, net	1.844241011	1.84	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000513-77-9), the chemical formula of the substance is found to be: BaCO3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
battery cell, Li-ion, NMC532	heating value, net	9.2063217	9.21	Calculated based on the carbon content. There is no heat from vapor condensation.
battery cell, Li-ion, NMC622	heating value, net	9.018724553	9.02	Calculated based on the carbon content. There is no heat from vapor condensation.

battery, Li-ion, NMC532, rechargeable	heating value, net	7.435923	7.44	Calculated based on the carbon content. The heat from water condensation is negligible.
battery, Li-ion, NMC622, rechargeable	heating value, net	7.168055153	7.17	Calculated based on the carbon content. The heat from water condensation is negligible.
benzimidazole-compound	heating value, net	27.71812285	27.72	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000051-17-2), the chemical formula of the substance is found to be: $C_7H_6N_2$, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
beverage carton, 1 L, for fresh milk (chilled)	heating value, net	0.499985	0.5	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
beverage carton, 1 L, for juice (ambient)	heating value, net	0.674551	0.67	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
beverage carton, 1 L, for UHT milk (ambient)	heating value, net	0.562175	0.56	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
biomethane, low pressure	heating value, net	52.89776084	34.97	Literature value, Source: United Nations Statistics Division (2018) International Recommendations for Energy Statistics (IRES). Available at: http://unstats.un.org/unsd/statcom/doc11/BG-IRES.pdf.
bromoxynil	heating value, net	10.5124757	10.51	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001689-84-5), the chemical formula of the substance is found to be: C7H3Br2NO, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
butyric acid	heating value, net	27.52530082	27.53	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000107-92-6), the chemical formula of the substance is found to be: C4H8O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
cake from recycling of waste plastic, WEEE	heating value, net	34.9588	22.35	Value taken from the general comment of the treatment dataset.
calcium carbonate, precipitated	heating value, net	3.636205863	3.64	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000471-34-1), the chemical formula of the substance is found to be: CaCO3, (PubChem 2020).
captan	heating value, net	14.21637536	14.22	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000133-06-2), the chemical formula of the substance is found to be: C9H8Cl3NO2S, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical

				data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
cathode, NMC532, for Li-ion battery	heating value, net	2.17554	2.18	Calculated based on the carbon content. There is no heat from vapor condensation.
cathode, NMC622, for Li-ion battery	heating value, net	0.9663579	0.97	Calculated based on the carbon content. There is no heat from vapor condensation.
chloridazon	heating value, net	20.79345236	20.79	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001698-60-8), the chemical formula of the substance is found to be: C10H8ClN3O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
chlormequat chloride	heating value, net	21.47811231	21.48	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000999-81-5), the chemical formula of the substance is found to be: C5H13Cl2N, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
chloroprene	heating value, net	23.28613918	23.29	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000126-99-8), the chemical formula of the substance is found to be: C4H5Cl, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
chlorothalonil	heating value, net	10.94939639	10.95	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001897-45-6), the chemical formula of the substance is found to be: C8Cl4N2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
chlorotoluron	heating value, net	24.51899265	24.52	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (015545-48-9), the chemical formula of the substance is found to be: C10H13ClN2O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
chlorpropham	heating value, net	23.83892911	23.84	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000101-21-3), the chemical formula of the substance is found to be: C10H12ClNO2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
cyanuric chloride	heating value, net	5.920695321	5.92	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000108-77-0), the chemical formula of the substance is found to be: C3Cl3N3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical

				data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
daminozide	heating value, net	22.71116999	22.71	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001596-84-5), the chemical formula of the substance is found to be: C6H12N2O3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
decabromodiphenyl ether	heating value, net	22.71116999	22.71	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001163-19-5), the chemical formula of the substance is found to be: C12Br10O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
diazole-compound	heating value, net	23.15699962	23.16	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000288-13-1), the chemical formula of the substance is found to be: C3H4N2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
dichlobenil	heating value, net	16.92399312	16.92	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001194-65-6), the chemical formula of the substance is found to be: C7H3Cl2N, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
dimethenamide	heating value, net	23.74397369	23.74	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (087674-68-8), the chemical formula of the substance is found to be: C12H18ClNO2S, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
dioctyl adipate	heating value, net	35.33960858	35.34	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000123-79-5), the chemical formula of the substance is found to be: C22H42O4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
dioctyl terephthalate	heating value, net	34.15343256	34.15	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (006422-86-2), the chemical formula of the substance is found to be: C24H38O4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
diphenylether-compound	heating value, net	32.77674941	32.78	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000101-84-8), the chemical formula of the substance is found to be: C12H10O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

electrolyte, for Na-ion battery	heating value, net	10.89104791	10.89	Calculated based on the carbon content.
ethephon	heating value, net	10.06932759	10.07	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (016672-87-0), the chemical formula of the substance is found to be: C2H6ClO3P, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
ethyl acrylate	heating value, net	27.85818047	27.86	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000140-88-5), the chemical formula of the substance is found to be: C5H8O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
fluazifop-butyl	heating value, net	24.35852586	24.36	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (069806-50-4), the chemical formula of the substance is found to be: C19H20F3NO4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
folpet	heating value, net	12.67966918	12.68	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000133-07-3), the chemical formula of the substance is found to be: C9H4Cl3NO2S, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
fosetyl-Al	heating value, net	12.32625616	12.33	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (039148-24-8), the chemical formula of the substance is found to be: C6H18AlO9P3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
generic C4 hydrocarbons	heating value, net	44.295985	44.3	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product. Arithmetic average heating value, netl of butane, butene and butadiene.
glued laminated bamboo	heating value, net	15653.872	15653.87	Jetsada P. & Panmanas S. (2017), Evaluation of lower heating value and elemental composition of bamboo using near infrared spectroscopy,Energy,Volume 121, Pages 147-158,ISSN 0360-5442,https://doi.org/10.1016/j.energy.2017.01.020.
glycidyl methacrylate	heating value, net	26.445	26.45	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (106-91-2), the chemical formula of the substance is found to be: C7H10O3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
glyphosate	heating value, net	12.19126505	12.19	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001071-83-6), the chemical formula of the substance is found to be: C3H8NO5P, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

hexamethylene-1,6-diisoncyanate	heating value, net	25.95533087	25.96	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000822-06-0), the chemical formula of the substance is found to be: C8H12N2O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
hexamethylene diamine	heating value, net	35.47450872	35.47	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000124-09-4), the chemical formula of the substance is found to be: C6H16N2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
hydrated lime, packed	heating value, net	0.0652	0.07	Calculated value. Considering the properties for 1 kg of packed hydrated lime. This means, 1 kg of hydrated lime, and additionally the 0.004373 kg packaging to pack the 1 kg hydrated lime.
hydrocarbons, aromatic, cyclic (C9+)	heating value, net	39.349	39.35	LHV is calculated based on the elemental composition of a representative substance, trimethylbenzene, C9H12.
indolylbutyric acid	heating value, net	29.23864969	29.24	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000133-32-4), the chemical formula of the substance is found to be: C12H13NO2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
ioxynil	heating value, net	7.848307107	7.85	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (001689-83-4), the chemical formula of the substance is found to be: C7H3I2NO, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
isophorondiisocyante	heating value, net	29.45896426	29.46	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (004098-71-9), the chemical formula of the substance is found to be: C12H18N2O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
isoproturon	heating value, net	31.74369088	31.74	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (034123-59-6), the chemical formula of the substance is found to be: C12H18N2O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
lauric diethanolamide	heating value, net	35.69710745	35.7	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000120-40-1), the chemical formula of the substance is found to be: C12H15N, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

limestone, milled, packed	heating value, net	0.0652	0	Not combustible
maleic hydrazide	heating value, net	17.31174325	17.31	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000123-33-1), the chemical formula of the substance is found to be: C4H4N2O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
mancozeb	heating value, net	8.069319393	8.07	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (008018-01-7), the chemical formula of the substance is found to be: C8H12MnN4S8Zn, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
maneb	heating value, net	8.228129333	8.23	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (012427-38-2), the chemical formula of the substance is found to be: C4H6MnN2S4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
mecoprop	heating value, net	23.1651008	23.17	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000093-65-2), the chemical formula of the substance is found to be: C10H11ClO3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
mepiquat chloride	heating value, net	29.97658062	29.98	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (024307-26-4), the chemical formula of the substance is found to be: C7H16ClN, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
metaldehyde	heating value, net	27.52530082	27.53	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000108-62-3), the chemical formula of the substance is found to be: C8H16O4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
metamitron	heating value, net	23.9895592	23.99	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (041394-05-2), the chemical formula of the substance is found to be: C10H10N4O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

metazachlor	heating value, net	25.32434729	25.32	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (067129-08-2), the chemical formula of the substance is found to be: C14H16ClN3O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
methallylchloride	heating value, net	25.44415003	25.44	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000563-47-3), the chemical formula of the substance is found to be: C4H7Cl, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
metolachlor	heating value, net	28.62929578	28.63	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (051218-45-2), the chemical formula of the substance is found to be: C15H22NO2Cl, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
m-nitrotoluene	heating value, net	24.76168301	24.76	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000099-08-1), the chemical formula of the substance is found to be: $C_7H_7NO_2$., (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
napropamide	heating value, net	32.17707052	32.18	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (015299-99-7), the chemical formula of the substance is found to be: C17H21NO2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
natural graphite, coated	heating value, net	30.28485	30.28	Calculated based on carbon content.
natural graphite, purified	heating value, net	30.28485	30.28	Calculated based on carbon content.
nitrile-compound	heating value, net	24.98185538	24.98	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (893737-15-0), the chemical formula of the substance is found to be: C14H11NO2S, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
o-nitrotoluene	heating value, net	24.76168301	24.76	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000088-72-2), the chemical formula of the substance is found to be: C7H7NO2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
orbencarb	heating value, net	24.46318319	24.46	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (034622-58-7), the chemical formula of the substance is found to be: C12H16ClNOS, (PubChem 2020). Reference: Kim, S., Chen, J.,

				Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
oxalic acid	heating value, net	10.77614389	10.78	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000144-62-7), the chemical formula of the substance is found to be: C2H2O4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
o-xylene	heating value, net	40.961	40.96	Lower heating value based on ChemEurope (available here: https://www.chemeurope.com/en/encyclopedia/Heat_of_combustion.html, last accessed 05-07-2023).
packing, lime product	heating value, net	0.0652	0.07	Calculated value. Considering the input of kraft paper (0.00425 kg) and packaging film, low density polyethylene (0.000123 kg).
paclobutrazol	heating value, net	26.83002395	26.83	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (076738-62-0), the chemical formula of the substance is found to be: C15H20ClN3O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
paper, newsprint	heating value, net	14.11	18.29	LHV of 'paper, sorted newsprint, pellet', dry material including ash, retrieved 20250214 from https://phyllis.nl/Browse/Standard/ECN-Phyllis. Reference: T. A. Moe: Wastepaper pellets as a source of fuel for auxiliary home heating, University of North Dakota, report, 21 p. (1995).
p-diisopropylbenzene	heating value, net	40.353	40.35	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (100-18-5), the chemical formula of the substance is found to be: C12H18, (PubChem 2020).
p-diisopropylbenzene, crude	heating value, net	40.35331317	40.35	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000100-18-5), the chemical formula of the substance is found to be: C12H18, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
pendimethalin	heating value, net	25.00243117	25	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (040487-42-1), the chemical formula of the substance is found to be: C13H19N3O4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
phenoxy-compound	heating value, net	29.96059982	29.96	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (002122-46-5), the chemical formula of the substance is found to be: C6H5O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
phthalimide-compound	heating value, net	23.90590994	23.91	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000085-41-6), the chemical formula of the substance is found to be: C8H5NO2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E.

				(2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
polychloroprene	heating value, net	23.28613918	23.29	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (009010-98-4), the chemical formula of the substance is found to be: C4H5Cl, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
polyurethane adhesive	heating value, net	30.67	27	Net heating value for polyurethane adhesive. Reference: Messmer, Annika & Chaudhary, Abhishek. (2015). Life cycle assessment of adhesives used in wood constructions. Masterthesis, ETH Zurich.
polyurethane, flexible foam, flame retardant	heating value, net	23.39360861	23.39	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (009009-54-5), the chemical formula of the substance is found to be: C3H8N2O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
printed paper	heating value, net	14.11	16.77	LHV of commercial office paper, dry material including ash, retrieved 20250214 from https://phyllis.nl/Browse/Standard/ECN-Phyllis. Reference: J.H.Canova and D.J.Bushnell: Testing and evaluating the combustion characteristics of densified RDF and mixed waste paper. In: Proc. Energy from biomass and wastes XVI (Ed. D.L.Klass), pp. 1191-1219, Institute of Gas Technology, Chicago (1993).
printed paper, offset	heating value, net	14.11	16.77	LHV of commercial office paper, dry material including ash, retrieved 20250214 from https://phyllis.nl/Browse/Standard/ECN-Phyllis. Reference: J.H.Canova and D.J.Bushnell: Testing and evaluating the combustion characteristics of densified RDF and mixed waste paper. In: Proc. Energy from biomass and wastes XVI (Ed. D.L.Klass), pp. 1191-1219, Institute of Gas Technology, Chicago (1993).
prochloraz	heating value, net	19.64047716	19.64	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (067747-09-5), the chemical formula of the substance is found to be: C15H16Cl3N3O2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
prohexadione calcium	heating value, net	19.38399481	19.38	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (127277-53-6), the chemical formula of the substance is found to be: C10H10O5Ca, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
prosulfocarb	heating value, net	34.83262491	34.83	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (052888-80-9), the chemical formula of the substance is found to be: C14H21NOS, (PubChem 2020).
protein concentrate, 8% in water, from whey	heating value, net	1.936	1.94	LHV for dry protein, estimated average value (24.2 MJ/kg), considering dry mass of 0.08kg. Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
PS/ABS, flakes, recycled	heating value, net	39.16655966	39.17	LHV for mix of polystyrene (PS)/acrylonitrile-butadiene-styrene (ABS), assumed to be 1:1 ratio. References: [1] PS: Courtemanche,B; Levendis,Y.A: A laboratory study on the NO, NO2, SO2, CO and CO2 emissions from the combustion of pulverized coal, municipal waste plastics and tires. Fuel 77

				(1998) 183-196. Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis. [2] ABS: LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (009003-56-9), the chemical formula of the substance is found to be: C15H17N, (PubChem 2020).
PS/ABS, pellets, recycled	heating value, net	39.16655966	39.17	LHV for mix of polystyrene (PS)/acrylonitrile-butadiene-styrene (ABS), assumed to be 1:1 ratio. References: [1] PS: Courtemanche,B; Levendis,Y.A: A laboratory study on the NO, NO2, SO2, CO and CO2 emissions from the combustion of pulverized coal, municipal waste plastics and tires. Fuel 77 (1998) 183-196. Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis. [2] ABS: LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (009003-56-9), the chemical formula of the substance is found to be: C15H17N, (PubChem 2020).
p-xylene	heating value, net	40.798	40.8	Lower heating value based on ChemEurope (available here: https://www.chemeurope.com/en/encyclopedia/Heat_of_combustion.html, last accessed 05-07-2023).
pyridazine-compound	heating value, net	24.22822671	24.23	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000289-80-5), the chemical formula of the substance is found to be: C 4H 4N 2, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
pyridine-compound	heating value, net	30.66355271	30.66	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000110-86-1), the chemical formula of the substance is found to be: C5H5N, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
quicklime, milled, packed	heating value, net	0.0652	0.07	Calculated value. Considering the properties for 1 kg of packed quicklime. This means, 1 kg of quicklime, and additionally the 0.004373 kg packaging to pack the 1 kg quicklime.
residue from shredder fraction from manual dismantling	heating value, net	0	27.77	Value taken from the general comment of the treatment dataset.
resorcinol	heating value, net	26.434	26.43	
sewage sludge, 70% water, WWT, condensate from light oil boiler	heating value, net	4.200170	1.260051	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, heat carrier liquid, 40% C3H8O2	heating value, net	18.669800	5.60094	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, rainwater	heating value, net	6.011110	1.803333	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

mineral oil storage				
sewage sludge, 70% water, WWT, WW from concrete production	heating value, net	3.814300	1.14429	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from CRT production	heating value, net	18.628100	5.58843	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from GGBFS production	heating value, net	16.303800	4.89114	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from glass production	heating value, net	3.838430	1.151529	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from grass refinery	heating value, net	18.669800	5.60094	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from hard fibreboard production	heating value, net	17.777000	5.3331	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from LCD backlight production	heating value, net	17.107600	5.13228	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from LCD production	heating value, net	9.144340	2.743302	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from liquid crystal production	heating value, net	18.660500	5.59815	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from maize starch production	heating value, net	9.851030	2.955309	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from medium density board production	heating value, net	16.630700	4.98921	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

sewage sludge, 70% water, WWT, WW from particle board production	heating value, net	18.669800	5.60094	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from PET pelletising	heating value, net	18.446700	5.53401	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from plywood production	heating value, net	18.615600	5.58468	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from polyester recycling	heating value, net	16.762500	5.02875	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from potato starch production	heating value, net	18.345300	5.50359	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from recycling of waste PET	heating value, net	6.858440	2.057532	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from recycling of waste PP	heating value, net	3.719080	1.115724	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from soft fibreboard production	heating value, net	18.6445	5.59335	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from textile production	heating value, net	2.675814	0.802744	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW from vegetable oil refinery	heating value, net	15.097	4.5291	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT, WW, average	heating value, net	8.589800	2.57694	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

sewage sludge, 70% water, WWT[R], WW from anaerobic digestion of whey	heating value, net	11.143800	3.34314	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, cake from recycling of waste plastic, WEEE	heating value, net	18.397300	5.51919	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, cake from sorting of waste plastic	heating value, net	18.600900	5.58027	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, municipal solid waste	heating value, net	1.296350	0.388905	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, refinery sludge	heating value, net	6.289050	1.886715	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste bitumen	heating value, net	8.806050	2.641815	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste graphical paper	heating value, net	4.817470	1.445241	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste newspaper	heating value, net	9.856050	2.956815	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste packaging paper	heating value, net	4.278930	1.283679	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste paint	heating value, net	18.143000	5.4429	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF,	heating value, net	9.303770	2.791131	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

waste paperboard				
sewage sludge, 70% water, WWT-SLF, waste plastic, mixture	heating value, net	6.071850	1.821555	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste polyethylene	heating value, net	16.054300	4.81629	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste polyethylene terephthalate	heating value, net	4.686940	1.406082	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste polypropylene	heating value, net	16.054300	4.81629	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste polystyrene	heating value, net	13.958500	4.18755	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste polyvinylchloride	heating value, net	14.121500	4.23645	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF, waste wood, untreated	heating value, net	13.839100	4.15173	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 70% water, WWT-SLF[W], waste plastic, consumer electronics	heating value, net	2.366740	0.710022	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, condensate from light oil boiler	heating value, net	2.66128	0.66532	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, heat	heating value, net	17.1826	4.29565	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

carrier liquid, 40% C3H8O2				
sewage sludge, 75% water, WWT, rainwater mineral oil storage	heating value, net	4.42402	1.106005	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from concrete production	heating value, net	2.21816	0.55454	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from CRT production	heating value, net	17.141	4.28525	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from GGBFS production	heating value, net	14.5516	3.6379	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from glass production	heating value, net	2.15302	0.538255	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from grass refinery	heating value, net	17.1826	4.29565	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from hard fibreboard production	heating value, net	16.255	4.06375	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from LCD backlight production	heating value, net	15.6219	3.905475	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from LCD production	heating value, net	7.24991	1.812478	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from liquid crystal production	heating value, net	17.1732	4.2933	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from maize starch production	heating value, net	8.09379	2.023448	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

sewage sludge, 75% water, WWT, WW from medium density board production	heating value, net	15.0237	3.755925	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from particle board production	heating value, net	17.1826	4.29565	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from PET pelletising	heating value, net	16.9259	4.231475	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from plywood production	heating value, net	17.1283	4.282075	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from potato starch production	heating value, net	16.8372	4.2093	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from recycling of waste PET	heating value, net	4.35524	1.08881	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from recycling of waste PP	heating value, net	1.94634	0.486585	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from soft fibreboard production	heating value, net	17.1559	4.288975	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from textile production	heating value, net	5.90223	5.90223	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW from vegetable oil refinery	heating value, net	13.5974	3.39935	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
sewage sludge, 75% water, WWT, WW, average	heating value, net	6.87903	1.719758	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.

sewage sludge, 75% water, WWT[R], WW from anaerobic digestion of whey	heating value, net	13.7395	3.434875	Value is calculated based on the composition of the sludge leaving the wastewater treatment facility.
single use paper cup, lid or container, for food packaging, from virgin fibre	heating value, net	15.08075	15.08	Measure of the thermal energy produced during the combustion of a product. Expressed in MJ per unit of product.
sodium dihydrogen phosphate	heating value, net	2.020018049	2.02	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (007558-80-7), the chemical formula of the substance is found to be: NaH2PO4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
sodium ethyl xanthate	heating value, net	11.775	11.78	net (lower) heating (calorific) value
sodium ferrocyanide	heating value, net	6.91309952	6.91	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (013601-19-9), the chemical formula of the substance is found to be: C6FeN6Na4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
synthesis gas, 1 to 1	heating value, net	20.138	20.14	
synthesis gas, 2 to 1	heating value, net	26.3925	26.39	
synthesis gas, 3 to 1	heating value, net	31.3801664	31.38	
tebuconazole	heating value, net	27.57701829	27.58	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (107534-96-3), the chemical formula of the substance is found to be: C16H22ClN3O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
triazine-compound	heating value, net	17.94973985	17.95	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000289-96-3), the chemical formula of the substance is found to be: C3H3N3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
triclopyr	heating value, net	11.8232984	11.82	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (055335-06-3), the chemical formula of the substance is found to be: C7H4Cl3NO3, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

trinexapac-ethyl	heating value, net	26.44016557	26.44	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (095266-40-3), the chemical formula of the substance is found to be: C13H16O5, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
tungsten carbide powder	heating value, net	1.858215174	1.86	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (012070-12-1), the chemical formula of the substance is found to be: WC, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
urea	heating value, net	14.13079088	14.13	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (000057-13-6), the chemical formula of the substance is found to be: CH4N2O, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
urea ammonium nitrate mix	heating value, net	7.900983581	7.9	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (015978-77-5), the chemical formula of the substance is found to be: CH6N4O4, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033
waste asphalt	heating value, net	0	2.09	Value taken from the general comment of the treatment dataset.
waste bitumen	heating value, net	40.2	40.2	The LHV of bitumen is considered as reported in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 2, Chapter 1). https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
waste bitumen sheet	heating value, net	40.2	40.2	The LHV of bitumen is considered as reported in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 2, Chapter 1). https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
waste building wood, chrome preserved	heating value, net	11.63	13.99	Value taken from the general comment of the treatment dataset.
waste emulsion paint	heating value, net	8.18	10.51	Value taken from the general comment of the treatment dataset.
waste expanded polystyrene	heating value, net	38.67	32.2	Value taken from the general comment of the treatment dataset.
waste mixed polyolefins, processed	heating value, net	37.211116	37.21112	calculated based on the heating value of the polyolefins assuming an average composition of 10% PET, 26.33% HDPE, 26.33% LDPE, 26.33% PP, 10% PS and 1% PVC
waste mixed polyolefins, unprocessed	heating value, net	37.211116	37.21112	calculated based on the heating value of the polyolefins assuming an average composition of 10% PET, 26.33% HDPE, 26.33% LDPE, 26.33% PP, 10% PS and 1% PVC

waste packaging paper	heating value, net	14.11	14.12	Value taken from the general comment of the treatment dataset.
waste paint	heating value, net	19.7	10.14	Value taken from the general comment of the treatment dataset.
waste paper, sorted	heating value, net	14.11	15.41	Average LHV value of 2 waste paper [13.35-17.47 MJ/kg], "as received" with 10% water. Retrieved 20250521 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste paper, unsorted	heating value, net	14.11	15.41	Average LHV value of 2 waste paper [13.35-17.47 MJ/kg], "as received" with 10% water. Retrieved 20250521 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste paper, unsorted	water in wet mass	0	0.1	water content on a wet matter basis
waste plastic plaster, for final disposal	heating value, net	16.36	1.21	Value taken from the general comment of the treatment dataset.
waste plastic, WEEE, dust	heating value, net	30.7321	30.67	Value taken from the general comment of the treatment dataset.
waste plastic, WEEE, unsorted	heating value, net	30.7321	30.7321	Assumed equal to "waste plastic, WEEE, dust".
waste polyethylene	heating value, net	42.47	39.01	Value taken from the general comment of the treatment dataset.
waste polyethylene terephthalate, bottle, for recycling, unsorted	heating value, net	19.57395833	19.57396	LHV for dry waste polyethylene terephthalate (PET), considering dry mass of 0.896kg and LHV of 21.85 MJ/kg. Reference: Martin-Gullon,I.; Esperanza, M.; Font,R.: Kinetic model for the pyrolysis of poly-(ethylene terephtalate) (PET). J. Anal. Appl. Pyrolysis 58-59 (2001) 635-650. Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyethylene terephthalate, dust	heating value, net	36.1599	35.18	Value taken from the general comment of the treatment dataset.
waste polyethylene, high density, for recycling, sorted	heating value, net	38.91891892	38.91892	LHV for dry waste high density polyethylene (HDPE), considering dry mass of 0.973kg and LHV of 40 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyethylene, high density, for recycling, unsorted	heating value, net	38.91891892	38.91892	LHV for dry waste high density polyethylene (HDPE), considering dry mass of 0.973kg and LHV of 40 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyethylene, high density, packaging, for recycling, unsorted	heating value, net	38.91891892	38.91892	LHV for dry waste high density polyethylene (HDPE), considering dry mass of 0.973kg and LHV of 40 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyethylene,	heating value, net	36.9945098	36.99451	LHV for dry waste low density polyethylene (LDPE), considering dry mass of 0.863kg and LHV of 42.88 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser:

low density, for recycling, unsorted				Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyethylene, low density, packaging, for recycling, unsorted	heating value, net	36.9945098	36.99451	LHV for dry waste low density polyethylene (LDPE), considering dry mass of 0.863kg and LHV of 42.88 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyethylene/polypropylene, for recycling, unsorted	heating value, net	37.69227273	37.69227	LHV for mix of dry waste polyethylene(PE)/polypropylene(PP), assumed to be 1:1 ratio, considering a dry mass of 0.928kg. References: [1] PE: Courtemanche, B.; Levendis, Y.A.: A laboratory study on the NO, NO2, SO2, CO and CO2 emissions from the combustion of pulverized coal, municipal waste plastics and tires. Fuel 77 (1998) 183-196. [2] PP: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polypropylene	heating value, net	32.78	32.6	Value taken from the general comment of the treatment dataset.
waste polypropylene, for recycling, unsorted	heating value, net	37.42588235	37.42588	LHV for dry waste polypropylene (PP), considering dry mass of 0.863 kg and LHV of PP equal to 43.38 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polypropylene, packaging, for recycling, unsorted	heating value, net	43.32045882	43.32046	LHV for dry waste polypropylene (PP), considering dry mass of 0.998 kg and LHV of PP equal to 43.38 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polystyrene, for recycling, unsorted	heating value, net	42.73844595	42.73845	LHV for dry waste polystyrene (PS), considering dry mass of 0.997kg and LHV of PS equal to 42.75 MJ/kg. Reference: Courtemanche, B.; Levendis, Y.A.: A laboratory study on the NO, NO2, SO2, CO and CO2 emissions from the combustion of pulverized coal, municipal waste plastics and tires. Fuel 77 (1998) 183-196. Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste polyvinylchloride, for recycling, unsorted	heating value, net	19.95002	19.95002	LHV for dry waste polyvinylchrolide (PVC), considering dry mass of 0.998 and LHV equal to 19.99 MJ/kg. Reference: R. Zevenhoven, M. Karlsson, M. Hupa and M. Frankenhaeuser: Combustion and gasification properties of plastics particles. Journal of the Air & Waste Management Association (June 1996) pp. 1-11 (1996). Retrieved 20241028 from https://phyllis.nl/Browse/Standard/ECN-Phyllis.
waste sealing sheet, polyethylene	heating value, net	42.47	33.12	Value taken from the general comment of the treatment dataset.
waste sealing sheet, polyvinylchloride	heating value, net	21.5	22.53	Value taken from the general comment of the treatment dataset.
waste sink from recycling of HDPE	heating value, net	43.7304	24.49	Value taken from the general comment of the treatment dataset.
waste yarn and waste textile	heating value, net	13.14	15.72	Value taken from the general comment of the treatment dataset.

woven bamboo mat panel	heating value, net	12798.552	12798.55	Jetsada P. & Panmanas S. (2017), Evaluation of lower heating value and elemental composition of bamboo using near infrared spectroscopy,Energy,Volume 121,Pages 147-158,ISSN 0360-5442,https://doi.org/10.1016/j.energy.2017.01.020.
xylene, mixed	heating value, net	40.90667	40.91	Lower heating value based on ChemEurope as an arithmetic average of the values for o-, m- and p-xylene (available here: https://www.chemeurope.com/en/encyclopedia/Heat_of_combustion.html, last accessed 05-07-2023).
zineb	heating value, net	7.916523708	7.92	LHV is calculated based on the elemental composition of the substance. Based on the CAS number of the substance (012122-67-7), the chemical formula of the substance is found to be: C4H6N2S4Zn, (PubChem 2020). Reference: Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A., Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved access to chemical data. Nucleic acids research, 47(D1), D1102–D1109. https://doi.org/10.1093/nar/gky1033

3 LCIA Methods

There were no major updates to LCIA methods for v3.12. However, several minor fixes were implemented for the IPCC and EF methods, and a unit error in the USEtox method was corrected. Additionally, characterization factors (CFs) for new elementary flows were added.

3.1 IPCC 2021

3.1.1 Differences to Version 3.11

Previous implementations were based on the preliminary report and material available on GitHub[1]. The changes are negligible except for sulfur hexafluoride as shown in **Table 6** ((e)-hex-2-en-1-ol is not used in ecoinvent currently).

Table 6. CFs updated from v3.11 to v3.12

	v3.11					v3.12				
Elementary flow (IPCC name)	**GWP 20**	**GWP 100**	**GWP 500**	**GTP 50**	**GTP 100**	**GWP 20**	**GWP 100**	**GWP 500**	**GTP 50**	**GTP 100**
Difluoromethane (HFC-32)	2690					2693				
1,1,1,2-Tetrafluoroethane (HFC-134a)	4140	1530				4144	1526			
Trichlorofluoro-methane (CFC-11)	8320	6230	2090	6350	3540	8321	6226	2093	6351	3536
Tetrafluoro-methane (PFC-14)	5300		10600		9050	5301		10587		9055
(e)-hex-2-en-1-ol		0.003					0.002			
Dichlorodifluoro-methane (CFC-12)			5710					5700		
Sulfur hexafluoride	18300	25200	34100	26200	30600	18200	24300	29000	25400	28800

Furthermore (Sand, M., Skeie, R.B., Sandstad, M. et al, 2023) suggest a CF for hydrogen (11.6 kg CO2-Eq/kg hydrogen). This CF was added to the impact categories/indicators "climate change… incl. SLCFs…|global warming potential (GWP100)" for performing sensitivity analysis.

For the implementation including biogenic CO2, the characterization factors for non-fossil methane and carbon monoxide were corrected (**Table 7**, see also section **3.2.4**)

Table 7 Characterization of carbon dioxide, carbon monoxide and methane in the IPCC implementations excluding and including biogenic CO2.

name	**compartment**	**excl. biogenic CO2**	**incl. biogenic CO2**	**excl. biogenic CO2,**	**incl. biogenic CO2,**

[1] https://github.com/chrisroadmap/ar6/blob/main/data_output/7sm/metrics_supplement_cleaned.csv

				incl. SLCFs	Incl. SLCFs
v3.11					
Carbon monoxide, non-fossil	air			2.491	2.491
Methane, non-fossil	air	27	27	27	27
v3.12					
Carbon monoxide, non-fossil	air			2.491	4.0624
Methane, non-fossil	air	27	29.8	27	29.8

3.2 EF / EN15804

3.2.1 IPCC Updates

Minor updates to climate change CFs were done as described in section **3.1.1** and shown **Table 8** for EF v3.1. The changes are negligible except for Sulfur Hexafluoride. The CF for Sulfuryl fluoride was added following IPCC 2021.

Table 8. CFs updated from v3.11 to v3.12.

Elementary Flow	IPCC Name	v3.11 GWP 100	v3.12 GWP 100
1,1,1,2-Tetrafluoroethane	HFC-134a	1530	1526
Trichlorofluoromethane	CFC-11	6230	6226
Sulfur hexafluoride		25200	24300
Sulfuryl fluoride			4630

3.2.2 Updated Mapping

The CFs for Hexafluoroethane (HFC-116 in EF terminology) were added. This mapping from ecoinvent to EN15804 (EF v3.1) was missing previously. Furthermore, there was an issue with the mapping of Perfluoropentane and Tetrafluoromethane related to changes between EF v3.0 and v3.1. This was fixed and now flows to all sub-compartments are characterized properly.

3.2.3 Additional CFs for Minerals

In addition to CFs provided by the method developers, CFs for the minerals and aggregates listed in Table 9 were calculated by weighting CFs for containing elements with mass shares. This was updated and extended to v3.12 (**Table 9**).

Table 9. **CFs for minerals and aggregates calculated by weighting CFs for contained elements with mass shares.**

Mineral	Formula	CF	CF v3.11	Change
Anhydrite	CaSO4	4.55E-05	4.55E-05	updated
Borax	B4H20Na2O17	4.84E-04	4.84E-04	updated
Calcite	CaCO3	0.00E+00		added
Carnallite	Cl3H12KMgO6	1.04E-05		added
Cinnabar	HgS	7.95E-02		added
Colemanite	Ca2B6H10O16	6.74E-04	6.74E-04	updated
Dolomite	C2CaMgO6	2.66E-10	2.66E-10	updated
Gypsum	CaH4O6S	3.59E-05	3.59E-05	updated
Kaolinite	Al2H4O9Si2	2.31E-10	2.31E-10	updated
Kieserite	H2MgO5S	4.47E-05	4.47E-05	updated
Pyrite	FeS2	1.03E-04	1.03E-04	updated
Pyrolusite	MnO2	1.61E-06		added
Silicon dioxide	SiO2	6.54E-12		added
Sodium chloride	NaCl	1.65E-05	1.65E-05	updated
Sodium nitrate	NaNO3	1.49E-08	1.49E-08	updated
Sodium sulfate	Na2SO4	4.36E-05	4.36E-05	updated
Spodumene	AlLiO6Si2	4.33E-07	4.29E-07	updated
Stibnite	Sb2S3	7.17E-01		added
Ulexite	B5CaH16NaO17	5.70E-04	5.70E-04	updated
Zirconia, as baddeleyite	ZrO2	4.03E-06		added
Aggregates				
Basalt		2.34E-09		added
Clay, bentonite		1.72E-09		added
Diatomite		6.58E-12	6.54E-12	updated
Feldspar		3.65E-09		added
Granite		1.65E-09		added
Laterite		9.47E-09		added
Olivine		8.17E-09		added
Perlite		2.66E-09		added
Pumice		3.28E-09		added
Steatite		3.88E-10		added
Vermiculite		5.67E-09		added

3.2.4 Biogenic Emissions

The known issue with wrong CFs in EF v3.x EN15804 methods was corrected (**Table 10**).

Table 10. **Characterization of carbon monoxide and methane in EF v3.x and EF v3.x EN15804.**

Name	Compartment	EF v3.1	EF v3.1 EN15804	EF v3.0	EF v3.0 EN15804
v3.11					
Carbon monoxide, non-fossil	air			0	0
Methane, non-fossil	air	27	27	34	34
v3.12					

Carbon monoxide, non-fossil	air			0	1.57
Methane, non-fossil	air	27	29.8	34	36.8

3.2.5 Corrected Unit

The unit for the impact category “eutrophication: terrestrial” in the method “EN15804+A2 - Core impact categories and indicators” was corrected from “mol H+-Eq” to “mol N-Eq”.

3.3 USEtox

The unit for the impact category “ecotoxicity: freshwater” in the “USEtox v2.13, endpoint” methods was correct from “PDF.m3.yr” to “PDF.m3.day”.

4 Fuels

4.1 Crude Petroleum Oil and Natural Gas

4.1.1 Extraction of Crude Petroleum Oil and Natural Gas

Version 3.12 brings an update for data on extraction (i.e., production) of crude petroleum oil and natural gas with a geographical coverage of 40 countries for onshore production and 36 countries for offshore production, as shown in **Table 11**. The underlying data sources and inventory modelling are described in (Meili, Jungbluth, & Bussa, 2025). Following the approach introduced with the update for version 3.9.1, the country-specific production activities were created using a common model, relying extensively on global data sources to ensure a high degree of consistency between the geographies covered. As a result, the extraction of crude petroleum oil and natural gas is modelled as average combined production of oil and gas, only distinguishing between offshore and onshore operations, for each country.

Table 11.Updated datasets for petroleum and natural gas production. In the column v3.12, “U” stands for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
petroleum and gas production, offshore	AE; AZ; BR; CA; CN; CO; DE; EC; GB; ID; IR; KW; KZ; LY; MX; MY; NG; NL; NO; QA; RO; RU; SA; US; VE; AR; AU; EG; IN; IT; PE; PL; TH; TM; TR; TT	2021-2023	natural gas, high pressure; petroleum	m^3; kg	U
petroleum and gas production, onshore	AE; AZ; BR; CA; CN; CO; DE; DZ; EC; GB; ID; IQ; IR; KW; KZ; LY; MX; MY; NG; NL; QA; RO; RU; SA; US; VE; AR; AU; BO; EG; IN; IT; OM; PE; PL; TH; TM; TR; TT; UZ	2021-2023	natural gas, high pressure; petroleum	m^3; kg	U

The main aspects considered for regionalisation of the extraction activities include emissions of methane (from gas venting and fugitive emission sources) and gas flaring, energy requirements, production data, and infrastructure inputs (borewell and pipeline distances). For this update, (Meili, Jungbluth, & Bussa, 2025) relied on the most recent versions of the main data sources available at the time of preparation, including (Energy Institute, 2024), (IEA, 2024) and (IOGP, 2024).

For the update for v3.12, (Meili, Jungbluth, & Bussa, 2025) used regional factors published by (IOGP, 2024) for freshwater use intensity as well as for reinjected produced water and the share of reinjected water on overall amount of produced water to calculate water discharge per unit of oil equivalent produced. Three-year averages for 2021-2023 were applied in both cases. It should be noted, however, that the regional coverage (as share of reported production) in the IOGP statistics varies substantially between regions (IOGP, 2024, p. 7).

The lowest coverages are observed for Russia & Central Asia (10% of regional production), Middle East (6%), and North America (14%). Alternative data sources and/or modelling approaches should be considered for future updates to ensure representativeness for the full scope of production in these regions. As discussed in section 10.1.6 in (Meili, Jungbluth, & Bussa, 2025, p. 62), the calculated amount of water produced exceed the freshwater input accounted for in most regions. Nevertheless, the authors assume a neutral water balance in terms of contribution to freshwater availability. This due to concerns about the completeness and representativeness of the available information available on water use in combination with the high uncertainty in terms of the quality of discharged water.

4.1.2 Petroleum Markets

Version 3.11 of the ecoinvent database, released in 2024, included an extensive update of the supply mixes for crude petroleum oil and natural gas to reflect recent changes in trade for these commodities. The markets for petroleum in the geographies of China and Japan were, however, neglected and are now published with v3.12.

Additionally, as already available for natural gas at high pressure, the corresponding market group for petroleum for the GLO region, which groups all existing geographies together, has been introduced for the sake of user convenience. The updated datasets are presented in **Table 12**.

Table 12. New activities related to petroleum markets. “N” stands for “New Activity”.

Activity Name	Geography	Time Period	v3.12
market for petroleum	CN	2023-2024	N
market for petroleum	JP	2023-2024	N
market group for petroleum	GLO	2015-2015	N

4.1.3 Emissions to Air - Vented and Fugitive Natural Gas Emissions

Chapter 9 in the (Meili, Jungbluth, & Bussa, 2025) report describes the emissions to air in comprehensive detail. This section in change report specifically clarifies assumptions related to vented natural gas emissions. The vented and fugitive natural gas emissions are considered which together represent intentional and unintentional methane releases during oil and gas production. Country-specific data from IEA Global Methane Tracker 2024 are combined with satellite observations of large “super-emitter” leaks. To avoid distortions, emissions are allocated by relative crude oil and gas production volumes, rather than based on how emissions are attributed for the onshore and offshore emissions data. For instance, Turkmenistan recorded the highest satellite-detected leaks at 2,546 Mt in 2023. Allocating these leaks according to total oil and gas emissions (a 40%/60% split) would distort the burden compared to allocation by production volumes (a 14%/86% split), highlighting the importance of the aforementioned methodology.

4.2 Natural Gas Liquids

4.2.1 Update of Product Information for Natural Gas Liquids

The product information for natural gas liquids (NGL) has been updated and the lower heating value corrected to 47.06 MJ/kg, based on the average composition of NGLs in USA for reference year 2023 (US EIA , 2023). Additionally, more context has been provided.

4.2.2 Natural Gas Liquids Production

4.2.2.1 New Geographies

New geographies (see **Table 13**) were created to reflect regional specificities in production. The NGL production datasets were regionalised by i) updating the PVs to the corresponding geography, ii) Linking the input of natural gas, high pressure to the regionalised offshore/onshore production source, and iii) including helium production only in 5 geographies making up 96% of global helium production. These new geographies allow for more accurate regionalized modelling and differentiation of upstream processes. All related production volumes for NGL and Helium were systematically updated. Mathematical relations in the dataset documentation and background calculations were adapted to ensure consistency.

Table 13. New activities related to natural gas liquids production and fractionation. “N” stands for “New Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
Natural gas liquids production	AE; AR; AU; BR; CA; DZ; IN; IQ; IR; KW; MX; NG; NO; QA; RU; SA; TH; US	2000-2024	Natural gas liquids	kg	N
Natural gas liquids, production	CA; DZ; QA; RU; US	2000-2024	Helium	kg	N
Natural gas liquids fractionation	AE; AR; AU; BR; CA; DZ; IN; IQ; IR; KW; MX; NG; NO; QA; RU; SA; TH; US	2000-2024	Ethane, Propane, Butan, Isobutane, Pentane	kg	N

4.2.2.2 Helium Production

Helium production datasets are now included only for the countries explicitly listed in **Table 13**. This reflects the fact that significantly relevant helium production is concentrated in a limited number of regions.

4.2.3 Natural Gas Liquids Fractionation

New datasets for NGL fractionation were created, corresponding to the new geographies established for NGL production (see **Table 13**). This ensures consistency between NGL production and downstream fractionation into individual components (ethane, propane, butanes and pentane). The PVs were updated and exchanges ‘Natural gas burned in gas turbine’ were updated to correctly link to the corresponding geographies. The assumed composition for NGLs across all geographies is Ethane – 38%, Propane – 33%, Butane and Isobutane – 18% and Pentane – 11%, and is taken from (US EIA , 2023)

4.3 Technical Corrections

4.3.1 Natural Gas Consumption in Croatia

Since v3.9, activities in Croatia consumed 'natural gas, high pressure' from the 'market group for natural gas, high pressure' in Europe without Switzerland. However, since the 'market for natural gas, high pressure' for Rest of Europe (RoE) is available, this would be the better fit, which has been corrected with this release.

4.3.2 Petroleum Consumption for Containerboard Production, Unspecified

The dataset 'containerboard production, unspecified' in the US falsely consumed petroleum (i.e., crude oil) instead of petrol, unleaded, which has been corrected (see **Table 14**).

Table 14. Updated activities. “U” stands for “Updated Activity”.

Activity Name	Geography	Time Period	v3.12
containerboard production, unspecified	US	2014-2022	U

4.3.3 Missing Market Datasets

Some markets activities in the heat and fuels sector were missing for some activities in previous releases in the linked system models. They were only available in the Undefined database. They have now been introduced and linked to their corresponding suppliers (see **Table 15**).

Table 15. New market activities in the linked system models.

Activity Name	Geography	Time Period
market for heat, solar+electric, multiple-dwelling, for hot water	GLO	2011-2011
market for heat, solar+gas, one-family house, for combined system	GLO	2011-2011
market for heat, solar+gas, one-family house, for hot water	GLO	2011-2011
market for heat, solar+gas, multiple-dwelling, for hot water	GLO	2011-2011
market for heat, solar+wood, one-family house, for combined system	GLO	2011-2011
market for heat, diffusion absorption heat pump	GLO	2011-2011

market for heat, diffusion absorption heat pump	GLO	2011-2011
market for petrol, 85% ethanol by volume from biomass	GLO	2011-2011

5 Chemicals and Plastics

The chemicals and plastics sector data has been extensively updated and expanded to improve the representation of numerous key substances and their derivatives in the ecoinvent database. These updates enhance the overall data quality, representation, and robustness across various levels of the sector value chain, as discussed in this chapter. These efforts will continue for future releases.

Version 3.12 of the ecoinvent database includes, but is not limited to, expanding the regional coverage for: (1) ethylene and propylene and their homopolymers (low density polyethylene, linear low and high density polyethylene, and polypropylene); (2) vinyl chloride monomer, and its polymers (emulsion- and solution-polymerised polyvinyl chloride); (3) acrylic acid; (4) ethylene oxide; (5) methanol, (6) industrial gases (nitrogen and oxygen); among others. The cumulative effect of these updates primarily affects regions that were previously included under the Global or Rest-of-World geographical coverage. Users requiring a more regional representation, previously constrained by coverage, are encouraged to update their system to the latest database version and use the most appropriate region.

Furthermore, this release includes a dedicated data expansion, covering a total of **forty** new chemical substances or plastic materials not previously included in earlier database versions, i.e., a 6% growth in Chemical Abstract Service (CAS) coverage compared to version 3.11 from 2024. The new data for a wide range of products covers **thirty-two** organic compounds, **five** inorganic substances, **two** plastic materials, and **one** rubber category (i.e., emulsion- and solution-polymerized styrene-butadiene rubber). This portfolio expansion is complemented by the introduction of **six** new generic datasets representative of important organic product groups—basic precursors and materials, alcohols, aromatics, carboxylic acids, esters, and unspecified organics—replacing the legacy flow ‘chemical, organic’. Users are encouraged to investigate whether adopting these newly added chemical and plastic materials along with the more specific product group entries could improve the accuracy of their assessments.

Version 3.12 also replaces several aggregated LCI datasets included in earlier versions, such as data for hydrogen cyanide, polystyrenes (general purpose, high impact, and expandable polystyrene), and polybutadiene, with disaggregated unit processes, to ensure appropriate background linking to the ecoinvent database. This results in significant score increases for a few LCIA metrics compared to version 3.11, using the Environmental Footprint 3.1 (EF3.1) methods, particularly for toxicity, metals and minerals depletion, and land use. Other indicators are affected or decrease to a lesser extent.

Finally, version 3.12 also incorporates **two** collaborations for industry-average datasets. The first concerns new data on bromine supply in Israel provided by the ICL Group, a leading producer of bromine and bromine-based products. The effort to improve the representation of bromine was complemented by internal analysis and database expansion to include major producing countries beyond Israel, such as the United States, China, and Japan. The second collaboration features new data for key polymer processing services, such as several configurations of blown film extrusion and plastic bag making, through a dedicated collaboration with French manufacturers and the Centre Technique Industriel de la Plasturgie et des Composites (IPC).

5.1 Regional Average Steam Cracking Operation Data

The steam cracking process supplies essential building blocks used in the chemical and plastic industries, namely light olefins and aromatics. In this process, hydrocarbon feedstocks and steam are heated to break down into valuable olefins, aromatics, and hydrogen. Hydrogen can be used on-site for process heat or sold as a co-product, while aromatics produced as pyrolysis gasoline—a mixture of benzene, toluene, and xylenes (BTXs)—are further processed to recover marketable BTXs.

Version 3.12 enhances the steam cracking data coverage by replacing the Rest-of-World geography available in version 3.11 with region-specific unit process data, reflecting country-average operations across **twenty-five** geographies. These countries are the primary locations where steam cracking facilities operate, each characterized by distinct regional hydrocarbon feedstock mixtures and products distribution. Therefore, this update affects the value chains of activities that previously relied on Rest-of-World coverage for steam cracking products, including plastics and derivatives of ethylene and propylene.

Details on the past and current configurations of steam cracking data in the ecoinvent database are provided in the following subsections, while **Table 65** of the Appendix lists datasets replaced from version 3.11 and those newly added at the regional level in version 3.12.

5.1.1 Backstory: Database Content

5.1.1.1 Up to and including Version 3.9.1

In ecoinvent version 3.9.1 and earlier, steam cracking data for the production of light olefins (e.g., ethylene, propylene, butadiene) and monocyclic aromatics (e.g., BTXs) were based on aggregated European industry ecoProfiles data from PlasticsEurope and CEFIC/APPE, covering **fifty** steam cracker units across the EU27 and Norway for 2009 (IFEU/PlasticsEurope, 2012). Data collection took place between 2007 and 2010. In the ecoinvent database, this data was represented for both Europe and the Rest-of-World regions. These aggregated life cycle inventories (LCIs) for steam cracking products were pre-allocated using a mass-based allocation key. Overall, this aggregated LCIs offered limited flexibility, transparency of the underlying model, and regional specificity.

5.1.1.2 Version 3.10 and 3.11

For version 3.10, newly added unit process data enhanced transparency in steam cracking operations and enabled greater flexibility for allocation methods and beyond. This update performed in collaboration with PlasticsEurope, and supported by ifeu gGmbH, aiming on improving the database content that represents these essential light olefins and aromatics building blocks.

Namely, version 3.10 replaced the outdated and aggregated LCI data using disaggregated average data from **seven** steam crackers, covering 39% of European capacity and referencing 2019 production in EU countries, Great Britain, Norway, and Switzerland (IFEU/PlasticsEurope, 2021). The collected primary data was supplemented with literature data and data from the ifeu internal database. A single multi-output unit process was introduced in the ecoinvent database to represent steam cracking, along with a modular extractive distillation dataset for butadiene purification. As before, however, the data represented Europe and the Rest-of-World with limited regional specificity and representation outside Europe. For more details, please refer to the documentation of changes implemented in the ecoinvent database version 3.10 (FitzGerald, et al., 2023).

While allocation remained mass-based, the recommendation of PlasticsEurope (PlasticsEurope, 2018) on steam cracking process allocation was applied. This allocation approach is based on classifying intended and non-indented products. Namely, as per this recommendation, feedstocks are partitioned to all allocatable outputs by mass, whereas emissions and utilities are only assigned to intended products (ethylene, propylene, C4 hydrocarbon mixture, pyrolysis gas –containing BTX–, and hydrogen) by mass.

In version 3.11, this data remains unchanged, except for a minor update to the infrastructure input, which has minimal impact on the system's representation. For more details, please refer to the documentation of changes implemented in the ecoinvent database version 3.11 (FitzGerald, et al., 2024).

5.1.2 Steam Cracking Data in Version 3.12

Version 3.12 further improves the global representation of steam cracking operations, supporting an ongoing initiative of expanding the regional coverage for chemicals and plastics in the ecoinvent database through a good foundation for essential chemical building blocks.

The aim mentioned above is achieved by incorporating unit process data for operations outside Europe to replace the Rest-of-World aggregate, which, in version 3.12, is disaggregated into **twenty-five** countries. At the European level, the industry-average data provided by PlasticsEurope, with support from ifeu gGmbH, used in version 3.10 – 3.11 remain in use for version 3.12. The included average regional unit process data are derived from several steam cracking models developed by the ecoinvent team, as briefly discussed below and illustrated in **Figure 1** and discussed next.

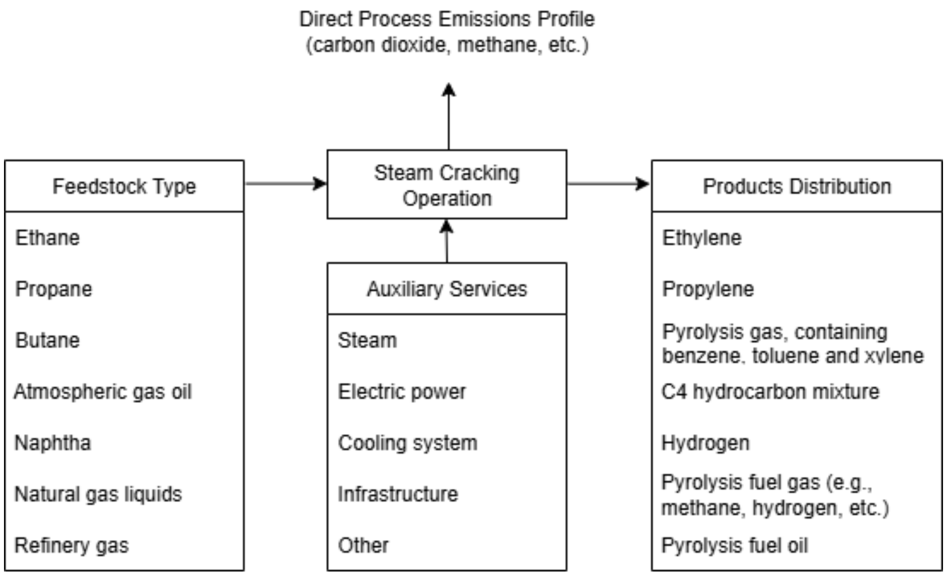

Figure 1. Simplified schematic of the steam cracking models. The in-house model generates LCIs based on the selected feedstock for steam cracking. Each configuration accounts for the required auxiliary services and provides detailed information on product distribution and emissions profiles according to the underlying unit process steps.

5.1.2.1 A brief technical overview

A hydrocarbon feedstock is mixed with steam, preheated, and cracked in furnace tubes at 750 – 875 °C to produce smaller unsaturated molecules, with product distribution controlled by residence time, temperature, and pressure. Subsequently, rapid quenching via transfer line exchangers prevents secondary reactions taking place while recovering heat to generate high-pressure steam for internal use. Liquid feedstock cracking requires primary fractionation to remove pyrolysis oils, whereas gaseous feedstock bypasses this step and proceeds directly to quenching. The cracked gas is then compressed in multiple stages, with cooling and knock-out drums preventing diolefin polymerization. Before fractionation, the gas undergoes acid gas removal, drying, and chilling—to avoid hydrate formation—using caustic washing, solvent scrubbing, and refrigeration systems. The fractionation section that follows processes cracked gas using cryogenic separation, with tower configurations depending on feedstock and design. A typical sequence includes a demethanizer (often with hydrogen recovery), followed by a deethanizer, depropanizer, and debutanizer (Zimmermann & Walzl, 2009)

Ethylene is purified from the C2 hydrocarbon mixture stream by selective hydrogenation or extractive distillation of acetylene and subsequent splitting and recycling of ethane. The C3 hydrocarbon mixture stream is selectively hydrogenated to convert minor components before splitting to recover propylene and recycle propane. Since butadiene cannot be separated from C4 mixtures by simple distillation due to azeotrope formation with 1,3-butadiene and butane, selective techniques such as liquid–liquid extraction or extractive distillation are used (Grub & Löser, 2011). In the BASF-NMP process, butadiene is isolated through **four** subprocesses: butenes/butanes predistillation removal, extractive distillation with N-methylpyrrolidone, degassing (removes acetylenes, diolefins, and other impurities), and final distillation to obtained high-purity 1,3-butadiene.

Finally, hydrogen recovery strategies vary by plant type, with naphtha-cracking units prioritizing high-purity recovery for internal use, whereas gas-cracking plants typically recover hydrogen with methane defined as fuel gas.

5.1.2.2 A brief overview of the ecoinvent models

The developed models are based on literature and industry data for the regional hydrocarbon feedstock mix of choice. They account for commercial yield patterns in, and product distribution of, the cracking furnace, acid gas removal, recycle streams for recovered materials, flexible on-site by-product fuel combustion, material and energy consumption, auxiliary and utility services, and process emissions for different feedstocks and feasible co-feeds. Feedstocks can be gaseous (e.g., ethane, propane, butane, natural gas liquids) or liquid (naphtha and atmospheric gas oil). Country-level feedstock average shares are based on annual survey data from 1997 to 2015, with the 2015 mix used in version 3.12 (Koottungal, 2015). Finally, existing version 3.10 – 3.11 extractive distillation data for regional C4 hydrocarbon mixtures was updated and regionalized according to the steam cracking activity to accurately reflect regional butadiene and mixed butene supply based on the output from steam cracking.

5.1.2.3 Cross-validation of LCIs and LCIA results

The LCIs obtained from the in-house models for each feedstock type were validated against the NEAT model, IPCC 2006 and Climate TRACE data and results (Climate TRACE, 2025; IPCC, 2006; Neelis M. , Patel, Gielen, & Blok, 2005; Neelis, Patel, & De Feber, 2003). A brief comparison with the former two benchmarks is illustrated in **Figure 2**, showing good alignment, within the uncertainty ranges, in products distribution and fuel-related carbon dioxide emission factors.

Furthermore, the life cycle impact assessment (LCIA) results were benchmarked with the PlasticsEurope data for the aggregated EU and EFTA region already covered in the ecoinvent database (IFEU/PlasticsEurope, 2021). Comparisons with PlasticsEurope LCIA results for the average steam cracking operation in the EU and EFTA region show maximum relative differences below 3% for all EF3.1 indicators, highlighting good alignment, as illustrated in **Figure 3**.

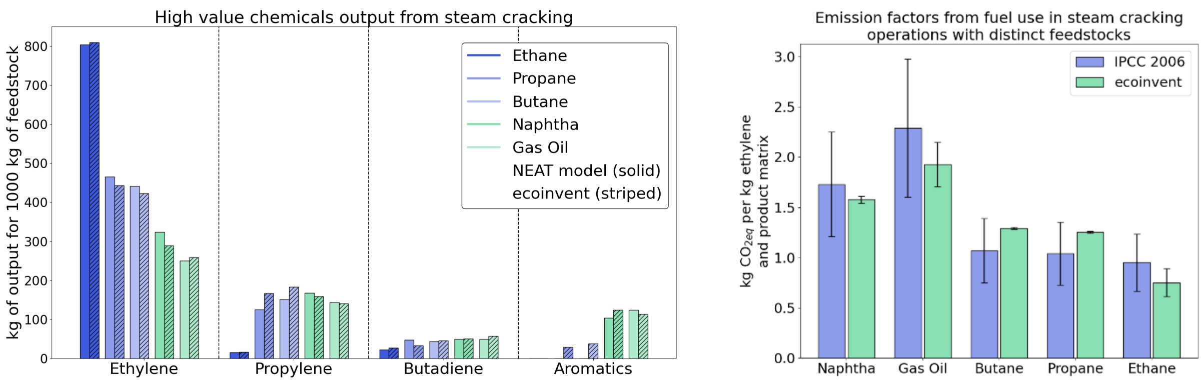

Figure 2. Cross-validation of foreground results obtained from the steam cracking operation models. Product distribution (left) and fuel-related carbon dioxide emission factors (right) in steam cracking operations using different feedstocks comparison of ecoinvent's in-house models with data from the NEAT model and the IPCC (2006) report.

Finally, LCIA results were also compared with pre-allocated global warming potential (GWP) scores reported by the American Chemistry Council (ACC) Plastics Division, the GREET database for the United States, and ifeu ecoProfile for the Gulf Cooperation Council countries (ACC/Franklin Associates, 2020; Wang, Elgowainy, & Han, 2022; IFEU/GPCA, 2017). Deviations were observed in these comparisons. Deviations stem from differences in modelling choices, such as rigid versus flexible data models, allocation methods, and background data. All deviations were assessed, justified, and the models' output data is deemed reliable. The primary source of deviation is the background data, which leads to a non-equivalent comparison, as steam cracking results are strongly influenced by upstream oil and gas extraction and refinery operations. Notably, oil and gas extraction and refinery operation activities are modelled differently across these benchmarks and may also reflect different reference years compared to what is represented.

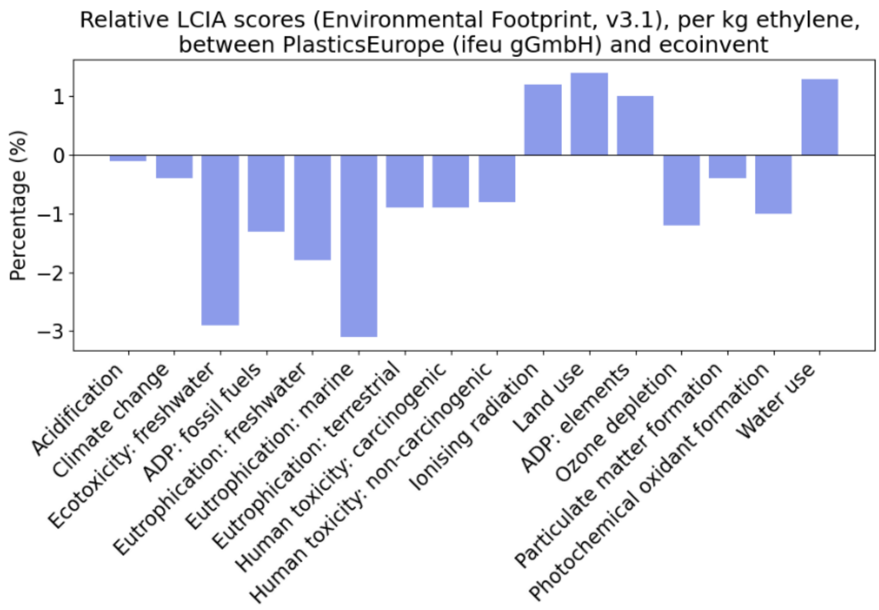

Figure 3. Cross-validation of LCIA results obtained from the steam cracking operation models. Relative scores comparison (EF 3.1) between the modelled European-average (EU & EFTA) operation of steam crackers and the average European (EU & EFTA) representation based on industry data from the ecoinvent database supplied by PlasticsEurope.

5.1.3 Distribution of GWP Scores for Ethylene: Version 3.12 Compared to 3.11

Figure 4 illustrates the distribution of GWP scores for ethylene production, via the average steam cracking process, across producing countries in version 3.12, compared with version 3.11. Coverage expands from **two** aggregated regions, Europe and Rest-of-World, to Europe plus **twenty-five** individual countries formerly included in Rest-of-World. Ethylene production via the average regional steam cracking in version 3.12 shows a broader GWP range, with production in specific countries exhibiting significantly higher or lower values compared to the aggregated Rest-of-World representation in version 3.11. Users who require a more regional representation in their assessments—but were previously unable to do so due to limited regional coverage—are encouraged to update the representation of their system.

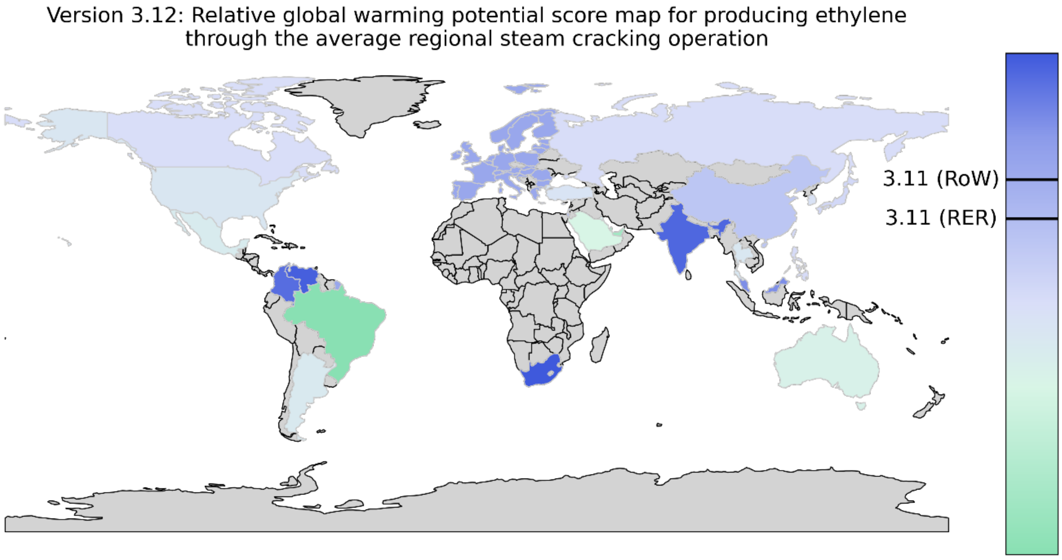

Figure 4. Comparison of GWP for ethylene production via steam cracking in versions 3.12 and 3.11. Relative GWP100 score world map (system model: allocation, cut-off) for the product ethylene supplied by the "unsaturated hydrocarbons production, steam cracking operation, average" data.

5.2 Existing Data Recontextualization: Regional Expansion

The addition of regional data for key chemical building blocks, as outlined in the previous subsection, not only enables but also motivates the further geographical expansion of version 3.12. This expansion aims to include regional datasets for widely used chemical and plastic products by building on and recontextualizing datasets from previous versions. In all cases, recontextualization is applied, and data are included in version 3.12, only where documented production facilities exist or where their inclusion can be otherwise justified.

The following sections provide detailed descriptions of selected products, including acrylic acid, ethylene oxide, methanol, and industrial gases (i.e., liquid nitrogen and liquid oxygen). Other regionalized substances, including chlorine, vinyl chloride monomer and its polymers, key plastics such as polyethylene (linear low-density, low-density, and high-density) and polypropylene granulate, among others, are only briefly discussed.

Table 66 – **Table 70** of the Appendix list all newly added data in version 3.12 that represent data regionalization through recontextualization.

5.2.1 Acrylic Acid

Acrylic acid is important in industry as it is used in coatings, adhesives, and superabsorbent polymers, while its derivatives, such as polyacrylic acid and acrylates, find applications in textiles, paints, and hygiene products. In version 3.11, acrylic acid production via propylene oxidation was covered only in Europe and the Rest-of-World, as propylene data was available only for a small number of regions.

With propylene supply now covered across the major producing countries, data for acrylic acid was collected from multiple sources in a dedicated assessment. Such sources include, but are not limited to, Ullmann's Encyclopedia, Statista, and WM Strategy market reports, and validated against information reported by Petrochemicals Europe and additional publications (Ohara, et al., 2020; Statista, 2023; WM-Strategy, 2019; Petrochemicals Europe, 2024). This assessment provides access to data representing roughly 98% of global acrylic acid production allowing a detailed coverage expansion in the ecoinvent database. Consequently, version 3.12 omits separate Global and European datasets, and transforming activity data for acrylic acid production is now included in **nineteen** countries and **one** aggregated region, as given below:

- **Africa**: South Africa
- **Americas**: Brazil, Argentina, Colombia, Mexico, United States
- **Asia**: China, Indonesia, India, Japan, South Korea, Malaysia, Singapore, Thailand, Taiwan, Saudi Arabia
- **Europe**: Germany, France, United Kingdom, Rest-of-Europe.

In version 3.11, market activity data coverage was limited to Europe and Rest-of-World. To better represent the acrylic acid distribution, in version 3,12, market activity data are included in **two** countries and **four** aggregated regions: China, Asia excluding China, Europe, South Africa, and Rest-of-World. All data involved in this update is listed in **Table 66**.

A relative representation of the GWP score for acrylic acid production across world regions in version 3.12, compared with version 3.11, is illustrated in **Figure 5**. In version 3.12, acrylic acid production, via propylene oxidation, displays a wider GWP range, with certain countries showing markedly higher or lower values compared to the aggregated Rest-of-World representation in version 3.11. Users who require a more region-specific representation in their assessments, but were previously limited by regional coverage, are encouraged to update their system accordingly.

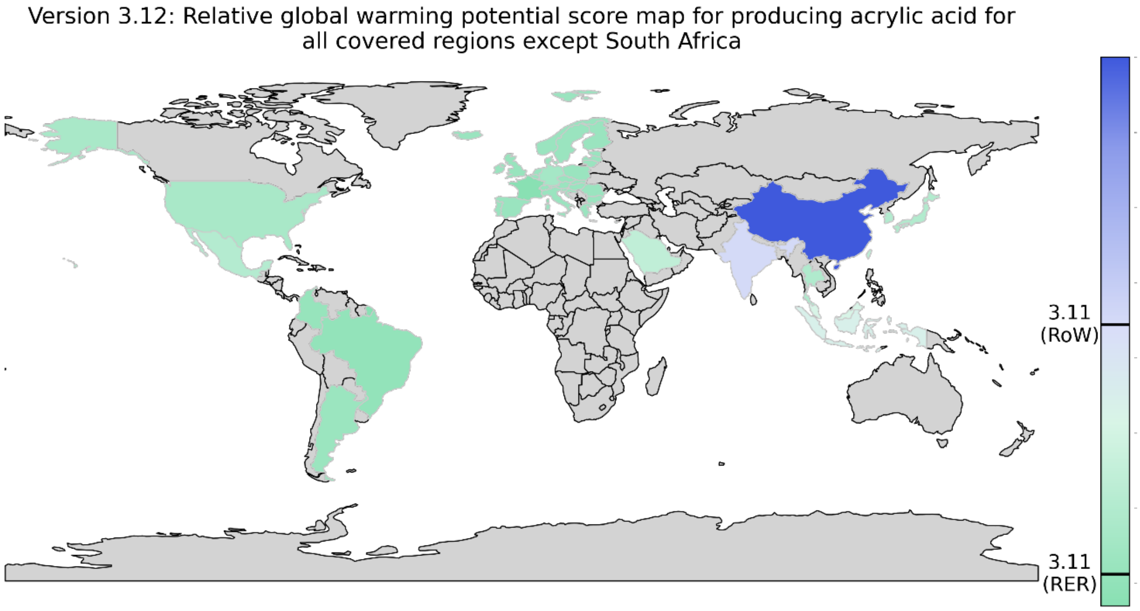

Figure 5. Comparison of GWP scores for acrylic acid production between versions 3.12 and 3.11. Relative GWP100 score world map (system model: allocation, cut-off) for the product acrylic acid supplied by the "acrylic acid production, propylene oxidation" transforming activities.

5.2.2 Ethylene Oxide

Ethylene oxide is important in industry because it is directly used as a disinfectant, sterilizing agent, and fumigant, and its derivatives play a major role in manufacturing. The most notable derivative, ethylene glycol, is used in antifreeze and polyester fibers, while other derivatives like amines and polyethylene glycols are applied in surfactants, solvents, and various chemical processes. In version 3.11, ethylene oxide production, via ethylene oxidation, was covered only in Europe and the Rest-of-World, as ethylene data was available only for a small number of regions.

With ethylene supply now covered across the major producing countries, version 3.12 replaces the previously covered regions of Europe and the Rest-of-World with data for **twenty-nine** individual countries. This is supported by compiling global ethylene oxide production volumes from multiple sources, with Ullmann's Encyclopedia providing historical coverage across **thirty-one** countries in 2000 and a report by Carbon Counts Company (UK) Ltd covering **twenty-four** countries in 2004, serving as key benchmarks (Rebsdat & Mayer, 2001; Zakkour & Cook, 2010). Furtrhermore, a collection of recent data from Statista covering selected producing countries, such as the United States, Japan, and the total global, was collected (Statista, 2020; Statista, 2019; Statista, 2023). Using information from these sources, production volumes and shares for **twenty-nine** countries were scaled and normalized to provide the comprehensive coverage included in version 3.12, serving as a sensible approximation of regional supply.

In version 3.12, and activity data for ethylene oxide production are now represented across countries, as given below:

- **Americas:** Canada, Mexico, United States of America, Brazil.
- **Asia:** China, India, Indonesia, Japan, South Korea, Kuwait, Saudi Arabia, Singapore, Taiwan, Turkey.
- **Europe:** Belgium, Bulgaria, Germany, Spain, France, United Kingdom, Italy, Netherlands, Poland, Romania, Slovakia, Sweden.
- **Oceania:** Australia.
- **Other / Multiple Continents:** Russia, Turkey.

In version 3.11, market activity data coverage was limited to Europe and Rest-of-World. To better represent the acrylic acid distribution, in version 3,12, market activity data are included in **eleven** countries (i.e., Canada, China, India, Japan, South Korea, Russia, Saudi Arabia, Taiwan, and the United States of America) and **two** aggregated regions (i.e., Europe w/o Russia and Rest-of-World). All data involved in this update is listed in **Table 67**.

A relative representation of the GWP scores for ethylene oxide production across world regions in version 3.12, compared with version 3.11, is illustrated in **Figure 6**. As in the case of acrylic acid, this update enables more accurate LCIA values based on regional ethylene feedstock usage.

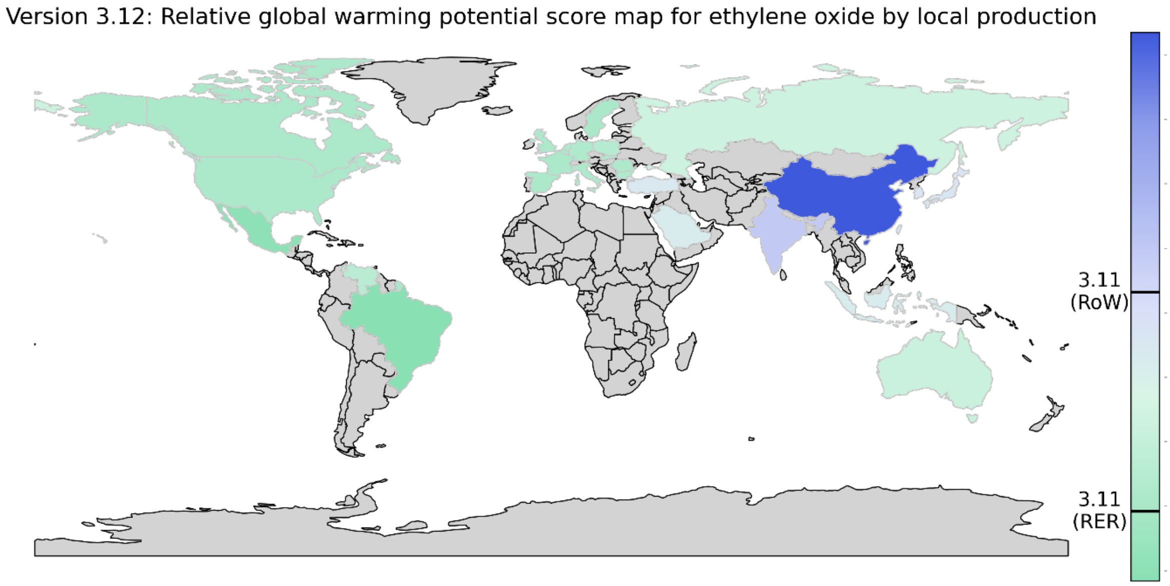

Figure 6. Comparison of GWP scores for ethylene oxide production between versions 3.12 and 3.11. Relative GWP100 score world map (system model: allocation, cut-off) for the product "ethylene oxide" supplied by the "ethylene oxide production, ethylene oxidation" transforming activities.

5.2.3 Methanol

Methanol is a key chemical building block for a wide range of bulk, specialty, and fine chemicals, including monomers used in plastics production. Methanol is produced from synthesis gas that is, in turn, generated from different fossil feedstocks. Namely, natural gas and coal-based facilities cover approximately 55-65% and 30-35% of global production, respectively (NETL, 2023). In version 3.11, methanol production was covered **four** regions, i.e., China, the United States, Europe, and Rest-of-World, as they represented a high share of the global methanol supply.

A comprehensive assessment was undertaken to evaluate the regional methanol supply in 2022. The analysis considered the distribution of production across different regions and countries, with data of varied detail collected on plant location, capacity, output volumes, and feedstock types. This information was aggregated into subregional totals, and subsequently validated against benchmarks published by governments, international organizations, and company reports to ensure consistency and accuracy (Methanex Corporation, 2022; Ministry of Energy and Energy Industries, 2025; IRENA, 2021; Ministry of Coal, Government of India, 2020; Mitsubishi Gas Chemical Company, 2023; MGC Advanced, 2025; DMS Projects, 2019; ICIS, 2017; Statista, 2025).

All in all, this update expands methanol production coverage from **four** regions to **twenty-four** distinct countries and **two** states in the United States of America. As a result, this update introduces differences from version 3.11 for countries previously represented in aggregate, which follow the supply chain of the main impact contributor to this process, namely natural gas. The trend of regional variations in GWP scores in version 3.12, compared with version 3.11, are illustrated in **Figure 7**, e.g., exact values are withheld. All data involved in this update is listed in **Table 68**.

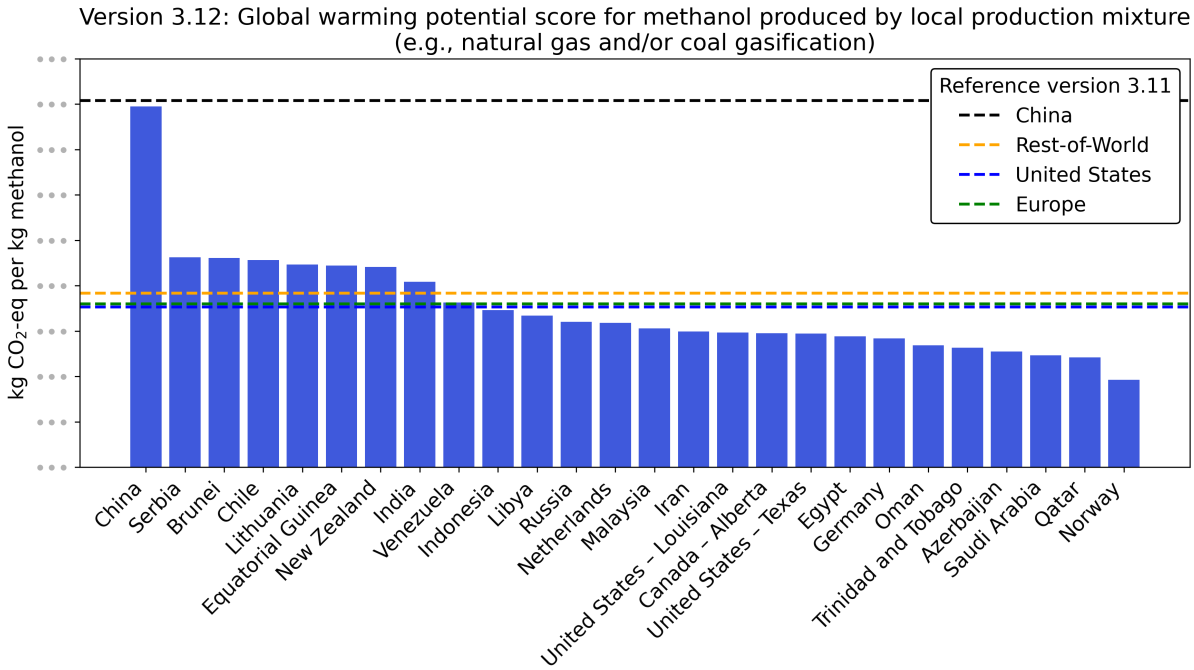

Figure 7. GWP score trend for methanol production mixture in version 3.12 compared to 3.11. GWP100 score (system model: allocation, cut-off) for the product "methanol" supplied by the local production mixture, which may include supply from the "methanol production, natural gas reforming" and "methanol production, from coal gasification" transforming activities.

5.2.4 Other Regionalized Chemical and Plastic Products

In this regionalization-through-recontextualization initiative, additional products have been analyzed following the methodology described in the acrylic acid, ethylene oxide, and methanol subsections above. To avoid repetition, this subsection provides only a brief mention of these actions. All data involved in this update is listed in **Table 69**.

Chlorine and sodium hydroxide production (via chlor-alkali electrolysis) coverage in version 3.11 included Europe, Canada–Quebec, and the Rest-of-World, while version 3.12 extends coverage to also include the United States of America. Similarly, phenol production, initially limited to Europe and Rest-of-World, now also encompasses China, India, Japan, and the United States of America. Polyethylene variants have also seen expanded coverage from being limited to Europe and Rest-of-World: linear low-density polyethylene (LLDPE) now also includes the United States of America, low-density polyethylene (LDPE) includes India, South Korea, and the United States of America, and high-density polyethylene (HDPE) covers India, Japan, South Korea, and the United States of America. Polypropylene coverage has been expanded to include China, Asia (excluding China), Africa, North America, and South America, in addition to Europe and the Rest of the World.

Vinyl chloride and its derivatives have been further regionalized. Europe and Rest-of-World coverage in version 3.11 has been disaggregated in version 3.12 to also include China, Asia excluding China, Africa, North America, and South America. Both emulsion-polymerized polyvinyl chloride (E-PVC) and suspension-polymerized polyvinyl chloride (S-PVC) follow the same expanded regional coverage. Polycarbonate production, previously included for Europe and Rest-of-World, is now detailed in version 3.12 with coverage for China, Germany, Spain, Japan, South Korea, the Netherlands, Saudi Arabia, Thailand, Taiwan, the United States of America, and the Rest-of-World.

All these updates provide more granular insights into global production value chains, supporting more precise regional assessments.

5.2.5 Industrial Gases: Oxygen and Nitrogen Supply

Up to version 3.11, liquid nitrogen and oxygen production via cryogenic air separation was available for Europe, Canada-Québec, and the Rest-of-World. However, such configuration shows significant variability in LCIA scores, largely due to the high electricity demand of this process and differences in the electricity supply mix for cryogenic unit operations. Expanding regional coverage for this process in the ecoinvent database enhances the accuracy of regional impact assessments for processes where oxygen or nitrogen consumption plays a significant role, for example, catalytic oxidation of hydrocarbons using oxygen instead of air.

To expand in granularity, data was regionalized according to the geographic distribution of chemical sector operations, assuming that industrial gas production via cryogenic air separation takes place in regions where the industry is economically significant. Regional distribution for industrial gases production is estimated from the chemical sector's gross value added in each region specified, providing a reasonable approximation of local supply (ICCA, 2019). The regions considered in version 3.12 are China, Asia excluding China, North America excluding Quebec, Quebec, Europe, and Latin America and Africa.

While LCIA results for Europe and Canada-Quebec remain largely unchanged, the newly added regional coverage replaces the Rest-of-World aggregate with more specific supply chains, with effects propagated throughout the ecoinvent database according to its linking logic. A relative representation of the relative GWP score change for the production of liquid oxygen in version 3.12, compared with version 3.11, is illustrated in **Figure 8**. The distribution of scores enables more accurate results, as it reflects regional differences in energy supply, a key contributor in the cryogenic air separation unit process. All datasets involved in this update are listed in **Table 70** of the Appendix.

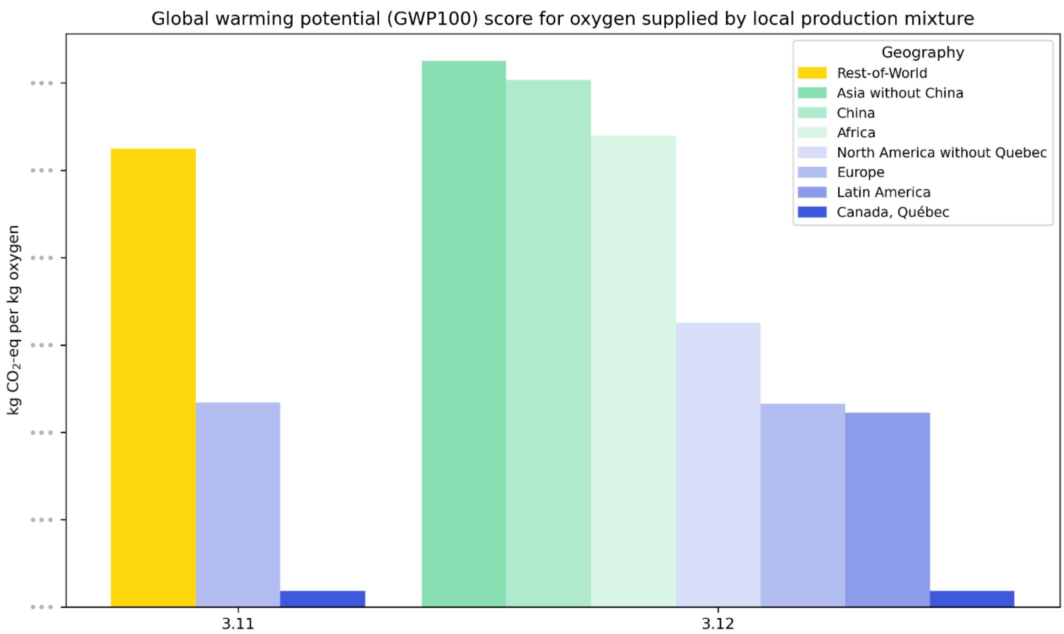

Figure 8. Comparison of GWP scores for oxygen supply from version 3.11 to 3.12. GWP100 score (system model: allocation, cut-off) for the product "oxygen" supplied by the local "industrial gases production, cryogenic air separation" datasets.

5.3 Styrene and Propylene Oxide

Styrene is primarily used in polymer production, with roughly 60% for polystyrene, 18% for styrene–acrylonitrile copolymers and ABS terpolymers, 5% for styrene–butadiene rubber, 6% for styrene–butadiene latexes, and 5% for unsaturated polyester resins. This distribution highlights the chemical's industrial significance, its role in key markets, and the potential environmental and economic impacts associated with its production and use. Globally, approximately 85% of styrene production comes from the direct dehydrogenation of ethylbenzene, while the remaining 15% is produced via the propylene oxide and styrene monomer (PO/SM) process (Falcke, et al., 2017; James & Castor, 2011).

Propylene oxide, a byproduct of the PO/SM process, is an important chemical intermediate used in polymers, oxygenated solvents, and industrial fluids. It ranks third in propene consumption, following polypropylene and acrylonitrile. Historically, propylene oxide was mainly produced via the chlorohydrin process until 1969, when peroxidation methods began to emerge. By 1998, about 50% of global production still relied on the chlorohydrin route, while newer technologies—including the PO–tert-butyl alcohol (PO-TBA) process, cumene–PO process, and hydrogen peroxide–PO (HPPO) process—gained traction (Baer, Bergamo, Forlin, Pottenger, & Lindner, 2012).

In version 3.11, styrene production data under the "styrene production from ethyl benzene dehydrogenation" unit process indented to reflect the direct dehydrogenation route. However, a portion of the energy consumption seems to be attributed to the PO/SM process through pre-allocation during dataset compilation, based on data originally developed from a company survey of **three** producers across **four** sites for version 3.8. Hence, version 3.12 updates the existing data to only reflect ethyl benzene dehydrogenation and adds new ones for the PO/SM process, included for the United States, Europe, China, Japan, South Korea, and the Rest-of-World. This data is derived from recalculations based on internal methodologies and information from literature sources. Additional regions have been added to represent market activities for the distribution of styrene in demand regions, such as China, Japan, South Korea, and the United States.

The inclusion of the PO/SM pathway expanded the propylene oxide production beyond the chlorohydrin process of version 3.11, which is represented in Europe and the Rest-of-World. In addition to the PO/SM route, version 3.12 introduces the PO/TBA pathway in locations where facilities operate, i.e., in Europe and the United States of America, according to what is reported in literature. Because the PO/TBA pathway produces tert-butanol as a byproduct—which was previously not included in the ecoinvent database—its dedicated production via direct isobutene hydration has also been included in version 3.12.

Along with the revised styrene data, these updates provide a more consistent and comprehensive representation of the production system for styrene and propylene oxide, while allowing users to select specific production technologies. All datasets/activities encompassed in this update are listed in **Table 16**.

Table 16: Styrene and propylene oxide related datasets in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns show activities that were updated or replaced in that version, while the "Version 3.12" columns list activities that either replace older ones, include new data not previously covered, or exclude certain data

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
"New Activity"			market for styrene	US; CN; JP; KR	2011 – 2011
styrene production, from ethyl benzene dehydrogenation	GLO; RER	2015 – 2020	styrene production, from ethyl benzene dehydrogenation	GLO; US; RER; CN; JP; KR	2017 – 2025
"New Activity"			styrene production, from ethyl benzene, PO/SM process	GLO; US; RER; CN; JP; KR	2017 – 2025
"New Activity"			propylene oxide production, from isobutene, PO/TBA process	RER; US	1989 – 2025
"New Activity"			tert-butanol production, isobutene direct hydration	GLO	2015 – 2025
"New Activity"			market for tert-butanol	GLO	2011 – 2011
"New Activity"			market for propylene oxide, liquid	US	2011 – 2011

5.4 Disaggregation of Previously Aggregated LCI Data

The key outcome of this update is the replacement of outdated aggregated datasets with disaggregated ones. All data encompassed in this update are listed in **Table 17**.

5.4.1 Hydrogen Cyanide

Hydrogen cyanide is primarily used in the production of chemicals such as adiponitrile, methyl methacrylate, cyanuric chloride, chelating agents, sodium cyanide, and methionine derivatives. Hydrogen cyanide is primarily produced by reacting hydrocarbons with ammonia. The main industrial methods include the Andrussow ammoxidation process and two ammonia–hydrocarbon dehydrogenation processes: the BMA (Blausäure-Methan-Ammoniak) and Shawinigan processes. In addition, the Sohio process (oxidation of propylene) also generates hydrogen cyanide as a byproduct during dedicated production of acrylonitrile. Among these, processes involving hydrocarbons and ammonia remain the most economically significant for hydrogen cyanide supply. According to Ullman's Encyclopedia (Gail, et al., 2011), approximately 25% of United States of America production and 20% of Western European production comes as a byproduct of acrylonitrile manufacture.

In version 3.11 and earlier, hydrogen cyanide production was represented by aggregated LCIs for the hydrocarbons–ammonia pathway, with the Sohio process modelled separately as a distinct unit process, as illustrated in **Figure 9** (left). This data was covered in Europe and the Rest-of-World.

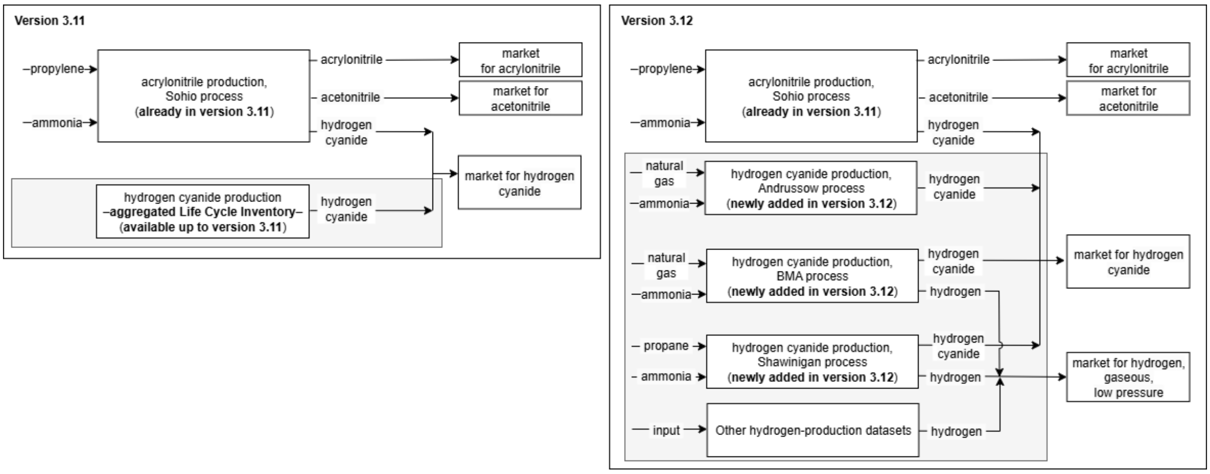

Figure 9. Hydrogen cyanide supply in ecoinvent. Simplistic overview of the updates to the hydrogen cyanide value chain in the ecoinvent database in version 3.11 (left) and 3.12 (right).

Version 3.12 introduces distinct unit process data for the production of hydrogen cyanide via (1) the Andrussow, (2) the BMA, and (3) the Shawinigan processes to replace the aggregated and technology-unspecified data in version 3.11 (**Figure 9**, right). The data for the **three** technologies are now covered in version 3.12 for Europe and the Rest-of-World. The key result of this update ensures appropriate linking of this data to the rest of the ecoinvent database while allowing users to select the specific technology of interest.

Figure 10 illustrates the relative changes in LCIA scores for the “market for hydrogen cyanide” between versions 3.12 and 3.11. A shift from aggregate to disaggregate data modeling affects LCIA indicators, using EF3.1, such as toxicity, metals and minerals depletion, and land use, among others. A reduction in GWP is also observed due to the updated representation of hydrogen cyanide production. Specifically, the outdated ecoProfiles used for the representation up to version 3.11 showcased a significantly higher GWP score. The notable increase of the latter indicators originates from the inclusion of previously unaccounted infrastructure, auxiliary services, and the integration with the ecoinvent database.

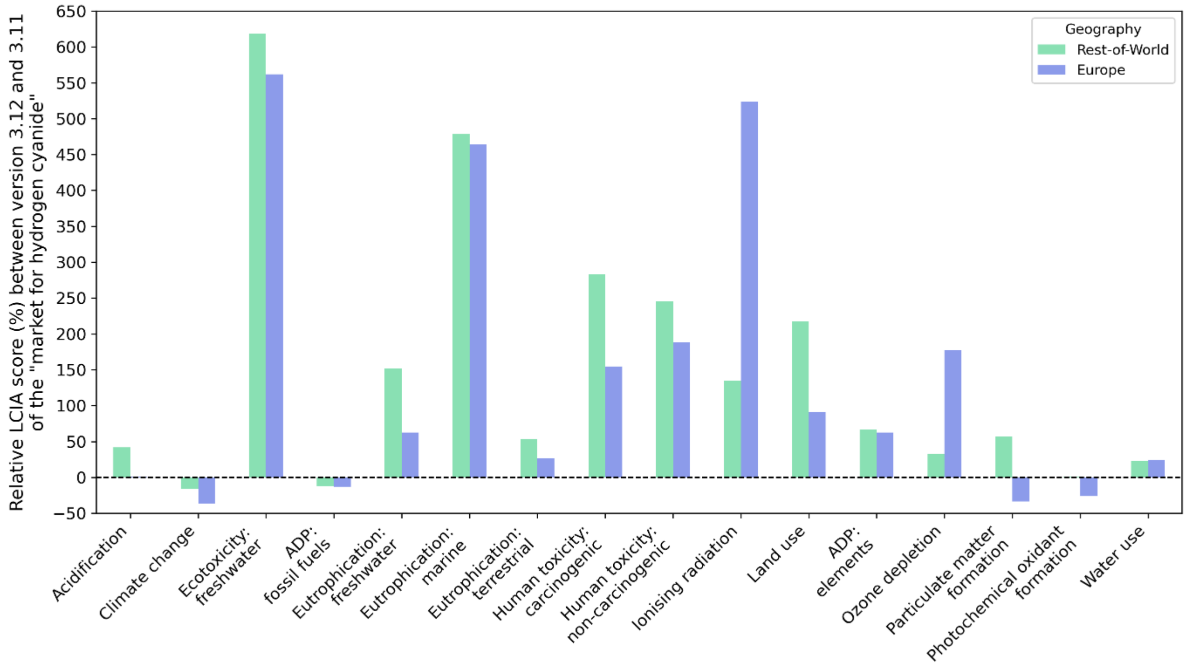

Figure 10. Relative LCIA score trend for the "market for hydrogen cyanide". Comparison of relative LCIA scores (using the EF3.1 and system model: allocation, cut-off) between version 3.12 and 3.11.

5.4.2 Polystyrene and Polybutadiene

Polystyrene (PS) is a widely used and versatile thermoplastic available in three forms (Maul, et al., 2007):

- general-purpose polystyrene (GPPS), valued for its transparency, mouldability, and heat stability, with applications in disposable cups, containers, electronics covers, and medical items.
- high-impact polystyrene (HIPS), valued for its ease of processing and high performance, used in packaging, disposable containers, electronics, toys, and automotive components.
- expandable polystyrene (EPS), a lightweight foam containing 95% air, widely applied in insulation and protective packaging for food, instruments, and fragile goods.

Polybutadiene (PB) is the second most produced synthetic rubber after styrene-butadiene rubber. About 70% goes into tires, while the rest is blended with other materials to create compounds for vulcanized products and plastics such as HIPS to enhance impact strength (European Commission, 2007).

This update disaggregates previously aggregated production data for GPPS, HIPS, EPS, and PB, based on older PlasticsEurope ecoProfiles, providing transparent and traceable unit process data. In version 3.11, this aggregated data was covered for Europe and the Rest-of-World. The new data is derived from calculations based on internal methodologies and complemented by information from literature sources (European Commission, 2007).

The newly added unit process data for PB production is covered for the United States of America, Europe, Japan, and the Rest-of-World, while the data for GPPS/HIPS/EPS is covered for Europe and the Rest-of-World. Additional regions have been added were appropriate to represent market activities for the distribution of GPPS/HIPS/EPS/PB in the supply and demand regions.

The key result of this update ensures appropriate linking of this data to the rest of the ecoinvent database. As before, the shift from aggregate to disaggregate data modelling affects LCIA indicators, using EF3.1, such as toxicity, metals and minerals depletion, and land use. The notable increase in the latter indicators originates from the inclusion of previously unaccounted infrastructure and auxiliary services.

Table 17: Hydrogen cyanide, polystyrenes, and polybutadiene related datasets in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column. The “Version 3.11” columns indicate activities updated or replaced in the new version, while “Version 3.12” columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
hydrogen cyanide production	GLO; RER	1992 – 1992	hydrogen cyanide production, Andrussow process	GLO; RER	2015 – 2025
			hydrogen cyanide production, BMA process	GLO; RER	2015 – 2025
			hydrogen cyanide production, Shawinigan process	GLO; RER	2015 – 2025
polybutadiene production	GLO; RER	2001 – 2002	polybutadiene production, solution polymerization	GLO; US; RER; JP	2007 – 2025
“New Activity”			market for polybutadiene	US; RER; JP	2011 – 2011
polystyrene production, expandable	GLO; RER	2001 – 2003	polystyrene production, expandable	GLO; RER	2007 – 2024
“New Activity”			market for polystyrene, expandable	RER	2011 – 2011
polystyrene production, general purpose	GLO; RER	2001 – 2003	polystyrene production, general purpose	GLO; RER	2007 – 2024
“New Activity”			market for polystyrene, general purpose	RER	2011 – 2011
polystyrene production, high impact	GLO; RER	2001 – 2003	polystyrene production, high impact	GLO; RER	2007 – 2024
“New Activity”			market for polystyrene, high impact	RER	2011 – 2011

5.5 New Chemical and Plastic Products: Portfolio Expansion

Overall, the version 3.11 database hosts chemicals and plastics data for **six hundred and thirty-six** unique CAS numbers, including **twenty** new CAS numbers added in that release that were not present in version 3.10, representing a growth of roughly 3%. These additions expanded coverage of chemicals and plastics by addressing key datasets previously missing from the database.

Version 3.12 expands the database content further with **forty** new CAS numbers, reflecting a growth of approximately 6% over version 3.11. The newly introduced products in version 3.12 comprise **thirty-two** organic compounds, **five** inorganic substances, **two** plastics, and **one** rubber category (emulsion- and solution-polymerised styrene-butadiene rubber, which we considered as unique products despite sharing the same CAS number). This initiative for product coverage expansion will continue in upcoming releases.

Data for the new substances are provided in **Table 18** , while the newly added transforming and market activities are shown in **Table 71** and **Table 72** of the Appendix, respectively.

Table 18: Chemical and plastic products newly covered in version 3.12. This table presents chemical substances or plastic materials not previously covered in the ecoinvent database, now included in version 3.12. Each entry lists the product type, designated functional group, and name along with its corresponding CAS number in separate columns.

Product Type	Functional Group	Product Name	CAS Number
Organic	Halogenated hydrocarbon	1,1,1-trichloroethane	71-55-6
Organic	Halogenated hydrocarbon	1,1,2-trichloroethane	79-00-5
Organic	Halogenated hydrocarbon	1-chloro-1,1-difluoroethane	75-68-3
Organic	Halogenated olefin	vinylidene chloride	75-35-4
Organic	Halogenated olefin	vinylidene fluoride	75-38-7
Organic	Ester	ethyl propionate	105-37-3
Organic	Ester	methyl propionate	554-12-1
Organic	Ester	propyl propionate	106-36-5
Organic	Cyclic carbonate ester	propylene carbonate	108-32-7
Organic	Carbonate ester	ethyl methyl carbonate	623-53-0
Organic	Acrylate ester	2-ethyl hexyl acrylate	103-11-7
Organic	Aldehyde	2-ethyl-2-hexenal	645-62-5
Organic	Aldehyde	2-ethylhexanal	123-05-7
Organic	Aldehyde	2-methylbutanal	96-17-3
Organic	Aldehyde	n-butyraldehyde	123-72-8

Organic	Aldehyde	pentanal	110-62-3
Organic	Aldehyde	isobutyraldehyde	78-84-2
Organic	Alcohol	2-ethylhexanol	104-76-7
Organic	Alcohol	allyl alcohol	107-18-6
Organic	Alcohol	tert-butanol	75-65-0
Organic	Alcohol	dehydrolinalool	29171-20-8
Organic	Alcohol	methylbutenol	115-18-4
Organic	Alcohol	methylbutynol	37365-71-2
Organic	Alcohol	linalool	78-70-6
Organic	Epoxide + Alcohol	glycidol	556-52-5
Organic	Ketone	diethyl ketone	96-22-0
Organic	Ketone	methyl isopropyl ketone	563-80-4
Organic	Ketone	methyl vinyl ketone	78-94-4
Organic	Ketone	methylheptenone	110-93-0
Organic	Enone (ketone + alkene)	mesityl oxide	141-79-7
Organic	Ether	methyl vinyl ether	107-25-5
Organic	Nitrile	succinonitrile	110-61-2
Inorganic	Metal halide	cobalt(II) chloride, anhydrous	7646-79-9
Inorganic	Carboxylate salt	calcium acetate	62-54-4
Inorganic	Carboxylate salt	potassium acetate	127-08-2
Inorganic	Inorganic nitrate	lithium nitrate	7790-69-4
Inorganic	Inorganic carbonate	manganese carbonate	598-62-9
Plastic	Fluoropolymer	polytetrafluoroethylene	9002-84-0
Plastic	Fluoropolymer	polyvinylidene fluoride	9002-85-1
Rubber	Synthetic rubber	styrene butadiene rubber, emulsion polymerised	9003-55-8
Rubber	Synthetic rubber	styrene butadiene rubber, solution polymerised	9003-55-8

5.6 Data for Generic flows: Chemical, Organic, Replacement

The ecoinvent database covers a broad range of chemical and plastic substances, and is expanding with every release, but data gaps remain due to the wide diversity of products across chemical, plastic, pharmaceutical, cosmetics, and flavouring industries.

The early ecoinvent team recognized this challenge and took initial steps by creating global proxy datasets, including one for “chemical, organic” flow based on an unweighted average of 20 substances, which laid the groundwork for closing data gaps through proxy flows.

Since the “chemical, organic” technosphere flow still remains valuable to ecoinvent users when specific chemical data is unavailable, version 3.12 introduces new datasets and flows to improve user experience and address data gaps for organic chemicals. Specifically, version 3.12 replaces the previous “chemical, organic” flow by covering several product groups that were previously uncovered, including:

- chemical, organic, basic precursors and materials
- chemical, organic, alcohols
- chemical, organic, aromatics
- chemical, organic, carboxylic acids
- chemical, organic, esters
- chemical, organic, unspecified

This initiative complements ongoing efforts to expand the database's product coverage and features. The globally modeled inventories represent unweighted averages of a broad range of organic substances within a specific product group, and users are encouraged to review their data usage and, where appropriate, replace generic or proxy entries with more specific data with respect to their functional group. Details of the newly covered product groups are provided in the following subsections, while **Table 19** lists version 3.11 datasets replaced as well as those newly added in version 3.12.

As a disclaimer, however, please note that the LCI of a production process—and consequently the LCIA scores—of a single substance within a product group does not always imply causation in the LCIs or similar LCIA scores for other substances in the same group. Hence, while using unweighted averages of chemicals of a given product group as proxies is a fast and practical way to close data gaps, the LCIA results should be interpreted carefully until more comprehensive data is available for individual substances that were previously lacking.

Figure 11 shows, in two subfigures, relative LCIA score changes, for all EF3.1 indicators, of the newly added flows compared to the “chemical, organic” flow of version 3.11. Overall, higher LCIA scores are observed across all metrics compared to the previous chemical organic flow, except for water use in certain product group flows. This is because the “chemical, organic” flow of versions up to 3.11 included several low molecular weight substances, such as ethylene, propylene, methanol, formaldehyde, among others. These compounds are key building blocks, and thus, their LCIA score values are significantly lower than main derivatives that comprise of a more specific chemical organic product group, leading to a distortion toward lower average scores for a more generic flow. At the same time, a significant increase in LCIA metrics related to toxicity and ozone depletion is observed in the specified product groups. This is primarily driven by ecosphere flows of substances involved in the transformation of molecules into these product groups. Even small releases of these substances into specific environmental compartments can result in disproportionately high impacts, a detail not captured in the simplified, generic grouping of organic chemicals from previous versions.

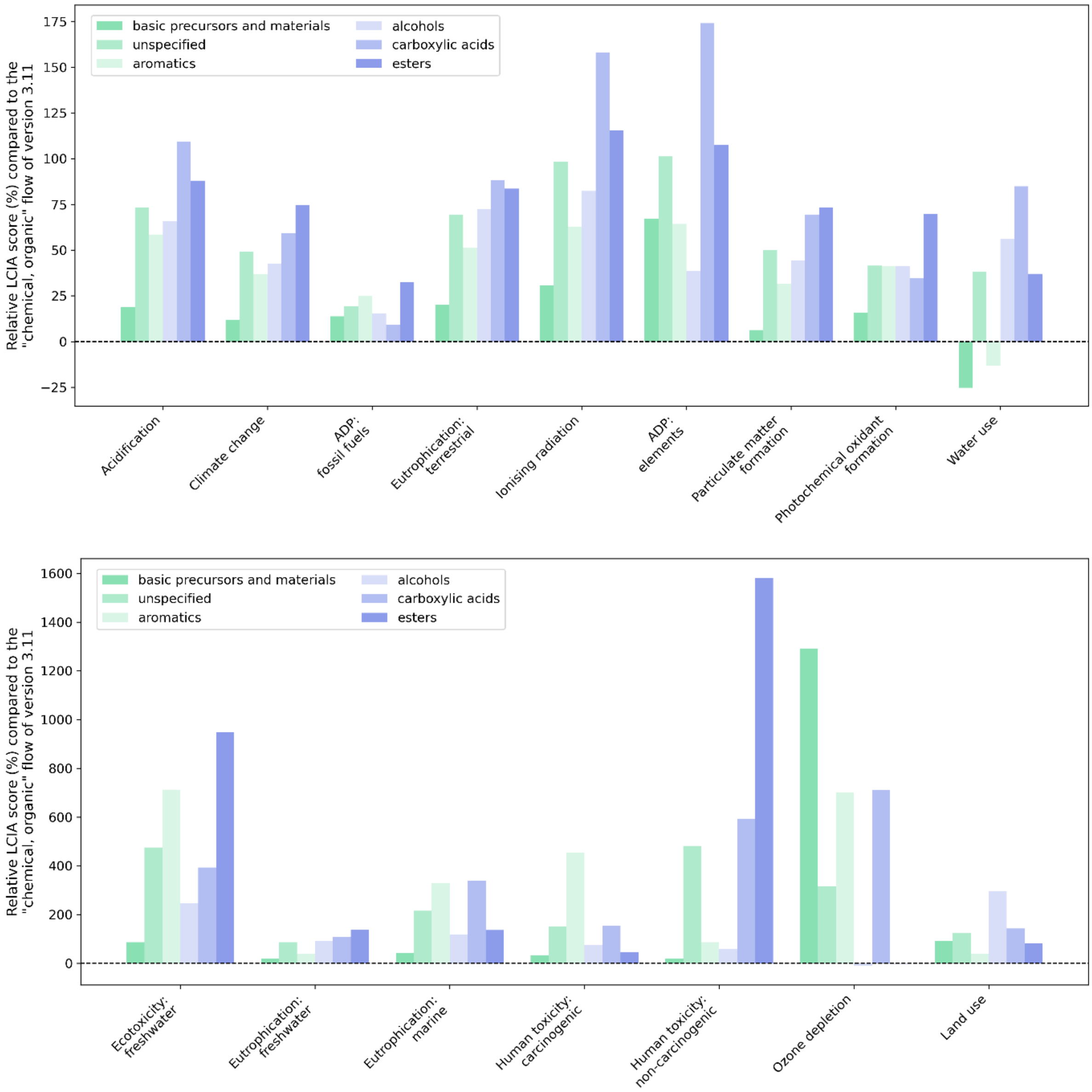

Figure 11. Scores trend for the new organic chemical proxy flows. Comparison of relative LCIA scores (using the EF3.1) for "chemical, organic" product group flows in version 3.12 versus the substituted generic "chemical, organic" flow of version 3.11.

Table 19: Generic flows for chemical organic related datasets in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns indicate activities updated or replaced in the new version, while

"Version 3.12" columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
chemical production, organic	GLO	2000 – 2000	chemical production, organic, basic precursors and materials	GLO	2025 – 2025
market for chemical, organic	GLO	2011 – 2011	market for chemical, organic, basic precursors and materials	GLO	2011 – 2011
"New Activity"			chemical production, organic, alcohols	GLO	2025 – 2025
"New Activity"			market for chemical, organic, alcohols	GLO	2025 – 2025
"New Activity"			chemical production, organic, aromatics	GLO	2025 – 2025
"New Activity"			market for chemical, organic, aromatics	GLO	2025 – 2025
"New Activity"			chemical production, organic, esters	GLO	2025 – 2025
"New Activity"			market for chemical, organic, esters	GLO	2025 – 2025
"New Activity"			chemical production, organic, aromatics	GLO	2025 – 2025
"New Activity"			market for chemical, organic, aromatics	GLO	2025 – 2025
"New Activity"			chemical production, organic, carboxylic acids	GLO	2025 – 2025
"New Activity"			market for chemical, organic, carboxylic acids	GLO	2025 – 2025
"New Activity"			chemical production, organic, unspecified	GLO	2025 – 2025
"New Activity"			market for chemical, organic, unspecified	GLO	2025 – 2025

5.6.1 Chemical, Organic, Basic Precursors and Materials

This flow represents an unweighted average of **twenty** to **thirty** organic substances that are key building blocks and materials in the chemical sector available in the ecoinvent database. This product flow is considered the closest match to the "chemical, organic" flow from earlier releases.

The organic chemicals considered in the averaging are essential in various industrial applications, serving as solvents, monomers, and intermediates in the production of plastics, resins, and synthetic fibers. Comprising olefins, aromatics, alcohols, and other functional compounds, they play a vital role in diverse chemical processes. Many are also used in pharmaceuticals, agrochemicals, and fuel additives, contributing to advancements in multiple sectors. Some are key components in high-performance materials, coatings, and adhesives, enhancing durability and functionality. The list also includes processed plastic materials that are widely used as final products or raw materials in various manufacturing sectors. Their widespread use highlights their importance in modern industry and technological development. The selection of entries was guided by **three** key aspects:

- A recent Cefic report named "The Carbon Managers, 2024" assessed **eighteen** key materials, representing essential base chemicals, industry intermediates, and major commodity polymers (CEFIC, 2024). According to this report, these products accounted for 64% of emissions and 49% of final energy use in the chemical sector in 2019. **Three** inorganic compounds were excluded from that list, and the remaining ones were included as unique entries in this dataset.
- To complete the dataset, we referred to the IEA's Technology Roadmap report which assessed **eighteen** chemicals and plastics (IEA, 2013). According to this report, this group represented 80% of the sector's energy demand and 75% of its greenhouse gas emissions. **One** inorganic compound was excluded from that list, and the remaining ones were included as unique entries in the dataset.
- Finally, additional substances were selected to fill gaps, based on their relevance to the industry, with some entries derived from ecoinvent internal assessment of importance.

5.6.2 Chemical, Organic, Alcohols

This dataset represents an unweighted average of **twenty** to **thirty** alcohol chemical substances available in the ecoinvent database. The selection of entries was based on expert judgment and will be revisited as the database expands.

The alcohol, and glycol, substances considered in the averaging are vital in various industrial processes, serving as solvents, intermediates, and key components in the production of chemicals, plastics, and pharmaceuticals. They are commonly used in manufacturing solvents, detergents, antifreeze, and personal care products, as well as in paints. These substances are building blocks for polyurethanes, plasticizers, and specialty polymers. Their chemical properties—such as solubility, volatility, and reactivity—make them essential in chemical synthesis, including esterification and polymerization. With applications in industries ranging from automotive to healthcare and materials production, they require precise handling to ensure safety and efficacy in diverse applications.

5.6.3 Chemical, Organic, Esters

This flow represents an unweighted average of **twenty** to **thirty** ester chemical substances available in the ecoinvent database. The selection of entries was based on expert judgment and will be revisited as the database expands.

The ester substances considered in the averaging are essential in a wide range of industrial and chemical applications, serving as solvents, plasticizers, intermediates, and monomers in the production of coatings, adhesives, polymers, and resins. This diverse group includes carboxylic esters, enoate esters such as acrylates and methacrylates, vinyl esters, and carbonate esters—each contributing unique properties like volatility, reactivity, and solubility. Enoate esters are key components in polymer and emulsion formulations, particularly in paints, textiles, and sealants, while carbonate esters are valued for their role in lithium-ion battery electrolytes and specialty solvents. Vinyl and alkyl acetates are widely used in formulations for inks, varnishes, and films. Esters participate in critical chemical processes such as transesterification and radical polymerization, making them vital to industries ranging from automotive and packaging to electronics and construction.

5.6.4 Chemical, Organic, Aromatics

This dataset represents an unweighted average of **twenty** to **thirty** aromatic chemical substances available in the ecoinvent database. The selection of entries was based on expert judgment and will be revisited as the database expands.

The aromatic substances considered in the averaging are crucial in various industrial applications, acting as intermediates, solvents, and precursors in the production of plastics, resins, and synthetic fibers. They are essential in manufacturing specialty chemicals like polymers, paints, coatings, and adhesives. These substances are involved in key chemical processes such as nitration, chlorination, and alkylation, which are vital for producing pharmaceuticals, agrochemicals, and explosives. Comprising benzene derivatives and other aromatic compounds, they are also integral to the production of plastics like polystyrene and polycarbonates, as well as high-performance materials. Due to their unique properties—stability, reactivity, and volatility—they play a significant role in industrial manufacturing, requiring careful handling to ensure safety and efficiency. Their extensive use underscores their importance in advancing chemical processes and materials technology.

5.6.5 Chemical, Organic, Carboxylic Acids

This flow represents an unweighted average of **twenty** to **thirty** carboxylic acid chemical substances available in the ecoinvent database. The selection of entries was based on expert judgment and will be revisited as the database expands.

The organic acid substances considered in the averaging are essential in a wide range of industrial applications, serving as intermediates, catalysts, and components in the synthesis of polymers, plastics, resins, food additives, pharmaceuticals, and agrochemicals. Their functional group enable chemical reactions like esterification, polymerization, and neutralization. These acids are also pivotal in producing specialty chemicals, solvents, and surfactants, contributing to advancements in the automotive, textile, and consumer goods industries. While their chemical properties make them highly versatile, careful handling is required to ensure safety and efficiency in industrial processes.

5.6.6 Chemical, Organic, Onspecified

This flow represents an unweighted average of a diverse range of organic chemicals and materials (i.e., more than a **hundred**). This dataset includes all unique entries from key organic chemical groups in version 3.12, such as basic precursors, alcohols, and aromatics, selected to ensure comprehensive coverage of the referenced subsections. Therefore, this product flow provides an approximate average of organic chemical flows derived from a large and diverse sample.

5.7 Bromine

Bromine is primarily used in flame retardants, drilling fluids, organic synthesis, pharmaceuticals, biocides for water treatment, and agriculture. It also plays a role in the production of dyes, insect repellents, perfumes, and photographic materials, and is used in specialized applications such as mercury emission control and paper manufacturing.

In bromine production, chlorine acts as the primary oxidizing agent, converting bromide ions from brines into elemental bromine. Bromide occurs in seawater at a concentration of about 65 mg/L, but more concentrated and economically viable sources are found in salt lakes, salines, and inland seas. The Dead Sea is one of the richest commercial sources, with bromide concentrations of nearly 5 g/L at the surface, 6.5 g/L in the southern basin near Ein Bokek, and up to 12 g/L in the end brine from potash production—this end brine serves as the primary raw material for bromine production in Israel (Frim, Mills, Ukeles, & Yoffe, 2015). In the United States, the main source of bromine is brine wells, particularly in Arkansas and Michigan, where bromide concentrations range from 2 to 5 g/L. Consequently, the bromide concentration in the source brine significantly affects the efficiency and economics of bromine production. The global annual bromine production, excluding the United States, is nearly 600,000 metric tons, with Israel and Jordan supplying a combined 400,000 metric tons and China 150,000 metric tons (Benvenuto, 2013).

The key outcome of this update is the incorporation of more reliable data for both primary and secondary producing regions, which were previously unaccounted for in versions up to 3.11. In short, the version 3.11 transforming activity for “bromine production” is split in three new ones to differentiate the origin of the consumed brine at different world regions, based on the following transforming activities:

- bromine production, bromide oxidation, from brines
- bromine production, bromide oxidation, from Dead Sea brine
- bromine production, bromide oxidation, from seawater

Version 3.12 improves the representation of bromine supply through collaboration with an industrial data provider and extends it with an internal assessment. New industrial average data for Israel, provided by the ICL Group, is included based on a survey of bromine production from Dead Sea brine. This data is recontextualized to Jordan, reflecting their shared concentrate brine resource. Furthermore, bromine production in other key regions of the world is also included, such as in the United States of America, China, Japan, and the Rest-of-World. In these geographical regions, the data is derived from literature sources and internal calculations. Finally, the previously covered bromine production in Europe has been removed due to limited data availability, while the single global bromine market coverage from version 3.11 remains unchanged. All data involved in this update is listed in **Table 20**.

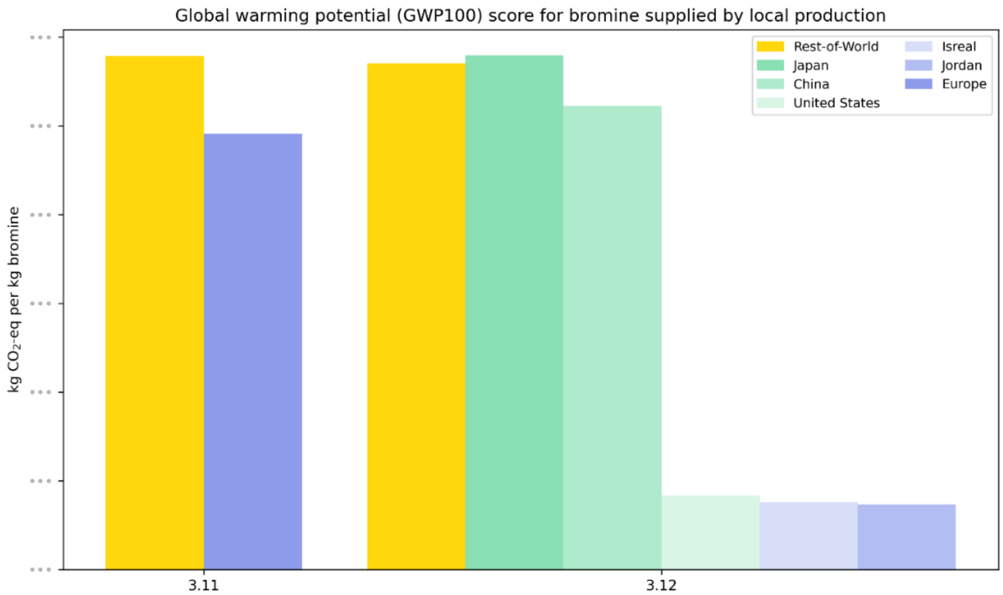

Figure 12. Comparison of GWP scores for bromine supply from version 3.11 to 3.12. GWP100 score (system model: allocation, cut-off) for the product "bromine" supplied by dedicated datasets.

A relative representation of the GWP score for bromine production in version 3.12, compared with version 3.11, is illustrated in **Figure 12**. GWP scores vary by location because different regions use brine with varying concentrations, which affects the amount of energy required. Therefore, users should note potential effects on their studies if bromine is a major contributor.

Beyond GWP, users applying the EF3.1 method (or others) will notice additional changes in several other LCIA indicators. Notably, there is a marked increase in the LCIA indicator "Ecotoxicity: freshwater" and a decrease in "Water use." The change in "Ecotoxicity: freshwater" score reflects the inclusion of previously omitted elementary flows to water, specifically chloride ions formed from the chlorine oxidation of bromide. The change in "Water use" scores, version 3.11 assumed complete evaporation to air, whereas version 3.12 recognizes that a substantial share remains in liquid form and returns to the reservoir.

Table 20: Bromine related datasets in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns indicate activities updated or replaced in the new version, while "Version 3.12" columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	**Geography**	**Time Period**	**Activity Name**	**Geography**	**Time Period**
Version 3.11			**Version 3.12**		
bromine production	RER; GLO	2010 – 2010	bromine production, bromide oxidation, from seawater	GLO; JP	2025 – 2025
"New Activity"			bromine production, bromide oxidation, from Dead Sea brine	IL; JO	2025 – 2025
"New Activity"			bromine production, bromide oxidation, from brines	US; CN	2025 – 2025

5.8 Plastic Processing

Industries ranging from packaging to healthcare depend on versatile plastic products manufactured through various processing techniques. In version 3.12, the database coverage for plastic manufacturing services is expanded. The new version covers several processes related to blown film co-extrusion configurations (i.e., (1) mono directional orienting, (2) three-, five-, and seven-layers, (3) average) and plastic bag making. All data involved in this update is listed in **Table 21** and **Table 22**.

This update was carried out in collaboration with industrial data providers and builds on the work completed in version 3.11 that focused on composite manufacturing services. Namely, primary data was collected from different factories in France by the Centre Technique Industriel de la Plasturgie et des Composites (IPC), which allowed the creation of highly regional plastic processing activities. The French data is, in turn, recontextualized to Rest-of-Europe, North America, Asia and Rest-of-World to enable more representative data for users operating outside of France. Information on the data collection process and more details on the covered processes are available in the datasets.

Table 21. New plastic processing services datasets in v3.12. If several geographies of the same activity with the same time period exist, all of them are listed in the "geography" column.

Activity Name	Geography	Time Period
plastic bag making	FR; RER; RAS; RNA; GLO	2021 – 2029
blown film co-extrusion, average configuration	FR; RER; RAS; RNA; GLO	2021 – 2029
blown film co-extrusion, five layers	FR; RER; RAS; RNA; GLO	2021 – 2029
blown film co-extrusion, mono directional orienting	FR; RER; RAS; RNA; GLO	2021 – 2029
blown film co-extrusion, seven layers	FR; RER; RAS; RNA; GLO	2021 – 2029
blown film extrusion, mono layer	FR; RER; RAS; RNA; GLO	2021 – 2029
blown film co-extrusion, three layers	FR; RER; RAS; RNA; GLO	2021 – 2029

These manufacturing datasets are modeled as services, therefore the main input components that comprise the final product are not included in the datasets. This allows the users to apply different input materials.

For all datasets in this project, only one Global market activity per service was created as it is encouraged to work with the regionalized service datasets (see **Table 22**).

Table 22. Corresponding markets to the newly introduced datasets.

Activity Name	Geography	Time Period
market for blown film extrusion, monolayer	GLO	2025 – 2025
market for blown film co-extruded, average configuration	GLO	2025 – 2025
market for blown film co-extruded, five layers	GLO	2025 – 2025
market for blown film co-extruded, three layers	GLO	2025 – 2025

market for blown film co-extruded, seven layers	GLO	2025 – 2025
market for plastic bag making	GLO	2025 – 2025
market for blown film co-extruded, monodirectional orienting	GLO	2025 – 2025

5.9 Other Updates: Database Maintenance

This subsection offers a brief overview of selected stand-alone data corrections/adjustments that may have specific impacts of interest to users in certain fields. All updated data discussed in the following subsections is listed in **Table 23**. Adjustments related to renaming, documentation enchantment, production volume updates, among others, are not discussed. All data related to updates that are not discussed herein is listed in **Table 73** of the Appendix.

5.9.1 Calcium Carbonate

Since version 3.8, the inventory of precipitated calcium carbonate production accounts for the inputs and outputs of an aggregated system—starting with "limestone, crushed, washed" to produce pure "calcium carbonate, precipitated"—which simplified the previous modeling of sequential process steps. In this system (i.e., published in v3.8 – 3.11), chemical intermediates are no longer accounted separately as it was the case in prior versions, and thus, could be consumed internally at various process stages. For example, carbon dioxide generated during "limestone calcination" could be reused in the "hydrated lime carbonization". This contrasts typical industrial process configurations, where carbon dioxide is emitted during the "limestone calcination" and then consumed as an input from the technosphere for the "hydrated lime carbonization". Furthermore, the inputs for heat and electricity were updated for version 3.8: generic energy inputs in the previous version of the datasets were replaced with values, which, however, reflect emissions per kilogram of limestone processed into quicklime, not per kilogram of pure calcium carbonate produced.

To address these issues, a rollback to the version 3.7.1 inventory structure is implemented version 3.12, along with an updated representation of relevant input and output flows. Significant changes in LCIA scores are expected for the main product "calcium carbonate, precipitated" (e.g., a nearly threefold increase in the GWP score), while the change in impact contribution in downstream uses are minor and limited to certain product groups related to plastic recycling and pulp and paper production.

Table 23: Data related to database maintenance for the Chemicals and Plastics sector representation. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns indicate activities updated or replaced in the new version, while "Version 3.12" columns list activities that replace older ones.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period

Version 3.11			Version 3.12		
calcium carbonate production, precipitated	GLO; RER	2015 – 2020	calcium carbonate production, precipitated	GLO; RER; RAS; US	2003 – 2015
acetylene production	GLO; RER	1991 – 2020	acetylene production, from natural gas, operated with a water quench	GLO; RER	2012 – 2024
			acetylene production, from natural gas, operated with an oil quench	GLO; RER	2012 – 2024
ethyl benzene production, from benzene alkylation	BE; CZ; DE; ES; FR; GB; IT; NL; RER	2017 – 2023	*"Updated Activity"*		
methyl acrylate production, methanol esterification with acrylic acid	RER; RNA; UN-EASIA; UN-SEASIA	1989 – 2023	*"Updated Activity"*		
ethyl acrylate production, ethanol esterification with acrylic acid	RER; RNA; UN-EASIA; UN-SEASIA	1989 – 2023	*"Updated Activity"*		
butyl acrylate production, butanol esterification with acrylic acid	RER; RNA; UN-EASIA; UN-SEASIA	1989 – 2023	*"Updated Activity"*		

5.9.2 Acetylene

In earlier database versions, the acetylene production dataset lacked key elements, including accurate natural gas feedstock quantities, representative energy consumption and process emission values, and considered a portion of produced gas used beyond system boundaries for its separation and use. This issue was addressed by revising the mass and energy balances for the production of acetylene, based on literature data, expert judgement, and additional modelling. New datasets replace the existing ones, covering acetylene production from natural gas using either water quench or oil quench systems after the cracked gas exits the reaction chamber. Oil quenching provides higher thermal efficiency by recovering more primary energy as steam, but unlike water quenching, coke deposits do not settle immediately, making removal more difficult, which affects the LCIA results.

The partial oxidation of natural gas for acetylene supply co-produces substantial synthesis gas along with acetylene, and multifunctionality is addressed by partitioning based on physical relations (here energy content) since it is considered a more sensible method for low-molecular-weight gaseous products, including hydrogen, carbon monoxide, and acetylene. **Table 24** compares different methods for partitioning the exchanges in this combined production data for the "acetylene production, from natural gas, operated with an oil quench" activity based on physical relationships and contrasts these options with economic allocation.

Table 24. Shares from different methods for partitioning the exchanges of the “acetylene production, from natural gas, operated with an oil quench” process.

Substance	Mass-based	Carbon content-based	Energy-based	Economic based
acetylene	19.9%	19.8%	27.4%	17.5%
synthesis gas, 3 to 1	80.1%	80.2%	72.6%	82.5%

5.9.3 Ethyl Benzene

In version 3.11, the representation of ethyl benzene production from benzene alkylation for European regions (United Kingdom, Italy, Netherlands, Réunion, Belgium, Czech Republic, Germany, Spain, France, and Rest-of-Europe) was updated. However, this update did not incorporate data on potential heat recovery also provided in the original source (Falcke, et al., 2017), but only the energy requirements. In version 3.12, this information has been included for consistency, aligning the representation with the approach also applied to styrene production update of this version (James & Castor, 2011). The updated values account for excess process heat, considering both heat recovery efficiency—reflecting how effectively waste heat is utilized—and the integration level of facilities, with a scale from 0 (non-integrated, standalone plants) to 1.0 (highly efficient, fully integrated plants). This update directly reduces the LCIA scores for ethyl benzene in version 3.12 compared to 3.11; however, other updates in the upstream value chain effects may influence the overall trend.

5.9.4 Acrylates

In version 3.12, the energy inputs in the following unit process datasets for acrylates have been updated based on more recent sources: (1) “methyl acrylate production via methanol esterification with acrylic acid”, (2) “ethyl acrylate production via ethanol esterification with acrylic acid”, and (3) “butyl acrylate production via butanol esterification with acrylic acid”. This update followed an initiative to obtain more representative inputs for butyl acrylate production, as version 3.11 relied on estimates based on a similar process. Specifically, energy values for methyl and ethyl acrylate were based on reported liquid-phase esterification data (Chauvel, Lefebvre, & Castex, 1989). Representative and more current values were identified for all three acrylates, including butyl acrylate, and updated accordingly in version 3.12, which, in turn, affects the LCIA scores for these substances.

6 Electricity

6.1 General Market Update

The overall methodological approach used to update the electricity market datasets remains consistent with the approach applied in ecoinvent versions 3.6 through 3.11. For this update, the reference year is 2022 except for Brazil (BR), Canada (CA), China (CN), India (IN), Switzerland (CH), the United States (US) which are updated to 2023 using the most comprehensive country-specific data sources available as outlined in Section **6.2**.

Consistent with v3.11, Enerdata (Enerdata, Global Energy & CO2 data, 2025) serves as the primary data source for electricity generation, for all regions except where the national updates as described in 6.2. and for European Union (EU) member states, where the European Commission's EuroSTAT database (European Commission, 2025) is used. As in version 3.11, data reported for different geographies were aggregated or disaggregated to align with the IEA resolution and were processed in a similar way as in the previous releases. Several data gaps and issues were addressed based on information from the previous ecoinvent releases and national energy balance reports. Additionally, missing classifications between main activity producers and auto-producers in the Enerdata export for v3.12 are added, consistent with prior ecoinvent versions. Disaggregation was carried out using data from the previous year wherever necessary, and was often supplemented with facility-level information from Enerdata's Power Plant Tracker database (Enerdata, Power Plant Tracker, 2025) for example, to identify certain auto-producers such as those in the pulp and paper industry, sugar mills, etc. In most cases, disaggregation was required for countries outside the major global economies, while it was not needed for Europe, the USA, Canada, China, India, or Brazil.

Electricity trade datasets were compiled from various sources depending on the region. For European countries, electricity trade data was primarily obtained from European data sources mainly from Eurostat database (European Commission, 2025), ENTSO-E (ENTSO-E, 2025) and Bundesnetzagentur (Bundesnetzagentur, 2025). Additional trade statistics were sourced from Enerdata (Enerdata, Global Energy & CO2 data, 2025) and further disaggregated using trade partner shares from WITS (WITS, 2025). For the United States, electricity import data for the year 2023 was obtained directly from the U.S. Energy Information Administration (EIA, 2025). Further details on trade updates are provided in **6.1.2** below.

6.1.1 New Technology Splits

Some technologies were missing for certain geographies that were not present in v3.11 and have been added in v3.12 as shown in **Table 25**.

Table 25. New technology splits.

Geography	Fuel Type and Technology	Technology Splits	Data Year	Data Source
United States – Puerto Rico (US-PR)	Hydropower (non-pumped)	100% electricity production, hydro, reservoir, tropical region	2024	(UNIDO, ICSHP, 2022) (Cooperativa Hidroeléctrica, n.d.) and own analysis based on satellite imagery

Egypt (EG)	Solar thermal	100% electricity production, solar thermal parabolic trough, 50 MW	2024	(SolarPACES, 2024)
Cameroon (CM)	Natural gas (non-CHP)	100% electricity production, natural gas, conventional power plant	2022	(Enerdata, Power Plant Tracker, 2025)

6.1.2 Electricity Trade Data and Import Splits

Electricity trade data frequently differs across sources, with discrepancies arising from temporal aggregation and the netting of electricity flows, but also differences in physical flows and commercial trade, which may lead to inconsistencies in the reported data. For EU member countries, Eurostat database was used (European Commission, 2025), which reflects physical trade between partner countries. However, the electricity trade data reported was incomplete for certain EU member countries like Germany, Moldova and Serbia. For Germany, Eurostat reporting for 2022 showed an import amount of unspecified origin of 23 558 GWh (which is 47.75 % of the total electricity imported to Germany). To mitigate this crucial data gap, supplementary electricity trade data for Germany was obtained from the Bundesnetzagentur (Bundesnetzagentur, 2025) as in v3.11 to ensure complete coverage. To account for unspecified electricity imports and address gaps in electricity trade statistics, the hierarchy of data sources from version 3.11 was applied, taking available data from the data sources at the top first, and then filling gaps with the data sources further down the list.

1. Eurostat (European Commission, 2025)
2. Bundesnetzagentur (Bundesnetzagentur, 2025)
3. ENTSO-E (ENTSO-E, 2025)
4. United Nations (UN) Comtrade (United Nations Comtrade, 2025)

The established hierarchy of data sources enables filling gaps in electricity trade datasets, as applied in version 3.11. For example, electricity import data for Moldova in 2022 was missing from the Eurostat database; therefore, Enerdata statistics were used in line with the hierarchy, with subsequent corrections made using Comtrade data (United Nations Comtrade, 2025). For Serbia, 5.1% of its electricity imports was reported from unspecified origin in Eurostat database which was assigned to Kosovo based on the electricity trade partner countries reported for Kosovo in ENTSOE. For Kosovo, no data was reported in Eurostat, and ENTSO-E also lacked consistent electricity trade figures from Kosovo's cross-border partners. To address this gap, total import values for Kosovo from Enerdata were used and then disaggregated among the cross-border partner countries based on the electricity trade splits applied in version 3.11. For Moldova, the split factor for trade across country borders was updated. In ecoinvent version 3.12, Moldova receives around 54% of electricity from Ukraine and around 46% from Romania.

6.1.2.1 New electricity imports trade datasets

Some electricity import origins were added because the respective electricity imports were not present in previous versions of ecoinvent. New electricity import datasets were therefore created to represent the electricity trade as reported in the statistics. **Table 26** presents the newly created electricity import trade datasets with their corresponding origin and destination geographies.

Table 26. New electricity imports trade datasets

Activity name	Geography	Time period	Product name
electricity, high voltage, coal import from DE	CH	2023-2023	electricity, high voltage
electricity, high voltage, import from RAF	KE	2022-2022	electricity, high voltage
electricity, high voltage, import from AM	GE	2022-2022	electricity, high voltage
electricity, high voltage, import from AZ	GE	2022-2022	electricity, high voltage
electricity, high voltage, import from RU	GE	2022-2022	electricity, high voltage
electricity, high voltage, import from DZ	NE	2022-2022	electricity, high voltage
electricity, high voltage, import from HU	SI	2022-2022	electricity, high voltage
electricity, high voltage, import from IN Northeastern Grid	MM	2022-2022	electricity, high voltage
electricity, high voltage, import from KG	UZ	2022-2022	electricity, high voltage
electricity, high voltage, import from RO	MD	2022-2022	electricity, high voltage
electricity, high voltage, import from MZ	BW	2022-2022	electricity, high voltage
electricity, high voltage, import from SA	KW	2022-2022	electricity, high voltage
electricity, high voltage, import from SI	HU	2022-2022	electricity, high voltage
electricity, high voltage, import from TH	MM	2022-2022	electricity, high voltage
electricity, high voltage, import from ZM	ZW	2022-2022	electricity, high voltage

6.2 National Update Based on Country-specific Data Sources

For further details on the different data sources used and detailed explanation of the country-specific electricity mixes for Brazil, Canada, China, India, Switzerland, and the U.S., please refer to the version 3.9 change report (Moreno Ruiz E. F., 2022).

6.2.1 Brazil

The Brazilian electricity market datasets are updated in line with previous ecoinvent versions, with 2023 taken as the reference year for the current update. The national energy balance was sourced from Brazil's Ministry of Mines and Energy (Minsitry of Mines and Energy, 2024). Electricity market share data compiled by (ACV Brazil, n.d.) was also incorporated into the update as in the previous ecoinvent versions.

6.2.2 China

The Chinese electricity market datasets are updated in line with previous ecoinvent versions, using national statistics from 2023 (National Bureau of Statistics of China, 2025).

6.2.3 India

The Indian electricity markets were updated in line with previous ecoinvent versions and represent the year 2022-2023 for v3.12. All electricity related statistics used for v3.12 updates are taken from the national statistics for the fiscal year[2] of 2022-2023 (Ministry of Power, 2024).

6.2.4 Switzerland

The Swiss electricity markets were updated in line with the ecoinvent version V3.8 (Moreno Ruiz E. F., 2021), which provides details on national data sources and methodologies. The present update uses 2023 as the reference year and are based on the national energy statistics (Swiss Federal Office of Energy, 2025), (Pronovo, 2025).

A technical correction was applied to the fossil fuel electricity reported from Germany to Switzerland, as described in section **6.4**.

6.2.5 Canada

The Canadian electricity market has been updated in line with the earlier ecoinvent versions, using the national statistics from 2023 (StatCAN, 2025).

6.2.6 United States

The US electricity market has been updated consistently with previous ecoinvent versions, based on 2023 national statistics from the EPA (EPA, 2025).

6.3 Residual Mix Update

The European electricity residual mix markets have been updated following the procedure established for version 3.9 of the ecoinvent database (Moreno Ruiz E. F., 2022) and represent the year 2024 in v3.12. The share of residual mixes implemented in v3.12 were calculated using the statistics from (AIB, 2025), applying the methodology developed by (Grexel, n.d.)

[2] The fiscal year of India starts on the 1st of April and ends on 31st March of the succeeding year (spanning two calendar years).

and used in earlier ecoinvent versions. For further details and explanation on the residual mix update, refer to the change report from v3.9 (Moreno Ruiz E. F., 2022).

An adjustment was made to the input data from (Grexel, n.d.) regarding electricity imports from Albania (AL) to Montenegro (ME). In 2024, some electricity volumes were reported as fossil “FO unspecified” for AL to ME imports, whereas no such volumes were recorded in 2023. Since Albania’s domestic electricity generation is nearly 100% renewable, these “FO unspecified” volumes were reassigned to specific generation technologies. The reassignment was based on Albania’s electricity import mix, ensuring the total reported volume from AL to ME remained unchanged. Using this method, the “FO unspecified” share was estimated to consist of 49% natural gas and 51% lignite.

6.4 Technical Corrections

A correction has been made regarding fossil fuel electricity imports from Germany to Switzerland. In version 3.11, all fossil-based electricity imports from Germany were grouped under the category “natural gas.” In version 3.12, this has been revised by separating the imports into coal, and natural gas-based electricity. With this disaggregation, fossil fuel electricity imports from Germany account for 0.58% from coal-based electricity and 0.28% from natural gas-based electricity within Switzerland’s total electricity mix. With this change in version 3.12, new datasets on electricity imports from Germany to Switzerland have been added, as outlined in **Table 26**.

7 Batteries and Electronics

The batteries and Electronics sector updates include several additional chemical components and various technical corrections to improve existing datasets or correct existing errors.

7.1 Technical Corrections

Table 27 below summarizes the changes in the datasets.

Table 27. Summary of corrections done to batteries and electronics datasets.

Activity Name	Geography	Correction Implemented
synthetic graphite production, battery grade, via Acheson powder route	CN	Update of the documentation to include the main reference of this dataset and to add details of the electricity calculation.
treatment of scrap lead acid battery, remelting	GLO, RER	Proxy update: replacement of the intermediate exchange flow "**sodium sulfate, anhydrite**" with "**sodium nitrate**" following proxy refinement. Mass input is maintained at unchanged amount.
electrolyte production, KOH, LiOH additive	GLO	Proxy update: replacement of the intermediate exchanges flow **"lithium"** and **"oxygen, liquid"** with **"lithium hydroxide"** following proxy refinement**.**
NCA oxide production, for Li-ion battery	CN, GLO	Update of the dataset to include the water used for rehydration of "**lithium hydroxide"**. The equation of the reaction is now corrected to: NCA(OH)2 + LiOH.**H2O** + 0.25 O2 --> Li-NCA-O2 + 2.5 H2O The properties of the exchanges "**lithium hydroxide**" and "**oxyge**n" were also updated.
cathode production, NMC622, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"polyvinylfluoride"** with **"polyvinylidene fluoride"** following proxy refinement**.** Mass input is maintained at unchanged amount.
cathode production, NMC811, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"polyvinylfluoride"** with **"polyvinylidene fluoride"** following proxy refinement. Mass input maintained at unchanged amoun

cathode production, LFP, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"polyvinylfluoride"** with **"polyvinylidene fluoride"** following proxy refinement. Mass input maintained at unchanged amount.
cathode production, NCA, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"polyvinylfluoride"** with **"polyvinylidene fluoride"** following proxy refinement. Mass input maintained at unchanged amount.
cathode production, NMC111, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"polyvinylfluoride"** with **"polyvinylidene fluoride"** following proxy refinement. Mass input maintained at unchanged amount.
cathode production, NMC532, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"polyvinylfluoride"** with **"polyvinylidene fluoride"** following proxy refinement. Mass input maintained at unchanged amount.
battery cell production, Li-ion, LiMn2O4	CN, GLO	Update of the documentation to clarify that the exchange **"used Li-ion Battery"** represents the manufacturing scrap.
anode production, graphite, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"latex"** with **"styrene butadiene rubber, emulsion polymerised"** following proxy refinement. Mass input maintained at unchanged amount**.**
anode production, silicon coated graphite, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"latex"** with **"styrene butadiene rubber, emulsion polymerised"** following proxy refinement. Mass input maintained at unchanged amount**.**
cathode production, LiMn2O4, for Li-ion battery	CN, GLO	Proxy update: replacement of the intermediate exchange **"latex"** with **"styrene butadiene rubber, emulsion polymerised"** following proxy refinement. Mass input maintained at unchanged amount**.** The energy is updated to a more recent source and to follow the same approach as the other chemistries of cathodes within the database.
NMC532 hydroxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.
NMC532 oxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.
NMC111 oxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.

NMC111 hydroxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.
NMC811 hydroxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.
NMC811 oxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.
NMC622 hydroxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.
NMC622 oxide production, for Li-ion battery	CN, GLO	Improvement of the documentation to include the chemical formula in the general comment.

Additionally, the heating value property were updated for the components of the battery sector.

7.2 New Data

Some new chemical components used in batteries where introduced. To see the complete list of newly introduced chemical compound please refer to section **5.6.3** of this report.

8 Metals

This update significantly expands and improves the data coverage of the Metals sector with new and updated datasets across multiple value chains.

In the aluminium sector, ecoinvent v3.12 includes updated datasets covering the entire production chain - from bauxite mining to ingot casting - together with an update of the electricity datasets supplying electricity to specific processing steps of this chain. These improvements offer a more accurate representation of the energy requirements and environmental impacts associated with aluminium production, enabling more precise modelling and decision-making.

In the steel sector, new datasets on different steel alloys have been added to meet the needs of users who require differentiated modelling for specific alloy compositions in specialised applications. This expansion supports more targeted and accurate life cycle assessments in sectors where material selection is critical to performance and sustainability outcomes.

New datasets are also introduced for Zamak production based on a high share of secondary zinc, providing detailed data for this zinc-based alloy widely used in casting applications. This is particularly relevant for industries requiring reliable modelling of Zamak's environmental footprint in applications such as automotive components and consumer products.

8.1 Aluminium

8.1.1 Aluminium Production

The aluminium production chain datasets, from bauxite mining to ingot casting has been updated with data from 2019 production, in collaboration with the International Aluminium Institute. Some activities (e.g., bauxite mining), have improved geographical coverage while others (e.g., aluminium production, primary, liquid, Soderberg) reflect the change of a decreased number of producing regions, and therefore only cover a global geography in v.3.12.

This update ensures that key production chains of metals, such as the one of aluminium, keep representing recent developments in production in several geographies. Furthermore, new import and export data has been leveraged, based on data from the International Aluminium Institute, to better represent markets composition. The new and updated datasets are reported in **Table 28**. The table also reports the datasets have have been removed in this release, as not relevant anymore of the supply chain.

Please note that the scores of the activities *anode production, prebake, for aluminium electrolysis* and *anode production, paste, for aluminium electrolysis* are affected by the change of using "petroleum coke" to using the exchange "calcined petroleum coke". This modification better represents the production process.

Following the reporting changes of IAI, the regions of 'IAI Area, EU27 & EFTA' and 'IAI Area, Russia & RER w/o EU27 & EFTA' have been adapted and renamed 'IAI Area, Western and Central Europe' and 'IAI Area, Russia and Eastern Europe' respectively.

Table 28.New and updated Aluminium production datasets. Activity names are reported in alphabetical order. In the column v3.12, "N": "New Activity", "U": "Updated Activity" and "D": "Deleted Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
aluminium hydroxide production	UN-OCEANIA	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	RNA	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	IAI Area, Asia, without China and GCC	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	IAI Area, Western and Central Europe	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	IAI Area, Russia and Eastern Europe	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	GLO	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	IAI Area, South America	2019-2019	aluminium hydroxide	kg	U
aluminium hydroxide production	IAI Area, Gulf Cooperation Council	2019-2019	aluminium hydroxide	kg	N
aluminium hydroxide production	CN	2019-2019	aluminium hydroxide	kg	U
aluminium oxide production	IAI Area, Gulf Cooperation Council	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	N
aluminium oxide production	IAI Area, South America	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U

aluminium oxide production	IAI Area, Western and Central Europe	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium oxide production	RNA	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium oxide production	IAI Area, Asia, without China and GCC	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium oxide production	GLO	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	N
aluminium oxide production	UN-OCEANIA	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium oxide production	CN	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium oxide production	IAI Area, Russia and Eastern Europe	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium production, primary, ingot	IAI Area, Africa	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U

aluminium production, primary, ingot	IAI Area, Asia, without China and GCC	2019-2019	aluminium oxide, metallurgical aluminium oxide, non-metallurgical	kg	U
aluminium production, primary, ingot	IAI Area, Western and Central Europe	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	IAI Area, Gulf Cooperation Council	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	IAI Area, Russia and Eastern Europe	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	IAI Area, South America	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	UN-OCEANIA	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	CA	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	CN	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, ingot	GLO	2019-2019	aluminium, primary, ingot	kg	U
aluminium production, primary, liquid, prebake	IAI Area, Russia and Eastern Europe	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	IAI Area, South America	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	UN-OCEANIA	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	CA	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	CN	2019-2019	aluminium, primary, liquid	kg	U

aluminium production, primary, liquid, prebake	GLO	2019-2019	aluminium, primary, liquid	kg	
aluminium production, primary, liquid, prebake	IAI Area, Africa	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	IAI Area, Asia, without China and GCC	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	IAI Area, Western and Central Europe	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, prebake	IAI Area, Gulf Cooperation Council	2019-2019	aluminium, primary, liquid	kg	U
aluminium production, primary, liquid, Söderberg	GLO	2019-2019	aluminium, primary, liquid	kg	U
anode production, paste, for aluminium electrolysis	GLO	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	CN	2019-2019	anode, prebake, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	GLO	2019-2019	anode, prebake, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	IAI Area, Africa	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	IAI Area, Asia, without China and GCC	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	IAI Area, Western and Central Europe	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	IAI Area, Gulf Cooperation Council	2019-2019	anode, paste, for aluminium electrolysis	kg	U

anode production, prebake, for aluminium electrolysis	IAI Area, Russia and Eastern Europe	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	IAI Area, South America	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	UN-OCEANIA	2019-2019	anode, paste, for aluminium electrolysis	kg	U
anode production, prebake, for aluminium electrolysis	CA	2019-2019	anode, paste, for aluminium electrolysis	kg	U
bauxite mine operation	IAI Area, South America	2019-2019	bauxite	kg	N
bauxite mine operation	UN-OCEANIA	2019-2019	bauxite	kg	N
bauxite mine operation	CN	2019-2019	bauxite	kg	N
bauxite mine operation	IAI Area, Asia, without China and GCC	2019-2019	bauxite	kg	N
bauxite mine operation	IAI Area, Western and Central Europe	2019-2019	bauxite	kg	N
bauxite mine operation	IAI Area, Gulf Cooperation Council	2019-2019	bauxite	kg	N
bauxite mine operation	GLO	2019-2019	bauxite	kg	U
market for aluminium oxide, metallurgical	IAI Area, Western and Central Europe	2019-2019	aluminium oxide, metallurgical	kg	U
market for aluminium oxide, metallurgical	IAI Area, South America	2019-2019	aluminium oxide, metallurgical	kg	N
market for aluminium oxide, metallurgical	IAI Area, Gulf Cooperation Council	2019-2019	aluminium oxide, metallurgical	kg	N

market for aluminium oxide, metallurgical	UN-OCEANIA	2019-2019	aluminium oxide, metallurgical	kg	N
market for aluminium oxide, metallurgical	CA	2019-2019	aluminium oxide, metallurgical	kg	N
market for aluminium oxide, metallurgical	CN	2019-2019	aluminium oxide, metallurgical	kg	N
market for aluminium oxide, metallurgical	GLO	2019-2019	aluminium oxide, metallurgical	kg	U
market for aluminium oxide, metallurgical	IAI Area, Asia, without China and GCC	2019-2019	aluminium oxide, metallurgical	kg	N
market for aluminium oxide, non-metallurgical	IAI Area, Western and Central Europe	2019-2019	aluminium oxide, metallurgical	kg	U
market for aluminium oxide, non-metallurgical	GLO	2019-2019	aluminium oxide, metallurgical	kg	U
market for aluminium, primary, ingot	IAI Area, South America	2019-2019	aluminium, primary, ingot	kg	N
market for aluminium, primary, ingot	UN-OCEANIA	2019-2019	aluminium, primary, ingot	kg	N
market for aluminium, primary, ingot	IAI Area, Western and Central Europe	2019-2019	aluminium, primary, ingot	kg	U
market for aluminium, primary, ingot	IAI Area, Gulf Cooperation Council	2019-2019	aluminium, primary, ingot	kg	N
market for aluminium, primary, ingot	IAI Area, North America	2019-2019	aluminium, primary, ingot	kg	U
market for aluminium, primary, ingot	CN	2019-2019	aluminium, primary, ingot	kg	N
market for aluminium, primary, ingot	GLO	2019-2019	aluminium, primary, ingot	kg	U

market for aluminium, primary, ingot	IAI Area, Asia, without China and GCC	2019-2019	aluminium, primary, ingot	kg	N
market for bauxite	IAI Area, Gulf Cooperation Council	2019-2019	bauxite	kg	N
market for bauxite	IAI Area, North America	2019-2019	bauxite	kg	N
market for bauxite	GLO	2019-2019	bauxite	kg	U
market for bauxite	IAI Area, Asia, without China and GCC	2019-2019	bauxite	kg	N
market for bauxite	IAI Area, Western and Central Europe	2019-2019	bauxite	kg	N
market for bauxite	IAI Area, South America	2019-2019	bauxite	kg	N
market for bauxite	UN-OCEANIA	2019-2019	bauxite	kg	N
market for bauxite	CN	2019-2019	bauxite	kg	N
aluminium oxide, metallurgical, import from Northern America	IAI Area, Western and Central Europe	2015-2015	aluminium oxide, metallurgical	kg	D
aluminium oxide, metallurgical, import from Rest of Europe	IAI Area, Western and Central Europe	2015-2015	aluminium oxide, metallurgical	kg	D
aluminium oxide, metallurgical, import from South America	IAI Area, Western and Central Europe	2015-2015	aluminium oxide, metallurgical	kg	D
aluminium, ingot, primary, import from Africa	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D

aluminium, ingot, primary, import from Africa	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Asia (excluding China)	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Asia (excluding China)	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from EU27 & EFTA	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Middle East (Gulf cooperation Council)	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Middle East (Gulf cooperation Council)	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Northern America	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Oceania	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Oceania	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Rest of Europe	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from Rest of Europe	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from South America	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, ingot	kg	D

aluminium, ingot, primary, import from South America	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium, ingot, primary, import from unspecified	IAI Area, North America	2016-2016	aluminium, primary, ingot	kg	D
aluminium production, primary, liquid, Söderberg	IAI Area, Western and Central Europe	2015-2015	aluminium, primary, liquid	kg	D
aluminium production, primary, liquid, Söderberg	IAI Area, Asia, without China and GCC	2015-2015	aluminium, primary, liquid	kg	D
aluminium production, primary, liquid, Söderberg	IAI Area, Russia and Eastern Europe	2015-2015	aluminium, primary, liquid	kg	D
aluminium production, primary, liquid, Söderberg	IAI Area, South America	2015-2015	aluminium, primary, liquid	kg	D
anode production, paste, for aluminium electrolysis	IAI Area, Africa	2015-2015	anode, paste, for aluminium electrolysis	kg	D
anode production, paste, for aluminium electrolysis	IAI Area, Asia, without China and GCC	2015-2015	anode, paste, for aluminium electrolysis	kg	D
anode production, paste, for aluminium electrolysis	IAI Area, Western and Central Europe	2015-2015	anode, paste, for aluminium electrolysis	kg	D
anode production, paste, for aluminium electrolysis	IAI Area, Gulf Cooperation Council	2015-2015	anode, paste, for aluminium electrolysis	kg	D
anode production, paste, for aluminium electrolysis	IAI Area, Russia and Eastern Europe	2015-2015	anode, paste, for aluminium electrolysis	kg	D
anode production, paste, for aluminium electrolysis	IAI Area, South America	2015-2015	anode, paste, for aluminium electrolysis	kg	D
anode production, paste, for aluminium electrolysis	UN-OCEANIA	2015-2015	anode, paste, for aluminium electrolysis	kg	D

8.1.2 Aluminium Industry Electricity

In version 3.12, electricity datasets for the aluminium industry were updated to reflect 2019 consumption patterns from the (IAI, 2024) replacing the previous v3.11 datasets that were based on 2015 statistics **Table 29.** These industry-specific electricity mixes represent the actual 2019 technological composition of electricity used for electrolysis and casting in primary aluminium production across different global regions, aligning with the updated aluminium supply chain datasets and providing more accurate environmental assessments than generic grid consumption data. The updated datasets serve as medium-voltage electricity inputs in the following aluminium production activities: anode production, prebake, for aluminium electrolysis; anode production, paste, for aluminium electrolysis; aluminium production, primary, ingot; aluminium production, primary, liquid, prebake; aluminium production, primary, liquid, Soderberg.

Table 29 contains the list of datasets that have been updated from version 3.11 with a new version, the new datasets introduced that do not have a matching dataset in v3.11 and the datasets that have been removed as they are no longer relevant for the updated regional electricity mixes.

Table 29. New and updated datasets for Aluminium Industry Electricity. In the column v3.12, "N": "New Activity", "U": "Updated Activity" and "D": "Deleted Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
electricity voltage transformation from high to medium voltage, aluminium industry	UN-OCEANIA	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	GLO	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	CN	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	CA	2019-2019	electricity, medium voltage, aluminium industry	kWh	U

market for electricity, high voltage, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, high voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	IAI Area, Gulf Cooperation Council	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	IAI Area, Africa	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	GLO	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	UN-OCEANIA	2019-2019	electricity, high voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	IAI Area, Gulf Cooperation Council	2019-2019	electricity, high voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	CA	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	CA	2019-2019	electricity, high voltage,	kWh	U

			aluminium industry		
market for electricity, medium voltage, aluminium industry	UN-OCEANIA	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	IAI Area, Gulf Cooperation Council	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	IAI Area, South America	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	GLO	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	CN	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	IAI Area, Africa	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, medium voltage, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	IAI Area, Africa	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	U

market for electricity, high voltage, aluminium industry	IAI Area, South America	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
market for electricity, high voltage, aluminium industry	CN	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity voltage transformation from high to medium voltage, aluminium industry	IAI Area, South America	2019-2019	electricity, medium voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	CN	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	GLO	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	IAI Area, Africa	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, coal, aluminium industry	UN-OCEANIA	2019-2019	electricity, high voltage, aluminium industry	kWh	U

electricity production, hydro, aluminium industry	CA	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	CN	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	IAI Area, Africa	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	IAI Area, South America	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	UN-OCEANIA	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, natural gas, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, natural gas, aluminium industry	IAI Area, Gulf Cooperation Council	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, natural gas, aluminium industry	IAI Area, South America	2019-2019	electricity, high voltage, aluminium industry	kWh	U

electricity production, nuclear, aluminium industry	GLO	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, nuclear, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, nuclear, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, oil, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, oil, aluminium industry	IAI Area, Gulf Cooperation Council	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, hydro, aluminium industry	GLO	2019-2019	electricity, high voltage, aluminium industry	kWh	N
electricity production, natural gas, aluminium industry	GLO	2019-2019	electricity, high voltage, aluminium industry	kWh	U
electricity production, natural gas, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, high voltage, aluminium industry	kWh	N
electricity production, natural gas, aluminium industry	UN-OCEANIA	2019-2019	electricity, high voltage, aluminium industry	kWh	N
electricity production, oil, aluminium industry	GLO	2019-2019	electricity, high voltage, aluminium industry	kWh	N
electricity production, oil, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, high voltage, aluminium industry	kWh	U

electricity production, other renewable, aluminium industry	CN	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other renewable, aluminium industry	GLO	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other renewable, aluminium industry	IAI Area, Asia, without China and GCC	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other renewable, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other renewable, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other renewable, aluminium industry	IAI Area, South America	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other renewable, aluminium industry	UN-OCEANIA	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other non-renewable, aluminium industry	GLO	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other non-renewable, aluminium industry	IAI Area, Africa	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other non-renewable, aluminium industry	IAI Area, Western and Central Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other non-renewable, aluminium industry	IAI Area, Russia and Eastern Europe	2019-2019	electricity, medium voltage, aluminium industry	kWh	N

electricity production, other non-renewable, aluminium industry	IAI Area, South America	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, other non-renewable, aluminium industry	UN-OCEANIA	2019-2019	electricity, medium voltage, aluminium industry	kWh	N
electricity production, coal, aluminium industry	RNA	2015-2015	electricity, high voltage, aluminium industry	kWh	D
electricity production, nuclear, aluminium industry	RNA	2015-2015	electricity, high voltage, aluminium industry	kWh	D
electricity production, natural gas, aluminium industry	CA	2015-2015	electricity, high voltage, aluminium industry	kWh	D
electricity production, oil, aluminium industry	UN-OCEANIA	2015-2015	electricity, high voltage, aluminium industry	kWh	D

8.2 Steel Alloys

In version 3.12, seven new steel alloy datasets were developed (together with their respective markets; **Table 30** to provide users with more accurate environmental impact assessments for specific steel grades.
These datasets are modelled based on 100% scrap input utilizing the Electric Arc Furnace (EAF) production route, reflecting modern secondary steel production practices.
The datasets were developed based on literature review and modelling approaches, incorporating established industry data on steel recycling processes, alloying element yields, and production parameters to create comprehensive life cycle inventories that account for the technical specificities of EAF-based alloy production. Key sources used to develop the datasets are (Tunc, Camdali, & Arasil, 2021) and the (JRC, 2013). Additional sources are documented in the individual dataset comments.
Each dataset reflects alloy-specific compositions adapted to mirror the precise metallurgical requirements of each steel grade. The datasets cover a diverse range of applications from structural construction and automotive components to bearing manufacturing and architectural projects, addressing the varying strength, corrosion resistance, and formability characteristics inherent to each alloy type. These improvements represent a significant enhancement of the ecoinvent database's coverage of steel alloys by incorporating alloy-specific compositions rather than generic steel datasets, providing users with more granular

and technically representative life cycle inventories for steel-based products and applications.

Table 30. New datasets for steel alloys.

Activity Name	Geography	Time Period	Product Name	Unit
steel production, electric arc furnace, bearing	RER	2023-2023	steel, bearing, 100% scrap	kg
steel production, electric arc furnace, carbon	RER	2023-2023	steel, carbon, 100% scrap	kg
steel production, electric arc furnace, case hardening	RER	2023-2023	steel, case hardening, 100% scrap	kg
steel production, electric arc furnace, high strength low alloy	RER	2023-2023	steel, high strength low alloy, 100% scrap	kg
steel production, electric arc furnace, structural	RER	2023-2023	steel, structural, 100% scrap	kg
steel production, electric arc furnace, weathering A	RER	2023-2023	steel, weathering A, 100% scrap	kg
steel production, electric arc furnace, weathering B	RER	2023-2023	steel, weathering B, 100% scrap	kg
market for steel, bearing, 100% scrap	GLO	2023-2023	steel, bearing, 100% scrap	kg
market for steel, carbon, 100% scrap	GLO	2023-2023	steel, carbon, 100% scrap	kg
market for steel, case hardening, 100% scrap	GLO	2023-2023	steel, case hardening, 100% scrap	kg
market for steel, high strength low alloy, 100% scrap	GLO	2023-2023	steel, high strength low alloy, 100% scrap	kg
market for steel, structural, 100% scrap	GLO	2023-2023	steel, structural, 100% scrap	kg
market for steel, weathering A, 100% scrap	GLO	2023-2023	steel, weathering A, 100% scrap	kg
market for steel, weathering B, 100% scrap	GLO	2023-2023	steel, weathering B, 100% scrap	kg

8.3 Zamak

In version 3.12, a new dataset for the production of the zinc alloy Zamak was developed to represent this widely used material across automotive, hardware, electrical, and decorative applications, in collaboration with the International Zinc Association. The dataset "zamak ingot production, 10% primary zinc input" models the production of Zamak alloys with their characteristic composition of zinc (93-96%), aluminum (3.7-4.5%), magnesium (0-0.05%), and copper (0-3%), covering the primary Zamak grades (2, 3, 5, and 7). The production process encompasses scrap sorting, melting with controlled addition of primary zinc and alloying elements, refining for impurity removal, and gravity casting into steel molds. Production data were collected from representative European manufacturers for 2023-2024, covering approximately 76% of annual European Zamak production. Additionally, an aggregated process-specific dataset "aggregated process-specific inputs, Zamak ingot production" was created to model the combined inputs of magnesium, chemical additives, and process gases, with the unit process inventory kept confidential to protect sensitive industrial data. Corresponding market datasets complete the supply chain representation for Zamak alloy production in the database **Table 31.**

Table 31. New datasets for Zamak

Activity Name	Geography	Time Period	Product Name	Unit
zamak ingot production, 10% primary zinc input	RER	2023-2024	zamak ingot, 10% primary zinc input	kg
aggregated process-specific inputs, zamak ingot production	RER	2023-2024	aggregated process-specific inputs, zamak ingot production	unit
market for zamak ingot, 10% primary zinc input	RER	2023-2024	zamak ingot, 10% primary zinc input	kg
market for aggregated process-specific inputs, zamak ingot production	RER	2023-2024	aggregated process-specific inputs, zamak ingot production	unit

8.4 Other Updates

Version 3.12 also contains improvements based on punctual corrections of datasets (**Table 32**). If not clearly described in the table, the correction represents a minor change.

Table 32. Dataset corrections. The column 'Object of the correction 'indicates the fields that were modified during the correction process, with additional comments provided for more significant changes.

Activity Name	Geography	Time Period	Product Name	Unit	Object of the Correction
abrasive blasting, alumina, carbon steel substrate	GLO	2022-2022	alumina, carbon steel substrate	m2	General Comment; Published Source
energy and auxilliary inputs, metal working factory, with heating from hard coal,	RER, GLO	2006-2007	energy and auxiliary inputs, metal working factory	kg	exchange FromTechnosphere 'heat, district or industrial, other than natural gas' corrected to link directly to specific heat source ('heat production, at hard coal industrial furnace 1-10MW') rather than the generic 'market for heat, district or industrial, other than natural gas'
energy and auxilliary inputs, metal working factory, with heating from heavy fuel oil,	RER, GLO	2006-2007	energy and auxiliary inputs, metal working factory	kg	exchange FromTechnosphere 'heat, district or industrial, other than natural gas' corrected to link directly to specific heat source ('heat production, heavy fuel oil, at industrial furnace 1MW') rather than the generic 'market for heat, district or industrial, other than natural gas'
energy and auxiliary inputs, metal working factory, with heating from light fuel oil,	RER.GLO	2006-2007	energy and auxiliary inputs, metal working factory	kg	exchange FromTechnosphere 'heat, district or industrial, other than natural gas' corrected to link directly to specific heat source ('heat production, light fuel oil, at industrial furnace 1MW') rather than the generic 'market for heat, district or

					industrial, other than natural gas'
Market for beryllium	GLO	2013-2020	beryllium	kg	General Comment
market for steel, chromium steel 18/8	GLO	2011-2011	steel, chromium steel 18/8	kg	Included activities ends; Geography comment
market for steel, low-alloyed	GLO	2011-2011	steel, low-alloyed	kg	Included activities ends; Geography comment; comment to the exchange FromTechnosphere 'iron scrap, unsorted'
market for steel, unalloyed	GLO	2011-2011	steel, unalloyed	kg	Included activities ends; Geography comment
reinforcing steel production	Europe without Austria	200-2002	reinforcing steel	kg	Included activities ends; General comment
reinforcing steel production	GLO	200-2002	reinforcing steel	kg	Included activities ends
steel production, chromium steel 18/8, hot rolled	GLO, RER	200-2002	steel, chromium steel 18/8, hot rolled	kg	Included activities ends
steel production, converter, low-alloyed	GLO RER	2013-2023	steel, low-alloyed	kg	Sampling procedure
steel production, converter, low-alloyed	RER, GLO	2013-2023	steel, low-alloyed	kg	Included activities ends
steel production, converter, unalloyed	GLO	2013-2023	steel, unalloyed		Sampling procedure
steel production, converter, unalloyed	RER	2013-2023	steel, unalloyed	kg	Included activities ends
steel production, electric, chromium steel 18/8	GLO RER	2013-2023	steel, chromium steel 18/8, hot rolled	kg	Sampling procedure
steel production, electric, low-alloyed	Europe without Switzerland	2010-2023	steel, low-alloyed	kg	Sampling procedure

steel production, electric, low-alloyed	Austria	2010-2023	steel, low-alloyed	kg	Included activities ends; General comment
steel production, low-alloyed, hot rolled	RER, GLO	200-2002	steel, low-alloyed, hot rolled	kg	Included activities ends
thermal spraying, atmospheric plasma spray, tungsten carbide-cobalt, on carbon steel substrate	GLO	2022-2022	thermal spraying, atmospheric plasma spray, tungsten carbide-cobalt, on carbon steel substrate	m2	General Comment; Published Source
thermal spraying, cold spray, tungsten carbide-cobalt, on carbon steel substrate	GLO	2022-2022	thermal spraying, cold spray, tungsten carbide-cobalt, on carbon steel substrate	m2	General Comment; Published Source
thermal spraying, high velocity oxyfuel, tungsten carbide-cobalt, on carbon steel substrate	GLO	2022-2022	thermal spraying, high velocity oxyfuel, tungsten carbide-cobalt, on carbon steel substrate	m2	General Comment; Published Source
Treatment of copper scrap by electrolytic refinement	RER, GLO	1994-2004	Copper scrap, sorted, pressed	kg	General Comment
zinc oxide production	RER	2005-2020	zinc oxide	kg	exchange FromTechnosphere *zinc scrap*: the proxy ‘iron scrap, sorted, pressed’ was replaced to 'zinc | zinc scrap, post-consumer' from the generic market for zinc, better reflecting the actual zinc supply chain.
zinc oxide production	GLO	2005-2020	zinc oxide	kg	exchange FromTechnosphere *zinc scrap*: the proxy ‘iron scrap, sorted, pressed’ was replaced to 'zinc | zinc scrap, post-consumer'

		from the generic market for zinc, better reflecting the actual zinc supply chain.

Additionally, there have been the following modifications to products included in **Table 33**.

Table 33: Products corrections. The column ‘Object of the correction‘ indicates the fields that were modified during the correction process.

Product	Object of the correction
copper, cathode	Product description has been modified to better reflect the final product form.
steel, chromium steel 18/8	Price property has been updated

9 Waste Management and Recycling

9.1 Sector Introduction

The waste treatment and recycling sector encompasses more than 3500 datasets covering the management of solid wastes (treatment, recycling, disposal) and wastewater treatment. There is a large interplay with other sectors as they generate wastes to be disposed of, or those treatments provide valuable products to re-enter the market. Waste specificity and regional differentiation are important characteristics of waste treatment datasets. Previous versions have seen large additions of datasets for the sector to increase regional and waste coverage.

9.2 Updates in the Waste Sector for Version 3.12

The waste sector does not introduce as many new datasets for 3.12, where previous updates saw new datasets due to remodelling and regionalisation. Focus has been on updating and amending the published datasets as well as developing data projects for future releases. This section details the updates that made it into version 3.12.

9.2.1 Integration of Recyclable Polymers

In version 3.11, European plastic recycling was expanded heavily via a collaboration with Plastic Recyclers Europe. For version 3.12, the plastic waste generated in mainly European datasets was assessed to determine whether their output flows would be recycled. The following datasets (see **Table 34**) had their waste plastic flows updated to utilise the new plastic recycling datasets:

Table 34. Datasets updated to integrate recyclable polymers in Europe.

Activity Name	Geography	Comment
extrusion of plastic sheets and thermoforming, inline	FR	Replacing waste polypropylene with recyclable.
metal working machine production, unspecified	RER	Replacing waste polyethylene with recyclable.
photovoltaic mounting system production, for facade installation	RER	Replacing waste polyethylene/polypropylene product with recyclable
photovoltaic mounting system production, for flat-roof installation	RER	Replacing waste polyethylene/polypropylene product with recyclable
photovoltaic mounting system production, for slanted-roof installation	RER	Replacing waste polyethylene/polypropylene product with recyclable
plastic tunnel construction	FR	Introducing 25.2% recyclable polyvinylchloride
treatment of kitchen and garden biowaste, home composting in heaps and containers	FR	Introducing 25.2% recyclable polyethylene
treatment of used vegetable cooking oil, purification	CA-QC	Replacing waste polyethylene terephthalate with recyclable (GLO recycling available)

tree seedling production, in heated greenhouse	RER	Introducing 20% recycling of low density and of high density polyethylene
tree seedling production, in unheated greenhouse	RER	Introducing 20% recycling of low density and of high density polyethylene
container production, for collection of post-consumer waste plastic for recycling	CH	Replacing waste polyethylene and polypropylene with recyclables.
container production, for collection of post-consumer waste plastic for recycling	Europe without Switzerland	Replacing waste polyethylene and polypropylene with recyclables.
tomato production, fresh grade, in unheated greenhouse	ES	Introducing 50% recycling based on data provider comment of waste polyethylene and polystyrene

This update enhances the modelling of supply chains, as the producers of the treated plastics are now linked to the recycling processes. In system models that avoid cut-off points between recyclers and producers (e.g. APOS), this can lead to an increased burden for the recycled outputs, as they are now partially burdened by their origin as well.

9.2.2 Update of Chromium Emissions of Electric Arc Furnace Slag Landfilling

Electric arc furnace slag goes to residual material landfill and contains Chromium. Recent outreach from users and measurements of this waste have shown that the available chromium for leaching to the environment (Chromium VI) is much less abundant, but rather stably bound as Chromium III in Chromite (BAFU & Carbotech, 2021). The following datasets (see **Table 35**) had their Chromium emissions reduced to align with this information.

Table 35. Updated datasets to update Chromium VI emission. Two datasets are concerned, in the Swiss and Global geographies.

Activity Name	Geography
treatment of electric arc furnace slag, residual material landfill	CH; GLO

This update influences toxicity scores especially for the metals sector, reducing it to much more representative levels.

9.2.3 Direct Disposal of Wastewater from Textile Production

In version 3.11 we introduced the wastewater treatment of wastewater from textile production for Europe and Global geographies. Some datasets in India and Bangladesh inadvertently linked to the Global treatment instead of linking directly to the previous “direct disposal of wastewater from textile production” as it was in previous versions and as intended by the data provider.

We therefore remedy this in version 3.12 by creating specific markets for wastewater from textile production in India and Bangladesh, so that the intended disposal pathway is preserved.

We introduced the following datasets as copies of the previous direct disposal pathway.

Table 36. Reintroduced textile wastewater datasets. India and Bangladesh get the direct disposal of wastewater from textile production and their own markets.

Activity Name	Geography
direct disposal of wastewater from textile production	IN
direct disposal of wastewater from textile production	BD
market for wastewater from textile production	IN
market for wastewater from textile production	BD

Which is now properly linked to and used by the following datasets in **Table 37**.

Table 37. Textile related datasets in India and Bangladesh. These datasets now link their wastewater disposal to the new direct disposals.

Activity Name	Geography
reeled raw silk hank production	IN
yarn production, jute	BD
batch dyeing, fibre, cotton	BD
yarn production, jute	IN
bleaching, textile	BD
bleaching and dyeing, yarn	BD
batch dyeing, fibre, cotton	IN
mercerizing, textile	IN
bleaching and dyeing, yarn	IN

bleaching, textile	IN

9.2.4 VOC and Transport in Plastic Recycling US/GLO

The US and GLO datasets for recycling PET and PE plastics had minor mistakes in the amount of VOC emission as well as the upstream transport value used in collection and delivery (represented in the market). The transport value was recalculated based on the source paper. The VOC value reported was the sum of transport, sorting and recycling but mistakenly placed entirely in the recycling activity, thus double counting the VOC emission of the transport. The VOC of the new transport was subtracted from the previous VOC value, giving a minor decrease in VOC emissions in recycling. The datasets impacted by this update are listed in **Table 38**.

Table 38. Datasets updated for VOC and transport. These plastic recycling datasets had erroneous sums of VOC compared to the source material. Transport and VOC updated after recalculation.

Activity Name	Geography	Comment
polyethylene terephthalate production, granulate, amorphous, recycled	GLO	VOC emissions recalculated (slight reduction)
polyethylene terephthalate production, granulate, amorphous, recycled	US	VOC emissions recalculated (slight reduction)
market for waste polyethylene terephthalate, for recycling, unsorted	GLO	Transport recalculated (collection, delivery)
market for waste polyethylene terephthalate, for recycling, unsorted	US	Transport recalculated (collection, delivery)
market for waste polyethylene, for recycling, unsorted	GLO	Transport recalculated (collection, delivery)
market for waste polyethylene, for recycling, unsorted	US	Transport recalculated (collection, delivery)

9.2.5 Landfarming Emissions of Carbon Dioxide

An error was identified in the landfarming datasets of sludges from treated leachate of municipal solid waste landfilling, which were introduced on v3.11. The carbon contained mineralizes to carbon dioxide, but a wrong scaling factor was used, leading to more carbon emitted than was contained in the sludge. The following datasets have been individually updated to have the correct sum of carbon released and the correct ratio of biogenic and fossil carbon:

Table 39. Landfarming datasets with updated carbon dioxide emission. These datasets were introduced in 3.11 for the regionalisation of municipal solid waste management in Europe and have for 3.12 had an

error adjusted in the emission of carbon dioxide to reflect the actual sludge from leachate treatment carbon content.

Activity Name	Geographies
treatment of sewage sludge, 97% water, WWT-SLF, municipal solid waste, landfarming	SK; SI; SE; PT; PL; NO; NL; LV; LT; IT; IS; IE; HU; HR; GR; GB; FR; FI; ES; EE; DK; DE; CZ; CY; BG; BE

9.2.6 Amending General Comment Errors

Some waste treatment datasets referred either to an outdated or a wrong reference product. The following datasets were updated (see **Table 40**).

Table 40. Dataset documentation updated. These datasets had wrong reference products mentioned in the general comment due to renaming and other errors. The meta documentation has been amended.

Activity Name	Geographies
treatment of inert waste, sanitary landfill	RER
treatment of waste aluminium, municipal incineration	Europe without Switzerland; GLO
treatment of waste aluminium, municipal incineration FAE	CH
treatment of waste copper, municipal incineration	Europe without Switzerland; GLO
treatment of waste copper, municipal incineration FAE	CH
treatment of waste mix of pitch and coke, from graphite block forming, unsanitary landfill	CN
treatment of waste steel, inert material landfill	Europe without Switzerland
treatment of waste steel, municipal incineration	Europe without Switzerland; GLO
treatment of waste steel, municipal incineration FAE	CH
treatment of waste tin sheet, municipal incineration	GLO

treatment of waste tin sheet, municipal incineration FAE	CH
treatment of waste tin sheet, sanitary landfill	EC; GLO; PE
treatment of wastewater from PV cell production, wastewater treatment	CH

9.2.7 ISIC Classification Alignment

Some waste treatment datasets had misaligned ISIC codes. We updated the following ISIC classifications for version 3.12. Especially residues from incineration were affected, as the treatments were classified as hazardous disposal, whilst their corresponding markets were erroneously classified as non-hazardous.

Table 41. Waste datasets with aligned ISIC values. These datasets had a mismatch between treatment and market activities in terms of their ISIC classification. Especially prevalent are the markets for incineration residues.

New ISIC value	Activity Name
0910:Support activities for petroleum and natural gas extraction	market for water discharge from petroleum extraction, offshore; market for water discharge from petroleum/natural gas extraction, onshore; treatment of water discharge from petroleum extraction, offshore; treatment of water discharge from petroleum/natural gas extraction, onshore
35:Electricity, gas, steam and air conditioning supply	heat production, biomethane, low pressure, at diffusion absorption heat pump 4kW, future
3510:Electric power generation, transmission and distribution	market for electricity, for reuse in municipal waste incineration only
3520:Manufacture of gas; distribution of gaseous fuels through mains	market for biogas; market for biogas, from grass
3530:Steam and air conditioning supply	heat and power co-generation, biogas, gas engine; heat and power co-generation, biogas, gas engine, renewable energy products; market for heat, for reuse in municipal waste incineration only
3700:Sewerage	market for leachate, SLF, cake from recycling of waste plastic, WEEE; market for leachate, SLF, cake from sorting of waste plastic; market for

	wastewater from PET pelletising; market for wastewater from recycling of waste PET; market for wastewater from recycling of waste PP
3822:Treatment and disposal of hazardous waste	market for antimony slag, desulfurised; market for antimony slag, water-quenched; market for ash from deinking sludge; market for ash from paper production sludge; market for average incineration residue; market for basic oxygen furnace dust; market for basic oxygen furnace secondary metallurgy slag; market for basic oxygen furnace slag; market for basic oxygen furnace sludge; market for basic oxygen furnace waste; market for blast furnace dust; market for blast furnace sludge; market for copper slag; market for decarbonising waste; market for drilling waste; market for dross from Al electrolysis; market for electric arc furnace dust; market for electric arc furnace secondary metallurgy slag; market for electric arc furnace slag; market for filter dust from Al electrolysis; market for green liquor dregs; market for H3PO4 purification residue; market for hard coal ash; market for lead smelter slag; market for lignite ash; market for mill scale; market for nickel smelter slag; market for pollutant from rail ballast; market for redmud from bauxite digestion; market for refinery sludge; market for refractory spent pot liner from Al electrolysis; market for residue from Na-dichromate production; market for residue from rutile production, synthetic, 56% water; market for residue from TiO2 production, chloride process; market for residue from TiO2 production, sulfate process; market for residues, MSWI, aluminium in car shredder residue; market for residues, MSWI, biowaste; market for residues, MSWI, cake from recycling of waste plastic, WEEE; market for residues, MSWI, cake from sorting of waste plastic; market for residues, MSWI, copper in car shredder residue; market for residues, MSWI, digester sludge; market for residues, MSWI, LDPE in waste fresh milk carton (chilled), post-industrial; market for residues, MSWI, LDPE/Alu in waste juice carton (ambient), post-industrial; market for residues, MSWI, LDPE/Alu in waste UHT milk carton (ambient), post-industrial; market for residues, MSWI, lead in car shredder residue; market for residues, MSWI, municipal solid waste; market for residues, MSWI, raw sewage sludge; market for residues, MSWI, residue from mechanical treatment, CRT display; market for residues, MSWI, residue from mechanical treatment, desktop computer; market for residues, MSWI, residue from mechanical treatment, industrial device; market for residues, MSWI, residue from mechanical treatment, IT accessory; market for residues, MSWI, residue from mechanical treatment, laptop computer; market for residues, MSWI, residue from mechanical treatment, laser printer; market for residues, MSWI, residue from mechanical treatment, LCD; market for residues, MSWI, residue from shredder fraction from manual dismantling; market for residues, MSWI, residues from sorting of waste plastic; market for residues, MSWI, sieving machine sludge from recycling of HDPE; market for residues, MSWI, spent anion exchange resin from potable water production; market for residues, MSWI, spent cation exchange resin from potable water production; market for residues, MSWI, steel in car shredder residue; market for residues, MSWI, used LCD module; market for residues, MSWI, waste bitumen sheet; market for residues, MSWI, waste building wood, chrome preserved; market for residues, MSWI, waste cement-fibre slab, dismantled; market for residues, MSWI, waste emulsion paint; market for residues, MSWI, waste expanded

	polystyrene; market for residues, MSWI, waste graphical paper; market for residues, MSWI, waste newspaper; market for residues, MSWI, waste packaging paper; market for residues, MSWI, waste paint; market for residues, MSWI, waste paperboard; market for residues, MSWI, waste plastic, consumer electronics; market for residues, MSWI, waste plastic, industrial electronics; market for residues, MSWI, waste plastic, mixture; market for residues, MSWI, waste plastic, WEEE, dust; market for residues, MSWI, waste polyethylene; market for residues, MSWI, waste polyethylene terephthalate; market for residues, MSWI, waste polyethylene terephthalate, dust; market for residues, MSWI, waste polypropylene; market for residues, MSWI, waste polystyrene; market for residues, MSWI, waste polyurethane; market for residues, MSWI, waste polyvinylchloride; market for residues, MSWI, waste polyvinylfluoride; market for residues, MSWI, waste rubber, unspecified; market for residues, MSWI, waste sealing sheet, polyethylene; market for residues, MSWI, waste sealing sheet, polyvinylchloride; market for residues, MSWI, waste sink from recycling of HDPE; market for residues, MSWI, waste textile, soiled; market for residues, MSWI, waste tin sheet; market for residues, MSWI, waste vapour barrier, flame-retarded; market for residues, MSWI, waste wire plastic; market for residues, MSWI, waste wood pole, chrome preserved; market for residues, MSWI, waste wood, untreated; market for residues, MSWI, zinc in car shredder residue; market for residues, MSWI[F], aluminium in car shredder residue; market for residues, MSWI[F], biowaste; market for residues, MSWI[F], copper in car shredder residue; market for residues, MSWI[F], digester sludge; market for residues, MSWI[F], lead in car shredder residue; market for residues, MSWI[F], municipal solid waste; market for residues, MSWI[F], raw sewage sludge; market for residues, MSWI[F], residue from mechanical treatment, CRT display; market for residues, MSWI[F], residue from mechanical treatment, desktop computer; market for residues, MSWI[F], residue from mechanical treatment, industrial device; market for residues, MSWI[F], residue from mechanical treatment, IT accessory; market for residues, MSWI[F], residue from mechanical treatment, laptop computer; market for residues, MSWI[F], residue from mechanical treatment, laser printer; market for residues, MSWI[F], residue from mechanical treatment, LCD; market for residues, MSWI[F], residue from shredder fraction from manual dismantling; market for residues, MSWI[F], spent anion exchange resin from potable water production; market for residues, MSWI[F], spent cation exchange resin from potable water production; market for residues, MSWI[F], steel in car shredder residue; market for residues, MSWI[F], used LCD module; market for residues, MSWI[F], waste bitumen sheet; market for residues, MSWI[F], waste building wood, chrome preserved; market for residues, MSWI[F], waste cement-fibre slab, dismantled; market for residues, MSWI[F], waste emulsion paint; market for residues, MSWI[F], waste expanded polystyrene; market for residues, MSWI[F], waste graphical paper; market for residues, MSWI[F], waste newspaper; market for residues, MSWI[F], waste packaging paper; market for residues, MSWI[F], waste paint; market for residues, MSWI[F], waste paperboard; market for residues, MSWI[F], waste plastic, consumer electronics; market for residues, MSWI[F], waste plastic, industrial electronics; market for residues, MSWI[F], waste plastic, mixture; market for residues, MSWI[F],

waste polyethylene; market for residues, MSWI[F], waste polyethylene terephthalate; market for residues, MSWI[F], waste polypropylene; market for residues, MSWI[F], waste polystyrene; market for residues, MSWI[F], waste polyurethane; market for residues, MSWI[F], waste polyvinylchloride; market for residues, MSWI[F], waste polyvinylfluoride; market for residues, MSWI[F], waste rubber, unspecified; market for residues, MSWI[F], waste sealing sheet, polyethylene; market for residues, MSWI[F], waste sealing sheet, polyvinylchloride; market for residues, MSWI[F], waste textile, soiled; market for residues, MSWI[F], waste tin sheet; market for residues, MSWI[F], waste vapour barrier, flame-retarded; market for residues, MSWI[F], waste wire plastic; market for residues, MSWI[F], waste wood pole, chrome preserved; market for residues, MSWI[F], waste wood, untreated; market for residues, MSWI[F], zinc in car shredder residue; market for residues, MSWI[F]-WWT, condensate from light oil boiler; market for residues, MSWI[F]-WWT, heat carrier liquid, 40% C3H8O2; market for residues, MSWI[F]-WWT, rainwater mineral oil storage; market for residues, MSWI[F]-WWT, WW from black chrome coating; market for residues, MSWI[F]-WWT, WW from ceramic production; market for residues, MSWI[F]-WWT, WW from concrete production; market for residues, MSWI[F]-WWT, WW from CRT production; market for residues, MSWI[F]-WWT, WW from glass production; market for residues, MSWI[F]-WWT, WW from grass refinery; market for residues, MSWI[F]-WWT, WW from LCD backlight production; market for residues, MSWI[F]-WWT, WW from LCD production; market for residues, MSWI[F]-WWT, WW from liquid crystal production; market for residues, MSWI[F]-WWT, WW from maize starch production; market for residues, MSWI[F]-WWT, WW from pig iron production; market for residues, MSWI[F]-WWT, WW from plywood production; market for residues, MSWI[F]-WWT, WW from potato starch production; market for residues, MSWI[F]-WWT, WW from PV cell production; market for residues, MSWI[F]-WWT, WW from soft fibreboard production; market for residues, MSWI[F]-WWT, WW from tube collector production; market for residues, MSWI[F]-WWT, WW from wafer fabrication; market for residues, MSWI[F]-WWT, WW, average; market for residues, MSWI[F]-WWT[R], WW from anaerobic digestion of whey; market for residues, MSWI[F]-WWT[U], WW from lorry production; market for residues, MSWI[F]-WWT-SLF, refinery sludge; market for residues, MSWI[F]-WWT-SLF, residue from cooling tower; market for residues, MSWI[F]-WWT-SLF, sludge from pulp and paper production; market for residues, MSWI[F]-WWT-SLF, waste aluminium; market for residues, MSWI[F]-WWT-SLF, waste asphalt; market for residues, MSWI[F]-WWT-SLF, waste bitumen; market for residues, MSWI[F]-WWT-SLF, waste emulsion paint; market for residues, MSWI[F]-WWT-SLF, waste graphical paper; market for residues, MSWI[F]-WWT-SLF, waste gypsum; market for residues, MSWI[F]-WWT-SLF, waste newspaper; market for residues, MSWI[F]-WWT-SLF, waste paint; market for residues, MSWI[F]-WWT-SLF, waste paperboard; market for residues, MSWI[F]-WWT-SLF, waste plastic plaster; market for residues, MSWI[F]-WWT-SLF, waste plastic, mixture; market for residues, MSWI[F]-WWT-SLF, waste polyethylene; market for residues, MSWI[F]-WWT-SLF, waste polyethylene terephthalate; market for residues, MSWI[F]-WWT-SLF, waste polypropylene; market for residues, MSWI[F]-WWT-SLF, waste polystyrene; market for residues, MSWI[F]-WWT-

	SLF, waste polyurethane; market for residues, MSWI[F]-WWT-SLF, waste polyvinylchloride; market for residues, MSWI[F]-WWT-SLF, waste wood, untreated; market for residues, MSWI[F]-WWT-SLF, wood ash mixture, pure; market for residues, MSWI-WWT, condensate from light oil boiler; market for residues, MSWI-WWT, heat carrier liquid, 40% C3H8O2; market for residues, MSWI-WWT, rainwater mineral oil storage; market for residues, MSWI-WWT, WW from ammonium paratungstate production; market for residues, MSWI-WWT, WW from black chrome coating; market for residues, MSWI-WWT, WW from ceramic production; market for residues, MSWI-WWT, WW from concrete production; market for residues, MSWI-WWT, WW from CRT production; market for residues, MSWI-WWT, WW from GGBFS production; market for residues, MSWI-WWT, WW from glass production; market for residues, MSWI-WWT, WW from grass refinery; market for residues, MSWI-WWT, WW from hard fibreboard production; market for residues, MSWI-WWT, WW from LCD backlight production; market for residues, MSWI-WWT, WW from LCD production; market for residues, MSWI-WWT, WW from liquid crystal production; market for residues, MSWI-WWT, WW from maize starch production; market for residues, MSWI-WWT, WW from medium density board production; market for residues, MSWI-WWT, WW from particle board production; market for residues, MSWI-WWT, WW from PET pelletising; market for residues, MSWI-WWT, WW from pig iron production; market for residues, MSWI-WWT, WW from plywood production; market for residues, MSWI-WWT, WW from polyester recycling; market for residues, MSWI-WWT, WW from potato starch production; market for residues, MSWI-WWT, WW from PV cell production; market for residues, MSWI-WWT, WW from recycling of waste PET; market for residues, MSWI-WWT, WW from recycling of waste PP; market for residues, MSWI-WWT, WW from soft fibreboard production; market for residues, MSWI-WWT, WW from tube collector production; market for residues, MSWI-WWT, WW from vegetable oil refinery; market for residues, MSWI-WWT, WW from wafer fabrication; market for residues, MSWI-WWT, WW, average; market for residues, MSWI-WWT[R], WW from anaerobic digestion of whey; market for residues, MSWI-WWT[U], WW from lorry production; market for residues, MSWI-WWT-SLF, cake from recycling of waste plastic, WEEE; market for residues, MSWI-WWT-SLF, cake from sorting of waste plastic; market for residues, MSWI-WWT-SLF, hard coal ash; market for residues, MSWI-WWT-SLF, inert waste; market for residues, MSWI-WWT-SLF, lignite ash; market for residues, MSWI-WWT-SLF, municipal solid waste; market for residues, MSWI-WWT-SLF, refinery sludge; market for residues, MSWI-WWT-SLF, residue from cooling tower; market for residues, MSWI-WWT-SLF, sludge from pulp and paper production; market for residues, MSWI-WWT-SLF, waste aluminium; market for residues, MSWI-WWT-SLF, waste asphalt; market for residues, MSWI-WWT-SLF, waste bitumen; market for residues, MSWI-WWT-SLF, waste emulsion paint; market for residues, MSWI-WWT-SLF, waste glass; market for residues, MSWI-WWT-SLF, waste graphical paper; market for residues, MSWI-WWT-SLF, waste gypsum; market for residues, MSWI-WWT-SLF, waste packaging paper; market for residues, MSWI-WWT-SLF, waste paint; market for residues, MSWI-WWT-SLF, waste paperboard; market for residues, MSWI-WWT-SLF, waste plastic plaster; market for residues, MSWI-WWT-SLF, waste plastic, mixture; market for residues,

	MSWI-WWT-SLF, waste polyethylene; market for residues, MSWI-WWT-SLF, waste polyethylene terephthalate; market for residues, MSWI-WWT-SLF, waste polypropylene; market for residues, MSWI-WWT-SLF, waste polystyrene; market for residues, MSWI-WWT-SLF, waste polyurethane; market for residues, MSWI-WWT-SLF, waste polyvinylchloride; market for residues, MSWI-WWT-SLF, waste tin sheet; market for residues, MSWI-WWT-SLF, waste wood, untreated; market for residues, MSWI-WWT-SLF, wood ash mixture, pure; market for residues, MSWI-WWT-SLF[W], waste plastic, consumer electronics; market for salt tailing from potash mine; market for sludge from steel rolling; market for sludge, NaCl electrolysis; market for sludge, NaCl electrolysis Hg; market for spent catalyst base from ethyleneoxide production; market for spent catalytic converter NOx reduction; market for spent Formox catalyst base from formaldehyde production; market for spent pot liner from Al electrolysis, carbon fraction; market for tin slag; market for waste emulsion paint; market for waste paint; market for zinc slag; treatment of spent catalytic converter NOx reduction, underground deposit; treatment of spent oxychlor catalyst, underground deposit

9.2.8 EN15804 Waste Inventory Indicators Alignment

Waste treatment processes often include the Elementary Exchanges “Hazardous waste disposed” and “Non-hazardous waste disposed”, to be used by the EN15804 system model and calculation. We are aware that the current implementation of these indicators differs from the several interpretations of the EN15804 standard used by others. The changes included in version 3.12 do not address all these concerns. A more thorough revision of the implementation will be carried out for a later version.

However, we can strive towards internal consistency. The following disposal datasets did not include the indicator, even though they are disposals of waste. We added the exchanges “Hazardous waste disposed” (HWD) or “Non-hazardous waste disposed” (NHWD) to the following activities:

Table 42. Datasets with EN15804 waste inventory indicators added. These datasets did not have an emission of the inventory indicators “Hazardous waste disposed” (HWD) or “Non-hazardous waste disposed” (NHWD). They have been added for version 3.12.

Activity Name	Indicator added
treatment of bilge oil, hazardous waste incineration	HWD
treatment of bilge oil, hazardous waste incineration, with energy recovery	HWD
treatment of coal slurry, impoundment	HWD
treatment of fly ash and scrubber sludge, hazardous waste incineration	HWD
treatment of fly ash and scrubber sludge, hazardous waste incineration, with energy recovery	HWD

treatment of hazardous waste, hazardous waste incineration	HWD
treatment of hazardous waste, hazardous waste incineration, with energy recovery	HWD
treatment of hazardous waste, underground deposit	HWD
treatment of refinery sludge, hazardous waste incineration	HWD
treatment of refinery sludge, hazardous waste incineration, with energy recovery	HWD
treatment of sludge from FeCl3 production, underground deposit	HWD
treatment of spent activated carbon with mercury, underground deposit	HWD
treatment of spent antifreezer liquid, hazardous waste incineration	HWD
treatment of spent antifreezer liquid, hazardous waste incineration, with energy recovery	HWD
treatment of spent catalytic converter NOx reduction, underground deposit	HWD
treatment of spent catalytic converter for cars, underground deposit	HWD
treatment of spent oxychlor catalyst, hazardous waste incineration	HWD
treatment of spent oxychlor catalyst, hazardous waste incineration, with energy recovery	HWD
treatment of spent oxychlor catalyst, underground deposit	HWD
treatment of spent solvent mixture, hazardous waste incineration	HWD
treatment of spent solvent mixture, hazardous waste incineration, with energy recovery	HWD
treatment of sulfidic tailings, from cinnabar mine operation, tailings impoundment	HWD
treatment of sulfidic tailings, from copper mine operation, tailings impoundment	HWD
treatment of sulfidic tailings, from gold mine operation, tailings impoundment	HWD
treatment of sulfidic tailings, from nickel mine operation, tailings impoundment	HWD
treatment of sulfidic tailings, from silver mine operation, tailings impoundment	HWD
treatment of sulfidic tailings, from zinc-lead mine operation, tailings impoundment	HWD
treatment of sulfidic tailings, generic, tailings impoundment	HWD
treatment of used capacitor, to hazardous waste incineration	HWD
treatment of used capacitor, to hazardous waste incineration, with energy recovery	HWD
treatment of waste emulsion paint, hazardous waste incineration	HWD
treatment of waste emulsion paint, hazardous waste incineration, with energy recovery	HWD
treatment of waste mineral oil, hazardous waste incineration	HWD

treatment of waste mineral oil, hazardous waste incineration, with energy recovery	HWD
treatment of waste paint, hazardous waste incineration	HWD
treatment of waste paint, hazardous waste incineration, with energy recovery	HWD
treatment of waste, from silicon wafer production, underground deposit	HWD
drying, sewage sludge	NHWD
treatment of Cu-based antifouling paint emissions	NHWD
treatment of Sn-based antifouling paint emissions	NHWD
treatment of biowaste by anaerobic digestion	NHWD
treatment of biowaste, industrial composting	NHWD
treatment of decommissioned pipeline, natural gas, inert material landfill	NHWD
treatment of drilling waste, landfarming	NHWD
treatment of garden biowaste, home composting in heaps	NHWD
treatment of glass cullet, from fluorescent lamps treatment, 0% water, inert material landfill	NHWD
treatment of glass cullet, from used cathode ray tube panels, 0% water, inert material landfill	NHWD
treatment of glass cullet, lead containing, from used cathode ray tube, 0% water, inert material landfill	NHWD
treatment of glass cullet, mixed glass from used cathode ray tube, 0% water, inert material landfill	NHWD
treatment of inert waste, inert material landfill	NHWD
treatment of kitchen and garden biowaste, home composting in heaps and containers	NHWD
treatment of lignite ash, opencast refill	HWD
treatment of limestone residue, inert material landfill	NHWD
treatment of municipal solid waste, open burning	NHWD
treatment of non-sulfidic overburden, off-site	NHWD
treatment of non-sulfidic tailing, off-site	NHWD
treatment of refinery sludge, landfarming	NHWD
treatment of slag from metallurgical grade silicon production, inert material landfill	NHWD
treatment of spoil from hard coal mining, in surface landfill	NHWD
treatment of spoil from lignite mining, in surface landfill	NHWD

treatment of used refrigerant R12, final disposal	NHWD
treatment of used refrigerant R12, venting	NHWD
treatment of used refrigerant R134a, final disposal	NHWD
treatment of used refrigerant R134a, venting	NHWD
treatment of used refrigerant R600a, final disposal	NHWD
treatment of used refrigerant R600a, venting	NHWD
treatment of used vegetable cooking oil by anaerobic digestion	NHWD
treatment of waste concrete, inert material landfill	NHWD
treatment of waste emulsion paint, inert material landfill	NHWD
treatment of waste glass, inert material landfill	NHWD
treatment of waste gypsum, inert material landfill	NHWD
treatment of waste mineral wool, inert material landfill	NHWD
treatment of waste paint, inert material landfill	NHWD
treatment of waste paperboard, inert material landfill	NHWD
treatment of waste plastic plaster, inert material landfill	NHWD
treatment of waste polyurethane, inert material landfill	NHWD
treatment of waste steel, inert material landfill	NHWD
treatment of waste zeolite, inert material landfill	NHWD
treatment of waste, electrical and electronic cables, open burning	NHWD
treatment of waste, pneumatic tyres, open burning	NHWD
treatment of wood ash mixture, pure, landfarming	NHWD
treatment, sludge from pulp and paper production, landfarming	NHWD
treatment of high level radioactive waste for final repository	HWD
treatment of low level radioactive waste for final repository	HWD
direct disposal of wastewater from textile production	NHWD
treatment of low level radioactive waste, plasma torch incineration	HWD
treatment of low level radioactive waste, surface or trench deposit	HWD
treatment of sewage sludge by anaerobic digestion	NHWD

treatment of tailing, from uranium milling	HWD
treatment of uranium tailing, non-radioactive emission	NHWD

10 Agriculture, Fishery, and Animal Husbandry

10.1 General

Regarding the Agriculture, Fishery & Animal Husbandry sector, several technical corrections have been implemented to improve existing datasets and correct existing issues. No new projects have been added to the database for v.3.12. Hence, this section will provide a clear description of technical corrections in specific datasets.

10.2 Technical Corrections

The detailed description of all changes is provided to support users in understanding variations that they might encounter when comparing the new version (v3.12) with the old one (v3.11). Changes may also potentially affect assessment results. Harmonisation of meta information, corrections of amounts, and adjustments in properties are classified as technical corrections.

Table 43 reports the modifications in dry mass, water in wet mass, and water content parameters for Brazilian (BR) sugarcane production datasets between versions v3.11 and v3.12. These adjustments were implemented to rectify inaccuracies identified in the reference product data for sugarcane, thereby improving the precision and internal consistency of the dataset.

Table 43. Properties updated from v3.11 to v3.12.

Activity Name	Geography	New value of dry mass in v3.12	New value of water content in v3.12	New value of water in wet mass in v3.12	Unit
sugarcane production	BR-GO	0.255	2.9216	0.745	kg
sugarcane production	BR-MG	0.255	2.9216	0.745	kg
sugarcane production	BR-MS	0.255	2.9216	0.745	kg
sugarcane production	BR-MT	0.255	2.9216	0.745	kg
sugarcane production	BR-PR	0.255	2.9216	0.745	kg
sugarcane production	BR-SP	0.255	2.9216	0.745	kg

The yield for the following datasets has been moved to the general comment section of the meta information to align with the expected standards and enhance coherence throughout the database. **Table 44** reports the list of datasets affected.

Table 44.Updated activities related to general comment correction.

Activity Name	Geography
barley grain production	AU-NSW
barley grain production	AU-QLD
barley grain production	AU-SA
barley grain production	AU-TAS
barley grain production	AU-VIC
barley grain production	AU-WA
coffee green bean production, arabica	BR-SP
coffee green bean production, arabica, irrigated	BR-MG
coffee green bean production, arabica, manual	BR-MG
coffee green bean production, arabica, mechanized	BR-MG
coffee green bean production, arabica, not irrigated	BR-MG
coffee green bean production, arabica, semi-mechanized	BR-MG
fruit tree seedling production, for planting	CH
asparagus seedling production, for planting	FR
jatropha seed production	GLO

maize grain production	AU-NSW
maize grain production	AU-QLD
maize grain production	AU-VIC
maize grain production, first crop	BR-BA
maize grain production, first crop	BR-GO
maize grain production, first crop	BR-MA
maize grain production, first crop	BR-MG
maize grain production, first crop	BR-PI
maize grain production, first crop	BR-PR
maize grain production, first crop	BR-RS
maize grain production, second crop	BR-GO
maize grain production, second crop	BR-MA
maize grain production, second crop	BR-MG
maize grain production, second crop	BR-MS
maize grain production, second crop	BR-MT
maize grain production, second crop	BR-PR
maize grain production, second crop	BR-SP
maize grain production, second crop	BR-TO
oat grain production	AU-NSW

oat grain production	AU-QLD
oat grain production	AU-SA
oat grain production	AU-TAS
oat grain production	AU-VIC
oat grain production	AU-WA
rape seed production	AU-NSW
rape seed production	AU-SA
rape seed production	AU-VIC
rape seed production	AU-WA
soybean production	BR-BA
soybean production	BR-GO
soybean production	BR-MA
soybean production	BR-MG
soybean production	BR-MS
soybean production	BR-MT
soybean production	BR-PI
soybean production	BR-PR
soybean production	BR-RS
soybean production	BR-SP

soybean production	BR-TO
wheat grain production	AU-NSW
wheat grain production	AU-QLD
wheat grain production	AU-SA
wheat grain production	AU-TAS
wheat grain production	AU-VIC
wheat grain production	AU-WA

For the sugarcane production datasets in Brazil (BR), yield information was added to the general comment section in the metadata because it was missing before (**Table 45**), to meet the information standards and increase coherence throughout the database.

Table 45. Added yield for sugarcane production (BR) activities.

Activity Name	Geography	Yield	Unit
sugarcane production	BR-GO	64230	kg
sugarcane production	BR-MG	71530	kg
sugarcane production	BR-MS	55510	kg
sugarcane production	BR-MT	55560	kg
sugarcane production	BR-PR	62060	kg

A technical correction was applied to the reporting of dinitrogen monoxide (N_2O) emissions since there was a mistake in the calculation in the previous version (v3.11) across two datasets within the United States of America (US). Consequently, the quantities of the N_2O elementary exchange were revised, as detailed in **Table 46** to meet the real emissions. These updated emission values are aligned with the Science Based Targets initiative (SBTi) guidelines.

Table 46. Updated activities related to N2O emission corrections.

Activity Name	Geography	Old value of N2O in v3.11	New value of N2O in v3.12	Unit
maize grain production	US-IL	3.91E-04	4.52E-04	kg
maize grain production	US-WI	1.59E-04	3.91E-04	kg

For the vegetable oil, based on the correction implemented in v3.11 regarding the reduction of wastewater by an order of magnitude of 1000, in the current version (v3.12), further corrections were applied to meet the outputs associated with the production of refined oil according to the reference documentation (Omni Tech International, 2010). Water emission (Elementary Exchange) was updated accordingly to meet the water balance. As a result, the amounts of the “wastewater” are updated for the datasets in **Table 47** and the amounts of the “Water” elementary exchange in **Table 48**:

Table 47. Updated activities related to wastewater corrections.

Activity Name	Geography	Old value of wastewater in v3.11	New value of wastewater in v3.12	Unit
cottonseed oil refinery operation	GLO	8.94E-5	1.23E-04	kg
cottonseed oil refinery operation	US	8.94E-5	1.23E-04	kg
palm oil refinery operation	GLO	8.94E-5	1.23E-04	kg
soybean oil refinery operation	GLO	8.94E-5	1.23E-04	kg
soybean oil refinery operation	RER	8.94E-5	1.23E-04	kg

soybean oil refinery operation	US	8.94E-5	1.23E-04	kg

Table 48. Updated activities related to water emissions corrections.

Activity Name	Geography	Old value of water emission in v3.11	New value of water emission in v3.12	Unit
cottonseed oil refinery operation	GLO	6.54E-5	3.3E-05	kg
cottonseed oil refinery operation	US	6.54E-5	3.3E-05	kg
palm oil refinery operation	GLO	6.54E-5	3.3E-05	kg
soybean oil refinery operation	GLO	6.54E-5	3.3E-05	kg
soybean oil refinery operation	RER	6.54E-5	3.3E-05	kg
soybean oil refinery operation	US	6.54E-5	3.3E-05	kg

Finally, some other minor issues were identified and updated, as reported below:

- For soybean meal and crude oil production, RER (Rest of Europe); The documentation (Included activities starts section) has been updated, as the soya beans are not imported overseas anymore, but in the updated version (v3.12), it is connected to the new Swiss (CH) market as an input.
- For floating collar net cage for aquaculture 25 m construction and maintenance, GLO (Global); the documentation (Product Information) is corrected to meet the correct unit for weight.

  For sugar beet production, GLO (Global); Irrigation flow was added as a weighted average of irrigation from the contributing geographies (France (FR), Germany (DE), Russia (RU), United States of America (US)). The added irrigation amount is 0.03424 m3.

11 Forestry and Wood

This version introduces data updates and enhancements to the Forestry and Wood sector. The introduction of Finnish forestry data expands the geographical coverage of the sector. Furthermore, product naming conventions across the entire sector are harmonised.

11.1 New Forestry Data for Finland

11.1.1 New Datasets and Products

The Finnish Forest Industries Federation provided data for forestry supply chains in Finland. The project was done in collaboration with Natural Resources Institute Finland (Luke). Three forestry datasets are introduced: pine, spruce, and birch. The datasets represent rotation forestry, and together they cover 97% of the annual harvested area in Finland. The datasets are based on average data from 2018–2022 (Luke, 2023) (Luke, 2024). However, they are considered valid for a longer period. Each dataset produces five products: sawlogs, pulpwood, and three energy wood fractions (energy wood, measured as dry mass, from young stand; fuel wood, measured as dry mass; forest chips, wet, measured as dry mass, from logging residues).

As part of the project, a dataset on seedling production was provided, representing average seedling production in Finland in 2023.

11.1.2 Modelling Choices

The activities are modelled as combined production, meaning that at the system model level, the inventories are subdivided between the products based on their physical properties. More specifically, flow-specific subdivision keys based on the dry mass of the reference products are used to distribute input and output flow amounts among the reference products. This modelling approach ensures fair burden sharing: input flows contributing to all reference products (such as land use-related exchanges) are distributed proportionally based on dry mass, while input flows contributing only to specific reference products (such as wood chipping) are allocated exclusively to those products (forest chips). This approach also maintains carbon balance across the subdivided datasets.

In the forestry inventories, land occupation and transformation are modelled with the following approach: The total harvested volume of the species over a year (m3/a) and the land area used for the species production (m2) are used to calculate the occupation. Land transformation is calculated as the average clear-cut area (m2/a) for the species divided by the harvested volume of the species (m3/a). It is important to note that land use and land use change related greenhouse gas emissions are currently not inventoried.

11.1.3 Adapted and Updated Activities Part of the Forestry Supply Chain

Existing forestry machinery and operation datasets were adapted to Finland to fill in the supply chains. Given Finland's substantial forestry machinery production, we copied the machinery production datasets from the geography of Global to Finland. Specifically, the input and output amounts of the machinery production inventories were scaled by the weights of typical forestry machinery used in Finland, and the heat inputs were linked to typical heat sources in Finland. Similarly, the forestry operations datasets were copied from the geography of Europe. Here, diesel consumption per hour was updated according to Finnish harvesting and forwarding data (Metsäteho, 2024). In addition, the emission profiles were updated (EEA, 2023). In harvesting datasets, the fate of saw chain oil in the environment was remodelled.

Table 49 lists all datasets. It is indicated whether the datasets are new or adapted from existing activities. The table also lists existing activities whose production volumes were updated as part of the project.

Table 49. New, adapted, and updated datasets part of the Finnish forestry project

Activity Name	Geography	Time Period	Product Name	New, adapted, or updated?
hardwood forestry, birch, sustainable forest management	FI	2018 - 2022	energy wood, green, from young stand, measured as dry mass forest chips, green, from logging residues, measured as dry mass fuel wood, green, measured as dry mass pulpwood, hardwood, with bark, green, measured as green volume over bark sawlog and veneer log, hardwood, with bark, green, measured as green volume over bark	N
softwood forestry, pine, sustainable forest management	FI	2018 - 2022	energy wood, green, from young stand, measured as dry mass forest chips, green, from logging residues, measured as dry mass fuel wood, green, measured as dry mass pulpwood, softwood, with bark, green, measured as green volume over bark sawlog and veneer log, softwood, with bark, green, measured as green volume over bark	N
softwood forestry, spruce, sustainable forest management	FI	2018 - 2022	energy wood, green, from young stand, measured as dry mass forest chips, green, from logging residues, measured as dry mass fuel wood, green, measured as dry mass	N

			pulpwood, softwood, with bark, green, measured as green volume over bark sawlog and veneer log, softwood, with bark, green, measured as green volume over bark	
tree seedling production	FI	2023 - 2023	tree seedling, for planting	N
energy wood harvester production	FI	2012 - 2012	energy wood harvester	A
forestry harvester production	FI	2012 - 2012	forestry harvester	A
forwarder production	FI	2012 - 2012	forwarder	A
forwarding, forwarder	FI	2018 - 2022	forwarding, forwarder	A
harvesting, forestry harvester	FI	2018 - 2022	harvesting, forestry harvester	A
harvesting/bundling, energy wood harvester	FI	2018 - 2022	harvesting/bundling, energy wood harvester	A
wood chipping, mobile chipper, at forest road	FI	2018 - 2022	wood chipping, chipper, mobile, diesel, at forest road	A
tree seedling production, in heated greenhouse	RER; GLO	2002 - 2002	tree seedling, for planting	U
tree seedling production, in unheated greenhouse	RER; GLO	2002 - 2002	tree seedling, for planting	U
energy wood harvester production	GLO	2012 - 2012	energy wood harvester	U
forestry harvester production	GLO	2012 - 2012	forestry harvester	U
forwarder production	GLO	2012 - 2012	forwarder	U
forwarding, forwarder	RER; GLO	2012 - 2012	forwarding, forwarder	U
harvesting, forestry harvester	RER; GLO	2012 - 2012	harvesting, forestry harvester	U
harvesting/bundling, energy wood harvester	RER; GLO	2012 - 2012	harvesting/bundling, energy wood harvester	U
wood chipping, mobile chipper, at forest road	RER; GLO	2012 - 2012	wood chipping, chipper, mobile, diesel, at forest road	U

New markets for the forestry products were created. They are listed in **Table 50**. The transportation modes and distances used in the markets are specific to Finland.

Table 50. **New markets created for the forestry products in Finland**

Activity Name	Geography	Time Period	Product Name
market for energy wood, green, from young stand, measured as dry mass	FI	2018 - 2022	energy wood, green, from young stand, measured as dry mass
market for forest chips, green, from logging residues, measured as dry mass	FI	2018 - 2022	forest chips, green, from logging residues, measured as dry mass
market for fuel wood, green, measured as dry mass	FI	2018 - 2022	fuel wood, green, measured as dry mass
market for pulpwood, hardwood, with bark, green, measured as green volume over bark	FI	2018 - 2022	pulpwood, hardwood, with bark, green, measured as green volume over bark
market for pulpwood, softwood, with bark, green, measured as green volume over bark	FI	2018 - 2022	pulpwood, softwood, with bark, green, measured as green volume over bark
market for sawlog and veneer log, hardwood, with bark, green, measured as green volume over bark	FI	2018 - 2022	sawlog and veneer log, hardwood, with bark, green, measured as green volume over bark
market for sawlog and veneer log, softwood, with bark, green, measured as green volume over bark	FI	2018 - 2022	sawlog and veneer log, softwood, with bark, green, measured as green volume over bark

11.2 Renaming of Products

We renamed a number of forestry and wood products to eliminate confusion between physical product characteristics and measurement basis, which are not always equivalent.

The new naming convention more clearly states four key attributes for each primary forestry product:

- Physical bark presence (with bark or debarked)
- Physical moisture state (green/dry)
- Measurement basis as related to bark, if bark is present (under bark/over bark)
- Measurement basis for moisture (green/dry)

Explicitly stating these properties helps users to clearly identify cases where the physical properties of a product differ from its measurement basis. The old and new names of products are listed in **Table 51**.

Table 51. **Revised naming convention for reference products in the forestry and wood sector.**

Old name	New name
pulpwood, hardwood, measured as solid wood under bark	pulpwood, hardwood, with bark, green, measured as green volume under bark
pulpwood, softwood, measured as solid wood under bark	pulpwood, softwood, with bark, green, measured as green volume under bark
sawlog and veneer log, eucalyptus ssp., measured as solid wood under bark	sawlog and veneer log, eucalyptus, with bark, green, measured as green volume under bark
sawlog and veneer log, hardwood, measured as solid wood under bark	sawlog and veneer log, hardwood, with bark, green, measured as green volume under bark
sawlog and veneer log, softwood, measured as solid wood under bark	sawlog and veneer log, softwood, with bark, green, measured as green volume under bark
sawlog and veneer log, azobe, measured as solid wood under bark	sawlog and veneer log, azobe, with bark, green, measured as green volume under bark
sawlog and veneer log, meranti, measured as solid wood under bark	sawlog and veneer log, meranti, with bark, green, measured as green volume under bark
sawlog and veneer log, paraná pine, measured as solid wood under bark	sawlog and veneer log, paraná pine, with bark, green, measured as green volume under bark
bark chips, wet, measured as dry mass	bark chips, green, measured as dry mass
bundle, energy wood, measured as dry mass	bundle, energy wood, green, measured as dry mass
cleft timber, measured as dry mass	cleft timber, green, measured as dry mass
sawdust, loose, wet, measured as dry mass	sawdust, green, loose, measured as dry mass
sawdust, wet, measured as dry mass	sawdust, green, collected, measured as dry mass
sawlog and veneer log, azobe, debarked, measured as solid wood	sawlog and veneer log, azobe, debarked, green, measured as green volume
sawlog and veneer log, meranti, debarked, measured as solid wood	sawlog and veneer log, meranti, debarked, green, measured as green volume
sawlog and veneer log, softwood, debarked, measured as solid wood	sawlog and veneer log, softwood, debarked, green, measured as green volume
shavings, hardwood, loose, measured as dry mass	shavings, hardwood, dry, loose, measured as dry mass
shavings, hardwood, measured as dry mass	shavings, hardwood, dry, collected, measured as dry mass
shavings, softwood, loose, measured as dry mass	shavings, softwood, dry, loose, measured as dry mass
shavings, softwood, measured as dry mass	shavings, softwood, dry, collected, measured as dry mass
slab and siding, hardwood, wet, measured as dry mass	slab and siding, hardwood, green, measured as dry mass

slab and siding, softwood, wet, measured as dry mass	slab and siding, softwood, green, measured as dry mass
wood chips and particles, willow	wood chips and particles, willow, dry, measured as dry mass
wood chips, from post-consumer wood, measured as dry mass	wood chips, from post-consumer wood, dry, measured as dry mass
wood chips, wet, measured as dry mass	wood chips, green, measured as dry mass
wood pellet, measured as dry mass	wood pellets, dry, measured as dry mass
residual hardwood, wet	residual hardwood, green, measured as green volume
residual softwood, wet	residual softwood, green, measured as green volume
residual wood, dry	residual wood, dry, measured as dry volume
bark	bark, green, measured as dry mass

Since these reference products were renamed, markets were accordingly renamed as well, as illustrated below in **Table 52**. Several additional non-market activities were renamed for clarity.

Table 52. Revised naming conventions for activities in the forestry and wood sector.

Old name	New name
market for sawlog and veneer log, azobe, measured as solid wood under bark	market for sawlog and veneer log, azobe, with bark, green, measured as green volume under bark
market for slab and siding, hardwood, wet, measured as dry mass	market for slab and siding, hardwood, green, measured as dry mass
market for sawlog and veneer log, azobe, debarked, measured as solid wood	market for sawlog and veneer log, azobe, debarked, green, measured as green volume
market for cleft timber, measured as dry mass	market for cleft timber, green, measured as dry mass
market for residual softwood, wet	market for residual softwood, green, measured as green volume
market for sawlog and veneer log, eucalyptus ssp., measured as solid wood under bark	market for sawlog and veneer log, eucalyptus, with bark, green, measured as green volume under bark
market for wood pellet, measured as dry mass	market for wood pellets, dry, measured as dry mass
market for sawlog and veneer log, hardwood, measured as solid wood under bark	market for sawlog and veneer log, hardwood, with bark, green, measured as green volume under bark
market for shavings, hardwood, measured as dry mass	market for shavings, hardwood, dry, collected, measured as dry mass

bark chips, wet, measured as dry mass to generic market for residual hardwood, wet	bark chips, green, measured as dry mass to generic market for residual hardwood, green, measured as green volume
market for residual hardwood, wet	market for residual hardwood, green, measured as green volume
market for sawdust, loose, wet, measured as dry mass	market for sawdust, green, loose, measured as dry mass
market for shavings, hardwood, loose, measured as dry mass	market for shavings, hardwood, dry, loose, measured as dry mass
market for wood chips and particles, willow	market for wood chips and particles, willow, dry, measured as dry mass
market for sawlog and veneer log, softwood, measured as solid wood under bark	market for sawlog and veneer log, softwood, with bark, green, measured as green volume under bark
sawlog and veneer log, meranti, debarked, measured as solid wood, import from MY	sawlog and veneer log, meranti, debarked, green, measured as green volume, import from MY
market for pulpwood, hardwood, measured as solid wood under bark	market for pulpwood, hardwood, with bark, green, measured as green volume under bark
sawdust, wet, measured as dry mass to generic market for residual softwood, wet	sawdust, green, collected, measured as dry mass to generic market for residual softwood, green, measured as green volume
market for bark chips, wet, measured as dry mass	market for bark chips, green, measured as dry mass
market for sawlog and veneer log, softwood, debarked, measured as solid wood	market for sawlog and veneer log, softwood, debarked, green, measured as green volume
shavings, hardwood, measured as dry mass to generic market for residual wood, dry	shavings, hardwood, dry, collected, measured as dry mass to generic market for residual wood, dry, measured as dry volume
market for shavings, softwood, measured as dry mass	market for shavings, softwood, dry, collected, measured as dry mass
market for wood chips, from post-consumer wood, measured as dry mass	market for wood chips, from post-consumer wood, dry, measured as dry mass
market for pulpwood, softwood, measured as solid wood under bark	market for pulpwood, softwood, with bark, green, measured as green volume under bark
market for residual wood, dry	market for residual wood, dry, measured as dry volume
slab and siding, hardwood, wet, measured as dry mass to generic market for residual hardwood, wet	slab and siding, hardwood, green, measured as dry mass to generic market for residual hardwood, green, measured as green volume
sawlog and veneer log, azobe, debarked, measured as solid wood, import from CM	sawlog and veneer log, azobe, debarked, green, measured as green volume, import from CM
pulpwood, softwood, measured as solid wood under bark, import from Europe without Switzerland	pulpwood, softwood, with bark, green, measured as green volume under bark, import from Europe without Switzerland
shavings, softwood, measured as dry mass to generic market for residual wood, dry	shavings, softwood, dry, collected, measured as dry mass to generic market for residual wood, dry, measured as dry volume

market for shavings, softwood, loose, measured as dry mass	market for shavings, softwood, dry, loose, measured as dry mass
market for sawlog and veneer log, meranti, debarked, measured as solid wood	market for sawlog and veneer log, meranti, debarked, green, measured as green volume
slab and siding, softwood, wet, measured as dry mass to generic market for residual softwood, wet	slab and siding, softwood, green, measured as dry mass to generic market for residual softwood, green, measured as green volume
sawlog and veneer log, softwood, measured as solid wood under bark, import from Europe without Switzerland	sawlog and veneer log, softwood, with bark, green, measured as green volume under bark, import from Europe without Switzerland
market for wood chips, wet, measured as dry mass	market for wood chips, green, measured as dry mass
market for sawlog and veneer log, meranti, measured as solid wood under bark	market for sawlog and veneer log, meranti, with bark, green, measured as green volume under bark
sawlog and veneer log, hardwood, measured as solid wood under bark, import from Europe without Switzerland	sawlog and veneer log, hardwood, with bark, green, measured as green volume under bark, import from Europe without Switzerland
market for bundle, energy wood, measured as dry mass	market for bundle, energy wood, green, measured as dry mass
market for sawdust, wet, measured as dry mass	market for sawdust, green, collected, measured as dry mass
market for sawlog and veneer log, paraná pine, measured as solid wood under bark	market for sawlog and veneer log, paraná pine, with bark, green, measured as green volume under bark
market for slab and siding, softwood, wet, measured as dry mass	market for slab and siding, softwood, green, measured as dry mass
market for bark	market for bark, green, measured as dry mass
market for waste wood, post-consumer	market for waste wood, post-consumer, measured as dry mass
suction, sawdust	suction, sawdust, at sawmill

11.3 Other Updates in the Sector

In addition to the new and updated data, various minor corrections were performed in the sector. They are listed in **Table 53**.

Table 53. Minor corrections in the Forestry & Wood sector.

Activity Name	Geography	Time Period	Product Name	Description of correction
forestry harvester production	GLO	2012 - 2012	forestry harvester	Correcting the water balance of the inventory.

forwarder production	GLO	2012 - 2012	forwarder	Correcting the water balance of the inventory.
energy wood harvester production	GLO	2012 - 2012	energy wood harvester	Correcting the water balance of the inventory.
wood chips production, hardwood, at sawmill	Europe without Switzerland	2011 - 2013	wood chips, wet, measured as dry mass	The input flow “slab and siding, hardwood, wet, measured as dry mass” had an activity link (AL) to an activity in Switzerland, even though it is produced in Europe without Switzerland. The AL was updated.
hardwood forestry, beech, sustainable forest management	DE; GLO	2010 - 2012	cleft timber, measured as dry mass; pulpwood, hardwood, measured as solid wood under bark; sawlog and veneer log, hardwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	Information was reintroduced to the general comment of the activity.
hardwood forestry, birch, sustainable forest management	SE; GLO	2010 - 2012	bundle, energy wood, measured as dry mass; cleft timber, measured as dry mass; pulpwood, hardwood, measured as solid wood under bark; sawlog and veneer log, hardwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	Information was reintroduced to the general comment of the activity.
hardwood forestry, mixed species, sustainable forest	CH	2010 - 2012	cleft timber, measured as dry mass; pulpwood, hardwood, measured as solid wood under bark; sawlog and veneer log, hardwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	Information was reintroduced to the general comment of the activity.
hardwood forestry, oak, sustainable forest management	DE; GLO	2010 - 2012	cleft timber, measured as dry mass; pulpwood, hardwood, measured as solid wood under bark; sawlog and veneer log, hardwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	Information was reintroduced to the general comment of the activity.
softwood forestry, mixed species, sustainable forest	CH	2010 - 2012	cleft timber, measured as dry mass;	Information was reintroduced to the general comment of the activity.

			pulpwood, softwood, measured as solid wood under bark; sawlog and veneer log, softwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	
softwood forestry, pine, sustainable forest management	DE; SE; GLO	2010 - 2012	bundle, energy wood, measured as dry mass [only SE & GLO]; cleft timber, measured as dry mass; pulpwood, softwood, measured as solid wood under bark; sawlog and veneer log, softwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	Information was reintroduced to the general comment of the activity.
softwood forestry, spruce, sustainable forest management	DE; SE; GLO	2010 - 2012	bundle, energy wood, measured as dry mass [only SE & GLO]; cleft timber, measured as dry mass; pulpwood, softwood, measured as solid wood under bark; sawlog and veneer log, softwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	Information was reintroduced to the general comment of the activity.
hardwood forestry, eucalyptus ssp., sustainable forest management	TH; GLO	2000 - 2005	sawlog and veneer log, eucalyptus ssp., measured as solid wood under bark	The dry mass property of eucalyptus was updated to 645.25 kg/m3 to harmonise the property across the supply chain. This affects the amounts of PM emissions to air, and the CO_2 uptake.

12 Textiles

The ecoinvent v3.12 release includes new textile datasets for hemp fibre production in France, an update of existing flax production in Europe and various other technical corrections to improve existing data.

12.1 New Data for Hemp Fibre Produced in France

ecoinvent release v3.12 sees the addition of new hemp datasets for France. Since 2015, hemp cultivation for fibre has seen a significant surge in Europe, with France being the largest producer accounting for over 60% of European hemp fibre production (European Commission, n.d.). Globally, France remains the top producer, contributing nearly 50% of global hemp fibre (Marquardt,S., & Savage, L., 2023).

The modelled data represents primary data from French hemp farmers and processors. Agricultural production and decortication data came from 4 French hemp cooperatives (La Chanvrière, Cavac, Interval/Eurochanvre, and Planète Chanvre), representing 98% of French production. Cottonization data came from France's only hemp fiber cottonization facility, providing 100% coverage for French operations. All data was harmonized by our project partners Interchanvre.

The newly introduced data covers the supply chain from agricultural production of the hemp crop, followed by decortication of the hemp stems and cottonisation of the fibres into staple length. Decorticated hemp fibre is a highly versatile material and can be used to produce textiles, technical textiles, bio composites etc. Cottonized hemp fibres have been cut to a length of around 40-50 mm, making them suitable for ring- or open-end-rotor-spinning into textile yarn (after the necessary spinning preparation steps). The new production datasets and their respective reference products are shown in **Figure 13**.

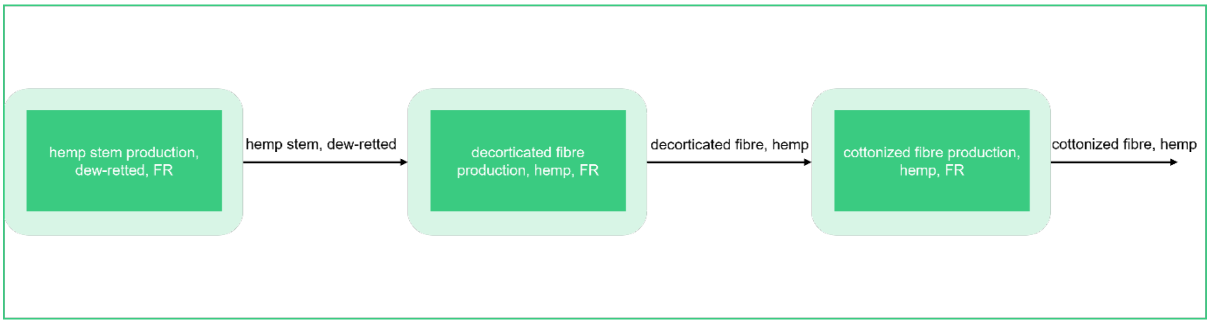

Figure 13. Newly introduced hemp production datasets for France. The diagram only shows the production datasets and respective reference products. Market datasets, by-products and wastes are not shown.

Apart from the mentioned Reference Products, the production datasets also account for the creation of valuable by-products. These include the following:

- **hemp hurd:** the inner woody core of hemp stems. It is separated from the outer bast fibres during the decortication. This material has various applications such as particle board production, insulation, mulch etc.
- **hemp noil**: also referred to as tow. These are short, tangled fibres which are not suitable for spinning. Obtained during processing stages such as combing or hackling in the cottonization stage. They are lower-grade fibres with applications in insulation, paper production, upholstery stuffing etc.

- **hemp residues:** generated during the decortication phase and mainly consisting of dust and leaf particles. Sold to be processed further.
- **hemp carding waste:** produced during cottonization. It is sold to paper mills.

A summary of the new datasets added as part of the hemp project is given in **Table 54.**

Table 54. Summary of new hemp datasets. Activity names are reported in alphabetical order. In the column v3.12, "N": "New Activity", "U": "Updated Activity" and "D": "Deleted Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
carding waste, hemp to generic market for cellulose fibre	FR	2021 – 2023	cellulose fibre	kg	N
cottonized fibre production, hemp	FR	2018 – 2020	cottonized fibre, hemp	kg	N
decorticated fibre production, hemp	FR	2021 – 2023	decorticated fibre, hemp	kg	N
hemp hurd to generic market for wood chips, dry, measured as dry mass	FR	2021 – 2023	wood chips, dry, measured as dry mass	kg	N
hemp noil to generic market for cellulose fibre	FR	2021 – 2023	cellulose fibre	kg	N
hemp residues to generic market for wood chips, dry, measured as dry mass	FR	2021 – 2023	wood chips, dry, measured as dry mass	kg	N
hemp stem production, dew-retted	FR	2021 – 2023	hemp stem, dew-retted	kg	N
market for carding waste, hemp	FR	2021 – 2023	carding waste, hemp	kg	N
market for cottonized fibre, hemp	FR	2021 – 2023	cottonized fibre, hemp	kg	N
market for decorticated fibre, hemp	FR	2021 – 2023	decorticated fibre, hemp	kg	N
market for hemp hurd	FR	2021 – 2023	hemp hurd	kg	N
market for hemp noil	FR	2021 – 2023	hemp noil	kg	N
market for hemp residues	FR	2021 – 2023	hemp residues	kg	N
market for hemp stem, dew-retted	FR	2021 – 2023	hemp stem, dew-retted	kg	N

12.2 Updating Flax Fibre Production in Europe

Linen is derived from flax fibres, with Europe being the world's top producer of textile flax. In ecoinvent v3.10, datasets were introduced which modelled the agricultural production of the flax plant (including dew-retting), followed by scutching to separate the bast fibres within the geography of Europe (RER). These datasets model average production and processing in France, Belgium and the Netherlands for flax products certified to the standard Masters of Flax Fibre™ (formerly European Flax™). Together, these three countries produce three quarters of the world's flax fibre. In v3.12, an update to these RER flax datasets has been carried out to add previously missing information. This update was done in collaboration with the original data supplier, the Alliance for European Flax-Linen & Hemp. The following changes were implemented:

— Addition of a new allocatable by-product 'flax shive' to the dataset **fibre production, flax, scutching - RER**. Flax shive (synonym: hurd) is a valuable product which comes out of the flax scutching process. It is sold for applications such as mulch, animal bedding and particle board production. Data on the amount and price of 'flax shive' was provided by the original data supplier. The new exchange replaces part of the old exchange 'waste wood, untreated' which was modelled entirely as a waste. The remaining outputs (dust, seeds and other miscellaneous plant material) are now modelled by the exchange 'biowaste'. Refer to Figure 14 for a visual summary of the changes.

— Addition of building, transformation and occupation exchanges to the dataset **fibre production, flax, scutching - RER**. These exchanges are mandatory according to ecoinvent's guidelines for good data quality and completeness. The new data was provided by the original data supplier.

— The general documentation of the European flax datasets was improved and updated to reflect the listed changes. The Product Information description for the produced reference and by-products was improved.

The changes highlighted in **Figure 14** resulted in a decrease in score for the reference product '**fibre, flax, long, scutched**' in the cut-off, EN15804 and APOS system models since part of the burden is now being allocated to the valuable flax shive.

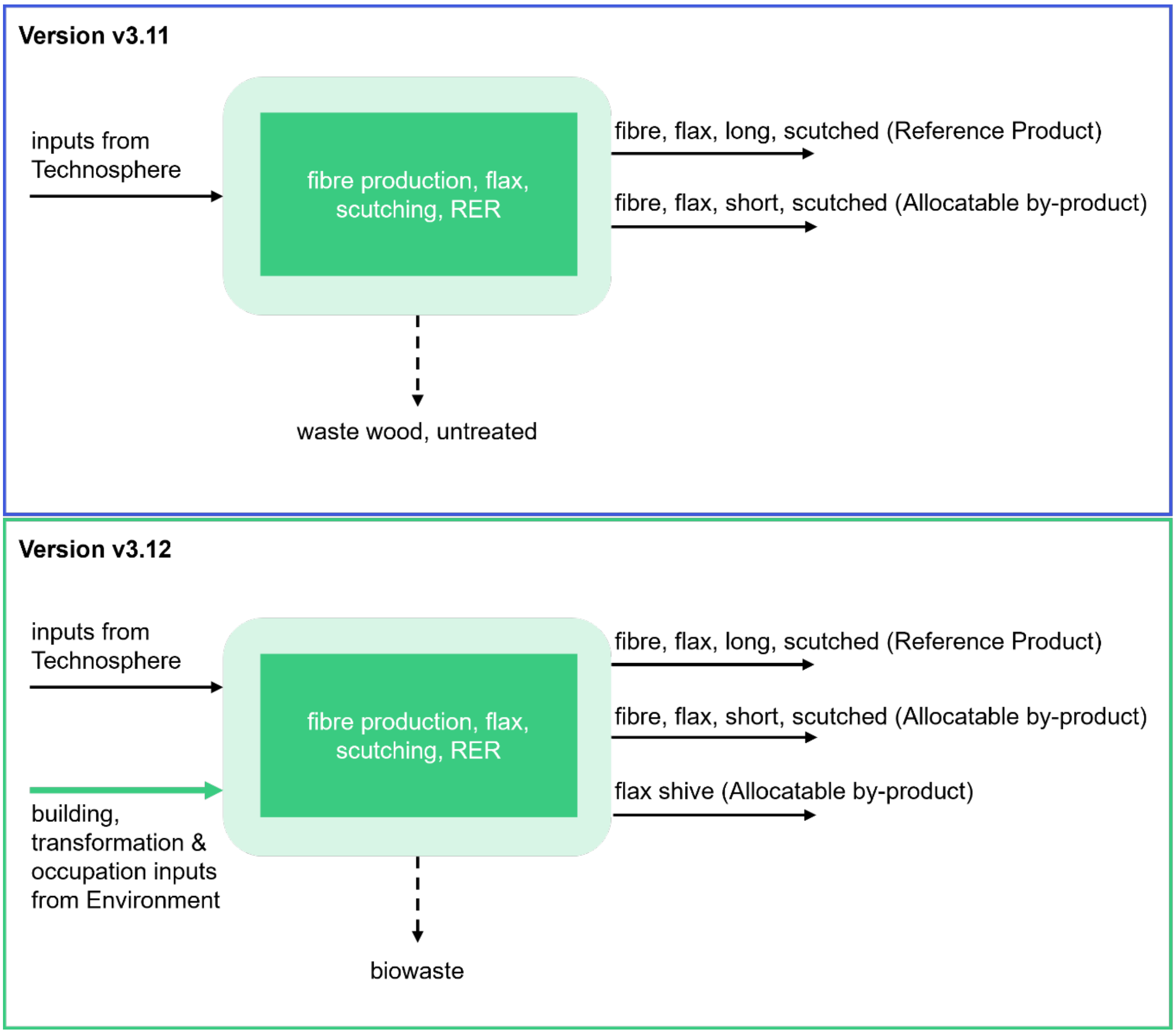

Figure 14. Comparison of the dataset fibre production, flax, scutching in v3.11 and the current release v3.12

For the consequential system model, products which come from constrained production (i.e. products which are produced within the database only as valuable by-products) need to be matched to a suitable unconstrained product which fulfils the same function. A product is unconstrained if at least one production Activity produces it as a Reference Product. This is because a constrained supplier cannot fulfil an increase in demand by increasing supply (production). In previous versions, the by-product 'fibre, flax, short, scutched' produced by **fibre production, flax, scutching - RER** was matched with the unconstrained product 'silky fibres'. This was in turn supplied by the product 'fibre, viscose'. For a more realistic modelling scenario in the consequential system model, the 'fibre, flax, short, scutched' by-product is now matched with the newly introduced product '**decorticated fibre, hemp**' in v3.12. This change resulted in a significant increase in the consequential score of the Reference Product 'fibre, flax, long, scutched' in the dataset **fibre production, flax, scutching - RER**.

A summary of the transforming activities and markets which were impacted by the flax update are listed in **Table 55**.

Table 55. **Summary of new and updated flax datasets.** Activity names are reported in alphabetical order. In the column v3.12, "N": "New Activity", "U": "Updated Activity" and "D": "Deleted Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
fibre, flax, short, scutched to generic market for decorticated fibre, hemp	RER	2014 – 2018	decorticated fibre, hemp	kg	N
fibre, flax, short, scutched to generic market for silky fibres	GLO	2020 – 2024	silky fibres	kg	D
fibre production, flax, scutching	RER	2014 – 2018	fibre, flax, long scutched	kg	U
flax shive to generic market for wood chips, dry, measured as dry mass	RER	2014 – 2018	wood chips, dry, measured as dry mass	kg	N
flax straw production, dew-retted	RER	2013 – 2018	flax straw, dew-retted	kg	U
market for fibre, flax, short, scutched	RER	2011 – 2016	fibre, flax, short, scutched	kg	U
market for flax shive	RER	2014 – 2018	flax shive	kg	N

12.2.1 Future Changes Concerning Flax Fibre Production in Europe Datasets

The latest changes improved the data quality of the 'fibre production, flax, scutching' dataset, however some remaining issues will be addressed in future releases. This includes the addition of the valuable by-product **flax seeds**, which is an output during flax scutching.

12.3 Technical Corrections for Textile Datasets

Textile technical corrections include various updates done to existing cotton & polyester datasets, the update of ISIC codes for various textile activities and the update of CPC codes for various products. These are summarized in the following sections.

12.3.1 Changes in Cotton Datasets

Various corrections were carried out to improve existing cotton datasets. These are summarized in **Table 56**.

Table 56. Summary of corrections (updates) done to cotton textile datasets. In the column v3.12, "N": "New Activity", "U": "Updated Activity" and "D": "Deleted Activity".

Activity Name	Geography	Correction implemented	v3.12
textile production, cotton, weaving	BD	Replacement of the exchange '**natural gas, liquefied**' with an adequate amount of '**liquefied petroleum gas**'. Addition of textile wastewater output and evaporated water output to environment.	U
textile production, cotton, weaving	GLO	Minor changes to the General Comment.	U
seed-cotton production, organic	IN-OR; GLO	Removal of references to irrigation in the documentation since this dataset models rain-fed production. Such discrepancies were a result of copy-paste errors.	U
seed-cotton production, conventional	GLO	Replacement of the exchange '**cottonseed**' with '**cottonseed, for sowing**', amount kept the same.	U
batch dyeing, fibre, cotton	BD	Deletion of dataset and replacement with **batch dyeing, woven fabric, cotton – BD.** This is because this dataset modelled the dyeing of cotton woven fabric, not fibres.	D
batch dyeing, woven fabric, cotton	BD	Addition of dataset to replace **batch dyeing, fibre, cotton** due to a mistake in the naming. Content of new dataset (exchange amount) are unchanged.	N
market for batch dyeing, woven fabric, cotton	BD	Addition of new market dataset since **batch dyeing, fibre, cotton** was corrected to **batch dyeing, woven fabric, cotton.**	N
yarn production, cotton, ring spinning, for knitting	GLO	Improvement of the documentation & updating Activity Name since this dataset models a global weighted average of different types of spinning technologies. The new Activity Name is **'yarn production, cotton, spinning, for knitting**'	U
yarn production, cotton, ring spinning, for weaving	GLO	Improvement of the documentation & updating Activity Name since this dataset models a global weighted average of different types of spinning technologies. The new Activity Name is **'yarn production, cotton, spinning, for weaving'**	U

As summarized in **Table 56**, changes were carried out to the cotton batch dyeing datasets to correct an error in the naming. Subsequently, the shares of the Activities which supply the **market for batch dyeing, fibre, cotton – GLO** are now different. This GLO market is supplied only by IN and RoW producers in v3.12, and no longer supplied by BD, leading to a slight change in its scores.

The Product Information description was improved for the following cotton products:

- fibre, cotton
- fibre, cotton, organic

— cottonseed
— cottonseed, for sowing
— cottonseed, organic
— cottonseed, organic, for sowing
— seed-cotton
— seed-cotton, organic

12.3.2 Changes in Polyester Production Datasets

The dataset '**polyester fibre production, finished**' (**Table 57**) models the melt-spinning process which produces FOY (fully oriented yarn) polyester filament yarn. However, the previous documentation made mention of the term 'staple fibres' which created an inconsistency between the technologies modelled within the system boundary and what was being described. The cutting of filament into staple fibres is not included in the system boundary of this dataset. The documentation (in both the GLO and IN geographies) has been updated. Furthermore, all Activity Links to global and European datasets were removed from the individual exchanges in the '**polyester fibre production, finished - IN**' dataset (Indian geography). These were previously present due to a copy-paste error since this dataset is a copy of the GLO dataset.

The product information and CPC classification of the reference product 'fibre, polyester' have been updated. See Section 12.3.4 for more information on textile CPC-code updates.

Table 57. **Summary of updated polyester datasets.** Activity names are reported in alphabetical order. In the column v3.12, "N": "New Activity", "U": "Updated Activity" and "D": "Deleted Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.12
polyester fibre production, finished	IN; GLO	2007 – 2022	fibre, polyester	kg	U

12.3.3 ISIC-code Updates for Textile Activities

ISIC-codes were corrected for enhanced searchability of the datasets. The list of updated ISIC-codes for textile Activities is given in **Table 58**.

Table 58. List of ISIC-code updates for textile data.

Activity Name	Geography	Updated ISIC-Classification in v3.12
fibre production, flax, scutching	RER	1311: Preparation and spinning of textile fibres
market for fibre, flax, long, scutched	RER	1311: Preparation and spinning of textile fibres
market for mulberry leaves	GLO	0129: Growing of other perennial crops

market for textile, nonwoven polyester	GLO	1399: Manufacture of other textiles n.e.c.
market for textile, nonwoven polypropylene	GLO	1399: Manufacture of other textiles n.e.c.
mulberry production	IN; GLO	0129: Growing of other perennial crops
textile production, nonwoven polyester, needle-punched	IN; GLO	1399: Manufacture of other textiles n.e.c.
textile production, nonwoven polypropylene, spunbond	IN; GLO	1399: Manufacture of other textiles n.e.c.

12.3.4 CPC-code Updates for Textile Exchanges

CPC-codes were corrected for enhanced searchability of the impacted products. The list of updated CPC-codes for textile products is given in Table **59**.

Table 59. List of CPC-code updates for textile products.

Exchange Name	Updated CPC-Classification in v3.12
fibre, cotton, organic	01921: Cotton, whether or not ginned
cottonseed, organic	0143: Cottonseed
fibre, polyester	35520: Synthetic filament yarn (except sewing thread and multiple or cabled yarn), not put up for retail sale
fibre, flax	26190: Other vegetable textile fibres, processed but not spun; tow and waste of these fibres
fibre, jute	26170: Jute and other textile bast fibres (except flax, true hemp and ramie), processed but not spun; tow and waste of these fibres
fibre, kenaf	26170: Jute and other textile bast fibres (except flax, true hemp and ramie), processed but not spun; tow and waste of these fibres
polar fleece, energy use only	28110: Pile fabrics and terry fabrics, knitted or crocheted
yarn, silk	26310: Silk yarn and yarn spun from silk waste; silk-worn gut
textile, nonwoven polyester	27922: Nonwovens
textile, nonwoven polypropylene	27922: Nonwovens

13 Transport

13.1 Introduction

In this release, the transport sector beneficiates from 3 main improvements regarding road, sea, and rail transport. The aim was to improve our current data quality, by updating when new data were available, and by reviewing and adding quality when data gaps were identified. The road transport received a correction regarding the wear emissions of brakes, the sea transport leveraged the (IMO, 2020) report regarding emission and fleet composition, meanwhile the rail got an improvement regarding quality of the dataset related to the dismantling of tram tracks and used railway tracks.

13.2 Brake Wear Emissions

Brake wear emissions are one of the sources of non-exhaust emissions coming from the use phase of a vehicle. In the previous versions of the database, the data source for most of the emissions was the (EEA, 2013) report. After performing some checks, an issue with the previous implementation was found. The problem was generated by an error in the order of magnitude of one of the emissions in the calculation: this generated a cascade effect on all the other emissions too and for this reason a full recalculation was performed. The datasets involved in this update are reported in **Table 60**.

Table 60. datasets involved in the brake wear update. In the column “v3.12”, “N” stands for “New Activity”, “U”

Activity Name	Geography	Time Period	Product Name	V 3.12
Treatment of brake wear emissions, lorry	RER	2009 - 2013	brake wear emissions, lorry	U
Treatment of brake wear emissions, lorry	GLO	2009 – 2013	brake wear emissions, lorry	U
Treatment of brake wear emissions, passenger car	RER	2012 - 2012	brake wear emissions, passenger car	U
Treatment of brake wear emissions, passenger car	GLO	2012 - 2012	brake wear emissions, passenger car	U

13.3 Sea Transport Update

Following the new regulations coming from the (IMO, 2020), an update of the seagoing fleet was planned. The goal of this update was to include the new limits related to sulphur content of heavy fuel oil (HFO) and the composition of the fleet with the latest data available (2018). This update was not limited to these two aspects, but work has been performed also to update the production phase (due to change of the average size of ships) and the maintenance of vessels.

In the study, the main update proposed is the limit of sulphur content of the HFO down to 0.5% m/m (mass by mass). Previously, the amount was 3.5%. It is important to mention that in the Emission Controlled Areas (ECA) the limit of sulphur is now 0.1%. To fulfil the ECA limitation, many times the vessels change fuel and instead of burning HFO they burn Marine Diesel OIL (MDO) which has a lower content of sulphur. Considering the boundary conditions of the dataset, the use of MDO is not accounted, and the vessels are modelled with only HFO.

The new report brought also updated data regarding the fleet composition, namely the size of the seagoing vessels which report to IMO. The type considered from the overall data available was only Type 1 and Type 2 vessels (meaning that their data were collected crossing AIS data and IHS data), to provide the highest quality of tracking possible. To represent the average vessel, thus the fleet average, an update of the calculation for average vessel size was performed. Now a weighted approach is employed, which takes into account several parameters, like total fuel consumption for each vessel size, and the distance sailed. This figure is then weighted including parameters like the number of vessels, and their average deadweight tonnage (DWT) to obtain a final average. A load factor is also included, directly taken by the (Notten P.J., Althaus H-J., Burke M. and Läderach A., 2018), ensuring comparability between versions. This methodology also feeds into the revised fuel consumption metric, which is expressed in tons of fuel per kilometer per ton DWT, weighted by the number of vessels in each size category. Because vessel size and operational distances have shifted, fuel consumption values across the fleet have been recalculated accordingly.

The production of vessels was reflected also by the change in size, because different amounts of materials are used. In addition to changes in operational data, new information has enabled more precise material specifications for vessel production:

- Aluminium content is now set at 0.5% of a vessel’s lightweight (LWT);
- Asbestos content is reduced to 0% for all new ships in line with IMO asbestos regulations.
- Insulation material values have been refined using new data, including consideration of disposal impacts.
- Solvent inputs for vessel painting have also been updated to reflect painting input
- Steel losses during construction of the ship have been included

The datasets affected by the update are available in **Table 61**.

It is important to highlight that the datasets related to **tanker for liquefied natural gas**, namely “tanker production, for liquefied natural gas”, “maintenance, tanker for liquefied natural gas”, and “transport, sea, freight, tanker for liquefied natural gas, heavy fuel oil” were not updated. This decision was taken in light of the complex situation of operation of an LNG tanker. Since ships are often operated with boiloff gas, they require specific solution to properly account for the related environmental impact, which are still in development.

Table 61: datasets involved in the seagoing vessels update. In the column “v3.12”, “N” stands for “New Activity”, “U” stands for "Updated Activity” and “D” stands for "Deleted Activity”.

Activity Name	Geography	Time Period	Product Name	V 3.12

Bulk carrier production, for dry goods	GLO	2007 - 2012	bulk carrier, for dry goods	U
Container ship production	GLO	2007 – 2012	container ship	U
Ferry production	GLO	2007 - 2012	ferry	U
Tanker production, for liquid goods other than petroleum and liquefied natural gas	GLO	2007 – 2012	tanker, for liquid goods other than petroleum and liquefied natural gas	U
Tanker production, for petroleum	GLO	2007 – 2012	tanker, for petroleum	U
Maintenance, bulk carrier, for dry goods	GLO	2007 – 2012	maintenance, bulk carrier, for dry goods	U
Maintenance container ship	GLO	2007 – 2012	maintenance, container ship	U
Maintenance, ferry	GLO	2007 – 2012	maintenance, ferry	U
Maintenance, tanker, for liquid goods other than petroleum and liquefied natural gas	GLO	2007 – 2012	maintenance, tanker, for liquid goods other than petroleum and liquefied natural gas	U
Maintenance, tanker, for petroleum	GLO	2007 – 2012	maintenance, tanker, for petroleum	U
Transport, freight, sea, bulk carrier for dry goods, heavy fuel oil	GLO	2007 – 2012	transport, freight, sea, bulk carrier for dry goods, heavy fuel oil	U
Transport, freight, sea, container ship, heavy fuel oil	GLO	2007 – 2012	transport, freight, sea, container ship, heavy fuel oil	U
Transport, freight, sea, ferry, heavy fuel oil	GLO	2007 – 2012	transport, freight, sea, ferry, heavy fuel oil	U
Transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	GLO	2007 – 2012	transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas, heavy fuel oil	U
Transport, freight, sea, tanker for petroleum	GLO	2007 – 2012	transport, freight, sea, tanker for petroleum, heavy fuel oil	U

13.4 Decommissioned and Used Track Update

The datasets reported in **Table 62** underwent an update that aimed to improve the quality of the data. These datasets were first implemented in version 2 of the ecoinvent database, and due to the assumption, that were used in version 2, the dataset was not reporting the presence of waste related with the activity.

The work performed consisted in the inclusion in the dataset of the exchanges related to the waste generated during the dismantling of the infrastructure, which was previously not included. Furthermore, the use of a skid-steer loader was included to proxy the use of machinery during the dismantling work.

Table 62: datasets involved in the decommissioned and used track update. In the column "v3.12", "N" stands for "New Activity", "U" stands for "Updated Activity" and "D" stands for "Deleted Activity".

Activity Name	Geography	Time Period	Product Name	V 3.12
Treatment of decommissioned tram track	CH	1985 – 2000	decommissioned tram track	U
Treatment of decommissioned tram track	GLO	1985 – 2000	decommissioned tram track	U
Treatment of used railway track	CH	1999 – 2000	used railway track	U
Treatment of used railway track	GLO	1999 – 2000	used railway track	U

14 Various Updates

14.1 Correction: Plastic Waste in Paper Sack Production

In paper sack production (**Table 63**), more accurate data on the plastic waste composition and the fate of the waste were available. The flow “waste plastic, mixture”, present in v3.11, was changed to “waste polyethylene, for recycling, unsorted” and “waste polyethylene”. The first one is recycled, and the second one is incinerated at a municipal incineration plant.

Table 63. Updated dataset to remodel the fate of plastic waste

Activity Name	Geography	Time Period	Product Name	Unit
paper sack production	GLO; RER	2021 - 2021	paper sack	kg

Furthermore, the activity link to kraft paper production was removed from the global dataset, as this activity link should only be present in the European dataset.

14.2 Correction: Printed Wiring Board Production for Surface Mounting

In the datasets “printed wiring board production, for surface mounting, Pb containing surface” and “printed wiring board production, for surface mounting, Pb free surface” (see **Table 64**. **Updated datasets in the electronics sector**, a mistake introduced in version 3.8 was corrected. The amounts of almost all most of the exchanges are updated.

Table 64. **Updated datasets in the electronics sector.**

Activity Name	Geography	Time Period	Product Name	Unit
printed wiring board production, for surface mounting, Pb containing surface	GLO	2003-2006	printed wiring board, for surface mounting, Pb containing surface	m2
printed wiring board production, for surface mounting, Pb free surface	GLO	2003-2006	printed wiring board, for surface mounting, Pb free surface	m2

14.3 Correction: Glass Tempering Service

Following user feedback regarding mass balance inconsistencies in service activities, a technical correction has been implemented for the "Tempering, flat glass" dataset in the [RER] and [GLO] target geographies. These datasets previously included 0.12 kg of flat glass as input representing process losses during tempering. However, they lacked the corresponding waste glass output, requiring users to manually account for these losses in their models. To improve clarity and ensure complete mass balance documentation, 0.12 kg of waste glass has been added as an output to this activity. This correction eliminates the need for users to independently calculate and add waste flows when using this service dataset.

14.4 Updates to Allocation Factors in the APOS System Model

For this new version, the allocation factors used in the APOS (Allocation at the Point of Substitution) system model were revised. The update concerns the intermediate step of allocation at the point of substitution. The calculation algorithm was refined to ensure that the right allocation key is used for each dataset. Therefore, the newly calculated scores will be consistent and aligned with the latest data inputs. This update resulted also in various score changes. The affected datasets are presented in **Table 74**. It is a list of datasets that their allocation factors and their scores changed more than 10%. It should be noted that the scores of these datasets were also impacted by various modifications and updates within the supply chain. Consequently, distinguishing the precise cause and magnitude of each change is challenging.

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16 Appendix

16.1 Products with Updated Prices

2-ethylhexanol [kg]; fuel wood, green, measured as dry mass [kg]; carding waste, hemp [kg]; vinylidene fluoride [kg]; styrene [kg]; steel, bearing, 100% scrap [kg]; methyl vinyl ketone [kg]; blown film co-extruded, monodirectional orienting [kg]; 1,1,1-trichloroethane [kg]; steel, weathering B, 100% scrap [kg]; methylheptenone [kg]; linalool [kg]; steel, weathering A, 100% scrap [kg]; chemical, organic, unspecified [kg]; sawlog and veneer log, hardwood, with bark, green, measured as green volume over bark [m3]; blown film extrusion, monolayer [kg]; methyl vinyl ether [kg]; steel, case hardening, 100% scrap [kg]; energy wood, green, from young stand, measured as dry mass [kg]; chemical, organic, alcohols [kg]; pulpwood, softwood, with bark, green, measured as green volume over bark [m3]; 2-ethylhexanal [kg]; ethyl propionate [kg]; blown film co-extruded, seven layers [kg]; dehydrolinalool [kg]; polytetrafluoroethylene [kg]; diethyl carbonate [kg]; blown film co-extruded, average configuration [kg]; methylbutynol [kg]; methyl isopropyl ketone [kg]; chemical, organic, carboxylic acids [kg]; 1,1,2-trichloroethane [kg]; plastic bag making [kg]; diethyl ketone [kg]; potassium acetate [kg]; styrene butadiene rubber, solution polymerised [kg]; flax shive [kg]; ethyl methyl carbonate [kg]; allyl alcohol [kg]; blown film co-extruded, three layers [kg]; hemp residues [kg]; 1-chloro-1,1-difluoroethane [kg]; steel, carbon, 100% scrap [kg]; aggregated process-specific inputs, zamak ingot production [unit]; zamak ingot, 10% primary zinc input [kg]; succinonitrile [kg]; 2-ethyl-2-hexenal [kg]; cottonized fibre, hemp [kg]; hydrogen, gaseous, medium pressure, merchant [kg]; chemical, organic, aromatics [kg]; sawlog and veneer log, softwood, with bark, green, measured as green volume over bark [m3]; n-butyraldehyde [kg]; pulpwood, hardwood, with bark, green, measured as green volume over bark [m3]; polyvinylidene fluoride [kg]; cobalt(II) chloride, anhydrous [kg]; 2-ethyl hexyl acrylate [kg]; vinylidene chloride [kg]; hemp hurd [kg]; methyl propionate [kg]; forest chips, green, from logging residues, measured as dry mass [kg]; manganese carbonate [kg]; methylbutenol [kg]; glycidol [kg]; styrene butadiene rubber, emulsion polymerised [kg]; lithium nitrate [kg]; decorticated fibre, hemp [kg]; hemp noil [kg]; hemp stem, dew-retted [kg]; chemical, organic, esters [kg]; isobutyraldehyde [kg]; methyl isobutyl ketone [kg]; mesityl oxide [kg]; hydrogen, gaseous, low pressure [kg]; pentanal [kg]; propylene carbonate [kg]; propyl propionate [kg]; tert-Butanol [kg]; calcium acetate [kg]; methanol rich hydrocarbon mixture [kg]; steel, structural, 100% scrap [kg]; 2-methylbutanal [kg]; blown film co-extruded, five layers [kg]; steel, high strength low alloy, 100% scrap [kg]; propylene oxide, liquid [kg]; batch dyeing, woven fabric, cotton [kg];

16.2 Additional information on Chemicals and Plastics

Table 65: Representation of steam cracking operations and related data in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns indicate activities updated or replaced in the new version, while "Version 3.12" columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
unsaturated hydrocarbons production, steam cracking operation, average	GLO	2019 – 2023	unsaturated hydrocarbons production, steam cracking operation, average	AR; AU; BR; CA; CN; CO; IL; IN; JP; KR; KW; MY; PH; QA; SA; TH; TR; TW; US; VE; ZA; SG; MX; AE	2015 – 2025
unsaturated hydrocarbons production, steam cracking operation, average	RER	2019 – 2023	unsaturated hydrocarbons production, steam cracking operation, average	RER w/o RU; RU	2019 – 2023
butadiene purification, extractive distillation of crude butadiene	GLO	2019 – 2023	butadiene purification, extractive distillation of crude butadiene	AR; AU; BR; CA; CN; CO; IL; IN; JP; KR; KW; MY; PH; QA; SA; TH; TR; TW; US; VE; ZA; SG; MX; AE	2019 – 2023
butadiene purification, extractive distillation of crude butadiene	RER	2019 – 2023	butadiene purification, extractive distillation of crude butadiene	RER w/o RU; RU	2019 – 2023
market for butadiene	GLO	2011 – 2011	market for butadiene	AE; AR; AU; CA; CN; IL; IN; JP; KR; SG; MY; QA; SA; TH; TR; TW; US; VE; ZA; GLO	2011 – 2011
market for butadiene	RER	2018 – 2018	market for butadiene	RU RER w/o RU	2011 – 2011 2018 – 2018
market for butadiene, crude	GLO	2022 – 2022	market for C4 hydrocarbon mixture	AE; AR; AU; CA; CN; IL; IN; JP; KR; SG; MY; QA; SA; TH; TR; TW; US; VE; ZA; BR; MX; PH; KW; CO	2022 – 2022
market for butadiene, crude	RER	2022 – 2022	market for C4 hydrocarbon mixture	RER w/o RU; RU	2022 – 2022

market for ethylene	GLO	2011 – 2011	market for ethylene	AE; AR; AU; CA; IL; IN; VE; JP; KR; MY; QA; SA; TH; TR; TW; US; GLO	2011 – 2011
market for ethylene	RER	2018 – 2018	market for ethylene	RU	2011 – 2011
				RER w/o RU	2018 – 2018
market for propylene	GLO	2011 – 2011	market for propylene	AE; AR; AU; CA; CN; IL; IN; VE; ZA; JP; KR; MY; QA; SA; TH; TR; TW; US; GLO	2024 – 2024
market for propylene	RER	2018 – 2018	market for propylene	RU	2011 – 2011
				RER w/o RU	2018 – 2018
			market for butene, mixed	AE; AR; AU; CA; CN; IL; IN; JP; KR; SG; MY; QA; SA; TH; TR; TW; US; VE; ZA	2011 – 2011
market for butene, mixed	RER	2018 – 2018	market for butene, mixed	RU	2011 – 2011
				RER w/o RU	2018 – 2018

Table 66: Acrylic acid related data in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns indicate activities updated or replaced in the new version, while "Version 3.12" columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
acrylic acid production, propylene oxidation	GLO;	1989 – 2022	acrylic acid production, propylene oxidation	ZA; AR; BR; CO; SA; MX; US; MY; TW; TH; SG; CN; ID; IN; JP; KR	1989 – 2022
"New activity"			acrylic acid production, propylene oxidation	DE; FR; GB	1989 – 2022

“New activity”			market for acrylic acid	ZA; RNA; CN; Asia without China	2011 – 2011

Table 67: Ethylene oxide related data in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column. The “Version 3.11” columns indicate activities updated or replaced in the new version, while “Version 3.12” columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
ethylene oxide production, ethylene oxidation	GLO	2019 – 2023	ethylene oxide production, ethylene oxidation	AU; BR; CA; CN; ID; IN; JP; KR; KW; MX; SA; SG; TR; TW; US; VE	2019 – 2023
ethylene oxide production, ethylene oxidation	RER	2019 – 2023	ethylene oxide production, ethylene oxidation	BE; BG; DE; ES; FR; GB; IT; NL; PL; RO; RU; SE; SK	2019 – 2023
“New activity”			market for ethylene oxide	US; SA; CN; KR; CA; TW; IN; JP	2011 – 2011
market for ethylene oxide	RER	2018 – 2018	market for ethylene oxide	RU	2011 – 2011
				RER w/o RU	2018 – 2018

Table 68: Methanol related data in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column. The “Version 3.11” columns indicate activities updated or replaced in the new version, while “Version 3.12” columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
methanol production, from	GLO	2017 – 2025	methanol production, from	AZ; BN; CA-AB; CL; EG; GQ; ID; IN; IR; LY; MY; NZ; OM; QA; SA; TT; VE	2017 – 2025

natural gas reforming			natural gas reforming		
methanol production, from natural gas reforming	US	2017 – 2025	methanol production, from natural gas reforming	US-LA; US-TRE	2017 – 2025
methanol production, from natural gas reforming	RER	2017 – 2025	methanol production, from natural gas reforming	DE; LT; NL; NO; RS; RU	2017 – 2025
“New activity”			market for methanol	OM; SA; QA; IR; UN-SAMERICA; CA; TT	2011 – 2011
market for methanol	RER	2011 – 2011	market for methanol	RER w/o RU; RU	2011 – 2011

Table 69: Other regionalized chemicals and plastics related data in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column. The “Version 3.11” columns indicate activities updated or replaced in the new version, while “Version 3.12” columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
“New activity”			polycarbonate production	CN; JP; KR; SA; TH; TW; US	2016 – 2024
polycarbonate production	RER	2016 – 2024	polycarbonate production	DE; ES; NL	2016 – 2024
“New activity”			phenol production, cumene oxidation	CN; IN; JP; US	2017 – 2022
“New activity”			chlor-alkali electrolysis, diaphragm cell	US	2000 – 2000
“New activity”			chlor-alkali electrolysis, membrane cell	US	2020 – 2025
“New activity”			chlorine production, liquid	US	2000 – 2000
“New activity”			vinyl chloride production	Asia without China; CN; RLA; RNA	2021 – 2026

polyvinyl chloride production, emulsion polymerisation	GLO	2021 – 2026	polyvinyl chloride production, emulsion polymerisation	Asia without China; CN; RAF; RNA; UN-SAMERICA	2021 – 2026
polyvinyl chloride production, suspension polymerisation	GLO	2021 – 2026	polyvinyl chloride production, suspension polymerisation	Asia without China; CN; RAF; RNA; UN-SAMERICA	2021 – 2026
“New activity”			polyethylene production, low density, granulate	IN; KR; US	2011 – 2016
“New activity”			polyethylene production, linear low density, granulate	US	2011 – 2016
“New activity”			polyethylene production, high density, granulate	IN; KR; JP; US	2011 – 2016
“New activity”			polypropylene production, granulate	CN; Asia without China; RNA; RLA; RAF	2011 – 2016
“New activity”			market for chlorine, gaseous	US	2011 – 2011
“New activity”			market for chlorine, liquid	US	2000 – 2000
“New activity”			market for sodium hydroxide, without water, in 50% solution state	US	2011 – 2011
“New activity”			market for vinyl chloride	Asia without China; CN; RNA	2011 – 2011
“New activity”			market for polyvinyl chloride, emulsion polymerised	Asia without China; CN; RNA	2011 – 2011
“New activity”			market for polyvinyl chloride, suspension polymerised	Asia without China; CN; RNA	2011 – 2011
“New activity”			market for polyethylene, low density, granulate	US; KR; IN	2011 – 2011
“New activity”			market for polyethylene, high density, granulate	IN; JP; KR; US	2011 – 2011
“New activity”			market for polypropylene, granulate	Asia without China; CN; RAF; RER; RLA; RNA	2011 – 2011

Table 70: Industrial gases related data in version 3.12 compared to 3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.11" columns indicate activities updated or replaced in the new version, while "Version 3.12" columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.11			**Version 3.12**		
industrial gases production, cryogenic air separation	GLO	2019 – 2023	industrial gases production, cryogenic air separation	North America without Quebec; RAF; CN; Asia without China; RLA	2019 – 2023
venting of nitrogen, liquid	GLO	2008 – 2012	venting of nitrogen, liquid	RNA; RAF; CN; Asia without China; RLA	2008 – 2012
market for nitrogen, liquid	GLO	2011 – 2011	market for nitrogen, liquid	RNA; RAF; CN; Asia without China; RLA	2011 – 2011
market for oxygen, liquid	GLO	2011 – 2011	market for oxygen, liquid	RNA; RAF; RER; CN; Asia without China; RLA	2011 – 2011

Table 71: Newly added transforming activity data in version 3.12 not previously covered. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column.

Activity Name	Geography	Time Period
2-ethyl hexyl acrylate production, 2-ethylhexanol esterification with acrylic acid	RER; RNA; UN-EASIA; UN-SEASIA	2015 – 2025
2-ethyl-2-hexenal production, butyraldehyde aldolization and subsequent dehydration	GLO	2015 – 2025
2-ethylhexanal production, 2-ethyl-2-hexenal partial hydrogenation	GLO; RAS; RER; US	2015 – 2025
2-ethylhexanol production, 2-ethylhexanal hydrogenation	GLO; RAS; RER; US	2015 – 2025
allyl alcohol production, allyl chloride hydrolysis	GLO; RER	2015 – 2024
butanals production, propylene hydroformylation	GLO	2015 – 2025
calcium acetate production, from calcium carbonate and acetic acid	GLO; RER	2015 – 2024
calcium acetate production, from calcium hydroxide and acetic acid	GLO; RER	2015 – 2024

diethyl ketone production, propionic acid ketonization	GLO	2015 – 2024
glycidol production, allyl alcohol epoxidation	GLO	2015 – 2024
linalool production, dehydrolinalool hydrogenation	GLO	2015 – 2024
mesityl oxide production	GLO	2015 – 2024
methyl vinyl ether production	GLO	2015 – 2024
methylbutenol production	GLO	2015 – 2025
methylbutynol production	GLO	2015 – 2025
methylheptenone production	GLO	2015 – 2025
dehydrolinalool production	GLO	2015 – 2025
methyl isopropyl ketone, one-step process, condensation of methyl ethyl ketone	GLO	2015 – 2024
methyl vinyl ketone, from acetone with formaldehyde, and dehydration	GLO	2015 – 2024
pentanal production, butene hydroformylation	GLO	2015 – 2025
potassium acetate production, from potassium hydroxide acetic acid	GLO	2003 – 2025
1,1,1-trichloroethane production, vinyl chloride chlorination	GLO	2015 – 2025
1,1,2-trichloroethane production, vinyl chloride chlorination	GLO	2015 – 2025
1-chloro-1,1-difluoroethane production, 1,1,1-trichloroethane fluorination	GLO	2015 – 2025
1-chloro-1,1-difluoroethane production, vinylidene chloride fluorination	GLO	2015 – 2025
cobalt(II) chloride production, cobalt oxide hydrochlorination	GLO; US	2015 – 2025
ethyl methyl carbonate production, via reactive distillation	GLO; CN; RER; US	2022 – 2025
lithium nitrate production	GLO	2015 – 2025
manganese carbonate production	GLO	2015 – 2025
ethyl propionate production, ethanol esterification with propanoic acid, via reactive distillation	GLO	2022 – 2024
methyl propionate production, esterification of propionic acid with methanol	GLO	2015 – 2025
methyl propionate production, ethylene carbomethoxylation	GLO	2015 – 2025
polytetrafluoroethylene production, emulsion polymerization	GLO	2015 – 2025
polyvinylidene fluoride production, emulsion polymerisation	GLO	2015 – 2025
propyl propionate production, propanol esterification with propionic acid, via reactive distillation	GLO; CN; RER; US	2025 – 2025
propylene carbonate production	GLO	2015 – 2024
styrene butadiene rubber production, emulsion polymerization	GLO; RAS; RER; RLA; RNA	2007 – 2025

styrene butadiene rubber production, solution polymerization	GLO; RAS; RER; RLA; RNA	2007 – 2025
succinonitrile production	GLO	2015 – 2025
vinylidene chloride production, 1,1,2-trichloroethane dehydrochlorination	GLO	2015 – 2025
vinylidene fluoride production, 1-chloro-1,1-difluoroethane dehydrochlorination	GLO	2015 – 2025

Table 72: Newly added market activity data in version 3.12 not previously covered. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column.

Activity Name	Geography	Time Period
market for 2-ethyl hexyl acrylate	GLO; RER	2025 – 2025
market for 2-ethyl-2-hexenal	GLO	2025 – 2025
market for 2-ethylhexanal	GLO; RER	2025 – 2025
market for 2-ethylhexanol	GLO; RER	2025 – 2025
market for 2-methylbutanal	GLO	2025 – 2025
market for allyl alcohol	GLO; RER	2025 – 2025
market for calcium acetate	GLO; RER	2025 – 2025
market for dehydrolinalool	GLO	2025 – 2025
market for diethyl ketone	GLO	2025 – 2025
market for glycidol	GLO	2025 – 2025
market for isobutyraldehyde	GLO	2025 – 2025
market for linalool	GLO	2025 – 2025
market for mesityl oxide	GLO	2025 – 2025
market for methyl isopropyl ketone	GLO	2025 – 2025
market for methyl vinyl ether	GLO	2025 – 2025
market for methyl vinyl ketone	GLO	2025 – 2025
market for methylbutenol	GLO	2025 – 2025
market for methylbutynol	GLO	2025 – 2025
market for methylheptenone	GLO	2025 – 2025

market for n-butyraldehyde	GLO	2025 – 2025
market for pentanal	GLO	2025 – 2025
market for potassium acetate	GLO	2025 – 2025
market for 1,1,1-trichloroethane	GLO	2025 – 2025
market for 1,1,2-trichloroethane	GLO	2025 – 2025
market for 1-chloro-1,1-difluoroethane	GLO	2025 – 2025
market for cobalt(II) chloride, anhydrous	GLO; US	2025 – 2025
market for ethyl methyl carbonate	GLO; CN; RER; US	2025 – 2025
market for propylene carbonate	GLO	2025 – 2025
market for ethyl propionate	GLO	2025 – 2025
market for lithium nitrate	GLO	2025 – 2025
market for manganese carbonate	GLO	2025 – 2025
market for methanol rich hydrocarbon mixture	GLO	2022 – 2025
market for methyl propionate	GLO	2025 – 2025
market for polytetrafluoroethylene	GLO	2025 – 2025
market for polyvinylidene fluoride	GLO	2025 – 2025
market for propyl propionate	GLO; CN; RER; US	2025 – 2025
market for styrene butadiene rubber, emulsion polymerised	GLO; RAS; RER; RLA; RNA	2025 – 2025
market for styrene butadiene rubber, solution polymerised	GLO; RAS; RER; RLA; RNA	2025 – 2025
market for succinonitrile	GLO	2025 – 2025
market for vinylidene chloride	GLO	2025 – 2025
market for vinylidene fluoride	GLO	2025 – 2025
methanol rich hydrocarbon mixture to generic market for residual fuels	GLO	2022 – 2025

Table 73: Other data related to database maintenance for the Chemicals and Plastics sector representation. In column v3.12, “N” stands for “New Activity”, “D” stands for “Deleted Activity”, and “U” stands for “Updated Activity”. If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column.

Activity Name	Geography	Time Period	Version 3.12
diethyl carbonate production, from phosgene and ethanol	GLO; RER	2015 – 2024	U
ethylene glycol dimethyl ether production	GLO; RER	2015 – 2025	U
ethylene glycols production, thermal hydrolysis of ethylene oxide	GLO; RER	2019 – 2023	U
magnesium sulfate production	GLO; RER	2000 – 2000	U
4-methyl-2-pentanone production	GLO; RER	2015 – 2024	U
market for 4-methyl-2-pentanone	GLO; RER	2011 – 2011	U
BTX production, from pyrolysis gas, average	RER	2019 – 2023	U
BTX production, from pyrolysis gas, average	GLO	1989 – 2022	U
2-methyl-2-butanol production	RER	1989 – 2022	U
market for butene, mixed	GLO	2011 – 2011	U
diethyl carbonate production, from phosgene and ethanol	GLO; RER	2015 – 2024	U
diethyl carbonate production, from phosgene and ethanol	CN; US	2015 – 2024	N
diethyl carbonate production, via reactive distillation	GLO; RER; CN; US	2014 – 2025	N
market for diethyl carbonate	CN; US	2025 – 2025	N
butene, mixed to generic market for generic C4 hydrocarbons	GLO; RER	2019 – 2023	D
cooling energy production, at -100 °C, R-134a-carbon dioxide-ethylene compression refrigeration system 1 MW	GLO	2017 – 2022	U
chemical production, inorganic	GLO	2025 – 2025	U
hydrogen production, steam methane reforming	RLA	2020 – 2005	N
sodium hydroxide to generic market for neutralising agent	US	2000 – 2000	N
sodium hypochlorite to generic market for bleach	US	2023 – 2023	N
market for sludge, NaCl electrolysis	US	2010 – 2022	N
chlor-alkali electrolysis, membrane cell	GLO	2020 – 2025	U

chlor-alkali electrolysis, diaphragm cell	GLO	2000 – 2000	U
vinyl chloride production	GLO	2021 – 2026	U
polyethylene production, low density, granulate	GLO; RER	2011 – 2016	U
polyethylene production, high density, granulate	GLO	2011 – 2016	U

16.3 Datasets Impacted by the Update of Allocation Factors in APOS System Model

Table 74. Datasets impacted by the update of allocation factors within the APOS.

Activity Name	Geography	Reference Product
air compressor production, screw-type compressor, 4kW	RER	air compressor, screw-type compressor, 4kW
allyl chloride production, reaction of propylene and chlorine	RER	1,3-dichloropropene
aluminium around steel bi-metal wire production, 3.67 mm external diameter	CA-QC	iron scrap, unsorted
beef cattle production on pasture	BR	iron scrap, unsorted
beef cattle production on pasture and feedlot	BR	iron scrap, unsorted
beef cattle production on pasture and proteic supplement	BR	iron scrap, unsorted
biogas production from grass	CH	biogas, from grass
biogas production from grass	CH	protein feed, 100% crude
calcined petroleum coke production	CN	gypsum, mineral
casting, aluminium, lost-wax	CA-QC	iron scrap, unsorted
casting, aluminium, lost-wax	CA-QC	casting, aluminium, lost-wax
casting, steel, lost-wax	CA-QC	casting, steel, lost-wax
casting, steel, lost-wax	CA-QC	iron scrap, unsorted
chlor-alkali electrolysis, average production	RER	potassium hydroxide
chlor-alkali electrolysis, average production	RER	hydrochloric acid, without water, in 30% solution state
chlor-alkali electrolysis, average production	RER	sulfuric acid

chlor-alkali electrolysis, membrane cell	RER	potassium hydroxide
chlor-alkali electrolysis, membrane cell	RER	hydrochloric acid, without water, in 30% solution state
chlor-alkali electrolysis, membrane cell	RER	sulfuric acid
citric acid production	CN	protein feed, 100% crude
citric acid production	RNA	protein feed, 100% crude
citric acid production	RER	protein feed, 100% crude
cobalt production	GLO	electrolyte, nickel-rich
cobalt production	GLO	cobalt hydroxide
cobalt production	GLO	nickel concentrate, 16% Ni
cobalt production	GLO	zinc sulfide
cobalt production	GLO	sulfur
cobalt production	GLO	ammonia, anhydrous, liquid
cobalt production	GLO	cobalt carbonate
cobalt production	GLO	cobalt acetate
coke production	DE	coal tar
coke production	DE	benzene
coke production	US	coal tar
coke production	US	benzene
compact fluorescent lamp production	GLO	iron scrap, unsorted
compression of sheet moulding compound	FR	iron scrap, unsorted
compression of sheet moulding compound	RNA	iron scrap, unsorted
compression of sheet moulding compound	RAS	iron scrap, unsorted
compression of sheet moulding compound	FR	compression of sheet moulding compound
compression of sheet moulding compound	RNA	compression of sheet moulding compound
container production, for collection of post-consumer waste plastic for recycling	CH	iron scrap, unsorted
container production, for collection of post-consumer waste plastic for recycling	Europe without Switzerland	iron scrap, unsorted
container production, for collection of post-consumer waste plastic for recycling	Europe without Switzerland	container, for collection of post-consumer waste plastic for recycling

container production, for collection of post-consumer waste plastic for recycling	CH	container, for collection of post-consumer waste plastic for recycling
container production, for collection of post-consumer waste plastic for recycling	US	container, for collection of post-consumer waste plastic for recycling
container production, for collection of post-consumer waste plastic for recycling	US	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	RU	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	JP	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	KR	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	CA-QC	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	CA-NB	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	CA-ON	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	RoW	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	AR	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	CN-ZJ	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	RO	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	IN-GJ	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	IN-KA	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	IN-MH	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	IN-RJ	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	IN-TN	iron scrap, unsorted
electricity production, nuclear, pressure water reactor, heavy water moderated	IN-UP	iron scrap, unsorted
epichlorohydrin production from allyl chloride	RER	trichloropropane
ethanol production from sweet sorghum	CN	electricity, high voltage

ethanol production from sweet sorghum	CN	ethanol, without water, in 95% solution state, from fermentation
ethanol production from sweet sorghum	CN	vinasse, from fermentation of sweet sorghum
ethanol production, ethylene hydration	RER	diethyl ether, without water, in 99.95% solution state
extrusion of plastic sheets and thermoforming, inline	FR	iron scrap, unsorted
extrusion of plastic sheets and thermoforming, inline	FR	extrusion of plastic sheets and thermoforming, inline
extrusion, co-extrusion of plastic sheets	FR	iron scrap, unsorted
extrusion, co-extrusion of plastic sheets	FR	extrusion, co-extrusion
fattening of calves for beef cattle production, on pasture	BR	iron scrap, unsorted
fattening of heifers for beef cattle production, on pasture	BR	iron scrap, unsorted
fibre production, flax, scutching	RER	fibre, flax, long, scutched
fibre production, flax, scutching	RER	fibre, flax, short, scutched
filament winding	FR	iron scrap, unsorted
filament winding	RNA	iron scrap, unsorted
filament winding	RAS	iron scrap, unsorted
filament winding	FR	filament winding
filament winding	RNA	filament winding
frozen fish sticks production, hake	RER	frozen fish sticks, hake
frozen fish sticks production, hake	RER	protein feed, 100% crude
glider production, passenger car	GLO	iron scrap, unsorted
grain oriented electrical steel production, 0.23 mm coil	RER	iron scrap, unsorted
grain oriented electrical steel production, 0.23 mm coil	RER	iron sulfate
greenhouse construction, glass walls and roof, metal tubes	FR	iron scrap, unsorted
greenhouse construction, glass walls and roof, metal tubes	FR	greenhouse, glass walls and roof
greenhouse construction, glass walls and roof, plastic tubes	FR	iron scrap, unsorted
greenhouse construction, glass walls and roof, plastic tubes	FR	greenhouse, glass walls and roof

greenhouse construction, plastic walls and roof, metal tubes	FR	greenhouse, plastic walls and roof
greenhouse construction, plastic walls and roof, metal tubes	FR	iron scrap, unsorted
greenhouse construction, plastic walls and roof, plastic tubes	FR	iron scrap, unsorted
greenhouse construction, plastic walls and roof, plastic tubes	FR	greenhouse, plastic walls and roof
hand lay-up	FR	iron scrap, unsorted
hand lay-up	RNA	iron scrap, unsorted
hand lay-up	FR	hand lay-up
hand lay-up	RAS	iron scrap, unsorted
heat and power co-generation, oil	ES	electricity, high voltage
heat and power co-generation, oil	TW	electricity, high voltage
heat and power co-generation, oil	TW	heat, district or industrial, other than natural gas
heat and power co-generation, oil	RU	electricity, high voltage
heat and power co-generation, oil	RU	heat, district or industrial, other than natural gas
heat and power co-generation, oil	IT	electricity, high voltage
heat and power co-generation, oil	GR	electricity, high voltage
heat and power co-generation, oil	GB	electricity, high voltage
heat and power co-generation, oil	US-HICC	electricity, high voltage
heat and power co-generation, oil	FI	electricity, high voltage
heat and power co-generation, oil	EE	electricity, high voltage
heat and power co-generation, oil	PL	electricity, high voltage
heat and power co-generation, oil	CZ	electricity, high voltage
heat and power co-generation, oil	UA	electricity, high voltage
heat and power co-generation, oil	DK	electricity, high voltage
heat and power co-generation, oil	RS	electricity, high voltage
heat and power co-generation, oil	FR	electricity, high voltage
heat and power co-generation, oil	LV	electricity, high voltage
heat and power co-generation, oil	HU	electricity, high voltage
heat and power co-generation, oil	LT	electricity, high voltage
heat and power co-generation, oil	SE	electricity, high voltage

heat and power co-generation, oil	SI	electricity, high voltage
heat and power co-generation, oil	LU	electricity, high voltage
heat and power co-generation, oil	US-TRE	electricity, high voltage
heat and power co-generation, oil	BE	electricity, high voltage
heat and power co-generation, oil	HR	electricity, high voltage
heat and power co-generation, oil	AT	electricity, high voltage
heat and power co-generation, oil	RO	electricity, high voltage
heat and power co-generation, oil	TR	electricity, high voltage
heat and power co-generation, oil	US-SERC	electricity, high voltage
heat and power co-generation, oil	NL	electricity, high voltage
heat and power co-generation, oil	KR	electricity, high voltage
heat and power co-generation, oil	AU	electricity, high voltage
heat and power co-generation, oil	US-ASCC	electricity, high voltage
heat and power co-generation, oil	US-MRO	electricity, high voltage
heat and power co-generation, oil	US-NPCC	electricity, high voltage
heat and power co-generation, oil	US-RFC	electricity, high voltage
heat and power co-generation, oil	US-WECC	electricity, high voltage
intensive beef cattle production on pasture	BR	iron scrap, unsorted
intensive beef cattle production, fat steers only, on pasture	BR	iron scrap, unsorted
kraft paper production	RER	turpentine
kraft paper production	RER	tall oil, crude
maintenance, aircraft, long haul, airframe	RER	maintenance, aircraft, long haul, airframe
maintenance, aircraft, medium haul, airframe	RER	maintenance, aircraft, medium haul, airframe
maintenance, aircraft, medium haul, engine	RER	maintenance, aircraft, medium haul, engine
maintenance, aircraft, short haul, airframe	RER	maintenance, aircraft, short haul, airframe
maintenance, aircraft, short haul, engine	RER	maintenance, aircraft, short haul, engine
maintenance, aircraft, very short haul, airframe	RER	maintenance, aircraft, very short haul, airframe
maintenance, aircraft, very short haul, engine	RER	maintenance, aircraft, very short haul, engine

maintenance, electric scooter, without battery	GLO	maintenance, electric scooter, without battery
maintenance, electric scooter, without battery	GLO	iron scrap, unsorted
maintenance, passenger car, electric, without battery	GLO	maintenance, passenger car, electric, without battery
maintenance, transmission network, electricity, high voltage direct current aerial line	RER	maintenance, transmission network, electricity, high voltage direct current aerial line
palm oil refinery operation	GLO	soap
petroleum refinery operation	CH	refinery gas
petroleum refinery operation	CH	electricity, high voltage
petroleum refinery operation	CH	sulfur
photovoltaics, electric installation for 3kWp module, at building	CH	iron scrap, unsorted
photovoltaics, electric installation for 3kWp module, at building	CH	photovoltaics, electric installation for 3kWp module, at building
plastic tunnel construction	FR	iron scrap, unsorted
polyethylene terephthalate production, granulate, bottle grade, recycled	GLO	waste polyethylene, for recycling, sorted
primary zinc production from concentrate	CA-QC	iron scrap, unsorted
primary zinc production from concentrate	CA-QC	cadmium sludge from zinc electrolysis
primary zinc production from concentrate	CA-QC	sulfur dioxide, liquid
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	yttrium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	samarium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	lanthanum oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	cerium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	erbium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	terbium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	dysprosium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	praseodymium oxide

rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	gadolinium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	ytterbium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	lutetium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	holmium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	thulium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	neodymium oxide
rare earth oxides production, from rare earth carbonate concentrate	CN-FJ	europium oxide
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	cerium oxide
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	magnesium sulfate
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	hydrogen fluoride
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	praseodymium oxide
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	samarium-europium-gadolinium oxide
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	lanthanum oxide
rare earth oxides production, from rare earth oxide concentrate, 50% REO	CN-NM	neodymium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	samarium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	yttrium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	lanthanum-cerium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	cerium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	terbium-dysprosium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	sodium chloride, powder
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	gadolinium oxide

rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	sulfur
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	calcium chloride
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	coal tar
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	iron ore concentrate
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	calcium carbonate, precipitated
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	lanthanum oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	praseodymium-neodymium oxide
rare earth oxides production, from rare earth oxide concentrate, 70% REO	CN-SC	europium oxide
resin transfer moulding, light	FR	iron scrap, unsorted
resin transfer moulding, light	RNA	iron scrap, unsorted
resin transfer moulding, light	FR	resin transfer moulding, light
resin transfer moulding, light	RNA	resin transfer moulding, light
resorcinol production, hydrolysis of meta-phenylene diamine	GLO	resorcinol
resorcinol production, hydrolysis of meta-phenylene diamine	GLO	o-phenylene diamine
resorcinol production, hydrolysis of meta-phenylene diamine	GLO	p-phenylene diamine
solid bleached and unbleached board carton production	CA-QC	turpentine
solid bleached and unbleached board carton production	RER	turpentine
soybean beverage production	CA-QC	protein feed, 100% crude
spray-up for composite production, spray-up of resin and fibres	FR	iron scrap, unsorted
spray-up for composite production, spray-up of resin and fibres	RNA	iron scrap, unsorted
spray-up for composite production, spray-up of resin and fibres	FR	spray-up for composite production, spray-up of resin and fibres
spray-up for composite production, spray-up of resin and fibres	RNA	spray-up for composite production, spray-up of resin and fibres

spray-up for composite production, spray-up of resin and fibres	RAS	iron scrap, unsorted
stamping for thermoplastic composite product, excluding electricity use	FR	iron scrap, unsorted
stamping for thermoplastic composite product, excluding electricity use	RNA	iron scrap, unsorted
stamping for thermoplastic composite product, excluding electricity use	FR	stamping for thermoplastic composite product
stamping for thermoplastic composite product, excluding electricity use	RAS	iron scrap, unsorted
stamping for thermoplastic composite product, excluding electricity use	RNA	stamping for thermoplastic composite product
steel production, electric, low-alloyed	IN	iron scrap, unsorted
sugarcane processing, traditional annexed plant	CO	sugar, from sugarcane
sugarcane processing, traditional annexed plant	CO	vinasse, from fermentation of sugarcane
sugarcane processing, traditional annexed plant	BR	vinasse, from fermentation of sugarcane
sugarcane processing, traditional annexed plant	CO	filter cake, from sugarcane juice filtration
sugarcane processing, traditional annexed plant	BR	filter cake, from sugarcane juice filtration
sugarcane processing, traditional annexed plant	BR	sugar, from sugarcane
sugarcane processing, traditional autonomous plant	BR	vinasse, from fermentation of sugarcane
sugarcane processing, traditional autonomous plant	BR	filter cake, from sugarcane juice filtration
sugarcane processing, traditional autonomous plant	BR	ethanol, without water, in 95% solution state, from fermentation
sulfate pulp production, from eucalyptus, bleached	RER	iron scrap, unsorted
sulfate pulp production, from eucalyptus, bleached	RLA	iron scrap, unsorted
sulfate pulp production, from hardwood, bleached	RER	methanol, from biomass
sulfate pulp production, from hardwood, bleached	RER	iron scrap, unsorted
sulfate pulp production, from softwood, bleached	RER	iron scrap, unsorted
sulfate pulp production, from softwood, bleached	RER	tall oil, crude
sulfate pulp production, from softwood, bleached	RER	methanol, from biomass
sulfate pulp production, from softwood, bleached	RER	turpentine

thermal energy storage construction, for adiabatic compressed air energy storage	GLO	thermal energy storage, for adiabatic compressed air energy storage
thermal storage system construction, solar thermal parabolic trough, 50 MW	ZA	thermal storage system, solar thermal parabolic trough, 50 MW
thermocompression for wet thermoset composite product, excluding electricity use	FR	iron scrap, unsorted
thermocompression for wet thermoset composite product, excluding electricity use	RNA	iron scrap, unsorted
thermocompression for wet thermoset composite product, excluding electricity use	FR	thermocompression for wet thermoset composite product
thermocompression for wet thermoset composite product, excluding electricity use	RAS	iron scrap, unsorted
thermocompression for wet thermoset composite product, excluding electricity use	RNA	thermocompression for wet thermoset composite product
thermoforming of plastic sheets	FR	iron scrap, unsorted
thermoforming of plastic sheets	FR	thermoforming of plastic sheets
tofu production	CA-QC	protein feed, 100% crude
transmission network construction, electricity, high voltage direct current land cable	RER	transmission network, electricity, high voltage direct current land cable
transmission network construction, electricity, medium voltage	CH	transmission network, electricity, medium voltage
vacuum infusion moulding for composite product	FR	iron scrap, unsorted
vacuum infusion moulding for composite product	RNA	iron scrap, unsorted
vacuum infusion moulding for composite product	FR	vacuum infusion moulding for composite product
vacuum infusion moulding for composite product	RAS	iron scrap, unsorted
vacuum infusion moulding for composite product	RNA	vacuum infusion moulding for composite product
wind turbine construction, small-scale, 6kW, onshore	DE	wind turbine, small-scale, 6kW, onshore
yogurt production, from cow milk	CA-QC	cheese, from cow milk, fresh, unripened
zinc mine operation	GLO	iron scrap, unsorted
zinc mine operation	GLO	bulk lead-zinc concentrate
zinc mine operation	GLO	gold, unrefined