Documentation of changes implemented in the ecoinvent database v3.11 (2024.11.19)

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Table of Contents

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1 Introduction to the new version

This report covers the changes to the ecoinvent database between version 3.10.1, released in 2024 and version 3.11, released in 2024. It describes both the database-wide changes that affect the whole database as well as the specific changes in the different sectors. These changes consist in the addition of new datasets, in the deletion of outdated ones, and in the updating of others.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 3.10.1 with version 3.11.

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 the ecoQuery by license holders only. This file lists all datasets available in version 3.10.1 and 3.11, with an indication of what changed. Changes that may affect the LCIA scores are reported.

The Correspondence File, which is available on the ecoinvent website, provides for each system model a mapping of datasets between versions 3.10.1 and 3.11, which indicates which new datasets are available in cases where datasets in the previous version have been deleted or replaced. To support users who are switching from version 3.10 to version 3.11, a Correspondence File for these two versions is also available.

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

The main updates introduced with v3.11 include the following:

- Fuels: ecoinvent 3.11 builds on the comprehensive oil and gas updates of previous versions. We've revised natural gas data for 57 countries, reflecting the latest geopolitical shifts in supply chains. The database now includes updated estimates for pipeline and Liquefied Natural Gas transport and improved data for coal and lignite production, with enhanced regional details.
- Energy: The electricity market mixes have been updated for all countries with 2021 data, and Brazil, China, and Switzerland have been updated with 2022 data.
- Chemicals and Plastics: We've made updates for key chemical precursors and derivatives. From improved data on carbon monoxide to enhanced datasets for polyvinyl chloride and unsaturated polyester/vinyl ester resins, this version provides a more detailed representation of chemical production chains. New datasets also cover composite manufacturing.
- Batteries: ecoinvent 3.11 introduces new datasets for lithium-ion chemistries, including NMC532 and NMC622, new and updated datasets for natural and synthetic graphite, and expands the coverage of salts and electrolytes for emerging technologies of sodium-ion batteries.
- Building and Construction: This sector has been enriched with new cement and clinker production data, reflecting specific Canadian regional practices. Updates also cover a variety of building materials.

- Wastes: We've regionalized municipal waste treatment data for 27 EU countries, including Switzerland, Norway, Iceland, and the United Kingdom. New datasets on mechanical and chemical recycling processes of waste plastic in Europe and China provide deeper insights into the fate of waste plastic.
- Agriculture: ecoinvent 3.11 introduces 136 new datasets, covering a range of crops across different regions in Switzerland—from apples to barley— with data on conventional and organic farming methods.
- Transport: We've updated the circulating fleet of passenger vehicles and introduced new datasets on aircraft maintenance, improving the accuracy and accessibility of transportation lifecycle analysis.
- Life Cycle Impact Assessment methods: We've revised and updated the modeling of biogenic carbon flows to allow for extended climate change assessment including biogenic carbon dioxide. Also, we have aligned the names of the EN15804 indicators with the nomenclature used in the EN15804+A2 and EN15804+A1 standards.

2 Database-wide changes

2.1 Renamed activities

Some activities were renamed for version 3.11. The changes are listed in **Table 1**.

Table 1. Activities renamed for v3.11. 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 v3.10.1	Activity Name v3.11
2,3-dimethylbutan to generic market for solvent, organic	2,3-dimethylbutane to generic market for solvent, organic
acetic acid production, butane oxidation	acetic acid production, from n-butane oxidation
acrylic acid production	acrylic acid production, propylene oxidation
alkyl sulphate (C12-14) production	alkyl sulfate (C12-14) production
anode production, silicon coated graphite, NMC811, for Li-ion battery	anode production, silicon coated graphite, for Li-ion battery
battery production, Li-ion, LFP, rechargeable, prismatic	battery production, Li-ion, LFP, rechargeable
battery production, Li-ion, LiMn2O4, rechargeable, prismatic	battery production, Li-ion, LiMn2O4, rechargeable
battery production, Li-ion, NCA, rechargeable, prismatic	battery production, Li-ion, NCA, rechargeable
battery production, Li-ion, NMC111, rechargeable, prismatic	battery production, Li-ion, NMC111, rechargeable
battery production, Li-ion, NMC811, rechargeable, prismatic	battery production, Li-ion, NMC811, rechargeable
battery production, NiMH, rechargeable, prismatic	battery production, NiMH, rechargeable
beet sugar production	sugar beet processing
butyl acetate production	butyl acetate production, butanol esterification with acetic acid
butyl acrylate production	butyl acrylate production, butanol esterification with acrylic acid
cabbage red production	red cabbage production
cabbage white production	white cabbage production
cement, unspecified, import from Europe	cement, unspecified, import from Europe without Switzerland

diesel, import from Europe	diesel, import from Europe without Switzerland
diesel, low-sulfur, import from Europe	diesel, low-sulfur, import from Europe without Switzerland
diethyl ether production	diethyl ether production, from ethanol dehydration
dimethyl ether production	dimethyl ether production, from methanol dehydration
disodium disulphite production	disodium disulfite production
electric arc furnace converter construction	electric arc furnace construction
electricity, high voltage, biofuels, import from Germany	electricity, high voltage, biofuels, import from DE
electricity, high voltage, hydro, reservoir, import from France	electricity, high voltage, hydro, reservoir, import from FR
electricity, high voltage, hydro, reservoir, import from France, renewable energy products	electricity, high voltage, hydro, reservoir, import from FR, renewable energy products
electricity, high voltage, hydro, run-of-river, import from France	electricity, high voltage, hydro, run-of-river, import from FR
electricity, high voltage, hydro, run-of-river, import from France, renewable energy products	electricity, high voltage, hydro, run-of-river, import from FR, renewable energy products
electricity, high voltage, natural gas, import from Germany	electricity, high voltage, natural gas, import from DE
electricity, high voltage, nuclear, import from France	electricity, high voltage, nuclear, import from FR
electricity, high voltage, wind power, import from Germany	electricity, high voltage, wind power, import from DE
electricity, high voltage, wind power, import from Germany, renewable energy products	electricity, high voltage, wind power, import from DE, renewable energy products
electricity, low voltage, photovoltaic, import from Germany	electricity, low voltage, photovoltaic, import from DE
electricity, medium voltage, municipal waste incineration, import from Germany	electricity, medium voltage, municipal waste incineration, import from DE
ethyl tert-butyl ether production, from bioethanol	ethyl tert-butyl ether production, from bioethanol and isobutene etherification
ethylene dichloride production	ethylene dichloride production, from ethylene chlorination
flyash brick production	fly ash brick production
formaldehyde production, methanol oxidation	formaldehyde production, methanol oxidation
heat, from municipal waste incineration to generic market for heat district or industrial, other than natural gas	heat, from municipal waste incineration to generic market for heat, district or industrial, other than natural gas
hydrocarbons purification, molecular sieve separation of naphtha	hydrocarbons purification, molecular sieve separation of naphtha

hydrocarbons, aromatic, cyclic (C9+) to generic market for residual hydrocarbon mix, from steam cracking operations	hydrocarbons, aromatic, cyclic (C9+) to generic market for residual fuels
isopropylamine production	isopropylamine production, from isopropanol amination
kerosene, import from Europe	kerosene, import from Europe without Switzerland
light fuel oil to generic market for residual hydrocarbon mix, from steam cracking operations	light fuel oil to generic market for residual fuels
light fuel oil, import from Europe	light fuel oil, import from Europe without Switzerland
lime production, algae	limestone production, from algae
lime production, hydrated, loose weight	hydrated lime production, loose
lime production, hydrated, packed	hydrated lime production, packed
lime production, hydraulic	hydraulic lime production
lime production, milled, loose	limestone production, milled, loose
lime production, milled, packed	limestone production, milled, packed
lime to generic market for soil pH raising agent	limestone to generic market for soil pH raising agent
liquefied petroleum gas, import from Europe	liquefied petroleum gas, import from Europe without Switzerland
lithium chloride production	lithium chloride production, from lithium carbonate and hydrochloric acid
market for 1-butanol	market for n-butanol
market for acetic acid, without water, in 98% solution state	market for acetic acid
market for alkyl sulphate (C12-14)	market for alkyl sulfate (C12-14)
market for battery, Li-ion, LFP, rechargeable, prismatic	market for battery, Li-ion, LFP, rechargeable
market for battery, Li-ion, LiMn2O4, rechargeable, prismatic	market for battery, Li-ion, LiMn2O4, rechargeable
market for battery, Li-ion, NCA, rechargeable, prismatic	market for battery, Li-ion, NCA, rechargeable
market for battery, Li-ion, NMC111, rechargeable, prismatic	market for battery, Li-ion, NMC111, rechargeable
market for battery, Li-ion, NMC811, rechargeable, prismatic	market for battery, Li-ion, NMC811, rechargeable
market for battery, NaCl	market for battery, Na-NiCl, rechargeable
market for battery, NiMH, rechargeable, prismatic	market for battery, NiMH, rechargeable

market for bottom ash, MSWI, scrap aluminium	market for bottom ash, MSWI, waste aluminium
market for bottom ash, MSWI, scrap copper	market for bottom ash, MSWI, waste copper
market for bottom ash, MSWI, scrap steel	market for bottom ash, MSWI, waste steel
market for bottom ash, MSWI, scrap tin sheet	market for bottom ash, MSWI, waste tin sheet
market for bottom ash, MSWI[F], scrap aluminium	market for bottom ash, MSWI[F], waste aluminium
market for bottom ash, MSWI[F], scrap copper	market for bottom ash, MSWI[F], waste copper
market for bottom ash, MSWI[F], scrap steel	market for bottom ash, MSWI[F], waste steel
market for bottom ash, MSWI[F], scrap tin sheet	market for bottom ash, MSWI[F], waste tin sheet
market for bottom ash, MSWI-WWT-SLF, scrap tin sheet	market for bottom ash, MSWI-WWT-SLF, waste tin sheet
market for butyl acetate	market for n-butyl acetate
market for cabbage red	market for red cabbage
market for cabbage white	market for white cabbage
market for disodium disulphite	market for disodium disulfite
market for electric arc furnace converter	market for electric arc furnace
market for flyash brick	market for fly ash brick
market for gallium, semiconductor-grade	market for gallium, high-grade
market for leachate, SLF, scrap tin sheet	market for leachate, SLF, waste tin sheet
market for lime	market for limestone, milled, loose
market for lime, hydrated, loose weight	market for hydrated lime, loose
market for lime, hydrated, packed	market for hydrated lime, packed
market for lime, hydraulic	market for hydraulic lime
market for lime, packed	market for limestone, milled, packed
market for methylchloride	market for methyl chloride
market for polymethyl methacrylate, sheet	market for polymethyl methacrylate
market for polyvinylchloride, bulk polymerised	market for polyvinyl chloride, unspecified polymerisation, weighted average
market for polyvinylchloride, emulsion polymerised	market for polyvinyl chloride, emulsion polymerised

market for polyvinylchloride, suspension polymerised	market for polyvinyl chloride, suspension polymerised
market for refrigerant R134a	market for tetrafluoroethane, R134a
market for residual hydrocarbon mix, from steam cracking operations	market for residual fuels
market for residues, MSWI, scrap tin sheet	market for residues, MSWI, waste tin sheet
market for residues, MSWI[F], scrap tin sheet	market for residues, MSWI[F], waste tin sheet
market for residues, MSWI-WWT-SLF, scrap tin sheet	market for residues, MSWI-WWT-SLF, waste tin sheet
market for scrap copper	market for waste copper
market for scrap steel	market for waste steel
market for scrap tin sheet	market for waste tin sheet
market for sewage sludge, 70% water, WWT-SLF, scrap tin sheet	market for sewage sludge, 70% water, WWT-SLF, waste tin sheet
market for sewage sludge, 97% water, WWT-SLF, scrap tin sheet	market for sewage sludge, 97% water, WWT-SLF, waste tin sheet
market for sodium cumenesulphonate	market for sodium cumenesulfonate
market for transport, freight train	market for transport, freight, train, fleet average
market for transport, freight, inland waterways, barge	market for transport, freight, inland waterways, barge, diesel
market for transport, freight, inland waterways, barge tanker	market for transport, freight, inland waterways, barge tanker, diesel
market for transport, freight, inland waterways, barge with reefer, cooling	market for transport, freight, inland waterways, barge with reefer, diesel, cooling
market for transport, freight, inland waterways, barge with reefer, freezing	market for transport, freight, inland waterways, barge with reefer, diesel, freezing
market for transport, freight, light commercial vehicle	market for transport, freight, light commercial vehicle, fleet average
market for transport, freight, light commercial vehicle, EURO1	market for transport, freight, light commercial vehicle, EURO 1, fleet average
market for transport, freight, light commercial vehicle, EURO2	market for transport, freight, light commercial vehicle, EURO 2, fleet average
market for transport, freight, light commercial vehicle, unregulated	market for transport, freight, light commercial vehicle, diesel, unregulated
market for transport, freight, lorry >32 metric ton, EURO1	market for transport, freight, lorry, >32 metric ton, diesel, EURO 1
market for transport, freight, lorry >32 metric ton, EURO2	market for transport, freight, lorry, >32 metric ton, diesel, EURO 2

market for transport, freight, lorry >32 metric ton, EURO3	market for transport, freight, lorry, >32 metric ton, diesel, EURO 3
market for transport, freight, lorry >32 metric ton, EURO4	market for transport, freight, lorry, >32 metric ton, diesel, EURO 4
market for transport, freight, lorry >32 metric ton, EURO5	market for transport, freight, lorry, >32 metric ton, diesel, EURO 5
market for transport, freight, lorry >32 metric ton, EURO6	market for transport, freight, lorry, >32 metric ton, diesel, EURO 6
market for transport, freight, lorry >32 metric ton, unregulated	market for transport, freight, lorry, >32 metric ton, diesel, unregulated
market for transport, freight, lorry 16-32 metric ton, EURO1	market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 1
market for transport, freight, lorry 16-32 metric ton, EURO2	market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 2
market for transport, freight, lorry 16-32 metric ton, EURO3	market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 3
market for transport, freight, lorry 16-32 metric ton, EURO4	market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 4
market for transport, freight, lorry 16-32 metric ton, EURO5	market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 5
market for transport, freight, lorry 16-32 metric ton, EURO6	market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 6
market for transport, freight, lorry 16-32 metric ton, unregulated	market for transport, freight, lorry, 16-32 metric ton, diesel, unregulated
market for transport, freight, lorry 3.5-7.5 metric ton, EURO1	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 1
market for transport, freight, lorry 3.5-7.5 metric ton, EURO2	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 2
market for transport, freight, lorry 3.5-7.5 metric ton, EURO3	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 3
market for transport, freight, lorry 3.5-7.5 metric ton, EURO4	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 4
market for transport, freight, lorry 3.5-7.5 metric ton, EURO5	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 5
market for transport, freight, lorry 3.5-7.5 metric ton, EURO6	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6
market for transport, freight, lorry 3.5-7.5 metric ton, unregulated	market for transport, freight, lorry, 3.5-7.5 metric ton, diesel, unregulated
market for transport, freight, lorry 7.5-16 metric ton, EURO1	market for transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 1
market for transport, freight, lorry 7.5-16 metric ton, EURO2	market for transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 2

market for transport, freight, lorry 7.5-16 metric ton, EURO3	market for transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 3
market for transport, freight, lorry 7.5-16 metric ton, EURO4	market for transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 4
market for transport, freight, lorry 7.5-16 metric ton, EURO5	market for transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 5
market for transport, freight, lorry 7.5-16 metric ton, EURO6	market for transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 6
market for transport, freight, lorry 7.5-16 metric ton, unregulated	market for transport, freight, lorry, 7.5-16 metric ton, diesel, unregulated
market for transport, freight, lorry with reefer, cooling	market for transport, freight, lorry with reefer, diesel, cooling, fleet average
market for transport, freight, lorry with reefer, freezing	market for transport, freight, lorry with reefer, diesel, freezing, fleet average
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refr(...)_11	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refri(...)_1	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, R134a refrigerant, cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, freezing	market for transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 3, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refr(...)_10	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refri(...)_2	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, R134a refrigerant, cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, freezing	market for transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 4, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refri(...)_3	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refri(...)_7	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, R134a refrigerant, cooling

market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, freezing	market for transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 5, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refr(...)_13	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refri(...)_5	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, R134a refrigerant, cooling
market for transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, freezing	market for transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 6, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refri(...)_14	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrig(...)_4	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, R134a refrigerant, cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, freezing	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refri(...)_12	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrig(...)_6	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, R134a refrigerant, cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, freezing	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refri(...)_16	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrig(...)_8	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, R134a refrigerant, cooling

market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, freezing	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refri(...)_15	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, CO2, liq. ref., freezing
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrig(...)_9	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, CO2, liq. ref., cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, cooling	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, R134a refrigerant, cooling
market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, freezing	market for transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, R134a refrigerant, freezing
market for transport, freight, lorry with refrigeration machine, cooling	market for transport, freight, lorry with refrigeration machine, diesel, cooling, fleet average
market for transport, freight, lorry with refrigeration machine, freezing	market for transport, freight, lorry with refrigeration machine, diesel, freezing, fleet average
market for transport, freight, sea, bulk carrier for dry goods	market for transport, freight, sea, bulk carrier for dry goods, heavy fuel oil
market for transport, freight, sea, container ship	market for transport, freight, sea, container ship, heavy fuel oil
market for transport, freight, sea, container ship with reefer, cooling	market for transport, freight, sea, container ship with reefer, heavy fuel oil, cooling
market for transport, freight, sea, container ship with reefer, freezing	market for transport, freight, sea, container ship with reefer, heavy fuel oil, freezing
market for transport, freight, sea, ferry	market for transport, freight, sea, ferry, heavy fuel oil
market for transport, freight, sea, tanker for liquefied natural gas	market for transport, freight, sea, tanker for liquefied natural gas, heavy fuel oil
market for transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	market for transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas, HFO
market for transport, freight, sea, tanker for petroleum	market for transport, freight, sea, tanker for petroleum, heavy fuel oil
market for transport, freight, train with reefer, cooling	market for transport, freight, train with reefer, cooling, fleet average
market for transport, freight, train with reefer, freezing	market for transport, freight, train with reefer, freezing, fleet average
market for transport, helicopter	market for transport, helicopter, kerosene
market for transport, helicopter, LTO cycle	market for transport, helicopter, kerosene, LTO cycle
market for transport, passenger aircraft, long haul	market for transport, passenger, aircraft, long haul

market for transport, passenger aircraft, medium haul	market for transport, passenger, aircraft, medium haul
market for transport, passenger aircraft, short haul	market for transport, passenger, aircraft, short haul
market for transport, passenger aircraft, unspecified	market for transport, passenger, aircraft, unspecified
market for transport, passenger aircraft, very short haul	market for transport, passenger, aircraft, very short haul
market for transport, passenger car	market for transport, passenger, car, fleet average
market for transport, passenger car with internal combustion engine	market for transport, passenger, car with internal combustion engine, fleet average
market for transport, passenger car, electric	market for transport, passenger, car, electric
market for transport, passenger car, EURO 3	market for transport, passenger, car, EURO 3, fleet average
market for transport, passenger car, EURO 4	market for transport, passenger, car, EURO 4, fleet average
market for transport, passenger car, EURO 5	market for transport, passenger, car, EURO 5, fleet average
market for transport, passenger car, large size, diesel, EURO 3	market for transport, passenger, car, diesel, large size, EURO 3
market for transport, passenger car, large size, diesel, EURO 4	market for transport, passenger, car, diesel, large size, EURO 4
market for transport, passenger car, large size, diesel, EURO 5	market for transport, passenger, car, diesel, large size, EURO 5
market for transport, passenger car, large size, natural gas, EURO 3	market for transport, passenger, car, natural gas, large size, EURO 3
market for transport, passenger car, large size, natural gas, EURO 4	market for transport, passenger, car, natural gas, large size, EURO 4
market for transport, passenger car, large size, natural gas, EURO 5	market for transport, passenger, car, natural gas, large size, EURO 5
market for transport, passenger car, large size, petrol, EURO 3	market for transport, passenger, car, petrol, large size, EURO 3
market for transport, passenger car, large size, petrol, EURO 4	market for transport, passenger, car, petrol, large size, EURO 4
market for transport, passenger car, large size, petrol, EURO 5	market for transport, passenger, car, petrol, large size, EURO 5
market for transport, passenger car, medium size, diesel, EURO 3	market for transport, passenger, car, diesel, medium size, EURO 3
market for transport, passenger car, medium size, diesel, EURO 4	market for transport, passenger, car, diesel, medium size, EURO 4
market for transport, passenger car, medium size, diesel, EURO 5	market for transport, passenger, car, diesel, medium size, EURO 5

market for transport, passenger car, medium size, liquefied petroleum gas, EURO 5	market for transport, passenger, car, liquefied petroleum gas, medium size, EURO 5
market for transport, passenger car, medium size, natural gas, EURO 3	market for transport, passenger, car, natural gas, medium size, EURO 3
market for transport, passenger car, medium size, natural gas, EURO 4	market for transport, passenger, car, natural gas, medium size, EURO 4
market for transport, passenger car, medium size, natural gas, EURO 5	market for transport, passenger, car, natural gas, medium size, EURO 5
market for transport, passenger car, medium size, petrol, EURO 3	market for transport, passenger, car, petrol, medium size, EURO 3
market for transport, passenger car, medium size, petrol, EURO 4	market for transport, passenger, car, petrol, medium size, EURO 4
market for transport, passenger car, medium size, petrol, EURO 5	market for transport, passenger, car, petrol, medium size, EURO 5
market for transport, passenger car, small size, diesel, EURO 3	market for transport, passenger, car, diesel, small size, EURO 3
market for transport, passenger car, small size, diesel, EURO 4	market for transport, passenger, car, diesel, small size, EURO 4
market for transport, passenger car, small size, diesel, EURO 5	market for transport, passenger, car, diesel, small size, EURO 5
market for transport, passenger car, small size, natural gas, EURO 3	market for transport, passenger, car, natural gas, small size, EURO 3
market for transport, passenger car, small size, natural gas, EURO 4	market for transport, passenger, car, natural gas, small size, EURO 4
market for transport, passenger car, small size, natural gas, EURO 5	market for transport, passenger, car, natural gas, small size, EURO 5
market for transport, passenger car, small size, petrol, EURO 3	market for transport, passenger, car, petrol, small size, EURO 3
market for transport, passenger car, small size, petrol, EURO 4	market for transport, passenger, car, petrol, small size, EURO 4
market for transport, passenger car, small size, petrol, EURO 5	market for transport, passenger, car, petrol, small size, EURO 5
market for transport, passenger coach	market for transport, passenger, coach, diesel
market for transport, passenger train	market for transport, passenger, train, fleet average
market for transport, passenger, electric bicycle	market for transport, passenger, bicycle, electric
market for transport, passenger, electric bicycle, electricity from renewable energy products	market for transport, passenger, bicycle, electric, electricity from renewable energy products
market for transport, passenger, electric scooter	market for transport, passenger, scooter, electric
market for transport, passenger, motor scooter	market for transport, passenger, motor scooter, fleet average

market for transport, regular bus	market for transport, passenger, bus, diesel, regular
market for transport, tractor and trailer, agricultural	market for transport, freight, tractor and trailer, diesel, agricultural
market for transport, tram	market for transport, passenger, tram, electric
market for transport, trolleybus	market for transport, passenger, trolleybus, electric
market group for transport, freight train	market group for transport, freight, train, fleet average
market group for transport, freight, inland waterways, barge	market group for transport, freight, inland waterways, barge, diesel
market group for transport, freight, inland waterways, barge tanker	market group for transport, freight, inland waterways, barge tanker, diesel
market group for transport, freight, light commercial vehicle	market group for transport, freight, light commercial vehicle, fleet average
market group for transport, freight, lorry, unspecified	market group for transport, freight, lorry, diesel, unspecified
methanol production, coal gasification	methanol production, from coal gasification
methanol production, natural gas reforming	methanol production, from natural gas reforming
methyl acrylate production	methyl acrylate production, methanol esterification with acrylic acid
methylchloride production	methyl chloride production, from methanol hydrochlorination
methylcyclohexane production	methylcyclohexane production, from toluene hydrogenation
peanut production, reduced tillage	peanut production, in cropping system
petrol, low-sulfur, import from Europe	petrol, low-sulfur, import from Europe without Switzerland
polyethylene terephthalate, granulate, amorphous, recycled to generic market for amorphous PET granulate	polyethylene terephthalate, granulate, amorphous, recycled to generic market for PET, granulate, amorphous
polyethylene terephthalate, granulate, bottle grade, recycled to generic market for bottle grade PET granulate	polyethylene terephthalate, granulate, bottle grade, recycled to generic market for PET, granulate, bottle grade
polyethylene, high density, granulate, recycled to generic market for high density PE granulate	polyethylene, high density, granulate, recycled to generic market for polyethylene, high density, granulate
polyvinylchloride production, bulk polymerisation	polyvinyl chloride production, unspecified polymerisation, weighted average
polyvinylchloride production, emulsion polymerisation	polyvinyl chloride production, emulsion polymerisation
polyvinylchloride production, suspension polymerisation	polyvinyl chloride production, suspension polymerisation

pyrolysis fuel gas to generic market for residual hydrocarbon mix, from steam cracking operations	pyrolysis fuel gas to generic market for residual fuels
pyrolysis fuel oil to generic market for residual hydrocarbon mix, from steam cracking operations	pyrolysis fuel oil to generic market for residual fuels
raffinate to generic market for residual hydrocarbon mix, from steam cracking operations	raffinate to generic market for residual fuels
samarium europium gadolinium concentrate to generic market for mischmetal	samarium-europium-gadolinium oxide to generic market for mischmetal
sodium borate mine operation and beneficiation	sodium borates mine operation and beneficiation
sodium cumenesulphonate production	sodium cumenesulfonate production
styrene production	styrene production, from ethyl benzene dehydrogenation
synthetic fuel production, from coal, high temperature Fisher-Tropsch operations	synthetic fuel production, from coal, high temperature Fischer-Tropsch operations
tissue paper production	tissue paper production, recycled
transport, freight train	transport, freight, train, fleet average
transport, freight train, diesel	transport, freight, train, diesel
transport, freight train, diesel, with particle filter	transport, freight, train, diesel, with particle filter
transport, freight train, electricity	transport, freight, train, electric
transport, freight train, steam	transport, freight, train, steam
transport, freight, inland waterways, barge	transport, freight, inland waterways, barge, diesel
transport, freight, inland waterways, barge tanker	transport, freight, inland waterways, barge tanker, diesel
transport, freight, inland waterways, barge with reefer, cooling	transport, freight, inland waterways, barge with reefer, diesel, cooling
transport, freight, inland waterways, barge with reefer, freezing	transport, freight, inland waterways, barge with reefer, diesel, freezing
transport, freight, light commercial vehicle	transport, freight, light commercial vehicle, fleet average
transport, freight, light commercial vehicle, EURO1	transport, freight, light commercial vehicle, EURO 1, fleet average
transport, freight, light commercial vehicle, EURO2	transport, freight, light commercial vehicle, EURO 2, fleet average
transport, freight, light commercial vehicle, unregulated	transport, freight, light commercial vehicle, diesel, unregulated
transport, freight, lorry >32 metric ton, EURO1	transport, freight, lorry, >32 metric ton, diesel, EURO 1

transport, freight, lorry >32 metric ton, EURO2	transport, freight, lorry, >32 metric ton, diesel, EURO 2
transport, freight, lorry >32 metric ton, EURO3	transport, freight, lorry, >32 metric ton, diesel, EURO 3
transport, freight, lorry >32 metric ton, EURO4	transport, freight, lorry, >32 metric ton, diesel, EURO 4
transport, freight, lorry >32 metric ton, EURO5	transport, freight, lorry, >32 metric ton, diesel, EURO 5
transport, freight, lorry >32 metric ton, EURO6	transport, freight, lorry, >32 metric ton, diesel, EURO 6
transport, freight, lorry >32 metric ton, unregulated	transport, freight, lorry, >32 metric ton, diesel, unregulated
transport, freight, lorry 16-32 metric ton, EURO1	transport, freight, lorry, 16-32 metric ton, diesel, EURO 1
transport, freight, lorry 16-32 metric ton, EURO2	transport, freight, lorry, 16-32 metric ton, diesel, EURO 2
transport, freight, lorry 16-32 metric ton, EURO3	transport, freight, lorry, 16-32 metric ton, diesel, EURO 3
transport, freight, lorry 16-32 metric ton, EURO4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 4
transport, freight, lorry 16-32 metric ton, EURO5	transport, freight, lorry, 16-32 metric ton, diesel, EURO 5
transport, freight, lorry 16-32 metric ton, EURO6	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6
transport, freight, lorry 16-32 metric ton, unregulated	transport, freight, lorry, 16-32 metric ton, diesel, unregulated
transport, freight, lorry 3.5-7.5 metric ton, EURO1	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 1
transport, freight, lorry 3.5-7.5 metric ton, EURO2	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 2
transport, freight, lorry 3.5-7.5 metric ton, EURO3	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 3
transport, freight, lorry 3.5-7.5 metric ton, EURO4	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 4
transport, freight, lorry 3.5-7.5 metric ton, EURO5	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 5
transport, freight, lorry 3.5-7.5 metric ton, EURO6	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6
transport, freight, lorry 3.5-7.5 metric ton, unregulated	transport, freight, lorry, 3.5-7.5 metric ton, diesel, unregulated
transport, freight, lorry 7.5-16 metric ton, EURO1	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 1

transport, freight, lorry 7.5-16 metric ton, EURO2	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 2
transport, freight, lorry 7.5-16 metric ton, EURO3	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 3
transport, freight, lorry 7.5-16 metric ton, EURO4	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 4
transport, freight, lorry 7.5-16 metric ton, EURO5	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 5
transport, freight, lorry 7.5-16 metric ton, EURO6	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 6
transport, freight, lorry 7.5-16 metric ton, unregulated	transport, freight, lorry, 7.5-16 metric ton, diesel, unregulated
transport, freight, lorry with reefer, cooling	transport, freight, lorry with reefer, diesel, cooling, fleet average
transport, freight, lorry with reefer, freezing	transport, freight, lorry with reefer, diesel, freezing, fleet average
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 3, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 4, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, R134a refrigerant, cooling

transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 5, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 6, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3,CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3,CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, CO2, liq. ref., cooling

transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine. 7.5-16 ton, diesel, EURO 6, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, R134a refrigerant, freezing
transport, freight, lorry, all sizes, EURO1 to generic market for transport, freight, lorry, unspecified	transport, freight, lorry, all sizes, EURO 1 to generic market for transport, freight, lorry, unspecified
transport, freight, lorry, all sizes, EURO2 to generic market for transport, freight, lorry, unspecified	transport, freight, lorry, all sizes, EURO 2 to generic market for transport, freight, lorry, unspecified
transport, freight, lorry, all sizes, EURO3 to generic market for transport, freight, lorry, unspecified	transport, freight, lorry, all sizes, EURO 3 to generic market for transport, freight, lorry, unspecified
transport, freight, lorry, all sizes, EURO4 to generic market for transport, freight, lorry, unspecified	transport, freight, lorry, all sizes, EURO 4 to generic market for transport, freight, lorry, unspecified
transport, freight, lorry, all sizes, EURO5 to generic market for transport, freight, lorry, unspecified	transport, freight, lorry, all sizes, EURO 5 to generic market for transport, freight, lorry, unspecified
transport, freight, lorry, all sizes, EURO6 to generic market for transport, freight, lorry, unspecified	transport, freight, lorry, all sizes, EURO 6 to generic market for transport, freight, lorry, unspecified
transport, freight, sea, bulk carrier for dry goods	transport, freight, sea, bulk carrier for dry goods, heavy fuel oil
transport, freight, sea, container ship	transport, freight, sea, container ship, heavy fuel oil
transport, freight, sea, container ship with reefer, cooling	transport, freight, sea, container ship with reefer, heavy fuel oil, cooling
transport, freight, sea, container ship with reefer, freezing	transport, freight, sea, container ship with reefer, heavy fuel oil, freezing
transport, freight, sea, ferry	transport, freight, sea, ferry, heavy fuel oil
transport, freight, sea, tanker for liquefied natural gas	transport, freight, sea, tanker for liquefied natural gas, heavy fuel oil
transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas, heavy fuel oil
transport, freight, sea, tanker for petroleum	transport, freight, sea, tanker for petroleum, heavy fuel oil
transport, freight, small lorry with refrigeration machine, EURO3, CO2 refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 3, CO2 refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO3, CO2 refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 3, CO2 refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO3, R134a refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 3, R134a refrigerant, cooling to generic market

transport, freight, small lorry with refrigeration machine, EURO3, R134a refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 3, R134a refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO4, CO2 refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 4, CO2 refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO4, CO2 refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 4, CO2 refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO4, R134a refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 4, R134a refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO4, R134a refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 4, R134a refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO5, CO2 refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 5, CO2 refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO5, CO2 refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 5, CO2 refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO5, R134a refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 5, R134a refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO5, R134a refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 5, R134a refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO6, CO2 refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 6, CO2 refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO6, CO2 refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 6, CO2 refrigerant, freezing to generic market
transport, freight, small lorry with refrigeration machine, EURO6, R134a refrigerant, cooling to generic market	transport, freight, small lorry with refrigeration machine, EURO 6, R134a refrigerant, cooling to generic market
transport, freight, small lorry with refrigeration machine, EURO6, R134a refrigerant, freezing to generic market	transport, freight, small lorry with refrigeration machine, EURO 6, R134a refrigerant, freezing to generic market
transport, freight, train with reefer, cooling	transport, freight, train with reefer, cooling, fleet average
transport, freight, train with reefer, freezing	transport, freight, train with reefer, freezing, fleet average
transport, helicopter	transport, helicopter, kerosene
transport, helicopter, LTO cycle	transport, helicopter, kerosene, LTO cycle
transport, passenger aircraft, all distances to generic market for transport, passenger aircraft, unspecified	transport, passenger, aircraft, all distances to generic market for transport, passenger, aircraft, unspecified

transport, passenger aircraft, long haul	transport, passenger, aircraft, long haul
transport, passenger aircraft, medium haul	transport, passenger, aircraft, medium haul
transport, passenger aircraft, short haul	transport, passenger, aircraft, short haul
transport, passenger aircraft, very short haul	transport, passenger, aircraft, very short haul
transport, passenger car	transport, passenger, car, fleet average
transport, passenger car with internal combustion engine	transport, passenger, car with internal combustion engine, fleet average
transport, passenger car, electric	transport, passenger, car, electric
transport, passenger car, EURO 3	transport, passenger, car, EURO 3, fleet average
transport, passenger car, EURO 4	transport, passenger, car, EURO 4, fleet average
transport, passenger car, EURO 5	transport, passenger, car, EURO 5, fleet average
transport, passenger car, large size, diesel, EURO 3	transport, passenger, car, diesel, large size, EURO 3
transport, passenger car, large size, diesel, EURO 4	transport, passenger, car, diesel, large size, EURO 4
transport, passenger car, large size, diesel, EURO 5	transport, passenger, car, diesel, large size, EURO 5
transport, passenger car, large size, natural gas, EURO 3	transport, passenger, car, natural gas, large size, EURO 3
transport, passenger car, large size, natural gas, EURO 4	transport, passenger, car, natural gas, large size, EURO 4
transport, passenger car, large size, natural gas, EURO 5	transport, passenger, car, natural gas, large size, EURO 5
transport, passenger car, large size, petrol, EURO 3	transport, passenger, car, petrol, large size, EURO 3
transport, passenger car, large size, petrol, EURO 4	transport, passenger, car, petrol, large size, EURO 4
transport, passenger car, large size, petrol, EURO 5	transport, passenger, car, petrol, large size, EURO 5
transport, passenger car, medium size, diesel, EURO 3	transport, passenger, car, diesel, medium size, EURO 3
transport, passenger car, medium size, diesel, EURO 4	transport, passenger, car, diesel, medium size, EURO 4
transport, passenger car, medium size, diesel, EURO 5	transport, passenger, car, diesel, medium size, EURO 5
transport, passenger car, medium size, liquefied petroleum gas (LPG), EURO 5	transport, passenger, car, liquefied petroleum gas, medium size, EURO 5
transport, passenger car, medium size, natural gas, EURO 3	transport, passenger, car, natural gas, medium size, EURO 3

transport, passenger car, medium size, natural gas, EURO 4	transport, passenger, car, natural gas, medium size, EURO 4
transport, passenger car, medium size, natural gas, EURO 5	transport, passenger, car, natural gas, medium size, EURO 5
transport, passenger car, medium size, petrol, EURO 3	transport, passenger, car, petrol, medium size, EURO 3
transport, passenger car, medium size, petrol, EURO 4	transport, passenger, car, petrol, medium size, EURO 4
transport, passenger car, medium size, petrol, EURO 5	transport, passenger, car, petrol, medium size, EURO 5
transport, passenger car, small size, diesel, EURO 3	transport, passenger, car, diesel, small size, EURO 3
transport, passenger car, small size, diesel, EURO 4	transport, passenger, car, diesel, small size, EURO 4
transport, passenger car, small size, diesel, EURO 5	transport, passenger, car, diesel, small size, EURO 5
transport, passenger car, small size, natural gas, EURO 3	transport, passenger, car, natural gas, small size, EURO 3
transport, passenger car, small size, natural gas, EURO 4	transport, passenger, car, natural gas, small size, EURO 4
transport, passenger car, small size, natural gas, EURO 5	transport, passenger, car, natural gas, small size, EURO 5
transport, passenger car, small size, petrol, EURO 3	transport, passenger, car, petrol, small size, EURO 3
transport, passenger car, small size, petrol, EURO 4	transport, passenger, car, petrol, small size, EURO 4
transport, passenger car, small size, petrol, EURO 5	transport, passenger, car, petrol, small size, EURO 5
transport, passenger coach	transport, passenger, coach, diesel
transport, passenger train	transport, passenger, train, fleet average
transport, passenger train, high-speed	transport, passenger, train, electric high-speed
transport, passenger train, long-distance	transport, passenger, train, electric, long-distance
transport, passenger train, regional	transport, passenger, train, electric, regional
transport, passenger train, urban	transport, passenger, train, electric, urban
transport, passenger, electric bicycle	transport, passenger, bicycle, electric
transport, passenger, electric bicycle, electricity from renewable energy products	transport, passenger, bicycle, electric, electricity from renewable energy products
transport, passenger, electric scooter	transport, passenger, scooter, electric
transport, passenger, motor scooter	transport, passenger, motor scooter, fleet average
transport, regular bus	transport, passenger, bus, diesel, regular

transport, tractor and trailer, agricultural	transport, freight, tractor and trailer, diesel, agricultural
transport, tram	transport, passenger, tram, electric
transport, trolleybus	transport, passenger, trolleybus, electric
treatment of bottom ash, MSWI, scrap aluminium, slag compartment	treatment of bottom ash, MSWI, waste aluminium, slag compartment
treatment of bottom ash, MSWI, scrap copper, slag compartment	treatment of bottom ash, MSWI, waste copper, slag compartment
treatment of bottom ash, MSWI, scrap steel, slag compartment	treatment of bottom ash, MSWI, waste steel, slag compartment
treatment of bottom ash, MSWI, scrap tin sheet, slag compartment	treatment of bottom ash, MSWI, waste tin sheet, slag compartment
treatment of bottom ash, MSWI[F], scrap aluminium, slag compartment	treatment of bottom ash, MSWI[F], waste aluminium, slag compartment
treatment of bottom ash, MSWI[F], scrap copper, slag compartment	treatment of bottom ash, MSWI[F], waste copper, slag compartment
treatment of bottom ash, MSWI[F], scrap steel, slag compartment	treatment of bottom ash, MSWI[F], waste steel, slag compartment
treatment of bottom ash, MSWI[F], scrap tin sheet, slag compartment	treatment of bottom ash, MSWI[F], waste tin sheet, slag compartment
treatment of bottom ash, MSWI-WWT-SLF, scrap tin sheet, slag compartment	treatment of bottom ash, MSWI-WWT-SLF, waste tin sheet, slag compartment
treatment of leachate, SLF, scrap tin sheet, wastewater treatment	treatment of leachate, SLF, waste tin sheet, wastewater treatment
treatment of residues, MSWI, scrap tin sheet, residual material landfill	treatment of residues, MSWI, waste tin sheet, residual material landfill
treatment of residues, MSWI[F], scrap tin sheet, residual material landfill	treatment of residues, MSWI[F], waste tin sheet, residual material landfill
treatment of residues, MSWI-WWT-SLF, scrap tin sheet, residual material landfill	treatment of residues, MSWI-WWT-SLF, waste tin sheet, residual material landfill
treatment of scrap aluminium, municipal incineration	treatment of waste aluminium, municipal incineration
treatment of scrap aluminium, municipal incineration FAE	treatment of waste aluminium, municipal incineration FAE
treatment of scrap copper, municipal incineration	treatment of waste copper, municipal incineration
treatment of scrap copper, municipal incineration FAE	treatment of waste copper, municipal incineration FAE
treatment of scrap steel, inert material landfill	treatment of waste steel, inert material landfill
treatment of scrap steel, municipal incineration	treatment of waste steel, municipal incineration
treatment of scrap steel, municipal incineration FAE	treatment of waste steel, municipal incineration FAE

treatment of scrap tin sheet, municipal incineration	treatment of waste tin sheet, municipal incineration
treatment of scrap tin sheet, municipal incineration FAE	treatment of waste tin sheet, municipal incineration FAE
treatment of scrap tin sheet, sanitary landfill	treatment of waste tin sheet, sanitary landfill
treatment of sewage sludge, 70% water, WWT-SLF, scrap tin sheet, municipal incineration	treatment of sewage sludge, 70% water, WWT-SLF, waste tin sheet, municipal incineration
treatment of sewage sludge, 97% water, WWT-SLF, scrap tin sheet, landfarming	treatment of sewage sludge, 97% water, WWT-SLF, waste tin sheet, landfarming
vinyl acetate production	vinyl acetate production, from ethylene acetoxylation

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 3.11.

Table 2. Intermediate exchanges renamed for version 3.11.

Intermediate exchange name in v3.10.1	Intermediate exchange name in v3.11
1-butanol	n-butanol
acetic acid, without water, in 98% solution state	acetic acid
alkyl sulphate (C12-14)	alkyl sulfate (C12-14)
battery, Li-ion, LFP, rechargeable, prismatic	battery, Li-ion, LFP, rechargeable
battery, Li-ion, LiMn2O4, rechargeable, prismatic	battery, Li-ion, LiMn2O4, rechargeable
battery, Li-ion, NCA, rechargeable, prismatic	battery, Li-ion, NCA, rechargeable
battery, Li-ion, NMC111, rechargeable, prismatic	battery, Li-ion, NMC111, rechargeable
battery, Li-ion, NMC811, rechargeable, prismatic	battery, Li-ion, NMC811, rechargeable
battery, NaCl	battery, Na-NiCl, rechargeable
battery, NiMH, rechargeable, prismatic	battery, NiMH, rechargeable
bottom ash, MSWI, scrap aluminium	bottom ash, MSWI, waste aluminium

bottom ash, MSWI, scrap copper	bottom ash, MSWI, waste copper
bottom ash, MSWI, scrap steel	bottom ash, MSWI, waste steel
bottom ash, MSWI, scrap tin sheet	bottom ash, MSWI, waste tin sheet
bottom ash, MSWI-WWT-SLF, scrap tin sheet	bottom ash, MSWI-WWT-SLF, waste tin sheet
bottom ash, MSWI[F], scrap aluminium	bottom ash, MSWI[F], waste aluminium
bottom ash, MSWI[F], scrap copper	bottom ash, MSWI[F], waste copper
bottom ash, MSWI[F], scrap steel	bottom ash, MSWI[F], waste steel
bottom ash, MSWI[F], scrap tin sheet	bottom ash, MSWI[F], waste tin sheet
butyl acetate	n-butyl acetate
cabbage red	red cabbage
cabbage white	white cabbage
disodium disulphite	disodium disulfite
electric arc furnace converter	electric arc furnace
flyash brick	fly ash brick
gallium, semiconductor-grade	gallium, high-grade
leachate, SLF, scrap tin sheet	leachate, SLF, waste tin sheet
lime	limestone, milled, loose
lime, hydrated, loose weight	hydrated lime, loose
lime, hydrated, packed	hydrated lime, packed
lime, hydraulic	hydraulic lime
lime, packed	limestone, milled, packed
methylchloride	methyl chloride
polymethyl methacrylate, sheet	polymethyl methacrylate
polyvinylchloride, bulk polymerised	polyvinyl chloride, unspecified polymerisation, weighted average
polyvinylchloride, emulsion polymerised	polyvinyl chloride, emulsion polymerised
polyvinylchloride, suspension polymerised	polyvinyl chloride, suspension polymerised
refrigerant R134a	tetrafluoroethane, R134a

residual hydrocarbon mix, from steam cracking operations	residual fuels
residues, MSWI, scrap tin sheet	residues, MSWI, waste tin sheet
residues, MSWI-WWT-SLF, scrap tin sheet	residues, MSWI-WWT-SLF, waste tin sheet
residues, MSWI[F], scrap tin sheet	residues, MSWI[F], waste tin sheet
scrap copper	waste copper
scrap steel	waste steel
scrap tin sheet	waste tin sheet
sewage sludge, 70% water, WWT-SLF, scrap tin sheet	sewage sludge, 70% water, WWT-SLF, waste tin sheet
sewage sludge, 97% water, WWT-SLF, scrap tin sheet	sewage sludge, 97% water, WWT-SLF, waste tin sheet
sodium cumenesulphonate	sodium cumenesulfonate
transport, freight train	transport, freight, train, fleet average
transport, freight, inland waterways, barge	transport, freight, inland waterways, barge, diesel
transport, freight, inland waterways, barge tanker	transport, freight, inland waterways, barge tanker, diesel
transport, freight, inland waterways, barge with reefer, cooling	transport, freight, inland waterways, barge with reefer, diesel, cooling
transport, freight, inland waterways, barge with reefer, freezing	transport, freight, inland waterways, barge with reefer, diesel, freezing
transport, freight, light commercial vehicle	transport, freight, light commercial vehicle, fleet average
transport, freight, light commercial vehicle, EURO1	transport, freight, light commercial vehicle, EURO 1, fleet average
transport, freight, light commercial vehicle, EURO2	transport, freight, light commercial vehicle, EURO 2, fleet average
transport, freight, light commercial vehicle, unregulated	transport, freight, light commercial vehicle, diesel, unregulated
transport, freight, lorry 16-32 metric ton, EURO1	transport, freight, lorry, 16-32 metric ton, diesel, EURO 1
transport, freight, lorry 16-32 metric ton, EURO2	transport, freight, lorry, 16-32 metric ton, diesel, EURO 2
transport, freight, lorry 16-32 metric ton, EURO3	transport, freight, lorry, 16-32 metric ton, diesel, EURO 3
transport, freight, lorry 16-32 metric ton, EURO4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 4
transport, freight, lorry 16-32 metric ton, EURO5	transport, freight, lorry, 16-32 metric ton, diesel, EURO 5
transport, freight, lorry 16-32 metric ton, EURO6	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6

transport, freight, lorry 16-32 metric ton, unregulated	transport, freight, lorry, 16-32 metric ton, diesel, unregulated
transport, freight, lorry 3.5-7.5 metric ton, EURO1	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 1
transport, freight, lorry 3.5-7.5 metric ton, EURO2	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 2
transport, freight, lorry 3.5-7.5 metric ton, EURO3	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 3
transport, freight, lorry 3.5-7.5 metric ton, EURO4	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 4
transport, freight, lorry 3.5-7.5 metric ton, EURO5	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 5
transport, freight, lorry 3.5-7.5 metric ton, EURO6	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6
transport, freight, lorry 3.5-7.5 metric ton, unregulated	transport, freight, lorry, 3.5-7.5 metric ton, diesel, unregulated
transport, freight, lorry 7.5-16 metric ton, EURO1	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 1
transport, freight, lorry 7.5-16 metric ton, EURO2	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 2
transport, freight, lorry 7.5-16 metric ton, EURO3	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 3
transport, freight, lorry 7.5-16 metric ton, EURO4	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 4
transport, freight, lorry 7.5-16 metric ton, EURO5	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 5
transport, freight, lorry 7.5-16 metric ton, EURO6	transport, freight, lorry, 7.5-16 metric ton, diesel, EURO 6
transport, freight, lorry 7.5-16 metric ton, unregulated	transport, freight, lorry, 7.5-16 metric ton, diesel, unregulated
transport, freight, lorry >32 metric ton, EURO1	transport, freight, lorry, >32 metric ton, diesel, EURO 1
transport, freight, lorry >32 metric ton, EURO2	transport, freight, lorry, >32 metric ton, diesel, EURO 2
transport, freight, lorry >32 metric ton, EURO3	transport, freight, lorry, >32 metric ton, diesel, EURO 3
transport, freight, lorry >32 metric ton, EURO4	transport, freight, lorry, >32 metric ton, diesel, EURO 4
transport, freight, lorry >32 metric ton, EURO5	transport, freight, lorry, >32 metric ton, diesel, EURO 5
transport, freight, lorry >32 metric ton, EURO6	transport, freight, lorry, >32 metric ton, diesel, EURO 6
transport, freight, lorry >32 metric ton, unregulated	transport, freight, lorry, >32 metric ton, diesel, unregulated
transport, freight, lorry with reefer, cooling	transport, freight, lorry with reefer, diesel, cooling, fleet average
transport, freight, lorry with reefer, freezing	transport, freight, lorry with reefer, diesel, freezing, fleet average
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, R134a refrigerant, cooling

transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 3, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 3, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 4, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 4, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 5, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 5, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, freezing	transport, freight, lorry with ref. machine, 3.5-7.5 ton, diesel, EURO 6, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, diesel, EURO 6, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, CO2, liq. ref., cooling

transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 3, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 4, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 5, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, R134a refrigerant, cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, R134a refrigerant, freezing
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, cooling	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, CO2, liq. ref., cooling
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, freezing	transport, freight, lorry with refrigeration machine, 7.5-16 ton, diesel, EURO 6, CO2, liq. ref., freezing
transport, freight, lorry with refrigeration machine, cooling	transport, freight, lorry with refrigeration machine, diesel, cooling, fleet average
transport, freight, lorry with refrigeration machine, freezing	transport, freight, lorry with refrigeration machine, diesel, freezing, fleet average
transport, freight, lorry, unspecified	transport, freight, lorry, diesel, unspecified
transport, freight, sea, bulk carrier for dry goods	transport, freight, sea, bulk carrier for dry goods, heavy fuel oil
transport, freight, sea, container ship	transport, freight, sea, container ship, heavy fuel oil
transport, freight, sea, container ship with reefer, cooling	transport, freight, sea, container ship with reefer, heavy fuel oil, cooling
transport, freight, sea, container ship with reefer, freezing	transport, freight, sea, container ship with reefer, heavy fuel oil, freezing

transport, freight, sea, ferry	transport, freight, sea, ferry, heavy fuel oil
transport, freight, sea, tanker for liquefied natural gas	transport, freight, sea, tanker for liquefied natural gas, heavy fuel oil
transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas, heavy fuel oil
transport, freight, sea, tanker for petroleum	transport, freight, sea, tanker for petroleum, heavy fuel oil
transport, freight, train with reefer, cooling	transport, freight, train with reefer, cooling, fleet average
transport, freight, train with reefer, freezing	transport, freight, train with reefer, freezing, fleet average
transport, helicopter	transport, helicopter, kerosene
transport, helicopter, LTO cycle	transport, helicopter, kerosene, LTO cycle
transport, passenger aircraft, long haul	transport, passenger, aircraft, long haul
transport, passenger aircraft, medium haul	transport, passenger, aircraft, medium haul
transport, passenger aircraft, short haul	transport, passenger, aircraft, short haul
transport, passenger aircraft, unspecified	transport, passenger, aircraft, unspecified
transport, passenger aircraft, very short haul	transport, passenger, aircraft, very short haul
transport, passenger car	transport, passenger, car, fleet average
transport, passenger car with internal combustion engine	transport, passenger, car with internal combustion engine, fleet average
transport, passenger car, EURO 3	transport, passenger, car, EURO 3, fleet average
transport, passenger car, EURO 4	transport, passenger, car, EURO 4, fleet average
transport, passenger car, EURO 5	transport, passenger, car, EURO 5, fleet average
transport, passenger car, electric	transport, passenger, car, electric
transport, passenger car, large size, diesel, EURO 3	transport, passenger, car, diesel, large size, EURO 3
transport, passenger car, large size, diesel, EURO 4	transport, passenger, car, diesel, large size, EURO 4
transport, passenger car, large size, diesel, EURO 5	transport, passenger, car, diesel, large size, EURO 5
transport, passenger car, large size, natural gas, EURO 3	transport, passenger, car, natural gas, large size, EURO 3
transport, passenger car, large size, natural gas, EURO 4	transport, passenger, car, natural gas, large size, EURO 4
transport, passenger car, large size, natural gas, EURO 5	transport, passenger, car, natural gas, large size, EURO 5

transport, passenger car, large size, petrol, EURO 3	transport, passenger, car, petrol, large size, EURO 3
transport, passenger car, large size, petrol, EURO 4	transport, passenger, car, petrol, large size, EURO 4
transport, passenger car, large size, petrol, EURO 5	transport, passenger, car, petrol, large size, EURO 5
transport, passenger car, medium size, diesel, EURO 3	transport, passenger, car, diesel, medium size, EURO 3
transport, passenger car, medium size, diesel, EURO 4	transport, passenger, car, diesel, medium size, EURO 4
transport, passenger car, medium size, diesel, EURO 5	transport, passenger, car, diesel, medium size, EURO 5
transport, passenger car, medium size, liquefied petroleum gas, EURO 5	transport, passenger, car, liquefied petroleum gas, medium size, EURO 5
transport, passenger car, medium size, natural gas, EURO 3	transport, passenger, car, natural gas, medium size, EURO 3
transport, passenger car, medium size, natural gas, EURO 4	transport, passenger, car, natural gas, medium size, EURO 4
transport, passenger car, medium size, natural gas, EURO 5	transport, passenger, car, natural gas, medium size, EURO 5
transport, passenger car, medium size, petrol, EURO 3	transport, passenger, car, petrol, medium size, EURO 3
transport, passenger car, medium size, petrol, EURO 4	transport, passenger, car, petrol, medium size, EURO 4
transport, passenger car, medium size, petrol, EURO 5	transport, passenger, car, petrol, medium size, EURO 5
transport, passenger car, small size, diesel, EURO 3	transport, passenger, car, diesel, small size, EURO 3
transport, passenger car, small size, diesel, EURO 4	transport, passenger, car, diesel, small size, EURO 4
transport, passenger car, small size, diesel, EURO 5	transport, passenger, car, diesel, small size, EURO 5
transport, passenger car, small size, natural gas, EURO 3	transport, passenger, car, natural gas, small size, EURO 3
transport, passenger car, small size, natural gas, EURO 4	transport, passenger, car, natural gas, small size, EURO 4
transport, passenger car, small size, natural gas, EURO 5	transport, passenger, car, natural gas, small size, EURO 5
transport, passenger car, small size, petrol, EURO 3	transport, passenger, car, petrol, small size, EURO 3
transport, passenger car, small size, petrol, EURO 4	transport, passenger, car, petrol, small size, EURO 4

transport, passenger car, small size, petrol, EURO 5	transport, passenger, car, petrol, small size, EURO 5
transport, passenger coach	transport, passenger, coach, diesel
transport, passenger train	transport, passenger, train, fleet average
transport, passenger, electric bicycle	transport, passenger, bicycle, electric
transport, passenger, electric bicycle, electricity from renewable energy products	transport, passenger, bicycle, electric, electricity from renewable energy products
transport, passenger, electric scooter	transport, passenger, scooter, electric
transport, passenger, motor scooter	transport, passenger, motor scooter, fleet average
transport, regular bus	transport, passenger, bus, diesel, regular
transport, tractor and trailer, agricultural	transport, freight, tractor and trailer, diesel, agricultural
transport, tram	transport, passenger, tram, electric
transport, trolleybus	transport, passenger, trolleybus, electric

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 3.11.

Elementary exchange name in v3.10.1	Elementary exchange name in v3.11
Carbon, organic, in soil or biomass stock	Carbon, organic, decrease in soil or biomass stock
Methane, bromo-, Halon 1001	Bromomethane
Methane, bromochlorodifluoro-, Halon 1211	Bromochlorodifluoromethane
Methane, bromotrifluoro-, Halon 1301	Bromotrifluoromethane
Pyrethrin	Pyrethrin II
Pyrethrum	Pyrethrins

3 Biogenic Carbon Balancing

3.1 Introduction

Several standards and guidelines exist in carbon footprinting. They have differences regarding the consideration of biogenic carbon flows. In the ecoinvent database, the main flows related to biogenic carbon are the elementary exchanges “Carbon dioxide, in air”, which represents the carbon dioxide uptake by biomass growth, and “Carbon dioxide, non-fossil” which accounts for biogenic releases. So far, these flows were not characterized (0/0) for the impact assessment. However, some standards like ISO 14067 and EN 15804 suggest characterizing these flows with -1/+1. To implement this -1/+1 characterization approach, we revised and harmonized biogenic carbon properties, uptake, and balances in the database to ensure accurate carbon accounting in inventories (see section 4.1 for the implementation of biogenic carbon dioxide in the IPCC 2021 method).

3.2 Main inventory revisions

To check and improve biogenic carbon balances and thereby in particular the amounts of biogenic carbon uptake in the database, the following items were revised and harmonized

1) properties of intermediate and elementary exchanges which affect biogenic carbon balances of activities (“carbon content, non-fossil” and “dry mass” as the carbon content is expressed relative to dry mass);

2) activities that include biogenic carbon uptake (“Carbon dioxide, in air”);

3) other activities in sectors where biogenic products are important, such as agriculture, forestry, and pulp and paper.

3.2.1 Harmonization of Carbon content, non-fossil property

Intermediate and elementary exchanges have (or should have) a “carbon content, non-fossil” (kg) property as a mandatory item within their properties. In most cases, this amount is estimated multiplying the dry mass (kg) of an exchange per its carbon content, non-fossil (dimensionless). Hence, to harmonize the “carbon content, non-fossil” (kg) property, also the “dry mass” (kg) property of intermediate and elementary exchanges has been revised.

3.2.2 Updated modeling of carbon uptake and release for land use change

Carbon uptake and release due to land use change are modeled with separate elementary exchanges: “Carbon dioxide, to soil or biomass stock” and “Carbon dioxide, from soil or biomass stock”. As shown in Figure 1, “Carbon dioxide, in air” is used in v3.10 to model the source of carbon uptake (“Carbon dioxide, to soil or biomass stock”) to balance land use change datasets with overall carbon uptake. For those with overall carbon release (“Carbon dioxide, from soil or biomass stock”), the source flow is “Carbon, organic, in soil or biomass stock”.

With the adoption of a -1/+1 characterization approach, so when implementing a -1 characterization factor for “Carbon dioxide, in air”, this would lead to double counting issue for carbon uptake since “Carbon dioxide, to soil or biomass stock” is already accounted and characterized with -1. This revealed that a change in modeling land use activities is needed.

Following the balancing of carbon release with “Carbon, organic, in soil or biomass stock”, we introduced the balancing elementary exchange “Carbon, organic, **increase** in soil or biomass stock”. This exchange replaces “Carbon dioxide, in air” and balances “Carbon dioxide, to soil or biomass stock”. To be consistent with terminology, we renamed “Carbon, organic, in soil or biomass stock” to “Carbon, organic, **decrease** in soil or biomass stock”. Both “balancing” exchanges are characterized with 0 and double counting is avoided.

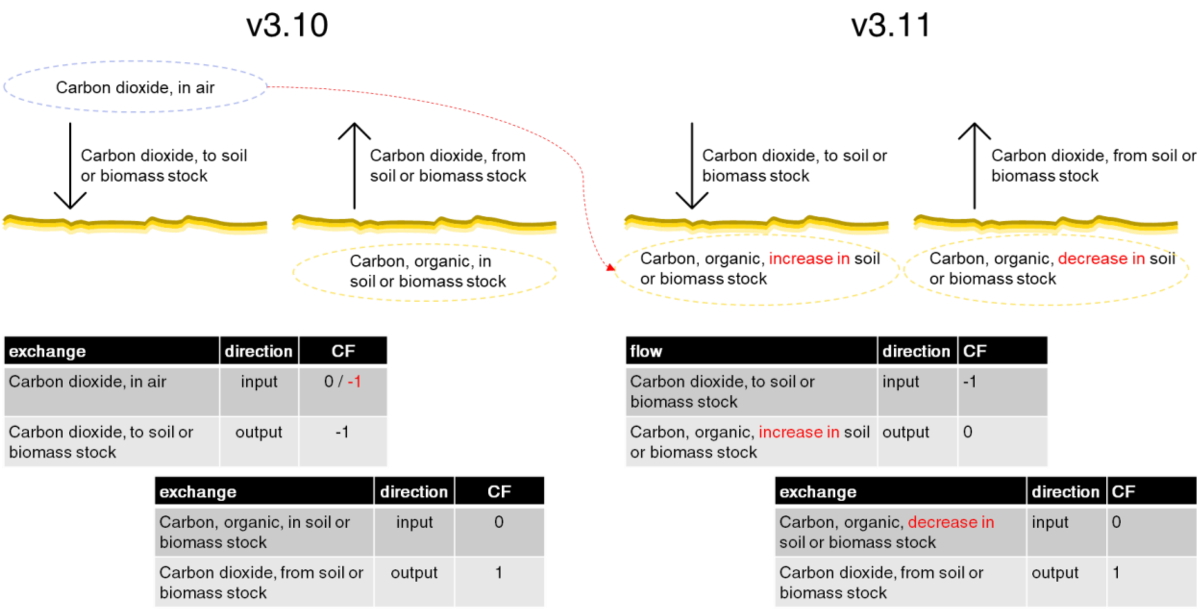

Figure 1. New modeling of carbon in land use change activities; CF = Characterization Factor.

Table 4 shows the activities that were adjusted to the modelling approach described above.

Table 4. Activities for which the carbon uptake and release for land use change were remodeled.

Activity Name	Geography
clear-cutting, grassland to arable land, annual crop	AU; IN
clear-cutting, grassland to arable land, annual crop	BR-AC; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MT; BR-PA; BR-PI; BR-RO; BR-RR; BR-RS; BR-SE; BR-TO
clear-cutting, grassland to arable land, forest, intensive	BR-BA; BR-ES; BR-GO; BR-MA; BR-MT; BR-PA; BR-PI; BR-TO
clear-cutting, grassland to arable land, pasture, man made	BR-AC; BR-AM; BR-AP; BR-BA; BR-CE; BR-ES; BR-MA; BR-MG; BR-MT; BR-PA; BR-PI; BR-RO; BR-RR; BR-SE; BR-TO
clear-cutting, grassland to arable land, perennial crop	BE; CR; EC; GH; ID; IN

clear-cutting, grassland to arable land, perennial crop	BR-AC; BR-AM; BR-AP; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MT; BR-PA; BR-PI; BR-RO; BR-RR; BR-RS; BR-SE; BR-TO
clear-cutting, grassland to arable land, perennial crop	BR-BA
clear-cutting, primary forest to arable land, annual crop	AR; AU; PE; TH; UA
clear-cutting, primary forest to arable land, annual crop	BR-AC; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MT; BR-PA; BR-PI; BR-RO; BR-RR; BR-RS; BR-SE; BR-TO
clear-cutting, primary forest to arable land, forest, intensive	BR-BA; BR-ES; BR-GO; BR-MA; BR-MT; BR-PA; BR-PI; BR-TO
clear-cutting, primary forest to arable land, pasture, man made	BR-AC; BR-AM; BR-AP; BR-BA; BR-CE; BR-ES; BR-MA; BR-MG; BR-MT; BR-PA; BR-PI; BR-RO; BR-RR; BR-SE; BR-TO
clear-cutting, primary forest to arable land, perennial crop	AR; CI; EC; GH; HN; ID; KE; MY; PE; PH; VN
clear-cutting, primary forest to arable land, perennial crop	BR-AC; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MT; BR-PA; BR-PI; BR-RO; BR-RR; BR-RS; BR-SE; BR-TO
clear-cutting, secondary forest to arable land, annual crop	AR; AU; PE; TH; UA
clear-cutting, secondary forest to arable land, perennial crop	AR; CI; EC; GH; HN; ID; KE; MY; PE; PH; VN
land already in use, annual cropland to annual crop	AR; AU; CA; CH; CN; DE; ES; FI; FR; HU; IL; IN; IT; MX; NL; NZ; PE; RU; TH; UA; US
land already in use, annual cropland to annual crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RR; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO
land already in use, annual cropland to forest, intensive	BR-BA; BR-ES; BR-GO; BR-MA; BR-MS; BR-MT; BR-PA; BR-PI; BR-PR; BR-SC; BR-SP; BR-TO
land already in use, annual cropland to pasture, man made	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-ES; BR-MA; BR-MG; BR-MT; BR-PA; BR-PB; BR-PI; BR-RJ; BR-RO; BR-RR; BR-SC; BR-SE; BR-TO
land already in use, annual cropland to perennial crop	AR; BE; CI; CL; CN; CO; CR; EC; ES; FR; HN; ID; IT; KE; LK; MG; MX; MY; PE; PH; TR; US; VN; ZA
land already in use, annual cropland to perennial crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PE; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RR; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO
land already in use, forest, intensive to annual crop	BR-AP; BR-MG; BR-RS
land already in use, forest, intensive to pasture, man made	BR-AP; BR-MG
land already in use, forest, intensive to perennial crop	BR-AP

land already in use, forest, intensive to perennial crop	BR-MG; BR-RS
land already in use, pasture, man made to annual crop	BR-DF; BR-GO; BR-MS; BR-PR; BR-RN; BR-RS; BR-SP
land already in use, pasture, man made to forest, intensive	BR-GO; BR-MS; BR-PR; BR-SP
land already in use, pasture, man made to perennial crop	BR-DF; BR-GO; BR-MS; BR-PE; BR-PR; BR-RN; BR-RS; BR-SP
land already in use, perennial cropland to annual crop	AR; AU; CA; CH; CN; DE; ES; FI; FR; HU; IL; IT; MX; NL; NZ; PE; RU; TH; UA; US
land already in use, perennial cropland to annual crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO
land already in use, perennial cropland to forest, intensive	BR-BA; BR-GO; BR-MS; BR-PI; BR-PR; BR-SC; BR-SP
land already in use, perennial cropland to forest, intensive	BR-ES; BR-MA; BR-MT; BR-PA; BR-TO
land already in use, perennial cropland to pasture, man made	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-ES; BR-MA; BR-MG; BR-MT; BR-PA; BR-PB; BR-PI; BR-RJ; BR-RO; BR-SC; BR-SE; BR-TO
land already in use, perennial cropland to perennial crop	AR; BE; CI; CL; CO; CR; EC; ES; FR; HN; ID; IT; KE; LK; MG; MX; MY; PE; PH; TR; US; VN; ZA
land already in use, perennial cropland to perennial crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PE; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO
land use change, annual crop	AR; AU; CA; CH; CN; DE; ES; FI; FR; HU; IL; IN; IT; MX; NL; NZ; PE; RU; TH; UA; US
land use change, annual crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RR; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO
land use change, forest, intensive	BR-BA; BR-ES; BR-GO; BR-MA; BR-MS; BR-MT; BR-PA; BR-PI; BR-PR; BR-SC; BR-SP; BR-TO
land use change, paddy rice	CN; IN
land use change, pasture, man made	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-ES; BR-MA; BR-MG; BR-MT; BR-PA; BR-PB; BR-PI; BR-RJ; BR-RO; BR-RR; BR-SC; BR-SE; BR-TO
land use change, perennial crop	AR; BE; CI; CL; CN; CO; CR; EC; ES; FR; IT; LK; MG; MX; PH; TR; US; VN; ZA
land use change, perennial crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PE; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RR; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO

land use change, perennial crop	GH; HN; ID; IN; KE; MY; PE
land use change, forest, intensive	BR-BA; BR-ES; BR-GO; BR-MA; BR-MS; BR-MT; BR-PA; BR-PI; BR-PR; BR-SC; BR-SP; BR-TO
land use change, pasture, man made	BR-AL; BR-BA; BR-CE; BR-ES; BR-MA; BR-MG; BR-PB; BR-PI; BR-RJ; BR-SC; BR-SE;
land use change, perennial crop	BR-AC; BR-AL; BR-AM; BR-AP; BR-BA; BR-CE; BR-DF; BR-ES; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PA; BR-PB; BR-PE; BR-PI; BR-PR; BR-RJ; BR-RN; BR-RO; BR-RR; BR-RS; BR-SC; BR-SE; BR-SP; BR-TO;

3.2.3 Carbon uptake in activities with biomass growth

Carbon uptake in activities with biomass growth can be modeled following this rule: The uptake should correspond to the carbon in products and by-products leaving the process (for example, crop and straw) minus the carbon in relevant products entering the process (for example, seed and seedlings). After correcting properties of exchanges, we have checked and – if needed – recalculated this uptake (amount of “Carbon dioxide, in air”) for activities with biomass growth, excluding exchanges with biogenic carbon content that don’t affect this “growth balance” (for example, compost or manure added to the soil).

Table 5, **Table 6**, and **Table 7** show the activities for which “Carbon dioxide, in air” was revised following the rule described above.

Table 5. Agricultural activities for which biogenic carbon uptake was revised.

Activity Name	Geography
almond production	CN; GLO; US
apple production	CL; CN; GLO; IT; US
apple production	ZA
apricot production	ES; FR; IT
apricot production	GLO; TR
aubergine production, in heated greenhouse	GLO
aubergine production, open field	GLO; IN
avocado production	GLO
banana production	CO; CR; EC; GLO; IN
barley grain production	AU-NSW; AU-QLD; AU-SA; AU-TAS; AU-VIC; AU-WA
beet seed production, Swiss integrated production, for sowing	CH
bell pepper production, in heated greenhouse	GLO
bell pepper production, open field	GLO; IN-MH; IN-UP
broccoli production	GLO
carrot production	CN; GLO; IL; NL
carrot seed production, Swiss integrated production, at farm	CH
cashew production	GLO; IN

Activity Name	Geography
castor bean production	GLO; IN
cauliflower production	GLO
celery production	GLO
chickpea production	GLO; IN
chilli production	GLO; IN-UP
cocoa bean production, sun-dried	CI; GH; GLO; ID
coconut production, dehusked	GLO; ID; PH
coconut production, dehusked	IN
coffee green bean production, arabica	BR-SP
coffee green bean production, arabica	CO; HN; IN
coffee green bean production, arabica	GLO
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, semi-mechanized	BR-MG
coffee green bean production, robusta	BR; GLO; ID; IN; VN
coriander production	GLO; IN
cucumber production, in heated greenhouse	GLO
fennel production	GLO
fodder beet seed production, for sowing	GLO
grape production	IN
green asparagus production	GLO
iceberg lettuce production	GLO
jatropha seed production	GLO
kiwi production	GLO
lemon production	ES; GLO; MX; TR
lettuce production	GLO
lettuce production, in heated greenhouse	GLO
linseed production	CA; GLO
linseed seed production, at farm	CH; GLO
linseed seed production, for sowing	CH; GLO
maize grain production	AR
maize grain production	AU-NSW; AU-QLD; AU-VIC
maize grain production	IN
maize grain production	US-IA; US-IL; US-IN; US-MN; US-NE; US-SD; US-WI
maize grain production	ZA
maize grain production, first crop	BR-BA; BR-GO; BR-MA; BR-MG; BR-PI; BR-PR; BR-RS
maize grain production, rainfed	GLO; ZA
maize grain production, second crop	BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PR; BR-SP; BR-TO
maize silage production	ZA
mandarin production	CN; ES; GLO
mandarin production	ZA
mango production	BR; GLO
melon production	GLO
millet production	GLO; IN

Activity Name	Geography
mint production	GLO; IN
mint production	US
mulberry production	GLO; IN
mustard production	GLO; IN
oat grain production	AU-NSW; AU-QLD; AU-SA; AU-TAS; AU-VIC; AU-WA
oat grain production	Canada without Quebec; FI
oat seed production, Swiss integrated production, at farm	CH
olive production	ES
olive production	GLO; IT
onion production	CN
onion production	GLO
onion production	IN
onion production	NL; NZ
orange production, fresh grade	ES
orange production, fresh grade	GLO
orange production, fresh grade	US
orange production, fresh grade	ZA
orange production, processing grade	BR
orange production, processing grade	GLO
orange production, processing grade	US
palm date production	GLO
palm date production, organic	GLO
palm fruit bunch production	CO
palm fruit bunch production	ID
papaya production	GLO
paris market carrot production	GLO
peach production	CN; ES; GLO; IT
peanut production	CN; GLO
peanut production, in cropping system	BR-SP
peanut seed production, at farm	GLO; IN
pear production	AR; BE; CN; GLO
pear production	ZA
pineapple production	GLO
pomegranate production	GLO; IN
potato production	CN
potato production	IN
potato production	RU
potato production	US-CO; US-ID; US-MN; US-ND; US-OR; US-WA; US-WI
radish production, in heated greenhouse	GLO
rape seed production	AU-NSW; AU-QLD; AU-SA; AU-VIC; AU-WA
rape seed production	Canada without Quebec
red cabbage production	GLO
rice production, basmati	GLO; IN
rice production, non-basmati	CN
rice production, non-basmati	GLO; US
rice production, non-basmati	IN

Activity Name	Geography
seed-cotton production, conventional	BD
seed-cotton production, conventional	GLO
seed-cotton production, conventional	IN-GJ
seed-cotton production, organic	GLO; IN-OR
sesame seed production	GLO; IN
soybean production	AR
soybean production	BR-BA; BR-GO; BR-MA; BR-MG; BR-MS; BR-MT; BR-PI; BR-PR; BR-RS; BR-SP; BR-TO
soybean production	IN
soybean production	US-IA; US-IL; US-IN; US-MN; US-ND; US-NE; US-OH
spinach production	GLO
straw production, stand-alone production	CH; GLO
strawberry production, in heated greenhouse	CH; GLO
strawberry production, in unheated greenhouse	CH; GLO
strawberry production, open field, macro tunnel	ES; GLO
strawberry production, open field, macro tunnel	US
sugar beet production	DE; RU; US
sugar beet production	FR
sugar beet seed production, for sowing	GLO
sugarcane production	GLO
sugarcane production	IN
sunflower production	FR
sunflower production	HU; RU
sunflower production	UA
sweet corn production	GLO; HU
sweet corn production	TH
sweet corn production	US-CA; US-FL; US-MN; US-OR; US-WA; US-WI
sweet sorghum production	CN; GLO
tea production, dried	CN; GLO; KE; LK
tea production, dried	IN-HP
tomato production, fresh grade, in heated greenhouse	GLO; NL
tomato production, fresh grade, in unheated greenhouse	ES; GLO
tomato production, fresh grade, open field	GLO; MX
tomato production, fresh grade, open field	IN-MH; IN-UP
tomato production, processing grade, open field	GLO
tomato production, processing grade, open field	IT
vanilla production	GLO; MG
wheat grain production	AU-NSW; AU-QLD; AU-SA; AU-TAS; AU-VIC; AU-WA
wheat grain production	Canada without Quebec
wheat grain production	GLO
wheat grain production	IN
white asparagus production	CN; FR; GLO; PE
white cabbage production	GLO
white cabbage production	IN-MH; IN-UP
zucchini production	GLO

Table 6. Fiber plant growing activities for which biogenic carbon uptake was revised.

Activity Name	Geography
flax production	GLO; IN
jute production, irrigated	GLO; IN
jute production, rainfed	BD; GLO
kenaf production, irrigated	GLO; IN
sunn hemp production	GLO; IN

Table 7. Forestry activities for which biogenic carbon uptake was revised.

Activity Name	Geography
bamboo forestry, sustainable forest management	BR; CN; CO; GLO; PH; EC
hardwood forestry, azobe, sustainable forest management	CM; GLO
hardwood forestry, eucalyptus ssp., planted forest management	GLO
hardwood forestry, eucalyptus ssp., sustainable forest management	GLO; TH
softwood forestry, paraná pine, sustainable forest management	BR; GLO

3.2.4 Modeling of biogenic carbon in other relevant sectors and activities

In some sectors, biogenic products are more present and important than in others, for example, in agriculture, forestry, pulp and paper, textiles, and fuels. We have checked biogenic carbon balances for relevant activities in these sectors and corrected if needed. For instance, in some cases, carbon output was double counted by including it in the by-product and as an emission.

3.2.4.1 Textiles

Table 8 shows the activities in the textiles sector that were corrected to improve the biogenic carbon balance.

Table 8. Activities in the textiles sector that were corrected to improve the biogenic carbon balance.

Activity Name	Geography
fibre production, jute, retting	BD; GLO; IN
fibre production, kenaf, retting	GLO; IN

3.2.4.2 Wood

Table 9 shows the activities in the wood sector that were corrected to improve the biogenic carbon balance.

Table 9. Activities in the wood sector that were corrected to improve the biogenic carbon balance.

Activity Name	Geography
bamboo pole production	EC
particleboard production, uncoated, from virgin wood	BR; GLO

3.2.4.3 Chemicals: ethanol from biomass

The datasets listed in **Table 10** have been updated since the amount of "Carbon dioxide, non-fossil" emissions to air, from fermentation, of the original data was calculated from the carbon balance (Jungbluth, et al., 2007). In certain cases, an input of "Carbon dioxide, in air" was included to satisfy the carbon balance (according to the carbon content property) between ethanol and its byproducts (Distiller's Dried Grains with Solubles, DDGS) after economic allocation.

As a result of updating the properties in the ecoinvent database a rebalancing of the data is required. This calculation considered not only the amounts of inputs and outputs but also their distinct properties, such as dry mass and non-fossil carbon content. However, there is no need for the "Carbon dioxide, in air" input for rebalancing, as this is uniformly handled in ecoinvent after allocation using carbon allocation correction (see section 3.3).

Finally, two new products are now added, namely (1) "protein, from grass" and (2) "protein concentrate, 8% in water, from whey", that substituted the generic "protein feed, 100% crude" exchange in the dataset for "ethanol production, from grass" and "ethanol production, from whey".

Table 10. Updated activities related to ethanol production from biomass.

Activity Name	Geography
ethanol production from grass	CH
ethanol production from maize	GLO
ethanol production from maize	US
ethanol production from potatoes	CH; GLO
ethanol production from rye	GLO; RER
ethanol production from sugar beet	GLO
ethanol production from sugar beet	CH
ethanol production from sugar beet molasses	CH; GLO
ethanol production from whey	CH; GLO
market for protein concentrate, 8% in water, from whey	GLO
market for protein, from grass	CH
protein concentrate, 8% in water, from whey to generic market for protein feed	CH; GLO
protein, from grass to generic market for protein feed	CH

3.3 Carbon allocation correction

Elementary exchanges are part of the carbon balance, and they are allocated to products by economic allocation. This means that the carbon uptake ("Carbon dioxide, in air") also gets allocated by economic allocation. This can lead to distortions in the balance. If we assume an activity producing logs and wood chips 50:50 on a mass basis, but carbon uptake is allocated 90:10 because the price of logs is nine times the price of wood chips, there will be too much carbon uptake in the allocated logs activity and too little in the allocated wood chips activity. The exchange “Carbon dioxide, non-fossil, resource correction” corrects the difference of the distorted result to the amount before allocation (**Figure 2**).

mass	carbon	allocation factor	CO2 uptake allocated	correction	CO2 uptake corrected
1 kg	0.5 kg	0.9	3.30 kg	-1.47 kg	1.83
1 kg	0.5 kg	0.1	0.37 kg	+1.47 kg	1.83

Figure 2. Example of biogenic carbon allocation correction.

4 LCIA Methods

There are three changes in methods for v3.11. First, a version of the IPCC 2021 method including biogenic carbon dioxide was introduced. Second, methods, categories, and indicators for EN15804 were renamed to be better aligned with the standard, which will make it easier for users to find the indicator and score they are looking for. Third, the "IMPACT World+, footprint version" method was updated from v2.0.1 to v2.1.

4.1 IPCC 2021

Several standards and guidelines exist in carbon footprinting. They have differences regarding the consideration of biogenic carbon flows. In the ecoinvent database, the main flows related to biogenic carbon are the elementary exchanges "Carbon dioxide, in air", which represents the carbon dioxide uptake by biomass growth, and "Carbon dioxide, non-fossil" which accounts for biogenic releases. So far, these flows were not characterized (0/0) for the impact assessment. However, some standards like ISO 14067 and EN 15804 demand characterizing these flows with -1/+1. Section 3 describes efforts in biogenic carbon balancing related to making such a -1/+1 implementation possible, which is done as an addition to the current implementation. This means that in v3.11 there are two complementary methods: "IPCC 2021" and "IPCC 2021 (incl. biogenic CO2)" (**Figure 3**).

"IPCC 2021" corresponds to the same method in v3.10 with a few adjustments:

- Impact categories were renamed to be more specific about the exclusion of biogenic carbon, for example, "climate change" is now "climate change: total (excl. biogenic CO2)".
- Aircraft emissions are provided separately in a new impact category (and – to be complete – the fossil emissions excluding aircraft emissions are provided as well).
- To increase transparency, emissions and removals are available separately for the land use impact category, which is renamed to "direct land use change" as this is what is available in ecoinvent.
- The categories including short-lived climate forcers (SLCFs) and other indicators (GWP20, GWP500, GTP50, and GTP100) for sensitivity analysis have been limited to avoid having an overwhelmingly large number of indicators. Therefore, SLCFs are only included for GWP100 for the four "main" categories (total, fossil, biogenic, direct land use change) and other indicators are only available for the total.

"IPCC 2021 (incl. biogenic CO2)" complements "IPCC 2021" with impact categories including biogenic carbon dioxide. These are total climate change without and with SLCFs and the "biogenic" category including biogenic carbon dioxide for the total as well as the emissions and removals separately to provide more information and transparency.

Impact categories from "IPCC 2021" and "IPCC 2021 (incl. biogenic CO2)" can be mapped to standards and guidelines (**Figure 3** shows this for EN15804 and ISO14067). Further carbon information like carbon content of products might be needed to comply with standards and guidelines, but this information does not come from LCIA methods.

				method/standard/guideline	IPCC 2021	IPCC 2021 (incl. biogenic CO2)	ISO 14067	EN15804
Impact category	**Impact category in v3.10**	**Indicator**	**ID**	**handling of biogenic CO2**	0/0 for biogenic CO2	-1/+1 for biogenic CO2	-1/+1 for biogenic CO2	-1/+1 for biogenic CO2
climate change: total (excl. biogenic CO2)	**climate change**	**GWP100**	A		x		(x)	(x)
climate change: total (incl. biogenic CO2)		GWP100	B			x	x	x
climate change: fossil	climate change: fossil	GWP100	C		x (= D + E)		x (= D + E)	x
climate change: fossil (excl. aircraft emissions)		GWP100	D		x		(x)	
climate change: aircraft emissions		GWP100	E		x		x	
climate change: direct land use change	climate change: land use	GWP100	F		x (= G + H)		x (= G + H)	x (= G + H)
climate change: emissions from direct land use change		GWP100	G		x		(x)	(x)
climate change: removals from direct land use change		GWP100	H		x		(x)	(x)
climate change: biogenic (excl. CO2)	climate change: biogenic	GWP100	H		x			
climate change: biogenic (incl. CO2)		GWP100	I			x (= J + K)	x (= J + K)	x (= J + K)
climate change: biogenic emissions (incl. CO2)		GWP100	J			x	(x)	(x)
climate change: biogenic removals (incl. CO2)		GWP100	K			x	(x)	(x)
climate change: total (excl. biogenic CO2, incl. SLCFs)	climate change: including SLCFs	GWP100			x		(x)	(x)
climate change: total (incl. biogenic CO2, incl. SLCFs)		GWP100				x	(x)	(x)
climate change: fossil (excl. biogenic CO2, incl. SLCFs)	climate change: fossil, including SLCFs	GWP100			x		(x)	(x)
climate change: direct land use change (incl. SLCFs)	climate change: land use, including SLCFs	GWP100			x		(x)	(x)
climate change: biogenic (excl. CO2, incl. SLCFs)	climate change: biogenic, including SLCFs	GWP100			x		(x)	(x)
climate change: total (excl. biogenic CO2)	climate change	GWP20			x			
climate change: total (excl. biogenic CO2)	climate change	GWP500			x			
climate change: total (excl. biogenic CO2)	climate change	GTP50			x			
climate change: total (excl. biogenic CO2)	climate change	GTP100			x			

Figure 3. Implementation of IPCC 2021 including biogenic carbon dioxide and how this maps to standards; (x) = not explicitly mentioned in the standard but recommended to be included in the analysis.

IMPORTANT NOTE: *We recommend using "IPCC 2021" where biogenic carbon dioxide is characterized with 0/0 whenever possible. Scores including biogenic carbon dioxide are subject to potential distortions by allocation and there is the risk of overestimating uptake. They should be handled with care, especially if they are negative, and they should never be used as stand-alone score. Users assume full responsibility for their application and interpretation.*

4.2 EN15804

Previously, four impact assessment methods were provided for the ‘Allocation, cut-off, EN15804’ system model: the *EF v3.x EN15804* methods, which provide the LCIA scores based on the CFs for *EF v3.0* and *EF v3.1*, the *TRACI v2.1* method, which is used for EPDs in the US, and the *EN15804* (inventory indicators ISO21930) method, which provides the resource indicators required in EPDs. The latter are not impact assessment indicators but are included in an impact assessment method to be more easily accessible to the users. For version 3.11, impact categories and indicators as in the EF methods and inventory indicators were re-arranged in new method and impact category names to be better aligned with the standard to help users find what they are looking for. Thereby, a distinction between EF v3.0 and EF v3.1 is only made where relevant (climate change, ecotoxicity: freshwater, and human toxicity: non-carcinogenic) (**Table 11**).

Table 11. Method and category names for EN15804 in v3.11 and v3.10.

method in v3.11/ category in v3.11	**method in v3.10/** category in v3.10
EN15804+A2 - Core impact categories and indicators	**EF v3.0 EN15804 or EF v3.1 EN15804**
climate change: total (EF v3.0 - IPCC 2013)	climate change
climate change: fossil (EF v3.0 - IPCC 2013)	climate change: fossil
climate change: biogenic (EF v3.0 - IPCC 2013)	climate change: biogenic
climate change: land use and land use change (EF v3.0 - IPCC 2013)	climate change: land use and land use change
ozone depletion	ozone depletion
acidification	acidification
eutrophication: freshwater	eutrophication: freshwater
eutrophication: marine	eutrophication: marine
eutrophication: terrestrial	eutrophication: terrestrial
photochemical oxidant formation: human health	photochemical oxidant formation: human health
material resources: metals/minerals	material resources: metals/minerals
energy resources: non-renewable	energy resources: non-renewable
water use	water use
climate change: total (EF v3.1 - IPCC 2021)	climate change
climate change: fossil (EF v3.1 - IPCC 2021)	climate change: fossil
climate change: biogenic (EF v3.1 - IPCC 2021)	climate change: biogenic
climate change: land use and land use change (EF v3.1 - IPCC 2021)	climate change: land use and land use change
EN15804+A2 - Additional impact categories and indicators	
particulate matter formation	particulate matter formation
ionising radiation: human health	ionising radiation: human health
ecotoxicity: freshwater (EF v3.0)	ecotoxicity: freshwater
human toxicity: carcinogenic	human toxicity: carcinogenic
human toxicity: non-carcinogenic (EF v3.0)	human toxicity: non-carcinogenic
land use	land use
ecotoxicity: freshwater (EF v3.1)	ecotoxicity: freshwater
human toxicity: non-carcinogenic (EF v3.1)	human toxicity: non-carcinogenic

Also inventory indicators of the EN15804 method were re-arranged in new method and impact category names to be better aligned with the standard to help users find what they are looking for. Since these do not correspond to common impact categories, “category” and “indicator” were used to provide a description and an acronym of the indicators (**Table 12**). Two indicators were added, but their value is 0 by default for now: “use of non-renewable secondary fuels” and “components for re-use”.

Table 12. Method, category, and indicator names for EN15804 inventory indicators in v3.11 and v3.10.

method in v3.11/ category in v3.11	**indicator in v3.11**	**method - category in v3.10** indicator in v3.10
EN15804+A2 - Indicators describing resource use		**EN15804 - inventory indicators ISO21930**
use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	PERE
use of renewable primary energy resources used as raw materials	PERM	PERM
total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PERT	Cumulative Energy Demand - renewable energy resources
use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	PENRE
use of non-renewable primary energy resources used as raw materials	PENRM	PENRM
total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PENRT	Cumulative Energy Demand - non-renewable energy resources
use of secondary material	SM	use of secondary material
use of renewable secondary fuels	RSF	use of renewable secondary fuels
use of non-renewable secondary fuels	NRSF	
net use of fresh water	FW	use of net fresh water
EN15804+A2 - Indicators describing waste categories		
hazardous waste disposed	HWD	hazardous waste disposed
non-hazardous waste disposed	NHWD	non-hazardous waste disposed
high-level radioactive waste disposed	HLRW	high-level radioactive waste disposed
intermediate and low-level radioactive waste disposed	ILLRW	intermediate and low-level radioactive waste disposed
EN15804+A2 - Indicators describing output flows		
components for re-use	CRU	
materials for recycling	MFR	materials for recycling
materials for energy recovery	MER	materials for energy recovery
exported energy	EE	recovered energy
exported energy - electricity	EEE	exported energy - electricity
exported energy - heat	EET	exported energy - heat
EN15804+A2 - Indicators describing biogenic carbon content at factory gate		
biogenic carbon content in product	BCCP	biogenic carbon content in product
biogenic carbon content in accompanying packaging	BCCAP	biogenic carbon content in accompanying packaging

4.3 IMPACT World+, footprint version

The footprint version of the “IMPACT World+” method was updated from version 2.0.1 to version 2.1. Characterization factors were provided by the method developers already mapped to ecoinvent elementary flows.

5 Fuels

5.1 Coal

While the global energy transition leads to a shift from coal to renewables and less carbon-intensive fossil fuels, global coal demand is still driven by emerging economies and has yet to reach its peak. Most of this demand comes from a few countries, with China and India at the forefront (Carbon Brief, 2024). Given its environmental relevance and the fact that coal will continue to play a significant role for some time, ecoinvent strives to represent global coal supply based on the best available data.

In this update, methane emissions, production volumes, and international trade were primarily updated. Additionally, the hard coal supply chains in Europe have been further regionalized, to represent the country-specific supply situation in 2022[1]. An effort was also made to improve consistency across coal activities in the database, particularly those that originated from different data providers in the SRI project[2], introduced with ecoinvent version 3.5.

5.1.1 Extraction of coal

The focus of the update was on methane emissions occurring during coal extraction and on annual production volumes. The main source for this data was the IEA Methane Tracker (IEA, 2024) and the Climate TRACE Emissions Inventory (Lewis, Tate, & Mei, 2023) for the remaining data gaps for the reference year 2022. The production volumes were sourced from EuroStat (EuroStat, 2024) for the available geographies, with data from the EIA (EIA, 2024) used for the remaining regions, except for India, where government statistics were also used (Coal Controller’s Organisation, 2023).

Additionally, the geography "Europe, without Russia and Türkiye", used for hard coal in earlier version of the ecoinvent database, has been regionalized into individual countries for which production data could be found (PL, CZ, GB, and NO). Some data sources indicated mining in Albania (EIA, 2024) (EuroStat, 2024); however, it was negligible. No data is available for Belarus, which is why production there has been omitted. The share of Ukrainian hard coal mining in Europe is not negligible, but since 2022, the reliability of available data for Ukraine is difficult to assess, which is why Ukraine is still only indirectly represented in Rest-of-World (RoW).

Until ecoinvent v3.4, the database included datasets for hard coal mine operations and preparation in both Poland (PL) and Western Europe (WEU), which were merged into "Europe, without Russia and Türkiye" for version 3.5. The Polish dataset has been reintroduced and updated, and the Czech (CZ) dataset was extrapolated from it. Hard coal mining activities in the United Kingdom (GB) and Norway (NO) have been extrapolated and updated accordingly from the WEU geography.

Updated datasets related to extraction of hard coal and lignite are shown in **Table 13**.

[1] It should be noted that for 2023, not all necessary data was available, and significant changes in global hard coal supply chains took place compared to previous years.

[2] www.ecoinvent.org/about/projects/sri-project/sri-project.html

Table 13. Updated datasets for hard coal and lignite mine operation. In column v3.11, “D” stands for “Deleted”, “N” for “New Activity”, and “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
hard coal mine operation	IN	2006-2022	hard coal, run-of-mine	kg	U
hard coal mine operation and hard coal preparation	Europe, without Russia and Türkiye	1990-2002	hard coal	kg	D
hard coal mine operation and hard coal preparation	CZ; GB; NO; PL	1990-2022	hard coal	kg	N
hard coal mine operation and hard coal preparation	ID; RLA; RNA; RU	1990-2022	hard coal	kg	U
hard coal mine operation and hard coal preparation	CN; GLO	1999-2022	hard coal	kg	U
hard coal mine operation and hard coal preparation	AU	2014-2022	hard coal	kg	U
hard coal mine operation, open cast, dragline	ZA	2014-2022	hard coal, run-of-mine	kg	U
hard coal mine operation, open cast, truck and shovel	ZA	2014-2022	hard coal, run-of-mine	kg	U
hard coal mine operation, underground	ZA	2014-2022	hard coal, run-of-mine	kg	U
lignite mine operation	GLO; RER	1983-2022	lignite	kg	U
lignite mine operation	IN	2006-2022	lignite	kg	U

The price properties of hard coal and lignite were updated based on the information available from UN Comtrade (United Nations, 2024). Averages for each product were derived from the prices of imports and exports into the main economies for hard coal (AU, CN, EU, IN, ID, JP, KR, RU, ZA, and US) and lignite (EU, US, IN, RU and CN), considering a three-year time period (2019-2022). The price properties, however, do not affect the extraction activities. However, it should be noted that the price for hard coal, run-of-mine was incorrect due to a unit error and has now been corrected.

The updated prices related to coal can be found in the Change Report Annex. **Table 14** indicates for which UN Comtrade categories price data were used for calculating the prices.

Table 14. UN Comtrade categories used for calculating the new prices for hard coal, hard coal, run-of-mine, and lignite in v3.11.

Product	UN Comtrade category
hard coal	270111, 270112, and 270119
hard coal, run-of-mine	270111, 270112, and 270119
lignite	2702

5.1.2 Imports, supply, and regional distribution of coal

All coal imports and corresponding markets have been updated. Additionally, some new routes have been added, while obsolete ones have been removed. Where possible, 2022 data from Eurostat was used, and for the remaining geographies, data from UN Comtrade was utilized.

The market for hard coal in Europe, without Russia and Türkiye, has been replaced with 22 regional markets for different geographies. Some countries, such as Bosnia and Herzegovina, Albania, Lithuania, Serbia, Iceland, Moldova, Greece, Romania, Luxembourg, Kosovo, and North Macedonia, which report hard coal consumption (EuroStat, 2024) and belong to the ecoinvent RER region, have been omitted. This is due to their very small consumption levels, which result in high uncertainty, and the fact that there are currently no activities in the v3.11 database that would consume hard coal in these geographies. Hungary and Slovenia, which also consume hard coal, were omitted as well because there is no direct consumer in the database. While these two geographies have hard coal power plants, they are currently not regionalized and thus would not consume from their domestic hard coal market. Lastly, similar to the decision for mining, no regional hard coal market was created for Ukraine due to the large data uncertainty; it is therefore represented within the RoW geography. It should be noted that Ukraine now consumes hard coal from RoW market, which has a lower climate change impact than the previous European hard coal market.

As relatively significant consumers, the hard coal markets for Japan (JP), which accounts for about 2.3%, and South Korea (KR), with 2.1% of global coal consumption (EIA, 2024), have been introduced. Although these two countries also extract hard coal domestically, their own production represents less than 1% of their total consumption. Therefore, an individual mining activity for each country has been omitted.

Updated datasets related to markets for hard coal and lignite are shown in **Table 15**.

Table 15. Updated datasets for markets for hard coal and lignite. In column v3.11, “D” stands for “Deleted”, “N” for “New Activity”, and “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
market for hard coal	IN	2010-2022	hard coal	kg	U
market for hard coal	GLO	2011-2022	hard coal	kg	U

market for hard coal	Europe, without Russia and Türkiye	2014-2020	hard coal	kg	D
market for hard coal	AT; BE; BG; CH; CZ; DE; DK; EE; ES; FI; FR; GB; HR; IE; IT; JP; KR; LV; NL; NO; PL; PT; SE; SK	2014-2022	hard coal	kg	N
market for hard coal	AU; CN; ID; RLA; RNA; RU	2014-2022	hard coal	kg	U
market for hard coal	ZA	2014-2022	hard coal	kg	U
market for lignite	IN	2010-2022	lignite	kg	U
market for lignite	GLO; RER	2011-2022	lignite	kg	U

With the introduction of new markets, additional import activities were needed and have been added. The “hard coal, import from XY” activities in “Europe, without Russia and Türkiye”, have been retained as an average trade route to Europe. However, the geography has been renamed to RER, though it still represents the same geographical scope. New imports in Europe now come from Poland, the Czech Republic, and RoW. Transport distances were calculated using a weighted average distance based on total export volumes to the import countries.

Switzerland had relatively high import volumes from China (CN), Belgium (BE), and Germany (DE), which is why specific import activities have been created for these cases. Since Germany and Belgium are not hard coal producers, they simply serve as re-exporters, and Switzerland consumes from their markets.

Portugal (PT) and Italy (IT) also had significant imports from countries that have not previously been mapped as exporters, namely Spain. For Portugal, even 100% of imports were from Spain. It’s not entirely clear where the hard coal originates from, as Spain reported domestic hard coal mining until 2018 (EuroStat, 2024), suggesting it could theoretically be stockpiled coal. Due to this uncertainty, both PT and IT are simply importing Spain’s hard coal mix too.

In RER, there were some notable imports from Ukraine, mainly by Slovakia, Poland, and Hungary, though these remained below 10% of their total consumption. Due to the high uncertainty in 2022, these imports have been omitted, but they are indirectly represented within the import from RoW activity.

For the new markets in South Korea and Japan, individual imports from AU, ID, RLA, RNA, CN, RU, and ZA have been modelled in the same manner as other imports.
The remaining re-exports in the RER region were omitted due to their insignificance and high uncertainty.

The hard coal market, RoW, previously did not include imports from other geographies. It was supplied solely by the hard coal mining activity in RoW, and in addition to the usual transport activities, a sea freight transport activity of 12 tkm was included as a rough proxy for the missing trade data. The market has now been updated to better represent a Rest-of-World scenario, meaning that imports from AU, ID, RLA, RNA, RU, ZA, and CN have been added. To calculate the transport distance, a weighted average transport distance to various destinations not individually mapped (mainly Türkiye, Malaysia, Vietnam, the Philippines, Thailand, Pakistan, and Morocco) was determined based on total export volumes and the corresponding distances from the exporting destination.

The two “hard coal, import from ZA” activities in Europe and India previously had emissions to water due to leaching from coal heaps at storage double-counted. These emissions are already accounted for in the hard coal markets and were also applied to the import activities from South Africa. Now, like other hard coal imports, they only account for additional losses during transportation, with these losses represented as particulate matter emissions.

The activities "hard coal, import from Indonesia" and "hard coal, import from Australia" in the Indian geography were renamed to align with the standard ecoinvent structure as "hard coal, import from ID" and "hard coal, import from AU."

Updated datasets related to imports from hard coal and lignite are shown in **Table 16**.

Table 16. Updated datasets for imports of hard coal and lignite. In column v3.11, “D” stands for “Deleted”, “N” for “New Activity”, and “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
hard coal, import from AU	IN	2010-2022	hard coal	kg	U
hard coal, import from AU	GLO; JP; KR	2015-2022	hard coal	kg	N
hard coal, import from AU	CN; ID; RER; RLA; ZA	2015-2022	hard coal	kg	U
hard coal, import from BE	CH	2015-2022	hard coal	kg	N
hard coal, import from CN	CH; GLO; ID; JP; KR	2015-2022	hard coal	kg	N
hard coal, import from CZ	RER	2015-2022	hard coal	kg	N
hard coal, import from DE	CH	2015-2022	hard coal	kg	N
hard coal, import from ES	IT; PT	2015-2022	hard coal	kg	N
hard coal, import from ID	IN	2010-2022	hard coal	kg	U
hard coal, import from ID	GLO; JP; KR	2015-2022	hard coal	kg	N
hard coal, import from ID	CN; RER; RNA	2015-2022	hard coal	kg	U
hard coal, import from PL	RER	2015-2022	hard coal	kg	N
hard coal, import from RLA	GLO; JP; KR	2015-2022	hard coal	kg	N
hard coal, import from RLA	CN; IN; RER; RNA	2015-2022	hard coal	kg	U
hard coal, import from RNA	GLO; JP; KR	2015-2022	hard coal	kg	N

hard coal, import from RNA	CN; ID; IN; RER; RLA	2015-2022	hard coal	kg	U
hard coal, import from RU	GLO; ID; JP; KR; RLA; ZA	2015-2022	hard coal	kg	N
hard coal, import from RU	CN; IN; RER	2015-2022	hard coal	kg	U
hard coal, import from RoW	RER; Russia (Asia)[3]	2015-2022	hard coal	kg	N
hard coal, import from ZA	GLO; JP; KR	2014-2022	hard coal	kg	N
hard coal, import from ZA	IN; RER	2014-2022	hard coal	kg	U

The intermediate exchange "hard coal, run-of-mine" was introduced in v3.5 for India and South Africa to disaggregate the supply chain by also considering this intermediate coal product. In South Africa, hard coal, run-of-mine undergoes additional washing before being used in the domestic market or exported. Previously, a small amount was directly exported (prior to washing) to the market for hard coal, run-of-mine, RoW. However, due to insufficient reliable data, it was decided that in v3.11, exports from South Africa to RoW now occur after the washing steps, along with the remaining exports. Consequently, the market for hard coal, run-of-mine, RoW has been removed from the database since it is no longer used.

In India, the market for hard coal, run-of-mine is used domestically but serves only as an intermediate step before reaching the standard hard coal market, which contains a high share of this lower-grade hard coal, along with a small share of domestically washed coal.

Updated datasets related to markets for hard coal, run-of-mine are shown in **Table 17**.

Table 17. Updated datasets for markets for hard coal, run-of-mine. In column v3.11, “D” stands for “Deleted”, and “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
market for hard coal, run-of-mine	GLO	2010-2020	hard coal, run-of-mine	kg	D
market for hard coal, run-of-mine	IN	2010-2022	hard coal, run-of-mine	kg	U
hard coal, run-of-mine to market for hard coal	IN	2006-2022	hard coal	kg	U

[3] The geography Russia (Asia) was used to avoid overlap with RER, as the ecoinvent RER geography includes Russia (Europe). It should be noted, however, that in the fuels sector, Russia (Europe) is always implicitly excluded from Russia.

Due to the low economic value of lignite, export volumes are very small and have been neglected in previous ecoinvent versions as well as in v3.11 due to their insignificance.

The total PVs of the markets previously reflected the sum of domestic mining activities and imports. Now, they represent the accurate total consumption for 2022. Additionally, new market groups have been introduced to make it easier for users to represent larger regions. These new market groups datasets are listed in **Table 18**.

Table 18. New market groups for hard coal and lignite.

Activity Name	Geography	Time Period	Product Name	Unit
market group for hard coal	GLO; RER	2022-2022	hard coal	kg
market group for lignite	GLO	2022-2022	lignite	kg

5.1.3 Life cycle impact assessment results

The GWP scores for hard coal mining have increased in almost every geography, with particularly strong increases in Latin America and the Caribbean (RLA) and South Africa. The exceptions are China and RoW, where scores have decreased.

A relative score comparison of all hard coal extraction activities is shown in **Figure 4**.

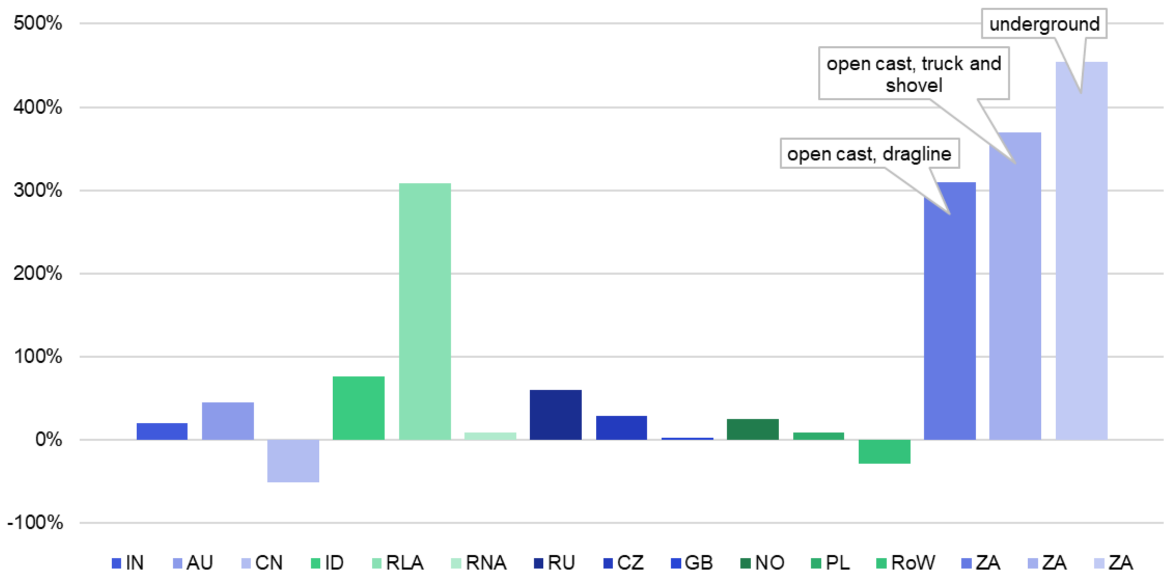

Figure 4. Relative change in climate change impact (based on IPCC 2021 GWP100) for hard coal mining across all geographies included in v3.11 compared to v3.10.1 (system model: Allocation, cut-off by

classification). The new European geographies are compared to the former “Europe, without Russia and Türkiye” geography.

The changes due to the updated lignite extraction activities are less drastic. Although lignite extraction in India sees a relative score change of -22%, the European market shows an increase of +132%, and RoW shows an increase of +36% in terms of climate change impact compared to v3.10.1.

Similarly to hard coal mining, hard coal market scores have increased in almost every geography, with particularly strong increases in RLA and South Africa. The exceptions are China, Japan and South Korea (compared to RoW), and RoW, where scores have decreased. Due to the sheer dominance of China (57% of global hard coal consumption) and RoW (8% of global consumption), this tends to slightly lower most of the scores in the database.

Some European markets, such as Estonia (EE), Latvia (LV), Bulgaria (BG), and Croatia (HR), have shown significantly higher score increases than others. This is because they source particularly high shares from Russia (RU) and RoW, which have a relatively high climate change impact compared to other main exporters like Indonesia (ID), Australia (AU), RNA, and South Africa, and additionally are emission-intensive in transportation.

A relative score comparison of all hard coal markets is shown in **Figure 5**.

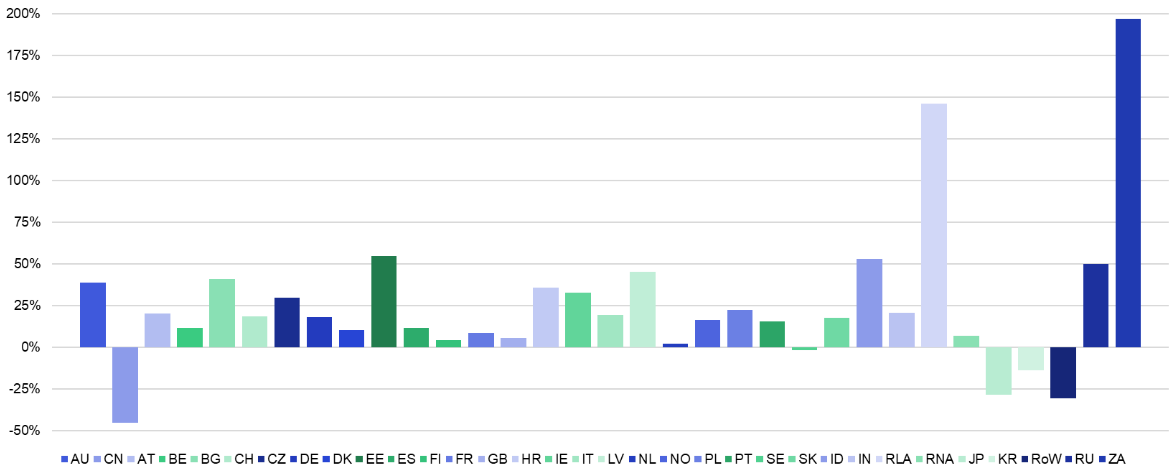

Figure 5. Relative change in climate change impact (based on IPCC 2021 GWP100) for “market for hard coal” across all geographies included in v3.11 compared to v3.10.1 (system model: Allocation, cut-off by classification). The new European geographies are compared to the former “Europe, without Russia and Türkiye” geography, while JP and KR are compared to RoW.

Additionally, below is a brief analysis of the significant database impacts from this update for the GWP100 indicator of the IPCC 2021 method:

- China: Some regionalized electricity markets, which are heavily coal-based, have decreased significantly. Similar effects are expected for coal-derived chemicals. The remaining sectors in China are not as strongly impacted, but overall, scores tend to decrease slightly as coal remains a backbone of the Chinese industry.
- South Africa: Score changes also here significantly, with electricity markets and coal-derived chemicals being most affected.

- Electricity: Other pronounced effects of the updated coal supply chains include countries that import a large share of electricity from South Africa, and South Korea due to its new country-specific hard coal market instead of RoW and an update to its power plants (see chapter 5.1.4). Some European countries heavily reliant on coal for electricity generation, such as Poland, see slight increases. Some geographies in RLA also show slight increases, not due to a high coal share in the mix, but rather due to the general increase in climate change impact for hard coal. A few countries consuming hard coal from RoW may see minor score decreases.
- Heat: Changes range from small decreases in RoW to small increases in RER.
- Chemicals: The decrease in GWP for coal-based chemicals manufacturing from the coal update is less pronounced than the changes in hard coal itself, due to the additional impact contributors in these activities. Generally, tend the GWP slightly down due to decreases in scores in China and RoW. Somewhat larger changes occur like already described in China And South Africa.
- Metals: Scores decreased moderately, primarily due to reductions in China and RoW.
- Cement: Changes range from small decreases in scores in RoW to moderate increases in South Africa.

The changes due to the updated lignite markets are less significant. Although the Indian market sees a relative score change of -19%, the European market of +115%, and RoW of +33% in terms of climate change impact compared to v3.10.1, the update barely impacts the supply chains. This is because the absolute impact of lignite remains very small compared to hard coal, and when lignite is incinerated, its own climate change impact is negligible compared to the emissions it produces. Additionally, unlike hard coal, lignite is not used as a material in the database; it is usually incinerated rather than used in material applications.

The analysis of other impact categories is less critical, as the coal update focused primarily on methane emissions and new trade patterns. However, due to the updated trade data, some impact categories show significant score changes when certain countries source coal differently in this update compared to v3.10.1. Key changes are highlighted below:

- Toxicity scores have decreased for geographies that import hard coal from South Africa. This is because particulate matter emissions were previously double-counted (see section 5.1.2), and correcting this also impacts consumers.
- Geographies that now consume higher shares of hard coal from Australia may see an increase in eutrophication, as spoil from hard coal mining is higher in the Australian mining dataset than in others.
- Russian mining activity has a higher human toxicity potential than other geographies (for various reasons), significantly impacting geographies that now import larger shares from Russia.

5.1.4 Other updates

The coal power plants in South Korea (KR) had outdated Activity Links to hard coal markets, using sources other than the automatically linked hard coal market, GLO/RoW. Consequently, the coal was sourced 43% from AU, 41% from ID, and 15% from RNA. With the creation of the new market for hard coal, KR, these Activity Links have been removed, and the power plants (and the geography KR in general) now consume from the corresponding Korean hard coal market (38% AU, 22% ID, 22% RU, 11% RNA, 5% ZA, 1.6% RLA, 0.4% CN). Since the climate change impact for all these geographies—except

China—has increased, and Russian coal, in particular, has one of the highest climate impacts globally, this change affects the South Korean supply chains, especially in the hard coal power plants.

Updated datasets related to hard coal power plants in South Korea are shown in **Table 19**.

Table 19. Updated datasets for hard coal power plants in South Korea.

Activity Name	Geography	Time Period	Product Name	Unit
electricity production, hard coal	KR	1980-2015	electricity, high voltage	kWh
heat and power co-generation, hard coal	KR	1980-2015	heat, district or industrial, other than natural gas	MJ

Meta information has been updated, corrected, and harmonized across all datasets. Additionally, uncertainties have been more standardized, particularly regarding methane emissions. Missing uncertainty information has also been addressed and corrected.

With the Biogenic Carbon Balancing update (see section 3), fossil carbon corrections were also made in the coal sector. There were some inconsistencies in how carbon properties were defined from mining activities to the domestic markets in India and South Africa. These inconsistencies have been corrected, and the activities are now better balanced.

5.2 Calcined petroleum coke

A new dataset for calcined petroleum coke (CPC) was generated, primarily serving as an input exchange for synthetic graphite production in China. Most of the data comes from the plant operator Vizag Calciner (Edwards, Hunt, Verma, Weyell, & Koop, 2020) in India and was extrapolated to the geography of China with additional information from the data provider of synthetic graphite (see section 8.1.3), produced in China.

New datasets related to calcined petroleum coke are shown in **Table 20**.

Table 20. New datasets for calcined petroleum coke.

Activity Name	Geography	Time Period	Product Name	Unit
calcined petroleum coke production	CN	2019-2019	calcined petroleum coke	kg
market for calcined petroleum coke	CN	2019-2019	calcined petroleum coke	kg

5.3 Crude petroleum oil and natural gas

5.3.1 Overview of updates

An extensive overhaul of the supply of crude petroleum oil and natural gas was undertaken for the release of version 3.9.1 of the ecoinvent database, released in 2022 and updated with more geographical coverage in version 3.10, released in 2023. The oil and natural gas updates for version 3.11 build on the same modelling approach to reflect the supply situation in 2023, based on the latest trade statistics available for the full calendar year of 2023.

New or updated natural gas supplies (at high pressure) are provided for 57 countries (**Figure 1**), representing 88% of global gas consumption, based on the situation in 2023. Through the update/addition of important gas-exporting nations like Australia, Oman, or Turkmenistan, the modelled gas imports to Japan, South Korea, and China reflects 89%, 98%, and 92%, respectively, of total imports to these countries in 2023. Consumption mixes for local distribution of natural gas (i.e., at low pressure) are updated for a total of fifteen countries, located in Asia (China, Japan, and South Korea), Europe (Belgium, France, Germany, Italy, the Netherlands, Spain, Switzerland, Turkey/Türkiye, and the United Kingdom) and North America (Canada, Mexico, and the USA) with version 3.11. Pipeline and LNG export shares for each country of origin to Rest-of-world are recalculated after covering individual countries and implemented in v3.11. The onshore/offshore transport pipeline and LNG shipping distances are revised in v3.11 for improved regionalization.

The supply mixes for crude petroleum oil were updated for Switzerland, Europe without Switzerland, the Region of North America (RNA), Brazil (BR), Colombia (CO), India (IN), Peru (PE), and South Africa (ZA) to reflect the situation in 2023. Oil and gas production was not updated for the v3.11 release. We maintain a total of 41 countries with oil and gas extraction which were covered in version 3.10, representing about 96% of the global production of petroleum and over 98% of natural gas output in 2021. Five new countries with exports of liquefied natural gas (LNG) were added for the v3.10 update, and the resulting updated set of 14 LNG-producing countries in v3.11 were responsible for over 93% of LNG exported globally in 2023 (Energy Institute, 2024).

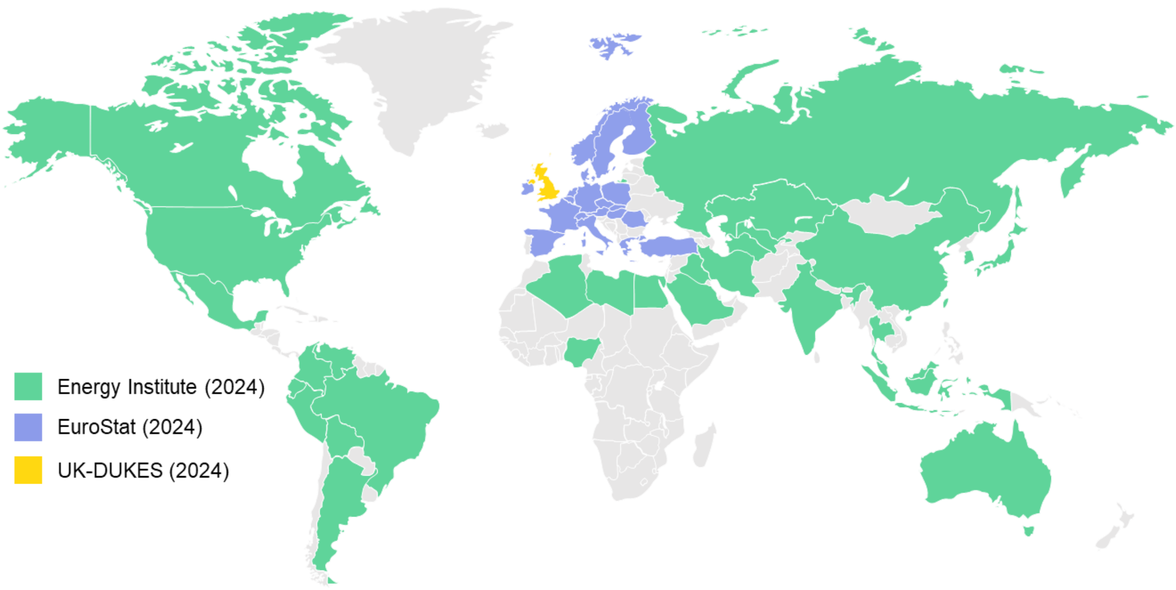

Figure 1. Country-specific supply mixes for natural gas (market for natural gas, high pressure) provided in v3.11. Data sources: Energy Institute 2024 (green); EuroStat (blue); UK-DUKES (national statistics; yellow).

5.3.2 Long-distance transport and supply of crude petroleum oil

The supply mixes for crude petroleum oil in Switzerland, Europe without Switzerland, and the Region of North America (RNA), introduced with v3.9.1, were updated to reflect the trade situation in 2023. The update for v3.11 also updates the market activities with regional supply mixes for Brazil (BR), Colombia (CO), India (IN), Peru (PE), and South Africa (ZA). Datasets for petroleum refinery operation in these five countries had been created as part of the first phase of the *Sustainable Recycling Industries (SRI)* project (Fehrenbach, et al., 2018). A summary of new and updated market activities for petroleum is provided in **Table 21**.

The inventory modelling of the long-distance transport (import) and supply mixes is described in (Meili, Jungbluth, & Bussa, 2024b). The underlying data source for this analysis was primarily global energy statistics from the Energy Institute's statistical review of world energy 2023 (Energy Institute, 2024). To avoid geographical overlaps in the implementation for the ecoinvent database, the global supply situation had to be converted into the corresponding market shares for the Rest-of-World geography (RoW; i.e., GLO without RER, RNA, and the five SRI countries). The GLO mix was derived from the information in (Meili, Jungbluth, & Bussa, 2024b) as the difference between supply to the global geography and the sum of the region-specific markets.

Table 21. Updated datasets for markets for petroleum.

Activity Name	Geography	Time Period	Product Name	Unit
market for petroleum	BR; CO; IN; PE; ZA; CH; Europe without Switzerland; GLO; RNA	2023-2024	petroleum	kg

5.3.3 Long-distance transport and regional distribution of natural gas

The inventory modelling of the long-distance transport (import) and supply mixes for natural gas (at high pressure) in v3.11 is described in (Bussa, Jungbluth, & Meili, 2024). This update largely follows the modelling approach introduced with version 3.9.1 in 2022. The focus of the sub-sections below is placed on highlighting any relevant differences between the versions.

5.3.3.1 Internal energy from gas: natural gas, burned in gas turbine

Internal energy supply, provided by combustion of natural gas during transmission and distribution, is modelled with the activity ‘natural gas, burned in gas turbine’. This activity is provided both for the supplying (exporting) and demanding (importing) nations in (Bussa, Jungbluth, & Meili, 2024). To reduce complexity, only one dataset is created per country (**Table 22**). For countries with indigenous production and significant imports, this means that a decision has be made as to whether to link the input of natural gas to domestic supply or the consumption mix. Consumption mixes were selected in cases where the net import exceeded (gross) indigenous production in 2023, based on the information available in (Energy Institute, 2024).

Table 22. Updated datasets for natural gas, burned in gas turbine.

Activity Name	Geography	Time Period	Product Name	Unit
natural gas, burned in gas turbine	AR; AU; BO; EG; IN; JP; KR; OM; PE; PL; RER; TH; TM; TT; TW; UZ; GLO	2023-2024	natural gas, burned in gas turbine	MJ
natural gas, burned in gas turbine	AE; AZ; BR; CA; CO; DZ; EC; ID; IQ; IR; KW; KZ; LY; MY; NG; QA; RU; SA; US; VE	2023-2024	natural gas, burned in gas turbine	MJ
natural gas, burned in gas turbine	BE; CH; CN; DE; ES; FR; GB; IT; MX; NL; NO; RO; TR	2023-2024	natural gas, burned in gas turbine	MJ

5.3.3.2 Liquefied natural gas (LNG) supply

Version 3.11 updates the existing list of countries for LNG supply. Through the addition of Australia (AU), Egypt (EG), Oman (OM), Peru (PE), and Trinidad and Tobago (TT), the update for version 3.10 increased the number of countries exporting liquefied natural gas (LNG) from 9 in v3.9.1 to 14 in version 3.10. All were updated for version 3.11 (**Table 23**). These countries combined represented over 93% of LNG exported globally in 2023 (Energy Institute, 2024).

Table 23. Updated datasets for production of liquefied natural gas (LNG). In the column v3.11, "U" for "Updated Activity".

Activity Name	Geography	Time Period	Product Name	Unit
natural gas production, liquefied	AE; AU; DZ; EG; ID; MY; NG; NO; OM; PE; TT; QA; RU; US	2023-2024	natural gas, liquefied	m^3

The geographical scope of import (**Table 24**) and evaporation (**Table 25**) of LNG was revised compared to v3.9.1, from regional (RER and RNA) to country-specific activities to better reflect the transport distances between the points of supply and demand. The transport distances for LNG shipping were updated in v3.11 (Bussa, Jungbluth, & Meili, 2024).

Table 24. Changes for datasets related to the import of liquefied natural gas (LNG). In column v3.11, "D" stands for "Deleted", "N" for "New Activity", and "U" for "Updated Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
natural gas, liquefied, import from AE	DE	2023-2024	natural gas, liquefied	m^3	N
	CN; JP; KR; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from AU	CN; GLO; JP; KR	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from DZ	JP; KR	2023-2024	natural gas, liquefied	m^3	N
	BE; CN; ES; FR; GB; IT; NL; RER; TR; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from EG	DE; FR; GB; NL	2023-2024	natural gas, liquefied	m^3	N
	CN; ES; GLO; IT; JP; KR; RER; TR	2023-2024	natural gas, liquefied	m^3	U
	BE	2023-2024	natural gas, liquefied	m^3	D
natural gas, liquefied, import from ID	RER	2023-2024	natural gas, liquefied	m^3	N
	CN; JP; KR; MX; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from MY	CN; JP; KR; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from NG	BE	2023-2024	natural gas, liquefied	m^3	N
	CN; ES; FR; GB; IT; JP; KR; NL; RER; TR; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from NO	BE; DE; ES; FR; GB; IT; NL; TR	2023-2024	natural gas, liquefied	m^3	N

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
	RER	2023-2024	natural gas, liquefied	m^3	U
	GLO	2023-2024	natural gas, liquefied	m^3	D
natural gas, liquefied, import from OM	ES; FR; RER; TR	2023-2024	natural gas, liquefied	m^3	N
	CN; GLO; JP; KR	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from PE	FR; MX; NL	2023-2024	natural gas, liquefied	m^3	N
	CA; CN; ES; GB; GLO; JP; KR; NL	2023-2024	natural gas, liquefied	m^3	U
	RER	2023-2024	natural gas, liquefied	m^3	D
natural gas, liquefied, import from QA	TR	2023-2024	natural gas, liquefied	m^3	D
	BE; CN; ES; FR; GB; IT; JP; KR; NL; RER; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from RU	GB	2023-2024	natural gas, liquefied	m^3	D
	TR	2023-2024	natural gas, liquefied	m^3	N
	BE; CN; ES; IT; FR; JP; KR; NL; RER; GLO	2023-2024	natural gas, liquefied	m^3	U
natural gas, liquefied, import from TT	DE; FR; JP	2023-2024	natural gas, liquefied	m^3	N
	CA; CN; ES; GB; GLO; KR; NL; RER; TR; US	2023-2024	natural gas, liquefied	m^3	U
	MX	2023-2024	natural gas, liquefied	m^3	D
natural gas, liquefied, import from US	DE	2023-2024	natural gas, liquefied	m^3	N
	BE; CN; ES; FR; GB; IT; JP; KR; MX; NL; RER; GLO; TR	2023-2024	natural gas, liquefied	m^3	U

Table 25. Changes for datasets related to the evaporation of imported liquefied natural gas (LNG). In column v3.11, "D" stands for "Deleted", "N" for "New Activity", and "U" for "Updated Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
	DE	2023-2024	natural gas, liquefied	m^3	N

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
evaporation of natural gas, import from AE	RER	2023-2024	natural gas, liquefied	m^3	D
	CN; JP; KR; GLO	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from AU	CN; GLO; JP; KR	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from DZ	JP; KR	2023-2024	natural gas, liquefied	m^3	N
	BE; CN; ES; FR; GB; IT; NL; RER; TR; GLO	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from EG	DE; FR; GB; NL	2023-2024	natural gas, liquefied	m^3	N
	CN; ES; GLO; IT; JP; KR; RER; TR	2023-2024	natural gas, liquefied	m^3	U
	BE	2023-2024	natural gas, liquefied	m^3	D
evaporation of natural gas, import from ID	RER	2023-2024	natural gas, liquefied	m^3	N
	CN; JP; KR; MX; GLO	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from MY	CN; JP; KR; GLO	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from NG	BE	2023-2024	natural gas, liquefied	m^3	N
	CN; ES; FR; GB; IT; JP; KR; NL; RER; TR; GLO	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from NO	BE; DE; ES; FR; GB; IT; NL; TR	2023-2024	natural gas, liquefied	m^3	N
	RER	2023-2024	natural gas, liquefied	m^3	U
	GLO	2023-2024	natural gas, liquefied	m^3	D
evaporation of natural gas, import from OM	ES; FR; RER; TR	2023-2024	natural gas, liquefied	m^3	N
	CN; GLO; JP; KR	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from PE	FR; MX; NL	2023-2024	natural gas, liquefied	m^3	N
	CA; CN; ES; GB; GLO; JP; KR; NL	2023-2024	natural gas, liquefied	m^3	U
	RER	2023-2024	natural gas, liquefied	m^3	D
evaporation of natural gas, import from QA	TR	2023-2024	natural gas, liquefied	m^3	D
	BE; CN; ES; FR; GB; IT; JP; KR; NL; RER; GLO	2023-2024	natural gas, liquefied	m^3	U

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
evaporation of natural gas, import from RU	GB	2023-2024	natural gas, liquefied	m^3	D
	TR	2023-2024	natural gas, liquefied	m^3	N
	BE; CN; ES; IT; FR; JP; KR; NL; RER; GLO	2023-2024	natural gas, liquefied	m^3	U
evaporation of natural gas, import from TT	DE; FR; JP	2023-2024	natural gas, liquefied	m^3	N
	CA; CN; ES; GB; GLO; KR; NL; RER; TR; US	2023-2024	natural gas, liquefied	m^3	U
	MX	2023-2024	natural gas, liquefied	m^3	D
evaporation of natural gas, import from US	DE	2023-2024	natural gas, liquefied	m^3	N
	BE; CN; ES; FR; GB; IT; JP; KR; MX; NL; RER; GLO; TR	2023-2024	natural gas, liquefied	m^3	U

5.3.3.3 Long-distance pipeline transport of natural gas

An overview of changes to datasets for long-distance transport of natural gas in pipelines is provided in **Table 26**. The offshore and onshore transport pipeline distances were updated in v3.11 (Bussa, Jungbluth, & Meili, 2024).

Table 26. Changes to datasets for long-distance pipeline transport of natural gas. In column v3.11, “D” stands for “Deleted”, “N” for “New Activity”, and “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
transport, pipeline, offshore, long distance, natural gas	AZ	2023-2024	transport, pipeline, offshore, long distance, natural gas	metric ton*km	N
transport, pipeline, offshore, long distance, natural gas	DZ; ID; IR; LY; NL; NO; QA; RU;	2023-2024	transport, pipeline, offshore, long distance, natural gas	metric ton*km	U
transport, pipeline, offshore, long distance, natural gas	GB; IR; MY; NL; US	2023-2024	transport, pipeline, offshore, long distance, natural gas	metric ton*km	D
transport, pipeline, onshore, long distance, natural gas	AZ; BO; CA; DZ; ID; IR; KZ; MX; NO; RU; US; TM; UZ	2023-2024	transport, pipeline, onshore, long distance, natural gas	metric ton*km	U
transport, pipeline, onshore, long distance, natural gas	IQ; KW; NL; QA; VE	2023-2024	transport, pipeline, onshore, long distance, natural gas	metric ton*km	D

5.3.3.4 Import and regional distribution of natural gas

The market activities for natural gas in the ecoinvent database are supplied by indigenous production (where relevant) and/or over import activities. For the former case, the activity ‘natural gas, high pressure, domestic supply with seasonal storage’ sits between production and the market, to account for energy requirements and losses from seasonal gas storage. The new and updated datasets related to domestic supply are listed in **Table 27**.

Table 27. New and updated datasets for natural gas supply at high pressure from domestic production. In column v3.11, “U” stands for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
natural gas, high pressure, domestic supply with seasonal storage	CA; CN; DE; GB; IT; MX; NL; NO; PL; RO; TR; US	2023-2024	natural gas, high pressure	m^3	U

Natural gas can be imported either over pipelines or as liquefied natural gas (LNG). The activity ‘natural gas, high pressure, import from XX’ in ecoinvent version 3.11 (and v3.9.1/3.10) generally corresponds to the datasets ‘natural gas, production XX, at long-distance pipeline’ in (Bussa, Jungbluth, & Meili, 2024), where XX refers to the two-letter country code for the geography where the gas was produced. The geography of the import activity refers to the importing country or region. In cases where the country of origin is a net exporter of gas, the activity ‘natural gas, high pressure, import from XX’ accounts for the shares of gas imported as LNG (linked to the corresponding evaporation activity, as listed in **Table 25**) and via long-distance pipelines (linked directly to petroleum and gas production in country XX). The changes to this type of import activities for natural gas at high pressure in v3.11 is provided in **Table 29**. In v3.11, the share of pipeline/LNG exports have been recalculated for QA, NG, ID, MY and RU, after deducting the supply to individual countries, as seen in **Table 28**.

Table 28. Share of recalculated pipeline/LNG split from the following countries to rest of the world.

Country	LNG share (%)	Pipeline share (%)	Comment
RU	32.1	67.9	
QA	98.1	1.9	The pipeline share represents a total of 1.5 bcm natural gas export to other middle east (except UAE).
ID	78.2	21.8	The pipeline share represents a total of 4.1 bcm and 0.4 bcm natural gas export to Singapore and Malaysia.
MY	94.6	5.4	The pipeline share represents a total of 5.4 bcm natural gas export to Thailand.
NG	82.2	17.8	

Table 29. Changes to datasets for import of natural gas at high pressure from net exporters. In column v3.11, "D" stands for "Deleted", "N" for "New Activity", and "U" for "Updated Activity". The asterisk "*" indicates import activities where a proxy process was used to link supply and demand over the markets.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
natural gas, high pressure, import from AE	DE	2023-2024	natural gas, high pressure	m3	N
	CN; JP; KR; GLO	2023-2024	natural gas, high pressure	m3	U
	RER	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from AR	GLO	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from AU	CN; GLO; JP; KR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from AZ	IT	2023-2024	natural gas, high pressure	m3	D
	RER; GLO; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from BO	BR	2018-2021	natural gas, high pressure	m3	U
	GL	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from CA	US	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from DZ	ES; FR; GB; IT; JP; KR; TR	2023-2024	natural gas, high pressure	m3	N
	BE; CN; NL; RER; GLO	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from EG	BE	2023-2024	natural gas, high pressure	m3	D
	DE; FR; GB; NL	2023-2024	natural gas, high pressure	m3	N
	CN; ES; GLO; IT; JP; KR; RER; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from ID	RER	2023-2024	natural gas, high pressure	m3	N
	CN; JP; KR; GLO; MX	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from IR	**IQ*;** GLO; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from KZ	CN; GLO	2023-2024	natural gas, high pressure	m3	U

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
natural gas, high pressure, import from LY	IT	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from MX	US	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from MY	CN; JP; KR; GLO	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from NG	BE	2023-2024	natural gas, high pressure	m3	N
	CN; JP; KR; NL; ES; FR; GB; GLO; IT; RER; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from NO	TR	2023-2024	natural gas, high pressure	m3	N
	BE; DE; ES; FR; GB; IT; NL; RER	2023-2024	natural gas, high pressure	m3	U
	GLO	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from OM	ES; FR; RER; TR	2023-2024	natural gas, high pressure	m3	N
	CN; GLO; JP; KR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from PE	FR; MX; GLO	2023-2024	natural gas, high pressure	m3	N
	CA; CN; ES; GB; JP; KR; NL	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from QA	TR	2023-2024	natural gas, high pressure	m3	D
	AE*; CN; JP; KR; NL BE; ES; FR; GB; GLO; IT; RER; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from RU	DE; GB	2023-2024	natural gas, high pressure	m3	D
	CN; JP; KR; BE; ES; FR; GLO; IT; NL; RER; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from TM	CN; GLO	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from TT	MX	2023-2024	natural gas, high pressure	m3	D
	DE; FR; JP	2023-2024	natural gas, high pressure	m3	U

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
	CA; CN; ES; GB; GLO; KR; NL; RER; TR; US	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from US	DE	2023-2024	natural gas, high pressure	m3	N
	CN; JP; KR; NL; RER; BE; CA; ES; FR; GB; GLO; IT; MX; TR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from UZ	CN; GLO	2023-2024	natural gas, high pressure	m3	U

In contrast to the import from net exporters of gas in **Table 29**, the supply from the countries listed in **Table 30** relies to varying degree on imports (depending on the extent of indigenous production in relation to own consumption). In this case, it was decided for the update in version 3.11 to model exports from these transit countries consistently over their consumption mixes. The import activities in **Table 30** only serve to connect the two market activities for natural gas at high pressure (i.e., the border-crossing), without considering any further flows (e.g., energy requirements, infrastructure inputs, or losses). Market activities for natural gas at high pressure (**Table 31**) must therefore be modelled with relative shares of supply based on own production and gross imports, while annual production volumes should refer to inland consumption, to avoid double-counting.

Table 30. New and updated datasets for import of natural gas at high pressure from net importers. In column v3.11, “D” stands for “Deleted”, “N” for “New Activity”, and “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
natural gas, high pressure, import from AT	DE; HU; IT; RER; SK	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from BE	FI; IT; TR	2023-2024	natural gas, high pressure	m3	N
	DE; FR; NL; RER	2023-2024	natural gas, high pressure	m3	U
	SE	2000-2024	natural gas, high pressure	m3	U
	GB	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from CH	DE; IT	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from CZ	SK	2023-2024	natural gas, high pressure	m3	N

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
	PL	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from DE	CZ; NL	2000-2024	natural gas, high pressure	m3	N
	AT; CH; DK; PL	2023-2024	natural gas, high pressure	m3	U
	RER	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from DK	DE; NL; PL; SE	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from ES	FI; IT; SE; RER	2023-2024	natural gas, high pressure	m3	N
	FR	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from FI	SE	2000-2024	natural gas, high pressure	m3	U
	RER	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from FR	DE; FI; IT; TR	2023-2024	natural gas, high pressure	m3	N
	BE; ES; CH	2023-2024	natural gas, high pressure	m3	U
	NL				D
natural gas, high pressure, import from GB	BE; IE	2023-2024	natural gas, high pressure	m3	N
	NL	2023-2024	natural gas, high pressure	m3	U
	RER; GLO; ES	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from GR	IT; RER	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from HU	SK	2023-2024	natural gas, high pressure	m3	N
	RO	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from IT	AT	2023-2024	natural gas, high pressure	m3	N
	CH; RER	2023-2024	natural gas, high pressure	m3	U

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
natural gas, high pressure, import from NL	FI	2023-2024	natural gas, high pressure	m3	N
	CH; DE;; RER	2023-2024	natural gas, high pressure	m3	U
	FR; GB; IT	2023-2024	natural gas, high pressure	m3	D
natural gas, high pressure, import from PL	RER	2023-2024	natural gas, high pressure	m3	U
natural gas, high pressure, import from RO	HU	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from RoE	ES; FI; GR; HU; IT; PL; RO; SE	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from SE	FI	2023-2024	natural gas, high pressure	m3	N
natural gas, high pressure, import from SK	AT; CZ; HU; PL	2023-2024	natural gas, high pressure	m3	N

The supply of natural gas in 2023 was modelled for selected countries within the EU, Norway, and Turkey based on statistics on imports by trade partner and own production from EuroStat (EuroStat, 2024a) (EuroStat, 2024b). The geographical coverage of country-specific gas supply at high pressure within EU-27 remained unchanged over the previous version of the ecoinvent database. The supply situation in the United Kingdom was derived from the '*Digest of UK Energy Statistics' (DUKES)* (Department of Energy Security and Net Zero, 2024), for Switzerland from (VSG, 2024) in (Bussa, Jungbluth, & Meili, 2024), and on the Energy Institute's *'Statistical Review of World Energy'* from June 2024 (Energy Institute, 2024) for countries modelled in the rest of the world. Imports to Rest-of-Europe (RoE) and the Rest-of-World (RoW) geographies were calculated by subtracting the sum of country-specific supply modelled separately from the total import of the respective regions. New market activities for local distribution (at low pressure) were added for China (CN), Japan (JP), and South Korea (KR). (**Table 31**)

Table 31. New and updated datasets for regional and local distribution of natural gas. In column v3.11, "D" stands for "Deleted", "N" for "New Activity", and "U" for "Updated Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
market for natural gas, high pressure	AE; AR; AU; AZ; BE; BO; BR; CA; CH; CN; CO; DE; DZ; EC; EG; ES; FR; GB; GLO; ID; IN; IQ; IR; IT; JP; KR; KW; KZ; LY; MX; MY; NG; NL; NO; OM; PE; QA;	2023-2024	natural gas, high pressure	m3	U

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
	RER; RO; RU; SA; TH; TM; TR; TT; TW; US; UZ; VE				
	CZ; DK; FI; FR; HU; IE; PL; SE; SK	2000-2000	natural gas, high pressure	m3	U
	AT	1997-2000	natural gas, high pressure	m3	U
natural gas pressure reduction, from high to low pressure	BE; CA; CH; CN; DE; ES; FR; GB; IT; JP; KR; MX; NL; RER; GLO; TR; US	2010-2010	natural gas, low pressure	m3	U
market for natural gas, low pressure	BE; CA; CH; CN; DE; ES; FR; GB; IT; JP; KR; MX; NL; RER; GLO; TR; US	2023-2024	natural gas, low pressure	m3	U

Full geographical coverage without overlaps was achieved for Europe and globally by preparing market shares for the Rest of Europe (RoE) and Rest-of-World geographies, respectively. The situation in Europe was modelled based on information from EuroStat, based on (EuroStat, 2024a) and (EuroStat, 2024b), by subtracting the sum of country-specific supply modelled in v3.11 from the total import to EU-27 countries in 2023. Analogously to petroleum supply, the GLO mix was derived as the difference between global supply in (Energy Institute, 2024) and the sum of the region-specific markets.

5.4 Natural gas liquids

5.4.1 Natural gas liquids fractionation

The heating in the ‘natural gas liquids fractionation, GLO’ was supplied by ‘heat, district or industrial, other than natural gas’ up until v3.10. The heating has been updated to ‘natural gas, burned in gas turbine’ for v3.11, to improve the accuracy of assumption, given that the process heat required is satisfied by burning natural gas, readily available on-site.

The estimate for infrastructure requirements for fractionation of natural gas liquids has also been updated and improved based on available plant data (Lummus Technology, 2023) (Enterprise Products Partners L.P., 2023). The density of natural gas liquids has been updated from 0.8 kg/l to 0.65 kg/l (Energy transfer, 2024).

This update will affect downstream activities in the chemicals sector, where light hydrocarbons are used as feedstock, specifically in steam cracking operations and propane dehydrogenation data.

5.4.2 Natural gas liquids production

The density of natural gas liquids in this dataset has been updated from 0.8 kg/l to 0.65 kg/l (Energy transfer, 2024).

5.5 Various updates

5.5.1 Correction: Fuel markets in South Africa

Corrections have been made for some fuel markets in South Africa. The PV amounts were not consistent with the PV comment, which contained the correct information. This correction has only a minimal impact on their corresponding market groups, as the PVs of the markets determine the shares within the market group.

Updated datasets related to this correction are shown in **Table 32**.

Table 32. Updated datasets for the production volume correction in fuel markets in South Africa.

Activity Name	Geography	Time Period	Product Name	Unit
market for diesel, low-sulfur	ZA	2016-2016	diesel, low-sulfur	kg
market for diesel	ZA	2016-2016	diesel	kg
market for petrol, unleaded	ZA	2016-2016	petrol, unleaded	kg

5.5.2 Correction: Heating values of coal power plants in South Africa

Corrections have been made to both conventional and supercritical coal power plant data. Initially, “heating value, net” (LHV) properties were mistakenly used when they should have been “heating value, gross” (HHV). Additionally, radiation properties for some isotopes were inaccurately attributed with masses, which has been rectified by setting them to 0 kg. This correction, however, has no influence on the dataset scores.

Updated datasets related to this correction are shown in **Table 33**.

Table 33. Updated datasets for heating value correction in coal power plants in South Africa.

Activity Name	Geography	Time Period	Product Name	Unit
electricity production, hard coal, conventional	ZA	2016-2017	electricity, high voltage	kWh
electricity production, hard coal, supercritical	ZA	2016-2017	electricity, high voltage	kWh

6 Electricity

6.1 Market updates based on general approach

In general, electricity markets for the US and Canada were updated with more recent data sources to the year 2022, while all other countries (except for Brazil, BR; China, CN; India, IN; and Switzerland, CH) were updated to 2021. The updates of the electricity markets for BR, CN, IN, CH, which are based on country-specific data sources, are described in section 6.2. The general approach for this update remained the same compared to the updates for ecoinvent v3.6 to v3.10. The electricity import data for the US was updated to the year 2022 because - in contrast to earlier versions of ecoinvent - the US trade data could be directly accessed for a corresponding year (EIA, 2024).

A major change concerns the data source used for the update: previously, data compiled by the International Energy Agency (IEA) was used, while version 3.11 uses the data sources behind the IEA data directly, in the case of European data (European Commission, 2024), whereas non-European data was provided by Enerdata (Enerdata, 2024). These data sources generally apply the same terminology and raw data sources, but in case of Enerdata, differ somewhat in the aggregation level compared to the IEA data. Thus, Enerdata values were aggregated or disaggregated to match the IEA resolution, which could then be processed as in previous releases. A number of data errors were corrected along the way (e.g., total generation was recalculated when the original values did not match the sums over the individual amounts, and missing classification of electricity generation from main producers or autoproducers has been added in line with previous ecoinvent versions). Trade statistics were used from Enerdata as well (Enerdata, 2024) and disaggregated with the trade partner shares based on (WITS, 2024). European trade data was furthermore directly obtained from European data sources (European Commission, 2024) (Bundesnetzagentur, 2024) (ENTSO-E, 2024). A Canadian data source for Canadian fossil power generation had been discontinued but was replaced by an alternative (StatCAN, 2024). Gibraltar was a special case as production statistics were unavailable from (Enerdata, 2024), but could be added from (Our World in Data, 2024), assuming that the difference between national electricity supply and consumption were the transformation, transmission and distribution losses. Production data are from (Our World in Data, 2024) data for calculation of losses is from IEA (International Energy Agency, 2024) and (The World Bank, 2024). Documentation in the datasets was updated accordingly.

A few additional adjustments were necessary as listed below.

6.1.1 New trade data and import splits

Several data sources for electricity trade data between countries differ in coverage and definition of trade (e.g. due to temporal aggregation and netting of electricity flows). Thus, slight data inconsistencies can occur where more than one data source is used. Furthermore, there is a data gap in national and regional statistics for Europe, where several countries do not specify where parts of their electricity imports in 2021 come from. A particularly severe case is Germany, that has received 41% of its electricity imports from unspecified origin. To mitigate the consequences of these data gaps, the following hierarchy of trade data utilization has been set up:

1. Eurostat (European Commission, 2024)

2. Bundesnetzagentur (Bundesnetzagentur, 2024)

3. ENTSO-E (ENTSO-E, 2024)

4. Country-by-country global electricity trade statistics (Our World in Data, 2024)

This approach strives to locate electricity trade data starting from the top of the list and then try to fill remaining gaps with the following data sets. At the last level, in case there were remaining gaps, the country-by-country statistics were used to distribute the remaining trade amount in proportion to the reported trade flows that were at that point not covered specifically, yet. This dataset thus replaces the distribution of remaining trade data in proportion trade data from the previous ecoinvent version, which was the approach followed in earlier ecoinvent releases. Thus, for most cases, the total imports match the reported imports in (Enerdata, 2024), while known imports from hierarchy step 1 to 3 with a remaining gap and no additional data in step 4 could also lead to neglecting a small share of imports as there is no data available for that (for DE, 6% of the respective imports, which is less than 0.5% of total DE electricity supply). This follows the general approach in ecoinvent from previous years, but with updated data sources. The resulting trade data were finally checked manually, and negligible amounts of implausible trade flows were removed.

6.1.2 New technology splits

Some splits for electricity generation technologies had to be added because they were not included in the previous ecoinvent versions. These splits are listed in **Table 34**. Temporal inconsistencies may occur due to limited data availability.

Table 34. New technology splits

Regions	Fuel type	Technology splits	Data year	Data source
TN	Natural gas (CHP)	100% heat and power co-generation, natural gas, conventional power plant, 100MW electrical (Units seem to be of small size (gas turbines/ internal combustions engines))	2023	(S&P Global, 2023)
CW	Natural gas (non-CHP)	100% electricity production, natural gas, conventional power plant (only gas turbines, steam turbines and internal combustion engines)	2023	(S&P Global, 2023)
KZ	Natural gas (non-CHP)	17.7% electricity production, natural gas, combined cycle power plant; 82.3% electricity production, natural gas, conventional power plant	2024	(Enerdata, 2024)
SV	Natural gas (non-CHP)	100% electricity production, natural gas, combined cycle power plant	2024	(Enerdata, 2024)
AE	nuclear	100% electricity production, nuclear, pressure water reactor	2024	(Enerdata, 2024)
CL	Solar thermal	100% electricity production, solar tower power plant, 20 MW	2021	(International Climate Initiative, 2021)
SA	Solar thermal	100% electricity production, solar thermal parabolic trough, 50 MW	2018	(NREL, 2023)

BH	Wind (total)	100% electricity production, wind, <1MW turbine, onshore	2024	(The Wind Power, 2024)
SA	Wind (total)	415.8 MW >3 MW, 5.5 MW 1-3 MW 98.7% electricity production, wind, >3MW turbine, onshore; 1.3% electricity production, wind, 1-3MW turbine, onshore	2024	(The Wind Power, 2024)
SV	Wind (total)	100% electricity production, wind, >3MW turbine, onshore	2024	(The Wind Power, 2024)
CR	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse reported, assume sugarcane like other countries in South America)	2024	(Global Energy Monitor, 2024)
EC	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse reported, assume sugarcane like other countries in South America)	2024	(Enerdata, 2024)
ID	Wood (CHP)	100% heat and power co-generation, wood chips, 6667 kW (wood and palm oil waste reported, assume like MY)	2023	(S&P Global, 2023)
JM	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse reported, assume sugarcane like other countries in South America)	2018	(Contreras-Lisperguer, et al., 2018)
MX	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse reported, assume sugarcane like other countries in South America)	2024	(Enerdata, 2024)
NZ	Wood (CHP)	100% heat and power co-generation, wood chips, 6667 kW, state-of-the-art 2014 (assume like AU)	2023	(S&P Global, 2023)
RU	Wood (CHP)	100% heat and power co-generation, wood chips, 6667 kW (assume like EE, LV)	2023	(S&P Global, 2023)
SV	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse reported, assume sugarcane like other countries in South America)	2024	(Enerdata, 2024)
TH	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse and rice reported, assume sugarcane like MY)	2023	(S&P Global, 2023)
TW	Wood (CHP)	100% heat and power co-generation, wood chips, 6667 kW, state-of-the-art 2014 (no data, assume like KR)	N/A	N/A
UA	Wood (CHP)	100% heat and power co-generation, wood chips, 6667 kW (assume like EE, LV)	2023	(Enerdata, 2024)
ZA	Wood (CHP)	100% treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal (bagasse reported, assume sugarcane)	2023	(Enerdata, 2024)

6.1.3 Updated import activities links

The datasets *electricity, high voltage, import from GE* and *MZ* are now being supplied by the markets of the respective geographies instead of a specific technology, as shown in **Table 35**.

Table 35. Updated import datasets.

Activity Name	Geography	Old Activity Link	New Activity Link
electricity, high voltage, import from GE	GE	electricity production, hydro, reservoir, alpine region, RoW	market for electricity, high voltage, GE
electricity, high voltage, import from MZ	TZ	electricity production, hydro, reservoir, non-alpine region, RoW	market for electricity, high voltage, MZ
electricity, high voltage, import from MZ	ZA	electricity production, hydro, reservoir, alpine region, RoW	market for electricity, high voltage, MZ

For the activities “treatment of blast furnace gas, in power plant” and “treatment of coal gas, in power plant” in Japan and Korea, there was not direct match in the Enerdata electricity generation statistics. Instead, generation from these fuels was included in the entry “electricity from coal” thus this value has been disaggregated based on the production volumes from ecoinvent v3.9.1. Likewise, missing data for different combustible fuels in the cases of Australia and Chile were calculated from the aggregated statistics by using split factors from ecoinvent v3.9.1.

6.1.4 New import datasets

With the update of electricity data, especially trade volumes, certain new import datasets had to be created to represent the trade of electricity mentioned in the statistics. **Table 36** lists all newly created import datasets for version 3.11, with their respective origin and destination (indicated by the geography).

Table 36. New import datasets.

Activity Name	Geography	Time period	Product Name
electricity, high voltage, import from NA	ZA	2021-2021	electricity, high voltage
electricity, high voltage, import from NG	TG	2021-2021	electricity, high voltage
electricity, high voltage, import from NO	GB	2021-2021	electricity, high voltage
electricity, high voltage, import from PA	GT	2021-2021	electricity, high voltage

electricity, high voltage, import from PA	SV	2021-2021	electricity, high voltage
electricity, high voltage, import from PY	AR	2021-2021	electricity, high voltage
electricity, high voltage, import from RU	AZ	2021-2021	electricity, high voltage
electricity, high voltage, import from RU	EE	2021-2021	electricity, high voltage
electricity, high voltage, import from RU	KZ	2021-2021	electricity, high voltage
electricity, high voltage, import from RU	MN	2021-2021	electricity, high voltage
electricity, high voltage, import from SV	CR	2021-2021	electricity, high voltage
electricity, high voltage, import from SV	GT	2021-2021	electricity, high voltage
electricity, high voltage, import from SV	PA	2021-2021	electricity, high voltage
electricity, high voltage, import from TG	BJ	2021-2021	electricity, high voltage
electricity, high voltage, import from TH	KH	2021-2021	electricity, high voltage
electricity, high voltage, import from TH	MY	2021-2021	electricity, high voltage
electricity, high voltage, import from TJ	UZ	2021-2021	electricity, high voltage
electricity, high voltage, import from TM	UZ	2021-2021	electricity, high voltage
electricity, high voltage, import from UA	RU	2021-2021	electricity, high voltage
electricity, high voltage, import from UY	AR	2021-2021	electricity, high voltage
electricity, high voltage, import from XK	ME	2021-2021	electricity, high voltage

6.2 National updates based on country-specific data sources

6.2.1 Brazil

The Brazilian electricity markets were updated analogous to the procedure described for v3.9 of the ecoinvent database and represent the year 2022 in v3.11. See the corresponding change report (https://ecoinvent.org/the-ecoinvent-database/data-releases/) for data sources and explanation.

6.2.2 China

The Chinese electricity markets were updated analogous to the procedure for v3.9 of the ecoinvent database and represent the year 2022 in v3.11. See the corresponding change report (https://ecoinvent.org/the-ecoinvent-database/data-releases/) for data sources and explanation.

6.2.3 India

The Indian electricity markets were updated analogous to the procedure for v3.9 of the ecoinvent database and represent the year 2021-22 for v3.11[4]. See the corresponding change report (https://ecoinvent.org/the-ecoinvent-database/data-releases/) for data sources and explanation.

6.2.4 Switzerland

The Swiss electricity markets were updated analogous to the procedure for v3.8 of the ecoinvent database and represent the year 2022 for v3.11. See the corresponding change report (https://ecoinvent.org/the-ecoinvent-database/data-releases/) for data sources and explanation.

6.3 Residual mixes

The European electricity residual mix markets were updated analogous to the procedure for v3.9 of the ecoinvent database and represent the year 2023 for v3.11. See the corresponding change report (https://ecoinvent.org/the-ecoinvent-database/data-releases/) for data sources and explanation.

6.3.1 Activity link for transmission network

The activity links for “transmission network, electricity, high voltage” *direct current land cable*, *direct current aerial line* and *direct current subsea cable* are now linked to the market for RER geography instead of RoW.

[4] The fiscal year in India starts on April 1st and ends on March 31st of the following year.

7 Chemicals

The chemicals 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 chemical sector value chain, as discussed in this chapter. These efforts will continue in future database releases.

Version 3.11 of the ecoinvent database includes, but is not limited to, updated data for carbon monoxide, acetic acid and its esters, acrylic esters, cumene, nitrobenzene, 2,4-dinitrotoluene, aniline, phosgene, and bisphenol A. The cumulative effect of these updates reduces most LCIA scores compared to version 3.10, for the EF v3.1 method, for datasets that are directly or indirectly derived from the substances mentioned above (e.g., isocyanates, polyurethanes, epoxy resins, polycarbonate, among others).

Furthermore, this version initiated a dedicated data expansion, covering new chemicals and updating existing ones to also include coverage in new locations whenever possible. The new data comprises of synthetic rubber (polychloroprene), along with eleven organic and six inorganic chemicals, while the geographical expansion enhances regionalization by consumption and production patterns reflecting local conditions. For example, the number of chemical or plastic products covered in North America and Asia each increased by approximately 20 substances compared to version 3.10.

Additionally, the aggregated data for methyl chloride, methyl methacrylate, and polymethyl methacrylate in earlier database versions are replaced with disaggregated unit processes, to ensure appropriate linking to the ecoinvent background data. This results in significant score increases for a few LCIA metrics compared to version 3.10, using the EF v3.1 methods, particularly for toxicity, metals and minerals depletion, and land use. Other indicators are affected, or decrease, to a lesser extent.

Furthermore, version 3.11 also incorporates three data submissions from industry, such as updated data on vinyl chloride and polyvinyl chloride production, provided by the European Council of Vinyl Manufacturers. It also updates data for the production of unsaturated polyester (UP) and epoxy vinyl ester (VE) resins, provided by the UP/VE sector group of cefic, the European Chemical Industry Council. The latter updates resulted in decreased LCIA scores compared to version 3.10, using the EF v3.1 methods, for the materials involved, by incorporating the latest available data.

Finally, version 3.11 also features new data for key composite manufacturing services, i.e., compression, molding, pultrusion, manual/hand processes, and filament winding processes, to expand the ecoinvent data portfolio.

7.1 New data for synthesis gas and carbon monoxide

Summary: *This update lowers <u>most</u> LCIA scores for the EF v3.1 method, for activities directly consuming carbon monoxide (e.g., acetic acid, phosgene), as well as indirectly impacting downstream processes (e.g., isocyanates, acetic acid and its esters, polyurethanes, and polycarbonate). The main contributors to this change are the consideration of alternative feedstocks for carbon monoxide production (i.e., natural gas instead of oil), marketable hydrogen co-product from synthesis gas fractionation, and the use of new references and calculations for the data creation.* **Figure 6** *summarizes schematically this update.*

Synthesis gas, a mixture of hydrogen and carbon monoxide, is crucial for producing carbon monoxide and methanol. It is also used in hydroformylation reactions. Carbon monoxide, in turn, is used in large volumes to synthesize acetic acid via catalytic methanol carbonylation. Additionally, carbon monoxide is involved in the production of various important industrial chemicals, such as phosgene, formic acid, methyl formate, N,N-dimethylformamide, and propionic acid.

This update enhances the representation of these key chemical building blocks by including the production of (1) synthesis gas from natural gas and (2) carbon monoxide from synthesis gas. Regarding the regional coverage, data is introduced for Europe, the United States, and the Rest-of-World. Efforts to further enhance coverage at both regional and technological levels, including the use of coal and biomass as raw materials, will be pursued in future releases.

In the preceding version 3.10, the production of synthesis gas from natural gas was not covered, and the carbon monoxide data relied on partial oxidation of oil. Carbon monoxide, however, is predominantly produced through steam reforming of natural gas rather than partial oxidation of oil. Furthermore, the previous data also considered the combustion of co-produced hydrogen to generate heat, that was consumed internally, excluding scenarios where the recovered hydrogen is a marketable product (**Figure 6**).

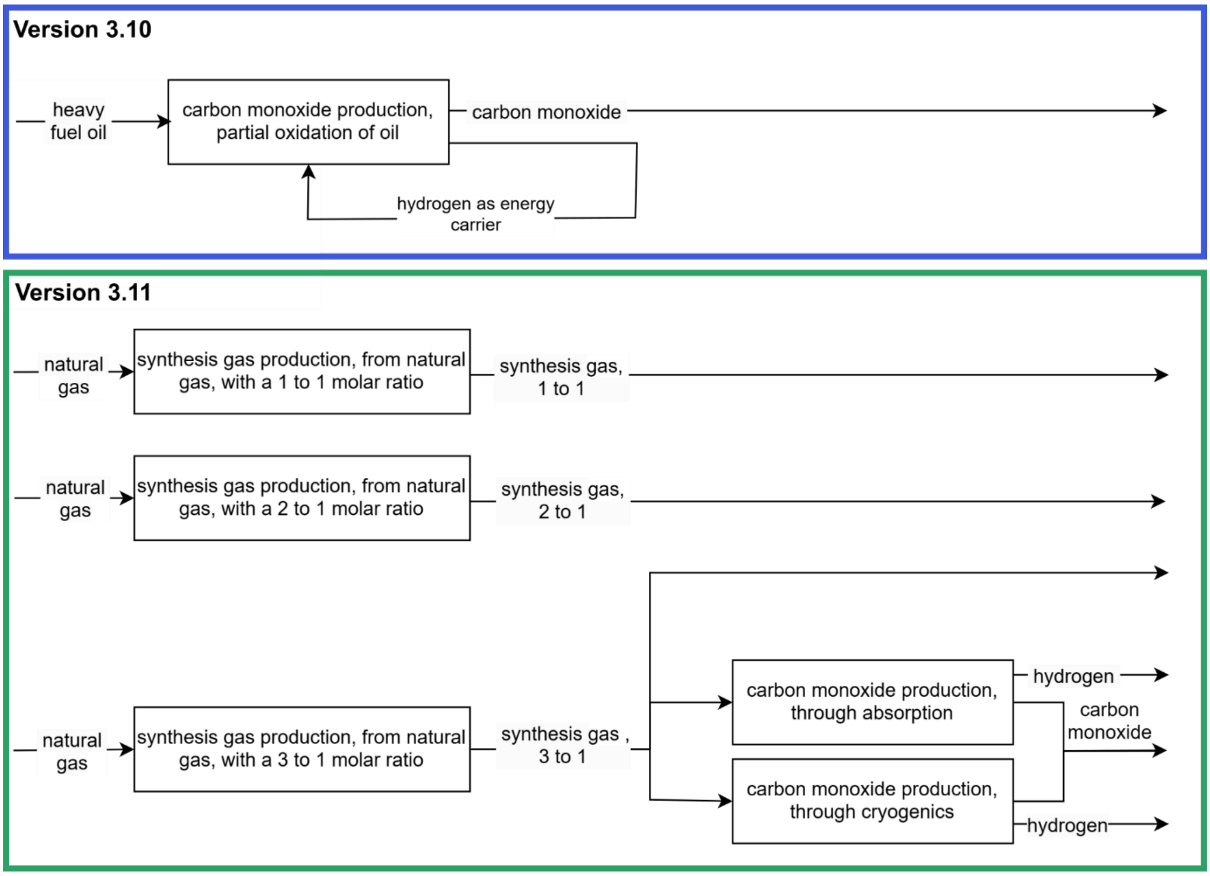

Figure 6. Schematic illustration of the synthesis gas and carbon monoxide value chain in ecoinvent version 3.11.

Version 3.11 covers the production of synthesis gas with three different molar ratios of hydrogen to carbon monoxide: (1) 1:1, (2) 2:1, and (3) 3:1. Additionally, the fractionation of synthesis gas (3:1) components, to produce pure carbon monoxide and hydrogen, is considered using (1) cryogenic separation and (2) absorption, with the co-produced hydrogen supplying the respective market. The multifunctionality of the "carbon monoxide production, from synthesis gas" data is addressed by partitioning based on physical relations (in this case, energy content) since it is considered as a more sensible method for gaseous fuels fractionation. **Table 37** compares different methods for partitioning the exchanges in the fractionation of synthesis gas based on physical relationships and contrasts these options with economic allocation.

Table 37. Shares from different methods for partitioning the exchanges of the "synthesis gas, 3 to 1" fractionation.

Substance	Mass-based	Carbon content-based	Energy-based	Economic-based
Carbon monoxide	82%	100%	34%	46%
Hydrogen	18%	0%	66%	54%

All data involved in this update is listed in **Table 38**.

Table 38. New and updated datasets in v3.11 for the synthesis gas and carbon monoxide value chain, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" column list activities that either replace older ones, or cover new data previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		
"New Activity"			synthesis gas production, from natural gas, with a 1 to 1 molar ratio	RER; GLO	1989-2022
"New Activity"			synthesis gas production, from natural gas, with a 2 to 1 molar ratio	RER; GLO	1989-2022
"New Activity"			synthesis gas production, from natural gas, with a 3 to 1 molar ratio	RER; US; GLO	1989 – 2022
carbon monoxide production	RER; GLO	1997 – 2000	carbon monoxide production, from synthesis gas, through absorption	RER; US; GLO	1989 – 2022
			carbon monoxide production, from synthesis gas, through cryogenic separation	RER; US; GLO	1989 – 2022
"New Activity"			market for synthesis gas, 1 to 1	RER; GLO	2023 – 2023
"New Activity"			market for synthesis gas, 2 to 1	RER; GLO	2023 – 2023
"New Activity"			market for synthesis gas, 3 to 1	RER; US; GLO	2023 – 2023

"New Activity"	market for carbon monoxide	US	2011 – 2011

7.2 New data for precursors in the polycarbonate process chain

Summary: *This update lowers most LCIA scores for the EF v3.1 method, for activities directly consuming bisphenol A, cumene, and phosgene (e.g., epoxy and BPA epoxy-based VE resins), as well as indirectly impacting downstream processes (e.g., isocyanates, polyurethanes, and polycarbonate). The key contributors to this change are the new data and representation for the precursors in the process chain of polycarbonate manufacturing and the carbon monoxide update mentioned in the previous section.* ***Figure 7*** *summarizes schematically this process chain and its update.*

Polycarbonate is a durable, thermally stable, transparent, and flame-resistant thermoplastic with exceptional electrical properties. Its versatility makes it widely used in various industries, including construction, electronics, automotive, packaging, and medical devices. Hence, due to its importance, version 3.11 enhances the representativeness of its entire production process system (**Figure 7**)

More specifically, this update improved the data representativeness for precursors in the polycarbonate process chain based on revised process-specific mass and energy balances, new references and calculations, regional production volumes, and market share information. In short, this update builds on the work completed in versions 3.9 and 3.10, finalizing the process chain updates for manufacturing polycarbonate. The updated process chain is illustrated in **Figure 7** and all updated and new data covered in version 3.11 are listed in **Table 39**.

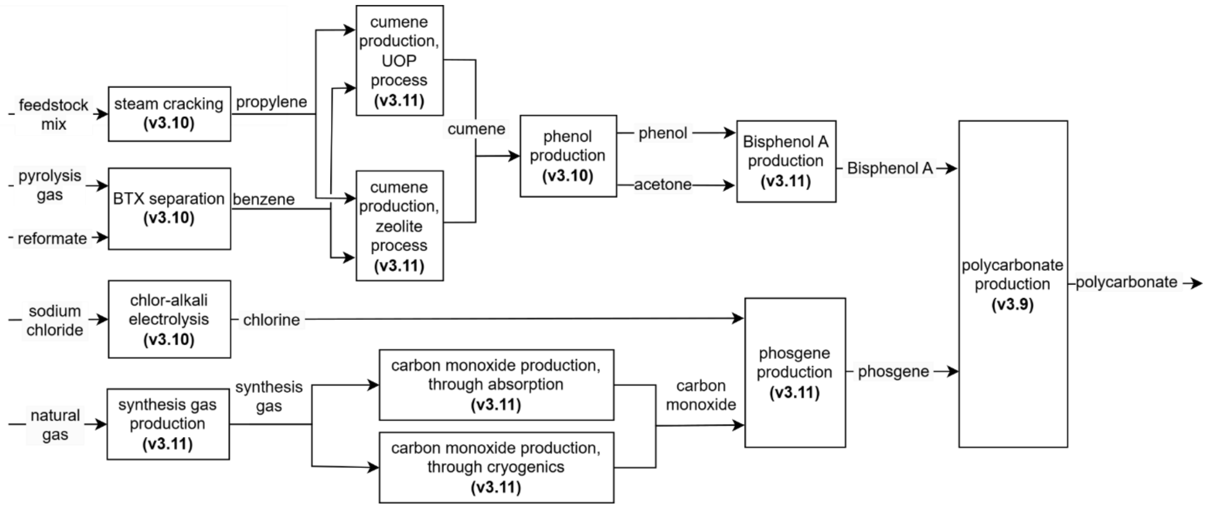

Figure 7. Simplified overview of the updates to the polycarbonate value chain in the ecoinvent database from versions 3.9 to 3.11. The content of the parenthesis in each dataset (i.e., box) indicates the version for which the data was created/updated.

This version includes new data for two technologies for cumene production via benzene alkylation: the UOP process and a zeolite-based process, covered for Europe and the Rest-of-World. In the UOP process, in addition to cumene, a byproduct stream of crude p-diisopropylbenzene is also produced, which is purified in a separate process. Furthermore, the global cumene market in version 3.10 has been split into two regions in version 3.11: Europe and Rest-of-World, resulting in a regional consumption that is influenced more by local production patterns.

Version 3.11 updates data for bisphenol A production across Europe, the United States, Japan, South Korea, and the Rest-of-World. Also, version 3.11 includes revised phosgene production data for Europe, the United States, and the Rest-of-World. Two types of unit process data for phosgene are introduced: one to produce liquid phosgene (-30°C, 5 bar) and another for the evaporation of liquid phosgene (100°C, 6 bar) yielding phosgene, gaseous. Market activities are now included for bisphenol A and phosgene in Europe, the United States, and the Rest-of-World.

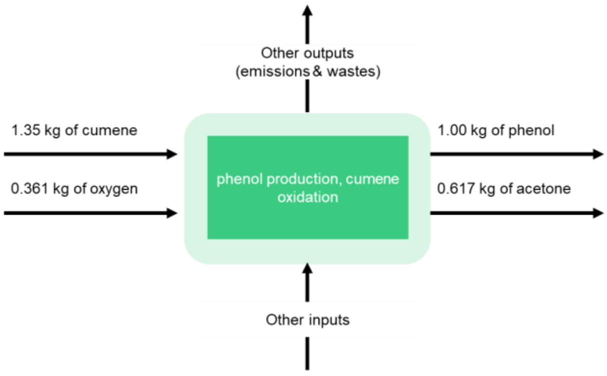

Figure 8. Simplified representation of the material balance for the ecoinvent transforming activity "phenol production, cumene oxidation".

Finally, while the Hock process data (i.e., the oxidation of cumene to co-produce phenol and acetone, shown in **Figure 8**) remains unchanged in version 3.11, revisions to multifunctionality treatment in this dataset have affected the LCIA results of downstream processes, including polycarbonate, as detailed in the next subsection.

Table 39. New, and updated datasets in v3.11 for the polycarbonate value chain, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" columns list activities that either replace older ones or cover new areas previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		
"Updated Activity"	RER; GLO	2000 – 2000	phosgene production, liquid	RER; US; GLO	2015 – 2023
"New Activity"			phosgene production, gaseous, from evaporation of phosgene, liquid	RER; US; GLO	2024 – 2024
"Updated Activity"	RER; GLO	2000 – 2020	bisphenol A production, powder	RER; US; JP; KR; GLO	2015 – 2023
cumene production, benzene alkylation	RER; GLO	2000 – 2000	cumene production, benzene alkylation, UOP process	RER; GLO	2018 – 2023
			cumene production, benzene alkylation, zeolite process	RER; GLO	2018 – 2023
"Updated Activity"			phenol production, cumene oxidation	GLO; RER	2017 – 2022
"Updated Activity"			polycarbonate production	GLO; RER	2016 – 2024
"New Activity"			market for cumene	RER	2018 – 2018

"New Activity"	market for bisphenol A, powder	RER; US	2011 – 2011
"New Activity"	market for phosgene, liquid	US	2011 – 2011
"New Activity"	market for phosgene, gaseous	RER; US; GLO	2011 – 2011

7.2.1 Hock Process multifunctionality: Phenol and acetone co-production

Summary: *This update lowers all LCIA scores for phenol and increase values of acetone. Therefore, this change also indirectly affects downstream processes e.g., through (1) phenol: bisphenol A, hydroquinone, o-cresol, nitrophenols, phenolic resin, polycarbonate and (2) acetone: bisphenol A, 4-methyl-2-pentanone, and pesticide, unspecified, polycarbonate.*

In version 3.10, in the data covering the Hock process, phenol was treated as the reference product and acetone as a byproduct; subsequently, economic allocation was applied to resolve this multifunctionality. Under normal market conditions, however, this process would rather be classified as a combined production technology, since both substances are reference products as described below.

In short, the Hock process is responsible for nearly the entire global production for both chemicals. Furthermore, only cases of exceptionally high phenol demand may lead to an oversupply of acetone, demoting acetone as a byproduct rather than a reference product. Hence, in version 3.11, the Hock process is handled as a combined production and the production inventory is first partitioned based on physical relationships instead of economic allocation.

Table 40 compares different methods for partitioning the exchanges in the Hock process based on physical relationships and contrasts these options with economic allocation. In version 3.11, the carbon content is used for partitioning the exchanges of the Hock process to account for both the mass of valuable products and their molecular characteristics. The use of the carbon content yields a phenol share slightly higher than when using mass or energy allocation, yet lower than that of the economic allocation, with the reverse trend for acetone. Finally, splitting the exchanges based on the energy content was precluded since neither substance is directly used as fuel.

Table 40. Shares from different methods for partitioning the exchanges of the Hock process.

Substance	Mass-based	Carbon content-based	Energy-based	Economic based
Phenol	62%	67%	62%	80%
Acetone	38%	33%	38%	20%

The Hock process is by far the most competitive synthetic route to phenol manufacturing as long as a market exists for the coproduct acetone. In 2018, over 99% of Global phenol production relied on the Hock process (Weber, Weber, & Weber, Phenol, 2020). Similarly, more than 95% of acetone is currently produced as a coproduct of phenol via the Hock process (Weber, Pompetzki, Bonmann, & Weber, 2014). Since acetone is primarily produced as a coproduct with phenol, phenol demand significantly influences the availability of acetone. Furthermore, when phenol demand increases due to market needs, acetone demand also rises because both chemicals serve similar markets, e.g., automotive and housing (Sifniades & Levy, 2000). Therefore, the Hock process can be considered as a combined production technology.

Regarding alternative pathways, a small amount of phenol was produced via a toluene-based process until 2006, with the last plant built in Japan in 1991. This route is only economical when toluene prices are significantly lower than benzene. Furthermore, while phenol is currently also recovered from coal tar, other production methods like direct benzene oxidation or cyclohexylbenzene oxidation have yet to be commercialized (Weber, Weber, & Weber, Phenol, 2020). Alternative technologies for dedicated acetone production include 2-propanol dehydrogenation and propene oxidation. However, while the former accounted for 80% of U.S. acetone production in 1960, its share declined to 6% by 1994 with the expanded use of the Hock process (Sifniades & Levy, 2000). Notably, if acetone supply by the Hock process exceeds demand, 2-propanol-based production share may decline further.

7.3 Updated data in the organic isocyanates process chain

Summary: *This update lowers most LCIA scores for the EF v3.1 method for the organic isocyanates data, as well as indirectly impacting downstream processes (e.g., polyurethanes, via toluene diisocyanate (TDI), and methylene diphenyl diisocyanate (MDI)). Furthermore, the organic isocyanates have also been indirectly influenced by the carbon monoxide and phosgene data update. The process chain for common diisocyanates, such as MDI and TDI, is depicted in* ***Figure 9*** *to demonstrate this connection.*

In version 3.10, a few organic isocyanates data tackled hydrogen chloride as a waste that is neutralized (hexamethylene diisocyanate (HDI), phenyl isocyanate (PhNCO), and isophorone diisocyanate (IPDI)), while others accounted it as a valuable byproduct (i.e., TDI and MDI). To better reflect the value of the hydrogen chloride byproduct, version 3.11 revises the mass and energy balances of the HDI, PhNCO, and IPDI data accordingly.

This harmonization was carried out since organic isocyanates are synthesized commercially from amines and phosgene with hydrogen chloride being produced as a byproduct. The hydrogen chloride byproduct from organic isocyanates facilities is part of the chlorine cycle of the chemical industry. In modern plants, hydrogen chloride is first separated from excess phosgene and solvents. It is then transported via pipeline to neighboring facilities where it is converted to chlorine through electrolysis, which is reused to manufacture phosgene, facilitating comprehensive recycling. Alternatively, the hydrogen chloride byproduct is supplied to producers of 1,2-dichloroethane or PVC or be absorbed in water and then sold or used in other industrial processes (Six & Richter, 2003).

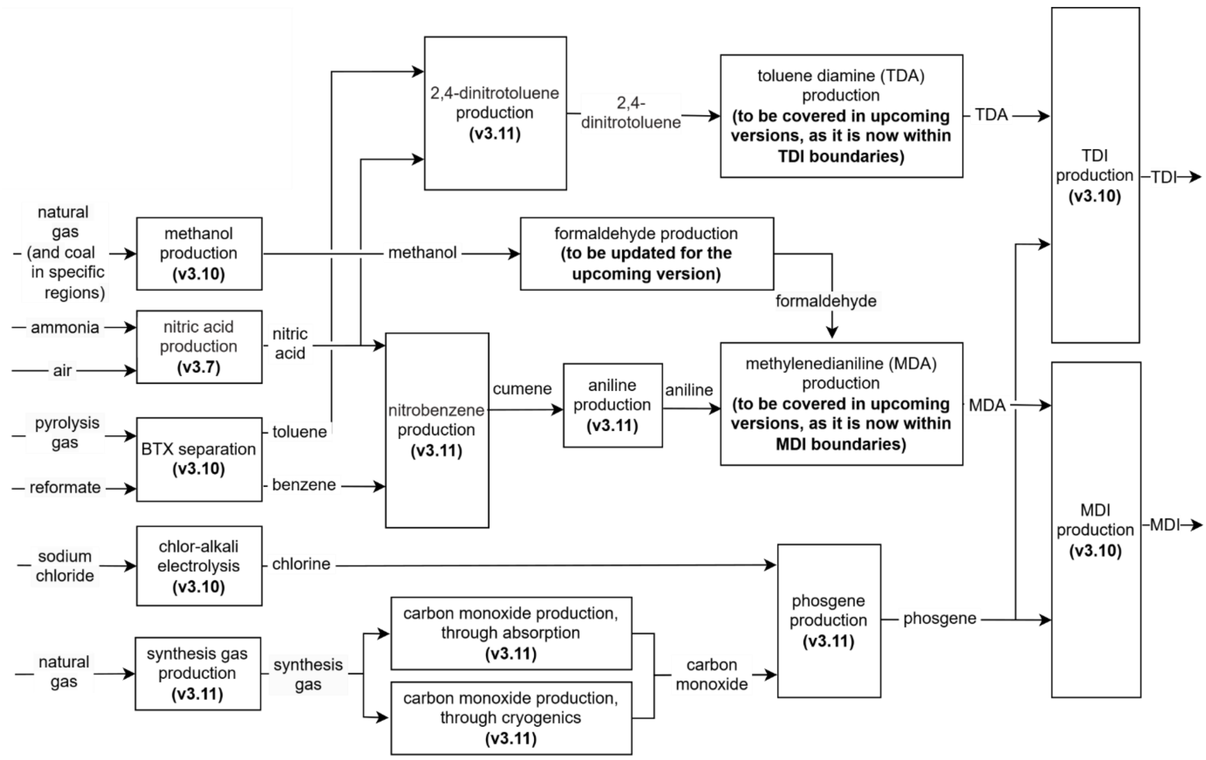

Figure 9. Simplified overview of the updates of the MDI and TDI value chain in the ecoinvent database from versions 3.7 to 3.11. The content of the parenthesis in each dataset (i.e., box) indicates the version for which the data is created/updated or short-term plans.

Finally, in version 3.11, data revisions for nitrobenzene, aniline, and 2,4-dinitrotoluene have refined the mass and energy balance to better reflect specific technologies and production volumes, which in turn affects the LCIA results for MDI and TDI, as these chemicals are used as precursors (see **Figure 9**). Namely, nitrobenzene and aniline production is now included for Europe, North America, Asia, and the Rest-of-World, while market activities cover the geographies of Europe and the Rest-of-World. All data involved in this update is listed in **Table 41**.

Table 41. New, and updated datasets in v3.11 for the organic isocyanates process chain, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" columns list activities that either replace older ones or cover new areas previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		
"Updated Activity"	RER; GLO	2020 – 2020	hexamethylene-1,6-diisocyanate production	RER; GLO	2020 – 2020
"Updated Activity"	RER; GLO	2010 – 2010	phenyl isocyanate production	RER; GLO	2010 – 2010

"Updated Activity"	RER; GLO	2010 – 2010	isophorondiisocyanate production	RER; GLO	2020 – 2020
"Updated Activity"	RER; GLO	1997 – 2000	nitrobenzene production	RER; US; RAS; GLO	1989 – 2024
"Updated Activity"	RER; GLO	2000 – 2020	aniline production	RER; US; RAS; GLO	1989 – 2024
"Updated Activity"	RER; GLO	2015 – 2020	2,4-dinitrotoluene production	RER; GLO	1989 – 2024
"New Activity"			market for aniline	RER	2018 – 2018

7.4 Industry data for unsaturated polyester (UP) and vinyl ester (VE) resins

Summary: *This update influences most LCIA scores for the EF v3.1 method, with decreases due to the use of the latest European average industry data, which replace older industry data.*

In collaboration with the UP/VE Resin Association, and supported by EY Climate Change & Sustainability Services, this update enhances the database content on UP and VE resins production. The data supplied is derived from a survey of industrial operations involving five European producers. This includes (1) VE resins based on bisphenol A epoxy, and (2) UP resins based on dicyclopentadiene, isophthalic acid, maleic and o-phthalic acids, as well as recycled polyethylene terephthalate. The key outcome of this update is the integration of the most current European average data, replacing older data also supplied by European resins producers. This data covers the European geography and are recontextualized for the Rest-of-World.

Along with the updated data, the information provided indicated that European manufacturing plants primarily utilize styrene produced in Europe instead of sourcing it from the global market. Hence, the global styrene market in version 3.10 has been segmented in version 3.11 into two regions: Europe and Rest-of-World, resulting in regional consumption that is influenced more by local production patterns. Since styrene is a primary raw material for these resins, the market segmentation influences most LCIA results for these products. All data involved in this update is listed in **Table 42**.

Table 42. New, and updated datasets in v3.11 for unsaturated polyester (UP) and vinyl ester (VE) resins, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" columns list activities that either replace older ones or cover new areas previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		

“Updated Activity”	RER; GLO	2013 – 2019	dicyclopentadiene based unsaturated polyester resin production	RER; GLO	2024 – 2026
“Updated Activity”	RER; GLO	2013 – 2019	isophthalic acid based unsaturated polyester resin production	RER; GLO	2024 – 2026
“Updated Activity”	RER; GLO	2013 – 2019	maleic unsaturated polyester resin production	RER; GLO	2024 – 2026
“Updated Activity”	RER; GLO	2013 – 2019	orthophthalic acid based unsaturated polyester resin production	RER; GLO	2024 – 2026
“Updated Activity”	RER; GLO	2013 – 2019	bisphenol A epoxy based vinyl ester resin production	RER; GLO	2024 – 2026
“New Activity”			recycled polyethylene terephthalate unsaturated polyester resin production	RER	2024 – 2026
“New Activity”			market for styrene	RER	2011 – 2011
“New Activity”			market for dicyclopentadiene based unsaturated polyester resin	RER	2013 – 2019
“New Activity”			market for isophthalic acid based unsaturated polyester resin	RER	2013 – 2019
“New Activity”			market for maleic unsaturated polyester resin	RER	2013 – 2019
“New Activity”			market for orthophthalic acid based unsaturated polyester resin	RER	2013 – 2019
“New Activity”			market for bisphenol A epoxy based vinyl ester resin	RER	2013 – 2019
“New Activity”			market for recycled polyethylene terephthalate unsaturated polyester resin	RER	2013 – 2019

7.5 Industry data for vinyl chloride (VC) and polyvinyl chloride (PVC)

Summary: *This update influences* *most* *LCIA scores for the EF v3.1 method, with decreases due to the use of the latest European average industry data, which replace older industry data.*

In collaboration with the European Council of Vinyl Manufacturers (ECVM), and supported by ifeu gGmbH, the latest European industry data has been used to update the data covering the manufacturing for vinyl chloride and polyvinyl chloride produced through (1) suspension (S-PVC) and (2) emulsion (E-PVC) polymerization. This update replaces older data also supplied by European producers. The new industry data used are representative for 68%, 73%, and 81% of the European capacity of VC, S-PVC, and E-PVC respectively (PlasticsEurope & ECVM, 2023). This data covers European geography and is also recontextualized for the Rest-of-World. Finally, a new dataset has been added: the “polyvinyl chloride production, unspecified polymerization, weighted average” dataset. This dataset represents the weighted average of S-PVC and E-PVC based on production volumes and is used in the ecoinvent database when the PVC type is unspecified. All updated datasets are summarized in **Table 43**.

Table 43. New, and updated datasets in v3.11 for vinyl chloride (VC) and polyvinyl chloride (PVC), mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" columns list activities that either replace older ones, cover new data previously not covered, or excluded data.

Activity Name	Geo-graphy	Time Period	Activity Name	Geo-graphy	Time Period
Version 3.10			**Version 3.11**		
vinyl chloride production	RER; GLO	2013 – 2018	vinyl chloride production	RER; GLO	2024 – 2026
polyvinylchloride production, emulsion polymerisation	RER; GLO	2013 – 2018	polyvinyl chloride production, emulsion polymerisation	RER; GLO	2024 – 2026
polyvinylchloride production, suspension polymerisation	RER; GLO	2013 – 2018	polyvinyl chloride production, suspension polymerisation	RER; GLO	2024 – 2026
"New Activity"			polyvinyl chloride production, unspecified polymerisation, weighted average	RER; GLO	1998 – 2001
market for polyvinylchloride, emulsion polymerised	GLO	2011 – 2011	market for polyvinyl chloride, emulsion polymerised	RER; GLO	2011 – 2011
market for polyvinylchloride, suspension polymerised	GLO	2011 – 2011	market for polyvinyl chloride, suspension polymerised	RER; GLO	2011 – 2011
"New Activity"			market for polyvinyl chloride, unspecified polymerisation, weighted average	RER	2011 – 2011
polyvinylchloride production, bulk polymerisation	RER; GLO	1998 – 2001	*"Deleted Activity"*		
market for polyvinylchloride, bulk polymerised	GLO	2011 – 2011	*"Deleted Activity"*		

7.6 Industry data for composite manufacturing services

Many industries, such as the automotive and aviation industry, rely on composite materials due to their high performance and design flexibility. Therefore, the database coverage for composite manufacturing services is updated with the release of version 3.11. The update covers several processes, including compression-based, molding-based, pultrusion-based, manual/hand-based, and filament winding-based processes (**Table 44**). 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 activities. The French data is 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, sector of the products, and more details on the covered processes are available in the published report by Ademe and IPC (ADEME, HARVEY, CHEIKH, & LECLERCQ, 2024). The published LCIA scores for the French datasets were cross-referenced and validated with this publication. The collaboration with IPC is ongoing to further expand the portfolio of composite production and manufacturing processes in upcoming releases.

Table 44. New composite producing service datasets in v3.11. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column.

Activity Name v3.11	Geography	Time Period
compression of sheet moulding compound	FR; RER; RAS; RNA; GLO	2019 – 2025
filament winding	FR; RER; RAS; RNA; GLO	2019 – 2025
hand lay-up	FR; RER; RAS; RNA; GLO	2019 – 2025
pultrusion, thermoset resins	FR; RER; RAS; RNA; GLO	2019 – 2025
resin transfer moulding, light	FR; RER; RAS; RNA; GLO	2019 – 2025
spray-up for composite production, spray-up of resin and fibres	FR; RER; RAS; RNA; GLO	2019 – 2025
stamping for thermoplastic composite product, excluding electricity use	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression for wet thermoset composite product, excluding electricity use	FR; RER; RAS; RNA; GLO	2019 – 2025
vacuum infusion moulding for composite production	FR; RER; RAS; RNA; GLO	2019 – 2025

These manufacturing datasets are modeled as services, therefore the main input components that comprise the final composite material (e.g., matrix and reinforcement) are not included in the dataset. This enables users to apply the service to different input materials.

In the thermocompression and stamping processes, electricity consumption is decoupled from the functional unit, as it scales in stages rather than linearly. For thermocompression, electricity consumption was modeled dependent on three parameters: (1) press capacity (50 – 150 t, 200 – 500 t), (2) temperature (120 °C, 180 °C), and (3) cycle time (20 min, 60 min). Similarly, for stamping, the covered data represent variation in the parameters (1) press capacity (50 – 150 t, 200 – 500 t), and (2) temperature (60 – 150 °C, 150 – 200 °C, > 200 °C). For a complete inventory, a user needs to combine the utilities dataset ("thermocompression for wet thermoset composite product, excluding electricity use"/"stamping for thermoplastic composite product, excluding electricity use") with the electricity consumption dataset (e.g. "thermocompression, electricity use, W – X t press, Y °C, Z minutes cycle"/"stamping, electricity use, X – Y t press, > Z °C"). All electricity consumption datasets are listed in **Table 45**.

Table 45. New complementary datasets for electricity consumption of stamping and thermocompression services. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column.

Activity Name v3.11	Geography	Time Period
stamping, electricity use, 50 – 150 t press, 60 - 150 °C	FR; RER; RAS; RNA; GLO	2019 – 2025
stamping, electricity use, 50 – 150 t press, 150 - 200 °C	FR; RER; RAS; RNA; GLO	2019 – 2025
stamping, electricity use, 50 – 150 t press, > 200 °C	FR; RER; RAS; RNA; GLO	2019 – 2025
stamping, electricity use, 300 – 500 t press, 60 - 150 °C	FR; RER; RAS; RNA; GLO	2019 – 2025
stamping, electricity use, 300 – 500 t press, 150 - 200 °C	FR; RER; RAS; RNA; GLO	2019 – 2025
stamping, electricity use, 300 – 500 t press, > 200 °C	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 50 – 150 t press, 120 °C, 20 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 50 – 150 t press, 120 °C, 60 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 50 – 150 t press, 180 °C, 20 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 50 – 150 t press, 180 °C, 60 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 200 – 500 t press, 120 °C, 20 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 200 – 500 t press, 120°C, 60 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 200 – 500 t press, 180°C, 20 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025
thermocompression, electricity use, 200 – 500 t press, 180°C, 60 minutes cycle	FR; RER; RAS; RNA; GLO	2019 – 2025

For all datasets in this project, only one Global market activity per service was created as it is encouraged to use directly the regionalized service datasets (**Table 46**).

Table 46. Corresponding markets to the newly introduced datasets.

Activity Name v3.11	Geography	Time Period
market for compression of sheet moulding compound	GLO	2011 – 2011
market for filament winding	GLO	2011 – 2011

market for hand lay-up	GLO	2011 – 2011
market for pultrusion, thermoset resins	GLO	2011 – 2011
market for resin transfer moulding, light	GLO	2011 – 2011
market for spray-up for composite production, spray-up of resin and fibres	GLO	2011 – 2011
market for stamping for thermoplastic composite product	GLO	2011 – 2011
market for stamping, electricity use, 50 – 150 t press, 60 - 150 °C	GLO	2011 – 2011
market for stamping, electricity use, 50 – 150 t press, 150 - 200 °C	GLO	2011 – 2011
market for stamping, electricity use, 50 – 150 t press, > 200 °C	GLO	2011 – 2011
market for stamping, electricity use, 300 – 500 t press, 60 - 150 °C	GLO	2011 – 2011
market for stamping, electricity use, 300 – 500 t press, 150 - 200 °C	GLO	2011 – 2011
market for stamping, electricity use, 300 – 500 t press, > 200 °C	GLO	2011 – 2011
market for thermocompression for wet thermoset composite product	GLO	2011 – 2011
market for thermocompression, electricity use, 50 – 150 t press, 120 °C, 20 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 50 – 150 t press, 120 °C, 60 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 50 – 150 t press, 180 °C, 20 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 50 – 150 t press, 180 °C, 60 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 200 – 500 t press, 120 °C, 20 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 200 – 500 t press, 120 °C, 60 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 200 – 500 t press, 180 °C, 20 minutes cycle	GLO	2011 – 2011
market for thermocompression, electricity use, 200 – 500 t press, 180 °C, 60 minutes cycle	GLO	2011 – 2011
market for vacuum infusion moulding for composite production	GLO	2011 – 2011

7.7 Database expansion and revision of existing data

This section presents an overview of substances not previously covered that are introduced in version 3.11. Additionally, it discusses updates of existing data for which coverage in new regions have been added. The efforts to further expand the content and regional coverage for chemicals and plastics will continue in future releases.

7.7.1 New data coverage and additional regional expansion

To enhance database coverage, this version includes new products not found in previous ecoinvent versions, specifically: eleven organic chemicals, six inorganic chemicals, and one synthetic rubber. The data for the new substances covered is listed in **Table 47**.

Table 47. New datasets in v3.11 for substances 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	Product Name	Time Period
chloroprene production, from butadiene chlorination	DE; US-LA; JP	chloroprene	1989 – 2023
chloroprene production, from acetylene hydrochlorination	CN; JP	chloroprene	1989 – 2023
market for chloroprene	RER; US; JP; CN	chloroprene	2011 – 2011
polychloroprene production	RER; US-LA; JP; CN	polychloroprene	2015 – 2023
market for polychloroprene	GLO	polychloroprene	2011 – 2011
glycidyl methacrylate production, from methacrylic acid epichlorohydrin	RER; US; JP; GLO	glycidyl methacrylate	2024 – 2024
market for glycidyl methacrylate	GLO	glycidyl methacrylate	2024 – 2024
diisopropyl ether production, from indirect hydration of propylene	RER; GLO	diisopropyl ether	2015 – 2023
market for diisopropyl ether	RER; RoW	diisopropyl ether	2020 – 2023
methyldiethanolamine production, from ethoxylation of methylamine	RER; GLO	methyldiethanolamine	2003 – 2024
market for methyldiethanolamine	RER; GLO	methyldiethanolamine	2023 – 2023
peracetic acid production, from acetaldehyde oxidation	RER; GLO	peracetic acid	2012 – 2023
peracetic acid production, from acetaldehyde oxidation	RER; GLO	peracetic acid	2012 – 2023
market for peracetic acid	RER; GLO	peracetic acid	2012 – 2023
m-toluidine production, from m-nitrotoluene hydration	RER; GLO	m-toluidine	2003 – 2023
market for m-toluidine	RER; GLO	m-toluidine	2020 – 2023

o-toluidine production, from o-nitrotoluene hydration	RER; GLO	o-toluidine	2003 – 2023
market for o-toluidine	RER; GLO	o-toluidine	2020 – 2023
p-toluidine production, from p-nitrotoluene hydration	RER; GLO	p-toluidine	2003 – 2023
market for p-toluidine	RER; GLO	p-toluidine	2020 – 2023
diethyl carbonate production, from phosgene and ethanol	RER; GLO	diethyl carbonate	2015 – 2024
market for diethyl carbonate	RER; GLO	diethyl carbonate	2020 – 2023
market for p-diisopropylbenzene, crude	GLO	p-diisopropylbenzene, crude	2020 – 2024
p-diisopropylbenzene purification, distillation of crude p-diisopropylbenzene	RER; GLO	p-diisopropylbenzene	2024 – 2024
p-diisopropylbenzene, crude to generic market for residual fuels	GLO	residual fuels	2019 – 2023
market for p-diisopropylbenzene	GLO	p-diisopropylbenzene	2020 – 2024
lithium hydride production, from lithium hydrogenation	GLO	lithium hydride	2003 – 2023
market for lithium hydride	GLO	lithium hydride	2020 – 2024
lithium aluminium hydride production, from lithium hydride and aluminium chloride	GLO	lithium aluminium hydride	2003 – 2023
market for lithium aluminium hydride	GLO	lithium aluminium hydride	2020 – 2024
sodium hexafluorophosphate production	CN; GLO	sodium hexafluorophosphate	2015 – 2024
market for sodium hexafluorophosphate	CN; GLO	sodium hexafluorophosphate	2015 – 2024
sodium ferrocyanide production	US; GLO	sodium ferrocyanide	2024 – 2024
market for sodium ferrocyanide	GLO	sodium ferrocyanide	2011 – 2011
disodium phosphate production, from sodium hydroxide and phosphoric acid	GLO	disodium phosphate	2015 – 2023
market for disodium phosphate	GLO	disodium phosphate	2020 – 2024
sodium dihydrogen phosphate production, from sodium hydroxide and phosphoric acid	GLO	sodium dihydrogen phosphate	2015 – 2023
market for sodium dihydrogen phosphate	GLO	sodium dihydrogen phosphate	2020 – 2024

Table 48 lists the regionalized updated data for locations previously not covered. This data is updated based on revised process-specific mass and energy balances, as well as new references and calculations.

Table 48. New, and updated datasets in v3.11, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" columns list activities that either replace older ones or cover new areas previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		
ethylene dichloride production	RER; GLO	1997 – 2000	ethylene dichloride production, from ethylene chlorination	RER; US; JP; GLO	2005 – 2023
dimethyl ether production	RER; GLO	2000 – 2000	dimethyl ether production, from methanol dehydration	RER; CN; GLO	2010 – 2023
phthalic anhydride production, o-xylene oxidation	RER; GLO	1995 – 1995	phthalic anhydride production, o-xylene oxidation	RER; US; JP; KR; GLO	1989 – 2022
ethyl benzene production	GLO	2000 – 2000	ethyl benzene production, from benzene alkylation	JP; US; GLO	2011 – 2023
ethyl benzene production	RER	2000 – 2000	ethyl benzene production, from benzene alkylation	BE; CZ; DE; ES; FR; GB; IT; NL; RER	2017 – 2023
"New Activity"			market for phthalic anhydride	RER	2018 – 2018
"New Activity"			market for dimethyl ether	CN	2023 – 2023
"New Activity"			sulfuric acid production	TN	2017 – 2022
"New Activity"			diammonium phosphate production	TN	2016 – 2016

7.7.2 Methyl chloride, methyl methacrylate (MMA), and polymethyl methacrylate (PMMA)

Summary: *A shift from aggregated to disaggregated data modeling affects LCIA indicators in the EF v3.1 method, such as toxicity, metals and minerals depletion, and land use. The notable increase of the latter indicators originates from the inclusion of previously unaccounted infrastructure, auxiliary services, and the integration with the ecoinvent database. Other indicators, such as global warming potential, show a decline for MMA/PMMA in all geographies, an increase for methyl chloride in RoW and a decrease in RER. These changes propagate downstream to other substances, e.g., silicon product.*

The key outcome of this update is the replacement of outdated aggregated datasets with disaggregated ones. This update covers the production of (1) methyl chloride, (2) MMA, and (3) PMMA. Furthermore, the production of MMA via the acetone cyanohydrin process is represented by two distinct datasets based on the auxiliary recovery stage from ammonium bisulfate, i.e., either (1) ammonium sulfate or (2) sulfuric acid. The key result of this update ensures appropriate linking of this data to the rest of the ecoinvent database. Hence, the updates of (1) crude petroleum oil and natural gas and (2) steam cracker of ecoinvent version 3.9 and 3.10, respectively, is now reflected in the LCIA scores for these substances (Moreno Ruiz, et al., 2022; FitzGerald D., 2023). All datasets/activities encompassed in this update are listed in **Table 49**.

Table 49. New, and updated datasets for methyl chloride, MMA, and PMMA, in v3.11, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" 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 3.10			**Version 3.11**		
methylchloride production	WEU; GLO	1997 – 1997	methyl chloride production, from methanol hydrochlorination	RER; JP; GLO	2003 – 2023
methyl methacrylate production	RER; GLO	1996 – 2001	methyl methacrylate production, acetone cyanohydrin process, with ammonium sulfate recovery	RER; RNA; RSA	1989 – 2024
			methyl methacrylate production, acetone cyanohydrin process, with sulfuric acid recovery	RER; RNA; RSA	1989 – 2024
"New Activity"			polymethyl methacrylate production	RER; RNA; RSA	2015 – 2024
polymethyl methacrylate production, sheet	RER; GLO	1996 – 2001	*"Deleted Activity"*		

polymethyl methacrylate production, beads	RER; GLO	1996 – 2001	*“Deleted Activity”*		
market for polymethyl methacrylate, beads	GLO	2011 – 2011	*“Deleted Activity”*		
polymethyl methacrylate production, sheet	GLO	2011 – 2011	*“Deleted Activity”*		
“New Activity”			market for polymethyl methacrylate	RER; GLO	2011 – 2011

7.7.3 Acetic acid: Broader technological portfolio and regional coverage

Summary: *The broader technological portfolio coverage of version 3.11 does not significantly affect the LCIA scores (based on the EF v3.1 method) at the market level, given that nearly 90% of global production depends on the methanol carbonylation pathway that was already covered. Nonetheless, upstream updates, i.e., carbon monoxide, affected the data based on methanol carbonylation.*

To enhance the database coverage for acetic acid manufacturing, version 3.10 data coverage is expanded by incorporating additional technologies and covering new regions. This includes: (1) high-pressure methanol carbonylation, (2) acetaldehyde oxidation, and (3) naphtha oxidation, alongside existing low-pressure methanol carbonylation and butane oxidation data from version 3.10. This data is covered with transforming activities for Europe, East-Asia, India, United States, and the Rest-of-World, and a single Global market. All data involved in this update is listed in **Table 50**.

Table 50. New, and updated datasets related to acetic acid in v3.11, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column. The “Version 3.10” columns indicate activities updated or replaced in the new version, while “Version 3.11” columns list activities that either replace older ones or cover new areas previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		
“New Activity”			acetic acid production, from acetaldehyde oxidation	RER; US; UN-EASIA; IN; GLO	1989 – 2023
acetic acid production, butane oxidation	RER; GLO	1989 – 2005	acetic acid production, from n-butane oxidation	RER; US; UN-EASIA; IN; GLO	1989 – 2023
“New Activity”			acetic acid production, from naphtha oxidation	RER; US; UN-EASIA; IN; GLO	1989 – 2023

"New Activity"			acetic acid production, from high-pressure methanol carbonylation	RER; US; UN-EASIA; IN; GLO	1989 – 2023
acetic acid production, methanol carboxylation (Monsanto), product in 98% solution state	RER; GLO	1989 – 2022	acetic acid production, from low-pressure methanol carbonylation	RER; US; UN-EASIA; IN; GLO	1989 – 2023
"New Activity"			butyric acid to generic market for fatty acid	GLO	2012 – 2012
"New Activity"			market for butyric acid	GLO	2011 – 2011

7.7.4 Acetic and acrylic esters: Data coverage enhancement

Summary: *The update primarily results in a decrease in most LCIA scores (based on the EF v3.1 method) for the methyl and butyl acrylate markets, as well as the ethyl and butyl acetate markets, while most LCIA scores for methyl acetate have increased. The latter increase occurs due to methyl acetate's coverage only as a byproduct in version 3.10 ("acetic acid production, butane oxidation"), and thus, its LCIA scores were based on the covered technology and the respective allocation key.*

To enhance the database coverage for acetic and acrylic esters, version 3.11 includes updated and new data based on new references and calculations, regional production volumes, and market share information. Namely, this update includes new data for methyl acetate production and updates for vinyl and n-butyl acetate for Europe and the Rest-of-World. Additionally, it features new data on ethyl acrylate production and updates for methyl and butyl acrylates across Europe, East Asia, Southeast Asia, and North America. Market activities are included for Europe and the Rest-of-World. All data involved in this update is listed in **Table 51**.

Table 51. New, and updated datasets for acetic and acrylic esters in v3.11, mapped to content of v3.10 (where relevant). If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The "Version 3.10" columns indicate activities updated or replaced in the new version, while "Version 3.11" columns list activities that either replace older ones or cover new areas previously not covered.

Activity Name	Geography	Time Period	Activity Name	Geography	Time Period
Version 3.10			**Version 3.11**		
methyl acrylate production	GLO	2000 – 2006	methyl acrylate production, methanol esterification with acrylic acid	RER; RNA; US-SEASIA; UN-EASIA	1989 – 2023
"New Activity"			ethyl acrylate production, ethanol esterification with acrylic acid	RER; RNA; US-SEASIA; UN-EASIA	1989 – 2023

butyl acrylate production	RER; GLO	1995 – 1995	butyl acrylate production, butanol esterification with acrylic acid	RER; RNA; US-SEASIA; UN-EASIA	1989 – 2023
“New Activity”			methyl acetate production, methanol esterification with acetic acid, via reactive distillation	RER; GLO	2002 – 2023
butyl acetate production	RER; GLO	1991 – 2020	butyl acetate production, butanol esterification with acetic acid	RER; GLO	2022 – 2025
vinyl acetate production	RER; GLO	2000 – 2000	vinyl acetate production, from ethylene acetoxylation	RER; US; JP; GLO	2011 – 2023
“New Activity”			market for methyl acrylate	RER	2018 – 2018
“New Activity”			market for ethyl acrylate	RoW	2011 – 2011
“New Activity”			market for ethyl acrylate	RER	2018 – 2018
“New Activity”			market for methyl acetate	RER	2018 – 2018
“New Activity”			market for vinyl acetate	RER	2018 – 2018
methyl acetate to generic market for solvent, organic	*GLO*	*2012 – 2012*	*“Deleted Activity”*		

7.8 Case-specific corrections: Causes and effects

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 is listed in **Table 52**, however, adjustments related to renaming and production volume updates are not discussed in the text.

7.8.1 Data for methanol production, coal gasification

In the preceding version 3.10, the dataset, covered for China and Rest-of-World, included technosphere flows for “oxygen, liquid” and “nitrogen, liquid” used in the gasification and acid gas removal units, respectively. However, since the air separation unit operation was already within the system boundaries of the original source, these flows were replaced in version 3.11 with elementary flows for “Oxygen” and “Nitrogen” (natural resources, in air). Consequently, an additional exchange has been included in the data to account for the “air separation facility”. These changes result in lower LCIA scores in version 3.11 compared to version 3.10, which propagate downstream to affect various other chemicals and plastics mainly for the following geographies: Global, China, and the Rest-of-World.

7.8.2 Data for carbon fibre reinforced plastic, injection moulded

The dataset covering the production of carbon fibre reinforced plastic of version 3.10 lacked representation of key components relevant to its scope. Specifically, the plastic input was omitted from the inventory, and the inputs were scaled to 1 kg of carbon fibre instead of 1 kg of carbon fibre reinforced plastic. This issue was addressed and corrected through expert judgement and information from literature. The correction led to lower LCIA scores for the EF v3.1 method, due to the downscaling of the share of the input from energy intensive carbon fibre production.

7.8.3 Data for lithium chloride

The lithium chloride production dataset in version 3.10 reported electricity consumption at an order of magnitude lower than the original source. This issue has been corrected, leading to increased LCIA scores for lithium chloride. Additionally, this correction affected the LCIA results for lithium, as it is produced through lithium chloride electrolysis in the "lithium production, lithium chloride electrolysis" dataset.

7.8.4 Data for chromium trioxide

The dataset for chromium trioxide production exhibited a mass imbalance since it did not cover the byproduct of this technology, i.e., sodium hydrogen sulfate, which was previously cut-off. Version 3.11 introduces updated references, mass balances, and calculations (Anger, et al., 2000; United States Patent No. US4291000A, 1981). As a result, all LCIA results of the EF v3.1 method decrease consistently due to the economic allocation applied. The mass balance changes, i.e., emissions of dichromate ions, affect certain LCIA indicators such as toxicity. While a detailed analysis is outside the scope of this report, the released amount of chromium compounds has been cross validated with available information. (Tumolo, et al., 2020).

7.8.5 Data for methyl ethyl ketone

The methyl ethyl ketone dataset in earlier database versions used proxy data for electricity and heat inputs. Version 3.11 includes revised process-specific mass and energy balances, along with updated references and calculations, resulting in higher LCIA scores for methyl ethyl ketone compared to version 3.10.

7.8.6 Data for potassium permanganate and ethyl tert-butyl ether

The production data for potassium permanganate and ethyl tert-butyl ether used a proxy for their respective main raw material input in earlier versions. Version 3.11 features updated inventories based on new calculations and now includes the exact substance that was previously proxied, resulting in higher LCIA scores for both substances compared to version 3.10.

7.8.7 Data for diethyl ether

The "diethyl ether production" data is based on the sulfuric acid process for ethanol dehydration, where ethanol and sulfuric acid (catalyst) are used in a ratio of 1:3. In previous database versions, sulfuric acid recycling and reuse in this continuous process was estimated conservatively, assuming its removal by washing with dilute sodium hydroxide instead. However, in practice, sulfuric acid is typically recirculated and reused for several months before scheduled maintenance is required to replace it due to contamination buildup.

In version 3.11, the assumptions for this data have been reviewed and adjusted through expert judgement and information from literature.

7.8.8 Data for polydimethylsiloxane

The polydimethylsiloxane production data in earlier database versions is modeled from dimethyldichlorosilane and water, with the formed hydrochloric acid being neutralized and disposed. According to a report by the Global Silicones Council (GSC) (Brandt B., 2012), neutralizing the hydrochloric acid byproduct of an industrial process system appears to be uncommon. Hydrochloric acid is recovered and utilized in the methyl chloride production process, which is then used to manufacture dimethyldichlorosilane, the precursor to polydimethylsiloxane, thereby facilitating an internal recycling loop. To better represent industrial manufacturing practices, this dataset was remodeled to being produced from methanol and hydrochloric acid based on literature (Brandt B., 2012). In addition, version 3.11 accounts for the recirculation of the formed hydrochloric acid with an efficiency of 95%, resulting in lower LCIA scores compared to version 3.10.

7.8.9 Infrastructure in “steam cracking operation” and “BTX production”

In version 3.10, infrastructure values for the following datasets were proxied due to the lack of available information on plants capacity and land use: (1) “unsaturated hydrocarbons production, steam cracking operation, average,” (2) “BTX production, from reformate, average,” and (3) “BTX production, from pyrolysis gas, average.”

Infrastructure estimates were based on data from two chemical facilities in Germany—the BASF site in Ludwigshafen and the Gendorf chemical factory—producing a variety of chemical substances. The assumptions included a built area of approximately 4.2 hectares, an average output of 50,000 tonnes per annum (tpa), and a lifespan of 50 years.

In version 3.11, infrastructure inputs for the data mentioned above are scaled based on more accurate plant capacities. While the lifespan remains unchanged, the capacities now reflect typical chemical manufacturing scales for olefins and aromatics, as outlined in the Handbook of Petrochemicals and Processes (Wells, 2018). Data has been collected and incorporated into the updated datasets, scaled according to the output product quantities, e.g., capacities of manufacturing plants, in tpa, for:

- ethylene: 30,000 – 1,315,000,
- propylene: 22,000 – 520,000,
- butadiene: 20,000 – 270,000,
- benzene: 25,000 – 760,000,
- toluene: 10,000 – 600,000,
- xylene, para: 20,000 – 570,000, and
- xylene, ortho: 8,000 – 122,000.

While more detailed information is available in the respective datasets, we note that this update influences LCIA scores for certain metrics. This outcome is based on the difference between the proxied capacity (i.e., 50,000 tpa) and the typical average capacity of olefins and aromatics manufacturing. In future releases, we will evaluate infrastructure inputs for other key substances based on reported capacities and update them wherever possible.

All in all, based on the EF v3.1 method, indicators such as metal and mineral depletion and land use show a significant decrease, while others, like global warming potential, are only slightly affected. These changes propagate downstream to various other chemicals and plastics.

Table 52. Database maintenance for the chemical sector data. In column v3.10, “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	v3.11
carbon fibre reinforced plastic, injection moulded	GLO	2016 – 2016	U
2-butanol production by hydration of butene	GLO; RER	1989 – 2024	U
market for 2-methylpentane	GLO	2012 – 2012	D
2-methylpentane to generic market for solvent, organic	GLO	2012 – 2012	D
BTX production, from pyrolysis gas, average	GLO; RER	2019 – 2023	U
BTX production, from reformate, average	GLO; RER	2019 – 2023	U
unsaturated hydrocarbons production, steam cracking operation, average	GLO; RER	2019 – 2023	U
diethyl ether production, from ethanol dehydration	GLO	2000 – 2015	U
isopropylamine production, from isopropanol amination	GLO; RER	2009 – 2023	U
lithium chloride production, from lithium carbonate and hydrochloric acid	GLO	2003 – 2024	U
lithium hexafluorophosphate production	CN; GLO	2015 – 2024	U
market for ethylene	CN	2011 – 2011	N
market for propylene	CN	2011 – 2011	N
market for hexamethylenediamine	RER	2020 – 2020	N
market for lithium hexafluorophosphate	CN	2015 – 2024	N
market for methyl acetate	GLO	2011 – 2011	U
market for methyl acetate	RER	2018 – 2018	N
market for polydimethylsiloxane	RER	2015 – 2020	N
methanol production, from coal gasification	CN; GLO	2020 – 2025	U
methanol production, from natural gas reforming	CN; GLO; RER; US	2017 – 2025	U
methyl ethyl ketone production	GLO; RER	1989 – 2024	U

polydimethylsiloxane production	RER	2011 – 2023	U
polydimethylsiloxane production	GLO	2011 – 2023	U
toluene diisocyanate production	GLO; RER	2020 – 2026	U
potassium permanganate production, manganese dioxide oxidation	GLO; RER	1990 – 2020	U
ethyl tert-butyl ether production, from bioethanol and isobutene etherification	GLO; RER	1998 – 2006	U
chromium trioxide production, flakes	GLO; RER	2000 – 2020	U
hydrocarbons, aromatic, cyclic (C9+) to generic market for residual fuels	GLO	2019 – 2023	U
light fuel oil to generic market for residual fuels	GLO	2019 – 2023	U
market for residual fuels	GLO	2019 – 2023	U
pyrolysis fuel gas to generic market for residual fuels	GLO	2019 – 2023	U
pyrolysis fuel oil to generic market for residual fuels	GLO	2019 – 2023	U
raffinate to generic market for residual fuels	GLO	2019 – 2023	U

8 Batteries

8.1 Updates

Some adjustments to the modelling approach were made on several datasets in the battery sector.

The tables below provide an overview of the updated activities and activity names or product names. Details of the changes are provided in the following corresponding sections.

Table 53. Updated activities related to the battery sector. “U” stands for “Updated Activity”, "D" stands for "Deleted Activity”, “R” stands for “replaced activity”

Activity Name	Geography	Time Period	v3.11
anode production, silicon coated graphite, NCA, for Li-ion battery	CN, GLO	2016-2023	D
anode production, silicon coated graphite, NMC811, for Li-ion battery	CN, GLO	2016-2023	U
anode production, graphite, for Li-ion battery	CN, GLO	2016-2020	U
cathode production, LFP, for Li-ion battery	CN, GLO	2018-2025	U
cathode production, NMC111, for Li-ion battery	CN, GLO	2020-2023	U
cathode production, NMC811, for Li-ion battery	CN, GLO	2018-2023	U
cathode production, NCA, for Li-ion battery	CN, GLO	2020-2023	U
battery cell production, Li-ion, LFP	CN, GLO	2018-2025	U
battery cell production, Li-ion, NCA	CN, GLO	2017-2023	U
battery cell production, Li-ion, NMC111	CN, GLO	2017-2023	U
battery cell production, Li-ion, NMC811	CN, GLO	2017-2023	U
electrolyte production, for Li-ion battery	GLO	2019-2020	U
synthetic graphite production, battery grade	CN	2015-2023	R
synthetic graphite production, battery grade	GLO	2015-2023	D
market for synthetic graphite, battery grade	CN, GLO	2020-2023	U

Table 54. Activities renamed for v3.11. Most of the changes aim at better defining the scope of the activity. More details of some changes are given in the corresponding chapters.

Activity Name v3.10	Activity Name v3.11
anode production, silicon coated graphite, NMC811, for Li-ion battery	anode production, silicon coated graphite, for Li-ion battery
battery production, Li-ion, NMC111, rechargeable, prismatic	battery production, Li-ion, NMC111, rechargeable
market for battery, Li-ion, NMC111, rechargeable, prismatic	market for battery, Li-ion, NMC111, rechargeable
battery production, Li-ion, NMC811, rechargeable, prismatic	battery production, Li-ion, NMC811, rechargeable
market for battery, Li-ion, NMC811, rechargeable, prismatic	market for battery, Li-ion, NMC811, rechargeable
battery production, Li-ion, NCA, rechargeable, prismatic	battery production, Li-ion, NCA, rechargeable
market for battery, Li-ion, NCA, rechargeable, prismatic	market for battery, Li-ion, NCA, rechargeable
battery production, Li-ion, LFP, rechargeable, prismatic	battery production, Li-ion, LFP, rechargeable
market for battery, Li-ion, LFP, rechargeable, prismatic	market for battery, Li-ion, LFP, rechargeable
battery production, NiMH, rechargeable, prismatic	battery production, NiMH, rechargeable
market for battery, NiMH, rechargeable, prismatic	market for battery, NiMH, rechargeable
market for battery, NaCl	market for battery, Na-NiCl, rechargeable
market for battery, Li-ion, LiMn2O4, rechargeable, prismatic	market for battery, Li-ion, LiMn2O4, rechargeable
battery production, Li-ion, LiMn2O4, rechargeable, prismatic	battery production, Li-ion, LiMn2O4, rechargeable
synthetic graphite production, battery grade	synthetic graphite production, via Acheson powder route

Table 55. Exchanges renamed for v3.11.

Exchange Name v3.10	Exchange Name v3.11
battery, Li-ion, NMC111, rechargeable, prismatic	battery, Li-ion, NMC111, rechargeable
battery, Li-ion, NMC811, rechargeable, prismatic	battery, Li-ion, NMC811, rechargeable

battery, Li-ion, NCA, rechargeable, prismatic	battery, Li-ion, NCA, rechargeable
battery, Li-ion, LFP, rechargeable, prismatic	battery, Li-ion, LFP, rechargeable
battery, NiMH, rechargeable, prismatic	battery, NiMH, rechargeable
battery, NaCl	battery, Na-NiCl, rechargeable
battery, Li-ion, LiMn2O4, rechargeable, prismatic	battery, Li-ion, LiMn2O4, rechargeable

8.1.1 Cathode, anode and cell modelling approach

8.1.1.1 anode, silicon coated graphite, for Li-ion battery

The datasets that produce ‘anode, silicon coated graphite, for Li-ion battery’ were updated with the following:

- Addition of the copper collector in the dataset (it was previously included in the cell datasets). This decision was taken as the energy to coat the copper current foil with the anode slurry is included within these datasets.
- Adjustment of the amounts of all components to maintain mass balance.
- Adjustment of properties of the output product (anode, silicon coated graphite, for Li-ion battery).
- Update of the energy requirement so that it is not based on the energy density of the cell but on the area of anode. This means that the reference product produced is not specific anymore to a given battery chemistry.
- The source for the energy consumption is adapted to have enough information to scale by area of anode (Von Drachenfels, Husmann, Khalid, Cerdas, & Herrmann, 2023).
- Adjustment of the comments to the exchanges.
- Adjustment of the technology comments and general comment.
- To be more representative of the current market, the amount of graphite is split between 65 % synthetic graphite and 35 % natural graphite.

With these updates, and with the update of synthetic graphite described in 8.1.3, the scores for the ‘anode, silicon coated graphite, for Li-ion battery’ are increased. For instance, the Global Warming Potential, calculated with the EF v3.1 methodology, has increased by more than 200%. This change is due in majority to the update of the synthetic graphite. Additionally, a part of the increase related to the fact that the copper current collector is included in the anode (whereas as before it was directly included in the cell dataset).

Users need to ensure that the current collector is not included twice at the cell level as the current collector is now included in the anode datasets and was previously in the cell dataset.

Note that, due to other updates in the database, the reference product 'anode, silicon coated graphite, for Li-ion battery' is not used anymore in the database. It is kept to ensure continuity for the users who wish to use it in their own Life-Cycle Assessment studies.

8.1.1.2 anode, graphite, for Li-ion battery

The dataset that produces 'anode, graphite, for Li-ion battery' was updated with the following:

- Addition of the copper collector in the dataset (it was previously included in the cell datasets). This decision was taken as the energy to coat the copper current foil with the anode slurry is included within these datasets.
- Adjustment of the amounts of all components to maintain mass balance.
- Adjustment of properties of the output product (anode, graphite, for Li-ion battery).
- Update of the energy requirement so that it is not based on the energy density of the cell but on the area of anode.
- The source for the energy consumption is adapted to have enough information to scale by area of anode (Von Drachenfels, Husmann, Khalid, Cerdas, & Herrmann, 2023).
- Adjustment of the comments to the exchanges.
- Adjustment of the technology comments and general comment.
- To be more representative of the current market, the amount of graphite is split between 65 % synthetic graphite and 35 % natural graphite.

With these updates, and with the update of synthetic graphite described in 8.1.3, the scores for the 'anode, graphite, for Li-ion battery' are increased. For instance, the Global Warming Potential, calculated with the EF v3.1 methodology, has increased by more than 200%. This change is in large part due to the update of the synthetic graphite. Additionally, a part of the increase related to the fact that the copper current collector is included in the anode (whereas as before it was directly included in the cell dataset).

Users need to ensure that the current collector is not included twice at the cell level as the current collector is now included in the anode datasets and was previously in the cell dataset.

8.1.1.3 Cathode

Some adjustments were made to Li-ion cathode production datasets of the database:

- The energy requirement for cathode production was updated based on a more recent source.
- The approach for calculating the energy requirement was modified so that the energy used should depend on the area of cathode and not the energy density of the cell using the cathode (Von Drachenfels, Husmann, Khalid, Cerdas, & Herrmann, 2023).
- The aluminium current collector was added to the cathode dataset. This is done because the energy used to coat the current collector is included within this dataset.
- The properties of the cathode were updated consequently.

These changes affect the cathode production datasets listed in **Table 53**.

The scores are slightly affected by these adjustments.

8.1.1.4 Cell

Because of the updates of the modeling approach for the anode and cathode datasets, the cell datasets needed to be modified to update the content of anode and cathode in the cell accordingly, accounting for the content of current collector (both in cathode and anode datasets). Additionally, the inputs of energy (heat and electricity) were updated to use a source that allowed more granularity regarding the different stages of the cell production.

Furthermore, the datasets for the NCA and NMC811 cells have been updated: they now use a graphite anode instead of silicon coated graphite anode. This change aligns with the source used for the modelling.

8.1.2 Li-ion electrolyte

The Li-ion electrolyte production dataset was modified with the following:

- adjusting the electricity for stirring based on more detailed literature data.
- removing the exchange ‘chemical factory, organics’ and replace with the infrastructure ‘liquid storage tank, chemicals, organics’.
- Removing all wastewater exchanges that were not necessary.
- Adjusting the production volume with more recent source.

The impacts are only slightly impacted. In the cut-off system model, there is a decrease of 6% of the impacts. This is due to a large extent to the decrease in energy consumption (due to the more accurate calculation of the electricity required for stirring) and to a lesser extent to the removal of the previously used ‘chemical factory, organics’.

8.1.3 Synthetic graphite

This dataset was updated to reflect the currently dominant production route (Acheson powder route) for battery-grade synthetic graphite. This production route is more intensive in energy requirements than previously modelled in ecoinvent. This dataset was developed in partnership with Tokai COBEX and based on the scientific publication led by the same stakeholders (Carrère, Khalid, Baumann, Bouzidi, & Allard, 2024).

To support this update, 2 new datasets were introduced:

- Calcined petroleum coke production (refer to section 5.2 for more details)
- Graphite block production, via Acheson block route

The markets for the by-products generated in the production process were also created.

Table 56. New datasets introduced to support the update of the synthetic graphite production dataset.

Activity Name	Geography	Time Period	Product Name	Unit
graphite block production, via Acheson block route	CN	2019-2024	graphite block	kg

market for graphite block	CN	2024-2024	graphite block	kg
market for graphite fines	CN	2024-2024	graphite fines	kg
market for graphitised block scrap	CN	2024-2024	graphitized block scrap	kg
market for used graphite crucibles	CN	2024-2024	used graphite crucibles	kg
market for calcined coke fines	CN	2024-2024	calcined coked fines	kg
market for baked block scrap	CN	2024-2024	baked block scrap	kg
market for graphite chips	CN	2024-2024	graphite chips	kg
market for recarburizer	CN	2024-2024	recarburizer	kg

'graphite block', obtained via the Acheson block route is the precursor for synthetic graphite production.

To support the creation of these datasets, two new waste exchanges were created and associated waste treatments were also created. Please refer to section 11 for the complete list of datasets.

Because of this update, the scores for synthetic graphite produced with the updated production route have increased significantly (i.e., by a factor of around 7 for the Global Warming Potential calculated with the EF v3.1 method in the cut-off system model).

8.1.4 Market updates

The markets were updated to be harmonized for all Li-ion datasets. This sector-wide update aims at applying the same approach for all the markets for battery related products. It includes using the same product code for similar products. For markets in the Global geography, the default modes of transport and transport distances from ecoinvent were used. For markets in specific geographies, a default transport distance was assumed in those geographies and the ecoinvent default transport values were scaled to the distance specific to those geographies.

8.1.5 Production Volumes updates

The production volumes of battery products were updated with statistics from 2023 for Li-ion batteries (excluding LiMn2O4 battery).

8.1.6 Renaming of activities

The pack production datasets are renamed to delete the mention of the 'prismatic' (that would be more adapted to the cell design and that do not have an impact on the pack design that is modelled). The corresponding reference product names and markets are updated as well. These updates are included in **Table 54** and **Table 55**.

Additionally, the name of 'battery, NaCl' was updated to 'battery, Na-Ni-Cl, rechargeable' to match the other datasets and align with the reference product name.

8.2 New battery chemistries and materials

8.2.1 NMC622

Several datasets are created for this battery technology. The datasets are based on published literature sources (Dai, Kelly, Dunn, & Benavides, 2018). **Table 57** lists the datasets that were created as part of the development of this new battery chemistry.

Table 57. New datasets added for the NMC622 battery chemistry.

Activity Name	Geography	Time Period	Product Name	Unit
NMC622 hydroxide production, for Li-ion battery	CN; GLO	2020-2024	NMC622 hydroxide	kg
NMC622 oxide production, for Li-ion battery	CN; GLO	2020-2024	NMC622 oxide	kg
cathode production, NMC622, for Li-ion battery	CN; GLO	2020-2024	cathode, NMC622, for Li-ion battery	kg
battery cell production, Li-ion, NMC622	CN; GLO	2020-2024	battery cell, Li-ion, NMC622	kg
battery production, Li-ion, NMC622, rechargeable	CN; GLO	2020-2024	battery, Li-ion, NMC622, rechargeable	kg
market for NMC622 hydroxide	CN; GLO	2024-2024	NMC622 hydroxide	kg
market for NMC622 oxide	CN; GLO	2024-2024	NMC622 oxide	kg
market for cathode, NMC622, for Li-ion battery	CN; GLO	2024-2024	cathode, NMC622, for Li-ion battery	kg
market for battery cell, Li-ion, NMC622	GLO	2024-2024	battery cell, Li-ion, NMC622	kg
market for battery, Li-ion, NMC622, rechargeable	GLO	2024-2024	battery, Li-ion, NMC622, rechargeable	kg

8.2.2 NMC532

Several datasets were created for this battery technology. The datasets are based on published literature sources ((Dai, Kelly, Dunn, & Benavides, 2018) and (Winjobi, Dai, & Kelly, 2018). **Table 58** lists the datasets that were created as part of the development of this new battery chemistry.

Table 58. New datasets added for the NMC532 battery chemistry

Activity Name	Geography	Time Period	Product Name	Unit

NMC532 hydroxide production, for Li-ion battery	CN; GLO	2020-2024	NMC532 hydroxide	kg
NMC532 oxide production, for Li-ion battery	CN; GLO	2020-2024	NMC532 oxide	kg
cathode production, NMC532, for Li-ion battery	CN; GLO	2020-2024	cathode, NMC532, for Li-ion battery	kg
battery cell production, Li-ion, NMC532	CN; GLO	2020-2024	battery cell, Li-ion, NMC532	kg
battery production, Li-ion, NMC532, rechargeable	CN; GLO	2020-2024	battery, Li-ion, NMC532, rechargeable	kg
market for NMC532 hydroxide	CN; GLO	2024-2024	NMC532 hydroxide	kg
market for NMC532 oxide	CN; GLO	2024-2024	NMC532 oxide	kg
market for cathode, NMC532, for Li-ion battery	CN; GLO	2024-2024	cathode, NMC532, for Li-ion battery	kg
market for battery cell, Li-ion, NMC532	GLO	2024-2024	battery cell, Li-ion, NMC532	kg
market for battery, Li-ion, NMC532, rechargeable	GLO	2024-2024	battery, Li-ion, NMC532, rechargeable	kg

As per the literature source, the battery cell uses a graphite anode.

Note as well that the datasets developed are in line with the adjustments of the cathode and cell design applied for the already existing battery chemistries in the database.

8.2.3 Na-ion electrolyte

This new dataset was created based on published literature (Peters, Buchholz, Passerini, & Weil, 2016). The Na-ion electrolyte can then be further used by users wanting to model sodium ion batteries. The production of the Na-ion electrolyte is assumed to be taking place only in China. However, markets were created for geographies China and Global.

To support this update a new dataset for the NaPF6 salt has been introduced (‘sodium hexafluorophosphate production’). Please refer to section 7.7.1 for the complete list of datasets and salts.

Table 59. New datasets for the Na-ion electrolyte

Activity Name	Geography	Time Period	Product Name	Unit
Electrolyte production, for Na-ion battery	CN	2023-2024	electrolyte, for Na-ion battery	kg

Market for electrolyte, for Na-ion battery	CN, GLO	2014-2024	electrolyte, for Na-ion battery	kg

8.2.4 LTO battery anode material

New datasets for lithium titanate spinel (LTO) production were created for 4 geographies based on published literature (da Silva Lima, Wu, Cadena, Groombridge, & Dewulf, 2023). For the creation of these datasets, there was also the need to create a new dataset for alumina saggar in the Global geography. The new datasets are listed in Table 60.

Table 60. New datasets for LTO related products.

Activity Name	Geography	Time Period	Product Name	Unit
alumina saggar production	GLO	2023-2024	alumina saggar	kg
lithium titanate spinel production	GLO; US; UN-EASIA; RER	2014-2024	lithium titanate spinel	kg
market for lithium titanate spinel	GLO; US; UN-EASIA; RER	2020-2024	lithium titanate spinel	kg
market for alumina saggar	GLO	2020-2024	alumina saggar	kg

The datasets can be further used by users who wish to model cells with LTO anodes.

8.2.5 Natural graphite

Two datasets were added for the production of natural graphite, based on published literature (Engels, et al., 2022). The process for natural graphite production was split into two phases: graphite purification followed by graphite coating. The product that is the output of the coating stage is the natural graphite that can be used in battery products.

The datasets created are listed in **Table 61**.

Table 61. New datasets for natural graphite.

Activity Name	Geography	Time Period	Product Name	Unit
purified natural graphite production	CN	2023-2024	natural graphite, purified	kg
coated natural graphite production	CN	2014-2024	natural graphite, coated	kg
market for natural graphite, purified	CN	2020-2024	natural graphite, purified	kg

market for natural graphite, coated	CN, GLO	2020-2024	natural graphite, coated	kg

To support the creation of these datasets, two new waste exchanges were created and associated treatment of tailings has also been created. Please refer to section 11.8 for the complete list of datasets.

9 Metals

This update expands and improves the data coverage of the metals sector with new and updated data. ecoinvent v3.11 introduces data on the production of grain-oriented electrical steel (GOES) in Europe and a related dataset for the production of a 3.2% silicon alloy steel used as feedstock in the production of GOES. Two datasets on gallium production in China are added: low-grade and high-grade (data provided by Empa). Improvements in the current coverage of the metals sector encompass a variety of aspects, namely the update of properties such as metal content and prices, the addition of missing exchanges, or their renaming. Prices were updated for approximately 60 metal products mostly based on the ISE (Institute of Rare Earths and Strategic Metals) database. Metal content properties were updated or added to more than 100 metal products. Mining datasets were updated with the integration of previously missing gangue exchanges, hence improving the impact assessment of those datasets. Finally, some metal scrap exchanges were renamed to improve clarity and support users to identify with more ease the relevant metal scrap exchange that they need.

9.1 Grain-oriented electrical steel

Data for grain-oriented electrical steel production were added to the database (**Table 62**), based on literature data and expert opinion. The data integration work resulted in the creation of a dataset that models the production of grain-oriented electrical steel in Europe, whose unit process inventory has been kept confidential in order not to disclose sensitive data. A dataset on steel production (3.2% Silicon content) for use for grain-oriented electrical-steel has also been added.

Table 62. New datasets for grain oriented electrical steel. In the column v3.11, "N" stands for "New Activity" and "U" stands for "Updated Activity".

Activity Name	Geography	Time Period
steel production, 3.2% silicon alloy, for grain oriented electrical steel	RER	2020-2021
market for steel, 3.2% silicon alloy, for grain oriented electrical steel	RER	2020-2021
grain oriented electrical steel production, 0.23 mm coil	RER	2020-2021
market for grain oriented electrical steel, 0.23 mm coil	RER	2020-2021
market for grain oriented electrical steel, 0.23 mm coil	GLO	2020-2021

9.2 Gallium production

Two datasets for Gallium production (low grade and high grade) in China were added (**Table 63**), improving Gallium's production chain from aluminium hydroxide production. The datasets are the result of a collaboration with Empa, the Swiss Federal Laboratories for Materials Science and Technology. These datasets refer to the production of 1 kg of semiconductor-grade gallium (6N - 7N - or 99.9999 - 99.99999% purity), which is produced by applying the partial recrystallization method (purification process) to the low-grade gallium (4N or 99.99% purity) in China. The two datasets *gallium production, semiconductor-grade, GLO* and *gallium, in Bayer liquor from aluminium production, GLO* were deleted.

Table 63. New datasets for Gallium production. In the column v3.11, "N" stands for "New Activity" and "U" stands for "Updated Activity".

Activity Name	Geography	Time Period	v3.11
low-grade gallium production, from spent Bayer liquor	CN	1999 - 2005	N
high-grade gallium production, from low-grade gallium	CN	2018 - 2022	N
market for gallium, semiconductor-grade	GLO	2019 - 2019	N
market for gallium, low-grade	GLO	2019 - 2019	N
market for gallium, in Bayer liquor from aluminium production	GLO	2019 - 2019	N
high-grade gallium production, from low-grade gallium	CN	2018 - 2022	N

9.3 Update of properties

Properties are a feature of the ecoinvent database and are linked to intermediate and elementary exchanges. Their purpose is to provide additional information about the composition and physical characteristics of a specific exchange. More than 490 properties of 120 products were added or updated (**Table 64**).

Table 64. Exchanges for which properties were updated or added.

Activity Name
aluminium alloy, AlMg3
aluminium alloy, metal matrix composite
aluminium around steel bi-metal stranded cable, 3x3.67mm external diameter wire
aluminium around steel bi-metal wire, 3.67mm external diameter
aluminium collector foil, for Li-ion battery
aluminium in car shredder residue

aluminium scrap, new
aluminium scrap, post-consumer, prepared for melting
aluminium, cast alloy
aluminium, in mixed metal scrap
aluminium, primary, cast alloy slab from continuous casting
aluminium, primary, ingot
aluminium, primary, liquid
aluminium, wrought alloy
anode, silicon coated graphite, for Li-ion battery
argon, crude, liquid
argon, liquid
battery, lead acid, rechargeable, stationary
beryllium hydroxide
boron carbide
cadmium sludge from zinc electrolysis
cadmium sludge from zinc electrolysis stockpiling
cadmium, semiconductor-grade
calcium borates
calcium carbide, technical grade
capacitor, tantalum-, for through-hole mounting
cast iron
chromium steel pipe
cladding, crossbar-pole, aluminium
cobalt acetate
cobalt carbonate
cobalt sulfate
copper carbonate

copper in car shredder residue
copper scrap, sorted, pressed
copper telluride cement
copper, cathode
crust from Parkes process for lead production
enriched uranium, 4.2%
ferrochromium, high-carbon, 68% Cr
ferromanganese, high-coal, 74.5% Mn
ferronickel
gallium, in Bayer liquor from aluminium production
gallium, semiconductor-grade
gold-silver, ingot
ilmenite, 54% titanium dioxide
indium rich leaching residues, from zinc production stockpiling
indium tin oxide powder, nanoscale, for sputtering target
iron ore, crude ore, 46% Fe
iron ore, crude ore, 63% Fe
iron sinter
iron-nickel-chromium alloy
lanthanum-cerium oxide
leach residue from copper production
lead concentrate
lead in car shredder residue
lead smelter slag
lithium brine, 6.7 % Li
lithium carbonate
magnesium-alloy, AZ91

manganese concentrate
metallization paste, back side, aluminium
nickel concentrate, 16% Ni
nickel smelter slag
nickel, class 1
pig iron
polyaluminium chloride
potassium carbonate
potassium chloride
potassium nitrate
potassium nitrate, agricultural grade
potassium nitrate, industrial grade
potassium nitrate, technical grade
praseodymium-neodymium oxide
prohexadione calcium
refractory, high aluminium oxide, packed
resistor, metal film type, through-hole mounting
resistor, wirewound, through-hole mounting
rutile, 95% titanium dioxide
samarium oxide
samarium-europium-gadolinium oxide
scrap lead acid battery
scrap tin sheet
silicon carbide
silicon, electronics grade
silicon, metallurgical grade
silicon, multi-Si, casted

silicon, single crystal, Czochralski process, electronics
silicon, single crystal, Czochralski process, photovoltaics
silicon, solar grade
slag from metallurgical grade silicon production
steel, chromium steel 18/8
steel, chromium steel 18/8, hot rolled
strontium carbonate
tantalum powder, capacitor-grade
tellurium, semiconductor-grade
terbium oxide
terbium-dysprosium oxide
tin concentrate
titania slag, 85% titanium dioxide
titania slag, 94% titanium dioxide
titanium zinc plate, without pre-weathering
tungsten carbide powder
tungsten concentrate
uranium, enriched 3.0%, in fuel element for light water reactor
uranium, enriched 3.8%, in fuel element for light water reactor
uranium, enriched 3.9%, in fuel element for light water reactor
uranium, enriched 4%, in fuel element for light water reactor
uranium, enriched 4.2%, in fuel element for light water reactor
uranium, in yellowcake
waste aluminium
waste bulk iron, excluding reinforcement
ytterbium oxide
yttrium oxide

zinc concentrate
zinc in car shredder residue
zircon
zirconium tetrachloride

9.4 Update of prices

Prices play an important role in the burden allocation, based on economic value. Prices were updated for approximately 60 metal products, mostly based on the information available in the ISE (Institute for Selten Eerden) database. Exchanges for which prices were updated are listed in Annex 1: Products with updated prices, as well as the Price Changes sheet of the Change Report Annex. The details for each new price are stored in the price comment of each product, which can be found among the properties of the product in the dataset that produces it.

9.5 Update of mining datasets

Several mining datasets were improved through the addition of the exchange "Gangue" and "non-sulfidic tailings" (**Table 65**). The lack of an exchange of "Gangue" in mining datasets caused the miscalculation of the LCIA method "Crustal scarcity indicator 2020".

Table 65. Updated mining datasets with the exchange "Gangue" and "Non-Sulfidic tailings".

Activity Name	Geography	Time period
copper production, cathode, solvent extraction and electrowinning process	GLO	1994 - 2003
ferronickel production	GLO	1994 - 2003
gold mine operation and refining	SE	2004 - 2006
gold production	US	2003 - 2006
gold production	TZ	2003 - 2006
gold production	CA	2003 - 2006
gold production	AU	2001 - 2006
gold-silver mine operation with refinery	CA-QC	2012 - 2012
gold-silver mine operation with refinery	GLO	2004 - 2006
gold-silver mine operation with refinery	PG	2000 - 2006
ilmenite - magnetite mine operation	GLO	2000 - 2015

iron ore mine operation and beneficiation	CA-QC	2011 - 2011
iron ore mine operation, 46% Fe	GLO	1999 - 2000
magnesium oxide production	RER	2000 - 2000
magnesium oxide production	GLO	2000 - 2000
magnesium sulfate production	RER	2000 - 2000
magnesium sulfate production	GLO	2000 - 2000
manganese concentrate production	GLO	1994 - 2003
molybdenite mine operation	GLO	1994 - 2003
nickel mine operation and benefication to nickel concentrate, 16% Ni	CA-QC	2010 - 2010
uranium mine operation, open cast	RNA	1980 - 1992
uranium mine operation, open cast	GLO	1980 - 1992
platinum group metal mine operation, ore with high palladium content	RU	1995 - 2002
portafer production	GLO	2000 - 2000
portafer production	CA-QC	2000 - 2000
portafer production	RER	2000 - 2000
silver-gold mine operation with refinery	CL	2002 - 2006
silver-gold mine operation with refinery	GLO	2002 - 2006
gold-silver mine operation and beneficiation	CA-QC	2012 - 2012

9.6 Renaming of metal scrap exchanges

In order to improve clarity on the use of specific metal scrap exchanges, some updates were performed. These updates are reported in the chapter dedicated to the waste sector, in section 11.9. For example, “scrap aluminium” whose fate was incineration or landfill, has been renamed “waste aluminium”, since “scrap aluminium” is scrap that is not recycled. This enhances clarity on the fate of each exchange.

9.7 Other updates

Other updates were implemented in the context of a continuous improvement of the sector (**Table 66**).

— The treatment chain of electronics scrap in Sweden was not correctly set up. Therefore, two new markets were introduced to better represent the regional chain in Sweden.

— The datasets *aluminium production, primary, liquid, prebake* and *aluminium production, primary, liquid, Söderberg* contained an exchange of *reinforcing steel* that was incorrect (confirmed by the data provider IAI). The exchange was replaced with *steel, low alloyed.*

— In the datasets for *transformer production*, the exchange *ferrite* was used as a proxy. Grain-oriented electrical steel is specifically designed and manufactured for use in transformer cores. Since this product became available for 3.11, the proxy was replaced with the newly created *grain-oriented electrical steel, 0.23 mm coil*.

— In the datasets of the activity *pig iron production* (GLO and RER geographies), the exchange of 2.1 MJ of blast furnace gas were reintroduced, as they were missing from previous updates.

— In the dataset of the activity *Magnetite production* the amounts of iron sulfate and sodium hydroxide were updated according to stoichiometric balance.

— Finally, the name of the activity *electric arc furnace converter construction* was modified, eliminating the term “converter”. The name of the product *electric arc furnace converter* was modified into *electric arc furnace*. The product information of *steel, low-alloyed* was modified to explain that this product can also be produced via the Electric Arc Furnace production route.

Table 66. Further updates of datasets belonging to the metals sector

Activity Name	Geography	Time period	v3.11
market for precious metal from electronics scrap, in anode slime	SE	2011 - 2011	N
market for metal part of electronics scrap, in copper, anode	SE	2011 - 2011	N
aluminium production, primary, liquid, Söderberg	GLO	2015 - 2015	U
aluminium production, primary, liquid, Söderberg	IAI Area, Asia, without China and GCC	2015 - 2015	U
aluminium production, primary, liquid, Söderberg	IAI Area, EU27 & EFTA	2015 - 2015	U
aluminium production, primary, liquid, Söderberg	IAI Area, Russia & RER w/o EU27 & EFTA	2015 - 2015	U
aluminium production, primary, liquid, Söderberg	IAI Area, South America	2015 - 2015	U
aluminium production, primary, liquid, prebake	CA	2015 - 2015	U
aluminium production, primary, liquid, prebake	CN	2015 - 2015	U
aluminium production, primary, liquid, prebake	GLO	2015 - 2015	U

aluminium production, primary, liquid, prebake	IAI Area, Africa	2015 - 2015	U
aluminium production, primary, liquid, prebake	IAI Area, Asia, without China and GCC	2015 - 2015	U
aluminium production, primary, liquid, prebake	IAI Area, EU27 & EFTA	2015 - 2015	U
aluminium production, primary, liquid, prebake	IAI Area, Gulf Cooperation Council	2015 - 2015	U
aluminium production, primary, liquid, prebake	IAI Area, Russia & RER w/o EU27 & EFTA	2015 - 2015	U
aluminium production, primary, liquid, prebake	IAI Area, South America	2015 - 2015	U
aluminium production, primary, liquid, prebake	UN-OCEANIA	2015 - 2015	U
transformer production, high voltage use	GLO	1994 - 2007	U
transformer production, low voltage use	GLO	1994 - 2007	U
pig iron production	GLO	2005 - 2021	U
pig iron production	RER	2005 - 2021	U
magnetite production	GLO	1994 - 1996	U

10 Building and Construction materials

Version 3.11 brings new datasets for limestone, cement, clinker and cement plant for Canada, as well as several updates on existing datasets of the sector, and renaming of the EN15804 indicators.

10.1 New limestone, cement and clinker datasets for Canada

In version 3.11, new datasets for limestone extraction and primary crushing, as well as clinker production, and cement manufacturing were developed through a collaboration with the National Research Council of Canada (NRC) and the Cement Association of Canada (CAC). These datasets cover both average Canadian production (CA) and specific data for Ontario (CA-ON). Datasets about limestone extraction and crushing form the basis for subsequent datasets on clinker manufacturing, which share the same geographical scope. The clinker datasets, in turn, are used to create four additional datasets for general use (GU) and general use limestone (GUL) cement, in accordance with the CSA A3001 standard, while also referencing other relevant North American standards such as ASTM C150 and ASTM C595.

These new limestone, clinker, and cement datasets exhibit high temporal representativeness, as the data were collected in 2020. The geographical and technological representativeness is equally robust, with the datasets covering 90% of Canada's national production and 100% of Ontario’s production. The only technological extrapolations involved adding specific industrial processes and machinery not disclosed by the data provider. These were incorporated into specific infrastructure and machinery exchanges for limestone extraction and crushing datasets, while a newly developed infrastructure exchange representing an integrated cement plant was used in both the cement and clinker production datasets (section 10.1.1).

Due to the overlap in geographical scope, market activities are limited to the average Canadian production for the investigated reference products. For further details, refer to **Table 67**.

Table 67. New limestone, cement and clinker datasets for Canada (CA) and Canada-Ontario (CA-ON).

Activity Name	Geography	Time Period	Product Name	Unit
limestone production, crushed, for mill, average	CA	2020-2020	limestone, crushed, for mill	kg
limestone production, crushed, for mill	CA-ON	2020-2020	limestone, crushed, for mill	kg
market for limestone, crushed, for mill	CA	2020-2020	limestone, crushed, for mill	kg
clinker production, average	CA	2020-2020	clinker	kg
clinker production	CA-ON	2020-2020	clinker	kg

market for clinker	CA	2020-2020	clinker	kg
cement production, general use (GU), average	CA	2020-2020	cement, general use (GU)	kg
cement production, general use (GU)	CA-ON	2020-2020	cement, general use (GU)	kg
market for cement, general use (GU)	CA	2024-2024	cement, general use (GU)	kg
cement production, general use limestone (GUL), average	CA	2020-2020	cement, general use limestone (GUL)	kg
cement production, general use limestone (GUL)	CA-ON	2020-2020	cement, general use limestone (GUL)	kg
market for cement, general use limestone (GUL)	CA	2024-2024	cement, general use limestone (GUL)	kg
cement, all types to generic market for cement, unspecified, average	CA	2020-2020	cement, unspecified	kg
cement, all types to generic market for cement, unspecified	CA-ON	2020-2020	cement, unspecified	kg
market for cement, unspecified	CA	2020-2020	cement, unspecified	kg
integrated cement plant construction	CA	2020-2024	integrated cement plant	unit
market for integrated cement plant	CA	2020-2024	integrated cement plant	unit

10.1.1 New integrated cement plant for clinker and cement manufacturing in Canada

An internally developed dataset on integrated cement plants in Canada (CA) is introduced in ecoinvent v3.11, offering a comprehensive representation of the facilities and machinery used for manufacturing both clinker and cement mixes, covering all major stages of production. This dataset specifically focuses on integrated cement plants, where clinker and cement are produced at the same site. It includes aggregated data on key infrastructure and equipment, such as vertical mills, kilns, preheaters, coolers, conveyor belts, and electrostatic precipitators (ESP) for dust collection. Additionally, for cement production, it covers machinery like ball mills, separators, and vibration screens. The dataset reflects the plant’s entire operational lifecycle (100 years), accounting for the replacement of machinery over time. Finally, it integrates infrastructure elements such as conveyor belts and storage silos, essential for both clinker and cement production.

The dataset is derived from metadata collected by the Athena Sustainable Materials Institute and provided by the National Research Council of Canada (NRC) and the Cement Association of Canada (CAC). It encompasses information on clinker and cement production from 13 integrated cement plants operated by CAC member companies, representing approximately 90% of national production for these products. Consequently, this dataset exhibits high geographical and technological representativeness for the Canadian market. It offers robust information for modeling Canadian cement production, including the necessary infrastructure, machinery, and processes. However, it excludes site-specific elements, such as large construction machinery and process-related emissions, which are addressed in separate datasets (e.g., clinker and cement manufacturing).

10.2 EN15804 impact assessment and indicators nomenclature update

For the 'Allocation, cut-off, EN15804' system model, used for the creation of Environmental Product Declarations (EPDs), the nomenclature for the impact assessment as well as the inventory indicators has been updated. The methods, categories and indicators have been renamed to be aligned with the nomenclature used in the EN15804+A2 and EN15804+A1 standards. More details about this renaming can be found in section 4.2.

10.3 Lime and limestone supply chain update

Based on literature, the term 'lime' usually refers to quicklime (or hydrated lime), and sometimes 'lime' is also used incorrectly to describe limestone. Thus, some exchanges representing limestone were incorrectly named as lime in the database. For example, the activity 'lime production, milled, loose' (v3.10 and previous versions) should instead be 'limestone production, milled, loose' and the reference product should be 'limestone, milled, loose', and not 'lime'. Therefore, the supply chain of lime (quicklime, hydrated lime and hydraulic lime) and limestone (unprocessed, crushed, milled) activities and products has been revised for v3.11. As a result, several activities and products in the database have been renamed, as shown in **Table 68**. The new nomenclature should bring more clarity to users to select the correct product for their study.

Table 68. Activities renamed for v3.11 in the building and construction sector.

Activity Name v3.10	Product Name v3.10	Activity Name v3.11	Product Name v3.10
lime production, milled, loose	lime	limestone production, milled, loose	limestone, milled, loose
market for lime	lime	market for limestone, milled, loose	limestone, milled, loose
lime production, milled, packed	lime, packed	limestone production, milled, packed	limestone, milled, packed
market for lime, packed	lime, packed	market for limestone, milled, packed	limestone, milled, packed
lime production, hydrated, loose weight	lime, hydrated, loose weight	hydrated lime production, loose	hydrated lime, loose
market for lime, hydrated, loose weight	lime, hydrated, loose weight	market for hydrated lime, loose	hydrated lime, loose
lime production, hydrated, packed	lime, hydrated, packed	hydrated lime production, packed	hydrated lime, packed
market for lime, hydrated, packed	lime, hydrated, packed	market for hydrated lime, packed	hydrated lime, packed

lime production, hydraulic	lime, hydraulic	hydraulic lime production	hydraulic lime
market for lime, hydraulic	lime, hydraulic	market for hydraulic lime	hydraulic lime
lime to generic market for soil pH raising agent	soil pH raising agent, as CaCO3	limestone to generic market for soil pH raising agent	soil pH raising agent, as CaCO3
lime production, algae	lime	limestone production, from algae	limestone, from algae
flyash brick production	flyash brick	fly ash brick production	fly ash brick
market for flyash brick	flyash brick	market for fly ash brick	fly ash brick

In addition to the nomenclature change, the production volumes of all the producing activities of lime and limestone, except the geography of CA-QC, have been updated, which affects the shares of the supplying activities to the market activities. Furthermore, during the revision of the supply chain of lime and limestone products, several inconsistencies were observed. These have been addressed and are discussed here. The affected datasets can be found in **Table 69**.

In previous versions, the product ‘limestone, unprocessed’, which is produced by the transforming activity ‘limestone quarry operation’, consisted 100% of CaCO3. This was modelled through the elementary exchange ‘Calcite’ as natural resource From Environment. However, limestone very rarely consists purely of CaCO3. Therefore, the composition of limestone has been revised to reflect a more realistic mix of calcite, quartz, and magnesite. In v3.11 limestone products (‘limestone, unprocessed’, ‘limestone, crushed, for mill, ‘limestone, crushed, washed’, ‘limestone, milled, loose’ and ‘limestone, milled, packed’) consist of 97% Calcite (CaCO3), 2% Silica (SiO2) and 1% Magnesite (MgCO3). This adjustment is based on findings from some EPDs and is further supported by the composition shares reported in (Hewlett, 2003). The sources of Calcite, Silica and Magnesite have been added as elementary exchanges as natural resource From Environment. Additionally, the properties (dry mass, carbon content, calcium content, etc.) of the lime and limestone products have been accordingly modified.

The activity ‘zinc mine operation’ was reviewed, since it was producing as a by-product ‘quicklime, milled, loose’, which entered the ‘market for quicklime, milled, loose’. As it is unclear how quicklime could be produced from zinc mining processes, as it requires energy-intensive pyroprocessing, we have reviewed the literature and contacted the data providers. As a result, we have replaced this exchange with ‘limestone, milled, loose’, as it is likely referring to finely-ground lime intended for agriculture, which is limestone, and not quicklime.

For the datasets that needed to be renamed, the downstream activities were investigated if they should be supplied by limestone or quicklime/hydrated lime. Only for a few datasets was there a need to replace the existing intermediate exchange of limestone or quicklime. For the following datasets, the exchange ‘quicklime, milled, loose’ was replaced by ‘limestone, milled, loose’: ‘bitumen seal production’, ‘tilapia feed production, commercial’, ‘trout feed production, commercial’, and ‘tilapia production, extensive aquaculture, in pond’.

Also, the contrary occurred, that limestone was wrongly used when it should have been another exchange. Therefore, for ‘shale brick production’, the intermediate exchange of limestone, which was used at the time as a proxy for barium carbonate, according to documentation of the dataset, has been replaced, i.e., the exchange ‘lime’ (‘limestone, milled, loose’) was replaced by ‘barium carbonate’. Additionally, for the datasets of ‘steel production, converter, low-alloyed / IN’ and ‘steel production, electric, low-alloyed / IN’ the existing exchange ‘lime’ (‘limestone, milled, loose’) was replaced by ‘quicklime, milled, loose’, according to information found in the documentation of the IN dataset, and following the activities of same name, but of other geographies.

Energy corrections were performed for ‘hydraulic lime production’ and ‘quicklime production, in pieces, loose’ datasets to meet fuel energy consumption per kg of limestone required (4.25 MJ/kg). This was corrected by adding hard coal or heavy fuel oil and the corresponding air emissions to the datasets (taken from the datasets ‘heat production, at hard coal industrial furnace 1-10MW’ and ‘heat production, heavy fuel oil, at industrial furnace 1MW’).

Table 69. Updated activities affected by the lime and limestone supply chain review. “U” stands for “Updated Activity”, "*" is used to indicate activities which have also the production volumes updated for v3.11.

Activity Name	Geography	Time Period	v3.11
limestone quarry operation	CH; GLO	1992-2002	U*
limestone quarry operation	CA-QC	2012-2012	U
limestone quarry operation	IN	2014-2017	U*
limestone production, crushed, for mill	CH; GLO	2000-2002	U*
limestone production, crushed, for mill	IN	2014-2017	U*
limestone production, crushed, washed	CH; GLO	2000-2002	U*
limestone production, from algae	FR	2002-2002	U
limestone production, milled, loose	CH; Europe without Switzerland; GLO	2000-2002	U*
limestone production, milled, packed	CH; Europe without Switzerland; GLO	2000-2002	U*
limestone, crushed, washed to generic market for supplementary cementitious materials	GLO; RER	2019-2019	U*
quicklime production, in pieces, loose	CH	2000-2002	U*
quicklime production, in pieces, loose	GLO	2000-2002	U*
quicklime production, milled, loose	CH; GLO	2000-2002	U*
quicklime production, milled, packed	CH; GLO	2000-2002	U*
hydrated lime production, loose	CH	2000-2002	U*
hydrated lime production, loose	GLO	2000-2002	U*

hydrated lime production, loose	CA-QC	2012-2012	U*
hydrated lime production, packed	CH; GLO	2000-2002	U*
hydraulic lime production	CH; GLO	1997-2001	U*
bitumen seal production	GLO; RER	1992-1993	U
tilapia feed production, commercial	GLO; PE	2012-2013	U
tilapia production, extensive aquaculture, in pond	GLO; RLA	2014-2017	U
trout feed production, commercial	GLO; RLA	2012-2013	U
shale brick production	CA-QC; GLO	2012-2012	U
steel production, converter, low-alloyed	IN	2010-2017	U
steel production, electric, low-alloyed	IN	2010-2017	U

10.4 Additional updates on existing datasets of the sector

Several other datasets of the Building and Construction sector have been re-modelled, corrected and updated for v3.11. These are listed in **Table 70**, and are further discussed in this section.

Table 70. Additional updates on existing datasets of the building and construction sector. “U” stands for “Updated Activity”, "*" is used to indicate activities which have also the production volumes updated for v3.11, and “**” is used to indicate activities which, apart from the production volume update, have also been re-calculated as a weighted average.

Activity Name	Geography	Time Period	v3.11
clinker production	BR	2016-2016	U*
clinker production	CO	2014-2017	U*
clinker production	EC	2019-2023	U*
clinker production	Europe without Switzerland; US	1998-2003	U*
clinker production	GLO	1998-2023	U**
clinker production	IN	2014-2017	U*
clinker production	PE	2014-2017	U*
clinker production	TN	2019-2019	U*

clinker production	ZA	2017-2017	U*
cement mortar production	CH; GLO	1994-2001	U
cement mortar production, hand-mixed, on-site	GLO; IN	2014-2017	U
lime mortar production	CH; GLO	1995-2001	U
autoclaved aerated concrete block production	CH	1995-2000	U*
autoclaved aerated concrete block production	GLO	1995-2000	U**
autoclaved aerated concrete block production	IN	2014-2017	U*
lightweight concrete block production, expanded clay	CH; GLO	1995-2000	U*
lightweight concrete block production, expanded perlite	CH; GLO	1995-2000	U*
lightweight concrete block production, expanded vermiculite	CH; GLO	1995-2000	U*
lightweight concrete block production, polystyrene	CH; GLO	1995-2000	U*
lightweight concrete block production, pumice	DE; GLO	1995-2000	U*
concrete production, 50MPa, with cement, CEM II/B	GLO	2017-2022	U
concrete production, 50MPa, with cement, CEM II/B-V	ZA	2017-2017	U
concrete production, 50MPa, with cement, Portland	CA-QC; North America without Quebec	2006-2006	U
concrete production, 50MPa, with cement, Portland	GLO	2019-2022	U
glazing production, double, U<1.1 W/m2K	GLO; RER	1996-2004	U
glazing production, triple, U<0.5 W/m2K	GLO; RER	1996-2004	U
gravel production, crushed	CA-QC; GLO	1997-2001	U
gravel production, crushed	CH	2013-2013	U
gravel production, crushed	IN	2014-2017	U
gravel and sand quarry operation	CH; GLO	1997-2001	U

10.4.1 Clinker production GLO

Usually, global (GLO) activities are calculated as a weighted average of all activities with same activity name, based on their production volumes. Due to the addition of clinker production in Canada (see **Section 10.1**), which has a high global market share for this product, the dataset ‘clinker production / GLO’ was updated as a weighted average of all geographies which produce this product in the database. For this, the production volumes of all geographies of ‘clinker production’ have been updated (see **Table 70**). Since clinker is the main constituent of cement, the downstream activities of cement (e.g., concrete, infrastructure) get also affected by the update of the GLO geography.

Additionally, in previous versions, clinker was seen as an additional waste treatment process, similar to incineration. For v3.11 it was decided that clinker should not serve this purpose, and therefore the activity ‘clinker production’ was removed as a supplying activity for waste markets, except when there was no other treatment available (e.g., ‘market for used tyre’). Since ‘clinker production’ receives the waste without the burden of the production of the waste, but the emissions generated by burning these wastes are considered in the clinker production activity, the wastes used as input are considered secondary fuels/materials.

10.4.2 Lime and cement mortar production

There are several types of mortars in the database, such as lime mortar and cement mortar. These datasets, as well as directly impacted datasets, were investigated and updated for v3.11 (see **Table 70**). The activity ‘lime mortar production’ was re-modelled by removing the ‘cement, Portland’ and ‘hydraulic lime’ exchanges and updating the amounts for ‘silica sand’ and ‘hydrated lime’. For the activities ‘cement mortar production’ and ‘cement mortar production, hand-mixed, on-site’ the ratios of sand, water and cement inputs were recalculated.

10.4.3 Concrete block production

There are several different types of concrete blocks in the database, which had their production volumes updated for v3.11 (see **Table 70**). The only exception is the product ‘concrete block’, for which the production volume has been updated in v3.10, due to the addition of ‘concrete block production’ in Ecuador.

In addition to the update of production volumes, the activity ‘autoclaved aerated concrete production’ for the GLO geography has been re-calculated as a weighted average of all activities with same activity name (CH and IN geographies), as in previous versions it was a copy of the CH dataset.

Furthermore, the activity ‘lightweight concrete block production, pumice’ for DE and GLO geographies was further investigated, as the datasets exhibited a mass imbalance. Based on a study, the composition of this product was updated, specifically the amounts of cement, pumice and water.

10.4.4 Concrete, 50MPa production

In previous versions, the dataset ‘concrete production, 50MPa, with cement, CEM II/B / GLO’ used to have a higher impact than the dataset ‘concrete production, 50MPa, with cement, Portland / RoW’. This is counterintuitive, since Portland cement has higher emissions than cement CEM II/B, so the opposite is expected. Therefore, all ‘concrete, 50MPa’ producing activities (see **Table 70**) were investigated and updated. The elementary exchange ‘Carbon dioxide, fossil’ to air was removed from the ‘‘concrete production, 50MPa, with cement, CEM II/B’ datasets, since this emission falls outside the dataset boundary. Additionally, the Portland cement input amount was determined to be too low in the ‘concrete production, 50MPa, with cement, Portland’ datasets. Thus, concrete mix recipes were researched in literature and updated accordingly in the datasets.

10.4.5 Gravel and sand quarry activities

For several sand and gravel quarry and production activities (see **Table 70**) the amounts of particulate matter (PM) emissions, namely the elementary exchanges ‘Particulate Matter, < 2.5 um’, ‘Particulate Matter, > 2.5 um and < 10um’ and ‘Particulate Matter, > 10 um’, were updated based on the (European Environment Agency, 2019) figures of PM emissions from drilling, blasting, material processing, internal transportation, material handling operation, and stockpiling. Following the update on PM emissions, also the mass balance regarding the wastes and emissions of Water To Environment were corrected.

10.4.6 Glazing production

In the glazing production activities (see **Table 70**) it was found that the amount of zeolite powder used as input was incorrect. Therefore, the zeolite amount for both activities was corrected, based on an average of nine products found in EPDs and literature.

10.4.7 Land use impacts of ‘building, hall, steel construction’

In general, if a dataset has an input From Technosphere of ‘building, hall, steel construction’, then the impacts of land use – ‘Occupation’ and ‘Transformation to/from’ elementary exchanges – should be added to the dataset. All datasets containing the exchange ‘building, hall, steel construction’ were analyzed. As a result, it was found that the datasets in **Table 71** were lacking the elementary exchanges of land use, which were added accordingly.

Table 71. Datasets in which ‘Transformation from/to’ and ‘Occupation’ elementary exchanges were added due to existence of ‘building, hall, steel construction’ intermediate exchange. “U” stands for “Updated Activity”.

Activity Name	Geography	Time Period	v3.11
batch dyeing, fibre, cotton	BD	2017-2017	U
bleaching and dyeing, yarn	IN	2016-2017	U
bleaching and dyeing, yarn	BD; GLO	2017-2017	U
cellulose fibre production	CH; GLO	2012-2012	U
fish canning plant construction and maintenance	GLO; RLA	2011-2012	U
fish curing plant construction and maintenance	GLO; PE	2011-2012	U
fish freezing plant construction and maintenance	GLO; PE	2011-2012	U
tap water production, artificial recharged wells	CA-QC; GLO	2012-2012	U
textile production, cotton, circular knitting	GLO	2016-2016	U
textile production, cotton, circular knitting	BD	2017-2017	U
textile production, cotton, weaving	GLO	2016-2016	U

textile production, cotton, weaving	BD	2017-2017	U
yarn production, cotton, ring spinning	BD	2017-2017	U
yarn production, cotton, ring spinning, for weaving	GLO	2016-2016	U

11 Wastes

Historically, wastes were predominantly dealt with through low-cost disposal in a landfill or incineration. However, the increasing complexity and volume of waste, combined with growing societal pressures on environmental protection, has seen a diversification in the range of waste management technologies and strategies being utilized. It is also becoming more common for product designers to consider the end-of-life phase during product development. Having access to good quality environmental data on waste management is essential to support better decision making across society.

11.1 Sector Overview

The waste management sector in the ecoinvent database comprises of more than 3’500 datasets, covering the management of wastes and wastewaters from a wide variety of sectors producing them. The sector can be subdivided into solid waste management (SWM) and wastewater treatment (WWT). SWM covers treatment, recycling, and disposal (landfilling) activities, while WWT covers the treatment of wastewater. The geographies covered for both SWM and WWT include more than fifty countries across the globe.

The waste management sector frequently overlaps with other sectors. For instance, where waste materials are recovered for recycling, they are reintroduced into industrial systems for reprocessing (e.g., recycling of steel scrap takes place in an electric arc furnace, which is a metallurgical activity). Similarly, where electrical and thermal energy is generated from waste management activities (e.g., incineration), it feeds into the electricity and heat sectors. Similarly, sludge from WWT can be introduced to anaerobic digestion, incineration, landfill, landfarming, etc.

However, it is worth mentioning here, that the term “treatment activity”, as considered in the ecoinvent database, refers to any activity that has a reference product with a negative sign. This effectively means that the activity supplies the service of treating, recycling, or disposing of the reference product. So, in the ecoinvent database all treatment-, recycling-, and disposal activities are “treatment activities.”

In the ecoinvent database, by-products and wastes are classified within attributional system models, exclusively by their need for treatment. As such, they are classified as ordinary by-products, wastes, recyclables (cut-off), and materials for treatment (mft) and non-materials for treatment (non-mft) (APOS). By-products and wastes, apart from ordinary by-products and non-mft’s, can potentially enter a “treatment activity,” so within this text we refer to them as “wastes.”

11.2 Sector Highlights

11.2.1 Solid Waste Management

SWM in the ecoinvent database is covered with data for various wastes, such as municipal solid wastes, waste papers, waste plastics, waste glass among others. All “treatment activities” follow the same core modeling principle; they model direct emissions to the environment based on the composition of the waste, as well as specific emission factors that vary between treatment and geographies. Further, they include material (chemicals), energy inputs, infrastructure, and model relevant by-products (electricity, heat, secondary metal products).

Treatments available are divided into: mechanical (sorting, dismantling, shredding, etc.); thermal (municipal solid waste incineration, hazardous waste incineration); disposal (landfilling, underground deposit, open burning and open dumping and disposal of tailings on land) and biological (composting, anaerobic digestion).

Regarding recycling datasets, they refer to the production of secondary materials such as metals, glass and plastics. Recycling is usually following products and by-products from treatment activities. They include materials to be processed, materials necessary for the process (chemicals), energy inputs, infrastructure and model relevant by-products that can be used in further production processes.

Finally, the SWM sector includes country specific consumption mixes for more than twelve wastes for the countries of Europe, Brazil, Colombia, Peru, India, and South Africa. Those mixes offer the possibility to users to model country specific burdens that arise from waste management. The mixes include different treatment processes based on the regional availability of them.

11.2.2 Wastewater Treatment

The WWT sub-sector in the ecoinvent database includes data for more than thirty different wastewater treatments. There are certain wastewaters that are treated in WWT facilities with various capacity and there are also different wastewaters from various industrial processes like wastewater from concrete production, wastewater from glass production, wastewater from anaerobic digestion of whey, wastewater from maize starch production.

All wastewater treatment activities model direct emissions to the environment based on the composition of the wastewater. The datasets include material (chemicals) and energy inputs infrastructure, and model relevant by-products (wastewater sludge).

11.2.3 Waste Tools

All the tools used to model datasets that are part of the waste sector are open access and freely available to everyone. People can use them and create regional specific treatments in addition to creating specific wastes that are not present in the sector. The tools deliver either spold files or xls files.

This chapter covers all the updates, changes and additions performed in the sector of Waste Management and Recycling for the database version 3.11.

11.3 Hydrothermal treatment of waste plastic

New data is added to model the process of hydrothermal treatment in collaboration with Mura Technology. The process could be characterized as a type of chemical recycling that treats mixed waste plastic that cannot be mechanically recycled due to heavy colorants, additives, mixes, etc. The final products generated from the process are naphtha, distillate gas oil, heavy wax residue, and heavy gas oil in the geography of the United Kingdom. All the new datasets created are reported in **Table 72**.

Table 72. New activities added for hydrothermal treatment of waste plastic.

Activity Name	Geography	Time Period	Product Name	Unit
treatment of waste mixed polyolefins, unprocessed, sorting	GB	2017-2023	waste mixed polyolefins, unprocessed	kg
treatment of waste mixed polyolefins, processed, hydrothermal treatment	GB	2017-2024	waste mixed polyolefins, processed	kg
distillate gas oil to generic market for diesel	GB	2022-2024	diesel	kg
market for heavy wax residue	RER	2010-2024	heavy wax residue	kg
heavy gas oil to generic market for heavy fuel oil	GB	2022-2024	heavy fuel oil	kg
hydrothermal treatment facility construction	GB	2023-2024	hydrothermal treatment facility	unit
market for hydrothermal treatment facility	GLO	2010-2024	hydrothermal treatment facility	unit
market for waste mixed polyolefins, unprocessed	GB	2010-2024	waste mixed polyolefins, unprocessed	kg
market for distillate gas oil	GB	2010-2024	distillate gas oil	kg
market for heavy gas oil	GB	2010-2024	heavy gas oil	kg
market for waste mixed polyolefins, processed	GB	2010-2024	waste mixed polyolefins, processed	kg
heavy wax residue to generic market for bitumen seal	GB	2022-2024	bitumen seal, V60	kg
treatment of waste plastic, mixture, municipal incineration	GB	2006-2012	waste plastic, mixture	kg
treatment of residues, MSWI, waste plastic, mixture, residual material landfill	GB	1994-2000	residues, MSWI, waste plastic, mixture	kg
treatment of bottom ash, MSWI, waste plastic, mixture, slag compartment	GB	1994-2000	bottom ash, MSWI, waste plastic, mixture	kg
market for residues, MSWI, waste plastic, mixture	GB	2010-2023	residues, MSWI, waste plastic, mixture	kg
market for bottom ash, MSWI, waste plastic, mixture	GB	2010-2023	bottom ash, MSWI, waste plastic, mixture	kg
market for waste plastic, mixture	GB	2010-2023	waste plastic, mixture	kg

11.4 Mechanical recycling of waste plastic

For v3.11, new datasets modeling mechanical recycling of waste plastics are added. The data was collected in collaboration with [Plastics Recyclers Europe] and it represents the geography of Europe. The modeled polymers include waste polyethylene (PE), polyethylene/polypropylene (PE/PP), high density polyethylene (HDPE), low density polyethylene (LDPE), polystyrene (PS), polyethylene terephthalate (PET), polyvinylchloride (PVC), polypropylene (PP), acrylonitrile-butadiene-styrene (ABS), acrylonitrile-butadiene-styrene/ polystyrene (ABS/PS), and mixed plastics generated from many different sources like household, industrial, agricultural, commercial, construction and demolition, WEEE, etc. Additional datasets were created to model the treatment of various wastes generated during the recycling processes. The newly created treatment and renaming datasets are mentioned in **Table 73**.

The new datasets replace the previous datasets included in 3.10 modeling the recycling of waste polyethylene and waste polyethylene terephthalate. The dataset mapping between v3.10 and v3.11 is reported in **Table 74**.

Table 73. New activities added for mechanical recycling of waste plastic.

Activity Name	Geography	Time Period	Product Name	Unit
pelletising of acrylonitrile-butadiene-styrene	RER	2022-2023	acrylonitrile-butadiene-styrene, flakes, recycled	kg
pelletising of polyethylene	RER	2022-2023	polyethylene, flakes, recycled	kg
pelletising of polyethylene terephthalate	RER	2022-2023	polyethylene terephthalate, flakes, recycled	kg
pelletising of polyethylene terephthalate, coloured	RER	2022-2023	polyethylene terephthalate, flakes, coloured, recycled	kg
pelletising of polyethylene terephthalate, food grade	RER	2022-2023	polyethylene terephthalate, flakes, food grade, recycled	kg
pelletising of polyethylene, high density	RER	2022-2023	polyethylene, high density, flakes, recycled	kg
pelletising of polyethylene, low density	RER	2022-2023	polyethylene, low density, flakes, recycled	kg
pelletising of polyethylene, low density, coloured	RER	2022-2023	polyethylene, low density, flakes, coloured, recycled	kg
pelletising of polyethylene/polypropylene	RER	2022-2023	polyethylene/polypropylene, flakes, recycled	kg
pelletising of polypropylene	RER	2022-2023	polypropylene, flakes, recycled	kg
pelletising of polystyrene	RER	2022-2023	polystyrene, flakes, recycled	kg
pelletising of polyvinylchloride	RER	2022-2023	polyvinylchloride, flakes, recycled	kg

pelletising of PS/ABS	RER	2022-2023	PS/ABS, flakes, recycled	kg
plastic converting	RER	2022-2022	plastic, mixed, recycled	
treatment of bottom ash, MSWI, cake from recycling of waste plastic, WEEE, slag compartment	RER	1994-2000	bottom ash, MSWI, cake from recycling of waste plastic, WEEE	kg
treatment of bottom ash, MSWI, cake from sorting of waste plastic, slag compartment	RER	1994-2000	bottom ash, MSWI, cake from sorting of waste plastic	kg
treatment of bottom ash, MSWI, residues from sorting of waste plastic, slag compartment	RER	1994-2000	bottom ash, MSWI, residues from sorting of waste plastic	kg
treatment of bottom ash, MSWI, sieving machine sludge from recycling of HDPE, slag compartment	RER	1994-2000	bottom ash, MSWI, sieving machine sludge from recycling of HDPE	kg
treatment of bottom ash, MSWI, waste plastic, WEEE, dust, slag compartment	RER	1994-2000	bottom ash, MSWI, waste plastic, WEEE, dust	kg
treatment of bottom ash, MSWI, waste polyethylene terephthalate, dust, slag compartment	RER	1994-2000	bottom ash, MSWI, waste polyethylene terephthalate, dust	kg
treatment of bottom ash, MSWI, waste sink from recycling of HDPE, slag compartment	RER	1994-2000	bottom ash, MSWI, waste sink from recycling of HDPE	kg
treatment of bottom ash, MSWI-WWT, WW from PET pelletising, slag compartment	RER	1994-2000	bottom ash, MSWI-WWT, WW from PET pelletising	kg
treatment of bottom ash, MSWI-WWT, WW from recycling of waste PET, slag compartment	RER	1994-2000	bottom ash, MSWI-WWT, WW from recycling of waste PET	kg
treatment of bottom ash, MSWI-WWT, WW from recycling of waste PP, slag compartment	RER	1994-2000	bottom ash, MSWI-WWT, WW from recycling of waste PP	kg
treatment of bottom ash, MSWI-WWT-SLF, cake from recycling of waste plastic, WEEE, slag compartment	RER	1994-2000	bottom ash, MSWI-WWT-SLF, cake from recycling of waste plastic, WEEE	kg
treatment of bottom ash, MSWI-WWT-SLF, cake from sorting of waste plastic, slag compartment	RER	1994-2000	bottom ash, MSWI-WWT-SLF, cake from sorting of waste plastic	kg
treatment of cake from recycling of waste plastic, WEEE, municipal incineration	RER	2006-2012	cake from recycling of waste plastic, WEEE	kg
treatment of cake from recycling of waste plastic, WEEE, sanitary landfill	RER	1994-2012	cake from recycling of waste plastic, WEEE	kg
treatment of cake from sorting of waste plastic, municipal incineration	RER	2006-01-01	cake from sorting of waste plastic	kg
treatment of cake from sorting of waste plastic, sanitary landfill	RER	2006-2012	cake from sorting of waste plastic	kg
treatment of leachate, SLF, cake from recycling of waste plastic, WEEE, wastewater treatment	RER	2010-2020	leachate, SLF, cake from recycling of waste plastic, WEEE	m3

treatment of leachate, SLF, cake from sorting of waste plastic, wastewater treatment	RER	2010-2020	leachate, SLF, cake from sorting of waste plastic	m3
treatment of residues from sorting of waste plastic, municipal incineration	RER	2006-2012	residues from sorting of waste plastic	kg
treatment of residues, MSWI, cake from recycling of waste plastic, WEEE, residual material landfill	RER	1994-2000	residues, MSWI, cake from recycling of waste plastic, WEEE	kg
treatment of residues, MSWI, cake from sorting of waste plastic, residual material landfill	RER	1994-2000	residues, MSWI, cake from sorting of waste plastic	kg
treatment of residues, MSWI, residues from sorting of waste plastic, residual material landfill	RER	1994-2000	residues, MSWI, residues from sorting of waste plastic	kg
treatment of residues, MSWI, sieving machine sludge from recycling of HDPE, residual material landfill	RER	1994-2000	residues, MSWI, sieving machine sludge from recycling of HDPE	kg
treatment of residues, MSWI, waste plastic, WEEE, dust, residual material landfill	RER	1994-2000	residues, MSWI, waste plastic, WEEE, dust	kg
treatment of residues, MSWI, waste polyethylene terephthalate, dust, residual material landfill	RER	1994-2000	residues, MSWI, waste polyethylene terephthalate, dust	kg
treatment of residues, MSWI, waste sink from recycling of HDPE, residual material landfill	RER	1994-2000	residues, MSWI, waste sink from recycling of HDPE	kg
treatment of residues, MSWI-WWT, WW from PET pelletising, residual material landfill	RER	1994-2000	residues, MSWI-WWT, WW from PET pelletising	kg
treatment of residues, MSWI-WWT, WW from recycling of waste PET, residual material landfill	RER	1994-2000	residues, MSWI-WWT, WW from recycling of waste PET	kg
treatment of residues, MSWI-WWT, WW from recycling of waste PP, residual material landfill	RER	1994-2000	residues, MSWI-WWT, WW from recycling of waste PP	kg
treatment of residues, MSWI-WWT-SLF, cake from recycling of waste plastic, WEEE, residual material landfill	RER	1994-2000	residues, MSWI-WWT-SLF, cake from recycling of waste plastic, WEEE	kg
treatment of residues, MSWI-WWT-SLF, cake from sorting of waste plastic, residual material landfill	RER	1994-2000	residues, MSWI-WWT-SLF, cake from sorting of waste plastic	kg
treatment of sewage sludge, 70% water, WWT, WW from PET pelletising, municipal incineration	RER	2000-2012	sewage sludge, 70% water, WWT, WW from PET pelletising	kg
treatment of sewage sludge, 70% water, WWT, WW from recycling of waste PET, municipal incineration	RER	2000-2012	sewage sludge, 70% water, WWT, WW from recycling of waste PET	kg

treatment of sewage sludge, 70% water, WWT, WW from recycling of waste PP, municipal incineration	RER	2000-2012	sewage sludge, 70% water, WWT, WW from recycling of waste PP	kg
treatment of sewage sludge, 70% water, WWT-SLF, cake from recycling of waste plastic, WEEE, municipal incineration	RER	2000-2012	sewage sludge, 70% water, WWT-SLF, cake from recycling of waste plastic, WEEE	kg
treatment of sewage sludge, 70% water, WWT-SLF, cake from sorting of waste plastic, municipal incineration	RER	2000-2012	sewage sludge, 70% water, WWT-SLF, cake from sorting of waste plastic	kg
treatment of sewage sludge, 75% water, WWT, WW from PET pelletising, sanitary landfill	RER	2000-2012	sewage sludge, 75% water, WWT, WW from PET pelletising	kg
treatment of sewage sludge, 75% water, WWT, WW from recycling of waste PET, sanitary landfill	RER	2000-2012	sewage sludge, 75% water, WWT, WW from recycling of waste PET	kg
treatment of sewage sludge, 75% water, WWT, WW from recycling of waste PP, sanitary landfill	RER	2000-2012	sewage sludge, 75% water, WWT, WW from recycling of waste PP	kg
treatment of sewage sludge, 97% water, WWT, WW from PET pelletising, landfarming	RER	2000-2021	sewage sludge, 97% water, WWT, WW from PET pelletising	kg
treatment of sewage sludge, 97% water, WWT, WW from recycling of waste PET, landfarming	RER	2000-2021	sewage sludge, 97% water, WWT, WW from recycling of waste PET	kg
treatment of sewage sludge, 97% water, WWT, WW from recycling of waste PP, landfarming	RER	2000-2021	sewage sludge, 97% water, WWT, WW from recycling of waste PP	kg
treatment of sewage sludge, 97% water, WWT-SLF, cake from recycling of waste plastic, WEEE, landfarming	RER	2000-2021	sewage sludge, 97% water, WWT-SLF, cake from recycling of waste plastic, WEEE	kg
treatment of sewage sludge, 97% water, WWT-SLF, cake from sorting of waste plastic, landfarming	RER	2000-2021	sewage sludge, 97% water, WWT-SLF, cake from sorting of waste plastic	kg
treatment of sieving machine sludge from recycling of HDPE, municipal incineration	RER	2006-2012	sieving machine sludge from recycling of HDPE	kg
treatment of waste plastic, consumer electronics, recycling	RER	2022-2022	waste plastic, consumer electronics, for recycling, unsorted	kg
treatment of waste plastic, mixed, recycling	RER	2022-2022	waste plastic, mixed, for recycling, unsorted	kg
treatment of waste plastic, refrigerator, flakes, recycling	RER	2022-2022	waste plastic, refrigerator, for recycling, unsorted	kg
treatment of waste plastic, refrigerator, pellets, recycling	RER	2021-2022	waste plastic, refrigerator, for recycling, unsorted	kg

treatment of waste plastic, small domestic appliances, recycling	RER	2021-2022	waste plastic, small domestic appliances, for recycling, unsorted	kg
treatment of waste plastic, television, recycling	RER	2022-2022	waste plastic, television, for recycling, unsorted	kg
treatment of waste plastic, WEEE, dust, municipal incineration	RER	2006-2012	waste plastic, WEEE, dust	kg
treatment of waste plastic, WEEE, recycling	RER	2022-2022	waste plastic, WEEE, unsorted	kg
treatment of waste polyethylene terephthalate, bottle, recycling	RER	2020-2022	waste polyethylene terephthalate, bottle, for recycling, unsorted	kg
treatment of waste polyethylene terephthalate, dust, municipal incineration	RER	2006-2012	waste polyethylene terephthalate, dust	kg
treatment of waste polyethylene terephthalate, food grade, recycling	RER	2020-2020	waste polyethylene terephthalate, bottle, for recycling, unsorted	kg
treatment of waste polyethylene terephthalate, recycling	RER	2021-2021	waste polyethylene terephthalate, for recycling, unsorted	kg
treatment of waste polyethylene, high density, packaging, recycling	RER	2021-2021	waste polyethylene, high density, packaging, for recycling, unsorted	kg
treatment of waste polyethylene, high density, recycling	RER	2021-2022	waste polyethylene, high density, for recycling, unsorted	kg
treatment of waste polyethylene, low density, flakes, recycling	RER	2023-2023	waste polyethylene, low density, for recycling, unsorted	kg
treatment of waste polyethylene, low density, packaging, recycling	RER	2021-2021	waste polyethylene, low density, packaging, for recycling, unsorted	kg
treatment of waste polyethylene, low density, pellets, recycling	RER	2022-2022	waste polyethylene, low density, for recycling, unsorted	kg
treatment of waste polyethylene, recycling	RER	2021-2023	waste polyethylene, for recycling, unsorted	kg
treatment of waste polyethylene/polypropylene, recycling	RER	2022-2022	waste polyethylene/polypropylene, for recycling, unsorted	kg
treatment of waste polypropylene, packaging, flakes, recycling	RER	2021-2021	waste polypropylene, packaging, for recycling, unsorted	kg
treatment of waste polypropylene, packaging, pellets, recycling	RER	2021-2021	waste polypropylene, packaging, for recycling, unsorted	kg

treatment of waste polypropylene, recycling	RER	2021-2023	waste polypropylene, for recycling, unsorted	kg
treatment of waste polystyrene, recycling	RER	2021-2021	waste polystyrene, for recycling, unsorted	kg
treatment of waste polyvinylchloride, recycling	RER	2021-2021	waste polyvinylchloride, for recycling, unsorted	kg
treatment of waste sink from recycling of HDPE, municipal incineration	RER	2006-2012	waste sink from recycling of HDPE	kg
treatment of wastewater from PET pelletising, wastewater treatment	RER	2010-2020	wastewater from PET pelletising	m3
plastic profiles to generic market for window frame, polyvinylchloride	RER	2023 - 2024	window frame, poly vinyl chloride, U=1.6 W/m2K	m2
polyethylene/polypropylene, pellets, recycled to generic markets for PP and HDPE	RER	2023 - 2024	polyethylene, high density, granulate	kg
polyethylene/polypropylene, pellets, recycled to generic markets for PP and HDPE	RER	2023 - 2024	polypropylene, granulate	kg
polyethylene, high density, pellets, recycled to generic market for polyethylene, high density, granulate	RER	2023 - 2024	polyethylene, high density, granulate	kg
polyethylene, low density, fines to generic market for polyethylene, low density, granulate	RER	2023 - 2024	polyethylene, low density, granulate	kg
polyethylene, low density, lumps to generic market for polyethylene, low density, granulate	RER	2023 - 2024	polyethylene, low density, granulate	kg
polyethylene, low density, pellets, coloured, recycled to generic market for polyethylene, low density, granulate	RER	2023 - 2024	polyethylene, low density, granulate	kg
polyethylene, low density, pellets, recycled to generic market for polyethylene, low density, granulate	RER	2023 - 2024	polyethylene, low density, granulate	kg
polyethylene, pellets, recycled to generic markets for LDPE and HDPE	RER	2023 - 2024	polyethylene, low density, granulate	kg
polyethylene, pellets, recycled to generic markets for LDPE and HDPE	RER	2023 - 2024	polyethylene, high density, granulate	kg
polyethylene terephthalate, backflushed from screenchangers generic market for PET, granulate, amorphous	RER	2023 - 2024	polyethylene terephthalate, granulate, amorphous	kg
polyethylene terephthalate, fines to generic market for PET, granulate, amorphous	RER	2023 - 2024	polyethylene terephthalate, granulate, amorphous	kg
polyethylene terephthalate, labels to generic market for PET, granulate, amorphous	RER	2023 - 2024	polyethylene terephthalate, granulate, amorphous	kg

polyethylene terephthalate, pellets, coloured, recycled to generic market for PET, granulate, amorphous	RER	2023 - 2024	polyethylene terephthalate, granulate, amorphous	kg
polyethylene terephthalate, pellets, food grade, recycled generic market for polyethylene terephthalate, bottle grade	RER	2023 - 2024	polyethylene terephthalate, granulate, bottle grade	kg
polyethylene terephthalate, pellets, recycled to generic market for PET, granulate, amorphous	RER	2023 - 2024	polyethylene terephthalate, granulate, amorphous	kg
polypropylene, pellets, recycled to generic market for polypropylene, granulate	RER	2023 - 2024	polypropylene, granulate	kg
polystyrene, pellets, recycled to generic market for polystyrene, high impact	RER	2023 - 2024	polystyrene, high impact	kg
polyvinylchloride, micronised powder, recycled to generic market for polyvinylchloride	RER	2023 - 2024	polyvinylchloride, suspension polymerised	kg
polyvinylchloride, rigid, pellets, recycled to generic market for polyvinylchloride	RER	2023 - 2024	polyvinylchloride, suspension polymerised	kg
PS/ABS, pellets, recycled to generic market for polystyrene, high impact	RER	2023 - 2024	polystyrene, high impact	kg
refuse-derived fuel to generic market for natural gas, high pressure	RER	2023 - 2024	natural gas, high pressure	m3

Table 74. Mapping of plastic recycling datasets between v3.10 and v3.11.

Activity Name 3.10	Geography 3.10	Activity Name 3.11	Geography 3.11
polyethylene terephthalate production, granulate, amorphous, recycled	CH; Europe without Switzerland	pelletising of polyethylene terephthalate	RER
polyethylene production, high density, granulate, recycled	CH; Europe without Switzerland	pelletising of polyethylene, high density	RER
polyethylene terephthalate production, granulate, bottle grade, recycled	CH	pelletising of polyethylene terephthalate, food grade	RER

11.5 Regionalization of Municipal Solid Waste in Europe

In 2020, the European Union generated roughly 2.1 billion tons of waste, over a tenth of which was Municipal Solid Waste (MSW). Waste composition is indicative of our daily consumption patterns. How we live is reflected on the waste we generate. In the last 20 years, the amount of this type of waste has continuously increased, which stresses the need to assess its environmental impacts.

Up until version 3.10, activities related to the treatment of Municipal Solid Waste (MSW) in different European countries were modelled using identical elemental composition for all countries. For example, it was assumed that MSW in Spain has the identical elemental composition as MSW of Sweeden. On top of this assumption, a national treatment mix was built for each geography depending on the treatment technologies used in every country.

Updates introduced for version 3.11 incorporate a regionalized and customized elemental composition based on waste generation patterns of each country. Fractional composition of MSW was obtained from literature (Albizzati, Foster, Gaudillat, Manfredi, & Tonini, 2024) for every country of the European Union included in Eurostat (Eurostat, 2023) .In addition, we obtained the composition from relevant sources for Switzerland (BAFU, 2023), United Kingdom (GOV.UK, 2023), (Statistics_Iceland, 2024) and Norway (Lausselet, et al., 2017), reaching 30 countries in total. MSW Fractions considered included but are not limited to the following:

- biowaste,
- plastic,
- paper,
- paperboard,
- metals,
- glass,
- textiles,
- electrical and electronic equipment (WEEE),
- batteries, and more.

Compositions are coupled with the elemental contents of the individual fractions based on literature (Götze, Pivnenko, Boldrin, Scheutz, & Astrup, 2016) (Riber, Petersen, & Christensen, 2009) (Edjabou, Petersen, Scheutz, & Astrup, 2016) (Edjabou, Takou, Boldrin, Petersen, & Astrup, 2021). Moreover, each country has an updated treatment mix that represents the shares of technologies currently used to treat MSW locally. The technologies included in the treatment mix are sanitary landfill, incineration with energy recovery, incineration without energy recovery, open burning, open dump, and unsanitary landfill and were modelled with ecoinvent waste tools (Doka, 2021). The respective markets also employ regionalized transport distances and regionalized losses when needed. All the datasets are mentioned in **Table 75**.

Table 75. New and updated activities added for regionalization of MSW in Europe.

Activity Name	Geography	Time Period	Product Name	Unit
treatment of municipal solid waste, municipal incineration	AT; BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	2006-2012	municipal solid waste	kg

treatment of municipal solid waste, municipal incineration FAE	CH	2006-2012	municipal solid waste	kg
treatment of municipal solid waste, municipal incineration, without energy recovery	AT; BE; CZ; DE; FI; FR; GB; HU; IS; IT; LU; NL; PL; RO; SI	2006-2012	municipal solid waste	kg
treatment of municipal solid waste, open burning	AT; BE; BG; CH; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	2006-2012	municipal solid waste	kg
treatment of municipal solid waste, open dump	HU; IE; BG; CH; EE; HR; LT; NO; RO; SI	2006-2012	municipal solid waste	kg
treatment of municipal solid waste, sanitary landfill	BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LV; MT; NL; NO; PL; PT; SE; SI; SK	1994-2012	municipal solid waste	kg
treatment of municipal solid waste, unsanitary landfill	AT; CH; CZ; ES; GR; HR; HU; IS; LT; LU; LV; MT; PL; RO; SK	2006-2012	municipal solid waste	kg
treatment of leachate, SLF, municipal solid waste, wastewater treatment	BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LV; MT; NL; NO; PL; PT; SE; SI; SK	2010-2020	leachate, SLF, municipal solid waste	m3
treatment of sewage sludge, 70% water, WWT-SLF, municipal solid waste, municipal incineration	BE; CY; CZ; DE; DK; ES; FI; FR; GB; GR; HU; IS IT; LT; NL; NO; PL; SE; SI; SK	2006-2012	sewage sludge, 70% water, WWT-SLF, municipal solid waste	kg
treatment of sewage sludge, 97% water, WWT-SLF, municipal solid waste, landfarming	BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LV; NL; NO; PL; PT; SE; SI; SK	2000-2021	sewage sludge, 97% water, WWT-SLF, municipal solid waste	kg
treatment of bottom ash, MSWI, municipal solid waste, slag compartment	AT; BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	1994-2000	bottom ash, MSWI, municipal solid waste	kg
treatment of bottom ash, MSWI[F], municipal solid waste, slag compartment	CH	1994-2000	bottom ash, MSWI[F], municipal solid waste	kg
treatment of bottom ash, MSWI-WWT-SLF, municipal solid waste, slag compartment	BE; CY; CZ; DE; DK; ES; FI; FR; GB; GR; HU; IS; IT; LT; NL; NO; PL; SE; SI; SK	1994-2000	bottom ash, MSWI-WWT-SLF, municipal solid waste	kg
treatment of residues, MSWI, municipal solid waste, residual material landfill	AT; BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	1994-2000	residues, MSWI, municipal solid waste	kg
treatment of residues, MSWI[F], municipal solid waste, residual material landfill	CH	1994-2000	residues, MSWI[F], municipal solid waste	kg
treatment of residues, MSWI-WWT-SLF, municipal solid waste, residual material landfill	BE; CY; CZ; DE; DK; ES; FI; FR; GB; GR; HU; IS; IT; LT; NL; NO; PL; SE; SI; SK	1994-2000	residues, MSWI-WWT-SLF, municipal solid waste	kg

market for municipal solid waste	BG; AT; BE; CH; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	2010-2023	municipal solid waste	kg
market for leachate, SLF, municipal solid waste	BE; BG; DE; CY; CZ; EE; DK; ES; GB; FI; FR; HR; GR; HU; IT; IE; IS; LV; LT; MT; PL; NL; NO; SE; PT; SI; SK	2010-2023	leachate, SLF, municipal solid waste	m3
market for sewage sludge, 70% water, WWT-SLF, municipal solid waste	BE; CY; CZ; DE; DK; ES; FI; FR; GB; GR; HU; IS; IT; LT; NL; NO; PL; SE; SI; SK	2010-2023	sewage sludge, 70% water, WWT-SLF, municipal solid waste	kg
market for sewage sludge, 97% water, WWT-SLF, municipal solid waste	BE; BG; CY; CZ; DE;DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LV; NL; NO; PL; PT; SE; SI; SK	2010-2023	sewage sludge, 97% water, WWT-SLF, municipal solid waste	kg
market for bottom ash, MSWI, municipal solid waste	AT; BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	2010-2023	bottom ash, MSWI, municipal solid waste	kg
market for bottom ash, MSWI[F], municipal solid waste	CH	2010-2023	bottom ash, MSWI[F], municipal solid waste	kg
market for residues, MSWI, municipal solid waste	AT; BE; BG; CY; CZ; DE; DK; EE; ES; FI; FR; GB; GR; HR; HU; IE; IS; IT; LT; LU; LV; MT; NL; NO; PL; PT; RO; SE; SI; SK	2010-2023	residues, MSWI, municipal solid waste	kg
market for residues, MSWI[F], municipal solid waste	CH	2010-2023	residues, MSWI[F], municipal solid waste	kg
market for residues, MSWI-WWT-SLF, municipal solid waste	BE; CY; CZ; DE; DK; ES; FI; FR; GB; GR; HU; IS; IT; LT; NL; NO; PL; SE; SI; SK	2010-2023	residues, MSWI-WWT-SLF, municipal solid waste	kg

11.6 Wastewater from textile production

New treatment datasets for wastewater from textile production are included in v 3.11. This wastewater is generated during different stages of textile production and its treatment covers the geographies of Europe and Global. The treatment datasets and the respective market are reported in detail in **Table 76**.

Table 76. New activities added for wastewater from textile production.

Activity Name	Geography	Time Period	Product Name	Unit

treatment of wastewater from textile production, wastewater treatment	RER; GLO	2010-2021	wastewater from textile production	m3
treatment of sewage sludge, 97% water, WWT, WW from textile production, landfarming	RER; GLO	2010-2012	sewage sludge, 97% water, WWT, WW from textile production	kg
treatment of sewage sludge, 75% water, WWT, WW from textile production, sanitary landfill	RER; GLO	2010-2012	sewage sludge, 75% water, WWT, WW from textile production	kg
treatment of sewage sludge, 70% water, WWT, WW from textile production, municipal incineration	RER; GLO	2010-2012	sewage sludge, 70% water, WWT, WW from textile production	kg
treatment of residues, MSWI-WWT, WW from textile production, residual material landfill	RER; GLO	2010-2021	residues, MSWI-WWT, WW from textile production	kg
treatment of bottom ash, MSWI-WWT, WW from textile production, slag compartment	RER; GLO	2010-2021	bottom ash, MSWI-WWT, WW from textile production	kg
market for wastewater from textile production	RER; GLO	2010-2021	wastewater from textile production	m3
market for sewage sludge, 97% water, WWT, WW from textile production	RER; GLO	2010-2021	sewage sludge, 97% water, WWT, WW from textile production	kg
market for sewage sludge, 75% water, WWT, WW from textile production	RER; GLO	2010-2021	sewage sludge, 75% water, WWT, WW from textile production	kg
market for sewage sludge, 70% water, WWT, WW from textile production	RER; GLO	2010-2021	sewage sludge, 70% water, WWT, WW from textile production	kg
market for residues, MSWI-WWT, WW from textile production	RER; GLO	2010-2021	residues, MSWI-WWT, WW from textile production	kg
market for bottom ash, MSWI-WWT, WW from textile production	RER; GLO	2010-2021	bottom ash, MSWI-WWT, WW from textile production	kg

11.7 Chemical recycling of waste polyester

Chemical recycling of waste polyester is modeled for v 3.11. Waste polyester is sourced from industrial activities of textile production, and it is chemically treated into polyethylene terephthalate pellets. The data was collected in collaboration with Alibaba Cloud – Energy Expert and it represents the geography of China. All the new datasets created are reported in **Table 77**.

Table 77. New activities added for chemical recycling of waste polyester.

Activity Name	Geography	Time Period	Product Name	Unit

treatment of waste polyester, industrial, from textile production, hydrothermal treatment	CN-ZJ	2022-2022	waste polyester, industrial, from textile production	kg
treatment of bottom ash, MSWI-WWT, WW from polyester recycling, slag compartment	CN-ZJ	1994-2000	bottom ash, MSWI-WWT, WW from polyester recycling	kg
treatment of residues, MSWI-WWT, WW from polyester recycling, residual material landfill	CN-ZJ	1994-2000	residues, MSWI-WWT, WW from polyester recycling	kg
treatment of sewage sludge, 70% water, WWT, WW from polyester recycling, municipal incineration	CN-ZJ	2006-2012	sewage sludge, 70% water, WWT, WW from polyester recycling	kg
polyethylene terephthalate, pellets, recycled fibre based to market for PET, granulate, amorphous	CN-ZJ	2022-2023	polyethylene terephthalate, granulate, amorphous	kg
market for polyethylene terephthalate, pellets, recycled fibre based	CN-ZJ	2022-2022	polyethylene terephthalate, pellets, recycled fibre based	kg
market for residues, MSWI-WWT, WW from polyester recycling	CN-ZJ	2010-2021	residues, MSWI-WWT, WW from polyester recycling	kg
market for sewage sludge, 70% water, WWT, WW from polyester recycling	CN-ZJ	2010-2021	sewage sludge, 70% water, WWT, WW from polyester recycling	kg
market for waste polyester, industrial, from textile production	CN-ZJ	2022-2022	waste polyester, industrial, from textile production	kg
market for bottom ash, MSWI-WWT, WW from polyester recycling	CN-ZJ	2010-2023	bottom ash, MSWI-WWT, WW from polyester recycling	kg

11.8 Graphite tailings

A new treatment dataset for non-sulfidic tailings is available in v3.11. The tailings are generated as by-product from mining operations of natural graphite in China. The treatment dataset and it respective market are reported in detail in **Table 78**.

Table 78. New activities added for graphite tailings.

Activity Name	Geography	Time Period	Product Name	Unit
treatment of non-sulfidic tailings, from natural graphite mine operation, residual material landfill	**CN**	**1994-2000**	non-sulfidic tailings, from natural graphite mine operation	**kg**
market for non-sulfidic tailings, from natural graphite mine operation	CN	2010-2024	non-sulfidic tailings, from natural graphite mine operation	kg

11.9 Metal scrap nomenclature

The term 'scrap' is commonly used to describe secondary materials generated as by-products from various activities and they are further processed to be re-used. In the ecoinvent database, the term has been used to describe both metal flows treated as waste and metal flows that get recycled to be re-used. For example, there is 'waste aluminium' treated as waste in a sanitary landfill, 'scrap aluminium' treated as waste in municipal incineration, and 'aluminium scrap, post-consumer' treated as recyclable and sent to a recycling facility.

In order to enhance clarity and consistency, the nomenclature of metal by-products is revised for v3.11. A metal by-product is called 'waste' only when the flow ends up in a formal or informal treatment activity, such as municipal incineration, sanitary landfill, open dump, etc. On the other hand, the term 'scrap' is used only when a metal by-product gets recycled to be used again as secondary material. According to this new nomenclature, many products and activities are renamed as indicated in **Table 79** and **Table 80**.

On top of the nomenclature update, an assessment is performed to identify what is the fate of these flows when they reach their end-of-life; if they are treated or recycled. The flows treated as waste are renamed as described above, while the flows send for recycling are replaced with relevant scrap metal exchanges as mentioned in **Table 81**.

Table 79. Product names updated based on the new metal waste nomenclature.

Product Name v3.10	Product Name v3.11
scrap aluminium	waste aluminium
scrap copper	waste copper
scrap steel	waste steel
scrap tin sheet	waste tin sheet
bottom ash, MSWI, scrap aluminium	bottom ash, MSWI, waste aluminium
bottom ash, MSWI, scrap copper	bottom ash, MSWI, waste copper
bottom ash, MSWI, scrap steel	bottom ash, MSWI, waste steel
bottom ash, MSWI, scrap tin sheet	bottom ash, MSWI, waste tin sheet
bottom ash, MSWI[F], scrap aluminium	bottom ash, MSWI[F], waste aluminium
bottom ash, MSWI[F], scrap copper	bottom ash, MSWI[F], waste copper
bottom ash, MSWI[F], scrap steel	bottom ash, MSWI[F], waste steel
bottom ash, MSWI[F], scrap tin sheet	bottom ash, MSWI[F], waste tin sheet
bottom ash, MSWI-WWT-SLF, scrap tin sheet	bottom ash, MSWI-WWT-SLF, waste tin sheet

leachate, SLF, scrap tin sheet	leachate, SLF, waste tin sheet
residues, MSWI, scrap tin sheet	residues, MSWI, waste tin sheet
residues, MSWI[F], scrap tin sheet	residues, MSWI[F], waste tin sheet
residues, MSWI-WWT-SLF, scrap tin sheet	residues, MSWI-WWT-SLF, waste tin sheet
sewage sludge, 70% water, WWT-SLF, scrap tin sheet	sewage sludge, 70% water, WWT-SLF, waste tin sheet
sewage sludge, 97% water, WWT-SLF, scrap tin sheet	sewage sludge, 97% water, WWT-SLF, waste tin sheet

Table 80. Activity names updated based on the new metal waste nomenclature.

Activity Name v3.10	Activity Name v3.11
market for bottom ash, MSWI, scrap aluminium	market for bottom ash, MSWI, waste aluminium
market for bottom ash, MSWI[F], scrap aluminium	market for bottom ash, MSWI[F], waste aluminium
treatment of bottom ash, MSWI, scrap aluminium, slag compartment	treatment of bottom ash, MSWI, waste aluminium, slag compartment
treatment of bottom ash, MSWI[F], scrap aluminium, slag compartment	treatment of bottom ash, MSWI[F], waste aluminium, slag compartment
treatment of scrap aluminium, municipal incineration	treatment of waste aluminium, municipal incineration
treatment of scrap aluminium, municipal incineration FAE	treatment of waste aluminium, municipal incineration FAE
market for bottom ash, MSWI, scrap copper	market for bottom ash, MSWI, waste copper
market for bottom ash, MSWI[F], scrap copper	market for bottom ash, MSWI[F], waste copper
market for scrap copper	market for waste copper
treatment of bottom ash, MSWI, scrap copper, slag compartment	treatment of bottom ash, MSWI, waste copper, slag compartment
treatment of bottom ash, MSWI[F], scrap copper, slag compartment	treatment of bottom ash, MSWI[F], waste copper, slag compartment
treatment of scrap copper, municipal incineration	treatment of waste copper, municipal incineration
treatment of scrap copper, municipal incineration FAE	treatment of waste copper, municipal incineration FAE
market for bottom ash, MSWI, scrap steel	market for bottom ash, MSWI, waste steel
market for bottom ash, MSWI[F], scrap steel	market for bottom ash, MSWI[F], waste steel

market for scrap steel	market for waste steel
treatment of bottom ash, MSWI, scrap steel, slag compartment	treatment of bottom ash, MSWI, waste steel, slag compartment
treatment of bottom ash, MSWI[F], scrap steel, slag compartment	treatment of bottom ash, MSWI[F], waste steel, slag compartment
treatment of scrap steel, inert material landfill	treatment of waste steel, inert material landfill
treatment of scrap steel, municipal incineration	treatment of waste steel, municipal incineration
treatment of scrap steel, municipal incineration FAE	treatment of waste steel, municipal incineration FAE
market for bottom ash, MSWI, scrap tin sheet	market for bottom ash, MSWI, waste tin sheet
market for bottom ash, MSWI-WWT-SLF, scrap tin sheet	market for bottom ash, MSWI-WWT-SLF, waste tin sheet
market for bottom ash, MSWI[F], scrap tin sheet	market for bottom ash, MSWI[F], waste tin sheet
market for leachate, SLF, scrap tin sheet	market for leachate, SLF, waste tin sheet
market for residues, MSWI, scrap tin sheet	market for residues, MSWI, waste tin sheet
market for residues, MSWI-WWT-SLF, scrap tin sheet	market for residues, MSWI-WWT-SLF, waste tin sheet
market for residues, MSWI[F], scrap tin sheet	market for residues, MSWI[F], waste tin sheet
market for scrap tin sheet	market for waste tin sheet
market for sewage sludge, 70% water, WWT-SLF, scrap tin sheet	market for sewage sludge, 70% water, WWT-SLF, waste tin sheet
market for sewage sludge, 97% water, WWT-SLF, scrap tin sheet	market for sewage sludge, 97% water, WWT-SLF, waste tin sheet
treatment of bottom ash, MSWI, scrap tin sheet, slag compartment	treatment of bottom ash, MSWI, waste tin sheet, slag compartment
treatment of bottom ash, MSWI-WWT-SLF, scrap tin sheet, slag compartment	treatment of bottom ash, MSWI-WWT-SLF, waste tin sheet, slag compartment
treatment of bottom ash, MSWI[F], scrap tin sheet, slag compartment	treatment of bottom ash, MSWI[F], waste tin sheet, slag compartment
treatment of leachate, SLF, scrap tin sheet, wastewater treatment	treatment of leachate, SLF, waste tin sheet, wastewater treatment
treatment of residues, MSWI, scrap tin sheet, residual material landfill	treatment of residues, MSWI, waste tin sheet, residual material landfill
treatment of residues, MSWI-WWT-SLF, scrap tin sheet, residual material landfill	treatment of residues, MSWI-WWT-SLF, waste tin sheet, residual material landfill
treatment of residues, MSWI[F], scrap tin sheet, residual material landfill	treatment of residues, MSWI[F], waste tin sheet, residual material landfill
treatment of scrap tin sheet, municipal incineration	treatment of waste tin sheet, municipal incineration

treatment of scrap tin sheet, municipal incineration FAE	treatment of waste tin sheet, municipal incineration FAE
treatment of scrap tin sheet, sanitary landfill	treatment of waste tin sheet, sanitary landfill
treatment of sewage sludge, 70% water, WWT-SLF, scrap tin sheet, municipal incineration	treatment of sewage sludge, 70% water, WWT-SLF, waste tin sheet, municipal incineration
treatment of sewage sludge, 97% water, WWT-SLF, scrap tin sheet, landfarming	treatment of sewage sludge, 97% water, WWT-SLF, waste tin sheet, landfarming

Table 81. Metal by-products with updated end-of-life fate

Activity Name	Geography	ByProduct v3.10	ByProduct v3.11
aircraft production, agricultural	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, agricultural	GLO	scrap steel	iron scrap, unsorted
aircraft production, belly-freight aircraft, long haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, belly-freight aircraft, long haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, belly-freight aircraft, medium haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, belly-freight aircraft, medium haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, belly-freight aircraft, short haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, belly-freight aircraft, short haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, belly-freight aircraft, very short haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, belly-freight aircraft, very short haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, dedicated freight aircraft, long haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, dedicated freight aircraft, long haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, dedicated freight aircraft, medium haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, dedicated freight aircraft, medium haul	GLO	scrap steel	iron scrap, unsorted

aircraft production, dedicated freight aircraft, short haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, dedicated freight aircraft, short haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, dedicated freight aircraft, very short haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, dedicated freight aircraft, very short haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, passenger aircraft, long haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, passenger aircraft, long haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, passenger aircraft, medium haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, passenger aircraft, medium haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, passenger aircraft, short haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, passenger aircraft, short haul	GLO	scrap steel	iron scrap, unsorted
aircraft production, passenger aircraft, very short haul	GLO	scrap aluminium	aluminium scrap, post-consumer
aircraft production, passenger aircraft, very short haul	GLO	scrap steel	iron scrap, unsorted
bulk carrier production, for dry goods	GLO	scrap steel	iron scrap, unsorted
casting, aluminium, lost-wax	CA-QC; GLO	scrap steel	iron scrap, unsorted
casting, steel, lost-wax	CA-QC; GLO	scrap steel	iron scrap, unsorted
container ship production	GLO	scrap aluminium	aluminium scrap, post-consumer
container ship production	GLO	scrap steel	iron scrap, unsorted
ferry production	GLO	scrap aluminium	aluminium scrap, post-consumer
ferry production	GLO	scrap steel	iron scrap, unsorted
fish curing, small fish	PE; GLO	scrap aluminium	aluminium scrap, post-consumer
hydropower plant construction, reservoir	CA-QC; GLO	scrap steel	iron scrap, unsorted
hydropower plant construction, run-of-river	CA-QC; GLO	scrap steel	iron scrap, unsorted
photovoltaic module production, building-integrated, for facade installation	GLO	scrap aluminium	aluminium scrap, post-consumer

photovoltaic module production, building-integrated, for slanted-roof installation	GLO	scrap aluminium	aluminium scrap, post-consumer
photovoltaic module production, building-integrated, for slanted-roof installation	GLO	scrap steel	iron scrap, unsorted
photovoltaic mounting system production, for 570kWp open ground module	GLO	scrap aluminium	aluminium scrap, post-consumer
photovoltaic mounting system production, for 570kWp open ground module	GLO	scrap steel	iron scrap, unsorted
photovoltaic mounting system production, for facade installation	GLO	scrap aluminium	aluminium scrap, post-consumer
photovoltaic mounting system production, for facade installation	GLO	scrap steel	iron scrap, unsorted
photovoltaic mounting system production, for flat-roof installation	GLO	scrap aluminium	aluminium scrap, post-consumer
photovoltaic mounting system production, for flat-roof installation	GLO	scrap steel	iron scrap, unsorted
photovoltaic mounting system production, for slanted-roof installation	GLO	scrap aluminium	aluminium scrap, post-consumer
photovoltaic mounting system production, for slanted-roof installation	GLO	scrap steel	iron scrap, unsorted
photovoltaics, electric installation for 3kWp module, at building	CH; GLO	scrap steel	iron scrap, unsorted
section bar extrusion, aluminium	RER; GLO	scrap aluminium	aluminium scrap, new
sheet rolling, aluminium	RER; GLO	scrap aluminium	aluminium scrap, new
treatment of electronics scrap from control units	RER; GLO	scrap steel	iron scrap, unsorted
treatment of used cathode ray tube display, manual dismantling	CH; GLO	scrap steel	iron scrap, unsorted
treatment of used door, outer, wood-aluminium, collection for final disposal	CH; GLO	scrap steel	iron scrap, unsorted
treatment of used door, outer, wood-glass, collection for final disposal	CH; GLO	scrap steel	iron scrap, unsorted
treatment of used flexible duct, aluminium/PET, DN of 125	CH; GLO	scrap aluminium	aluminium scrap, post-consumer
treatment of used flexible duct, aluminium/PET, DN of 125	CH; GLO	scrap steel	iron scrap, unsorted
treatment of used intermodal shipping container, 20-foot	GLO	scrap steel	iron scrap, unsorted
treatment of used intermodal shipping container, 40-foot	GLO	scrap steel	iron scrap, unsorted
treatment of used intermodal shipping container, 40-foot, high-cube	GLO	scrap steel	iron scrap, unsorted

treatment of used intermodal shipping container, 45-foot, high-cube	GLO	scrap steel	iron scrap, unsorted
treatment of used sealing tape, aluminium/PE, 50 mm wide	CH; GLO	scrap aluminium	aluminium scrap, post-consumer
water works construction, capacity 1.1E10l/year, conventional treatment	CH; Europe without Switzerland; CA-QC; GLO	scrap steel	iron scrap, unsorted
water works construction, capacity 1.1E10l/year, direct filtration treatment	CH; Europe without Switzerland; CA-QC; GLO	scrap steel	iron scrap, unsorted
water works construction, capacity 1.1E10l/year, microstrainer treatment	CA-QC; Europe without Switzerland; GLO	scrap steel	iron scrap, unsorted
water works construction, capacity 1.1E10l/year, ultrafiltration treatment	CA-QC; Europe without Switzerland; GLO	scrap steel	iron scrap, unsorted
water works construction, capacity 6.23E10l/year, seawater reverse osmosis, conventional pretreatment	GLO	scrap aluminium	iron scrap, unsorted
water works construction, capacity 6.23E10l/year, seawater reverse osmosis, ultrafiltration pretreatment	GLO	scrap steel	iron scrap, unsorted
wind power plant construction, 2MW, offshore, fixed parts	GLO	scrap steel	iron scrap, unsorted
wind power plant construction, 800kW, fixed parts	GLO	scrap steel	iron scrap, unsorted
wind turbine construction, 2.3MW, precast concrete tower, onshore	CA-QC; GLO	scrap steel	iron scrap, unsorted
wind turbine construction, 2MW, onshore	GLO	scrap steel	iron scrap, unsorted
wind turbine construction, 4.5MW, onshore	GLO	scrap steel	iron scrap, unsorted
wind turbine construction, 750kW, onshore	CA-QC; GLO	scrap steel	iron scrap, unsorted
wind turbine construction, small-scale, 6kW, onshore	DE	scrap steel	iron scrap, unsorted
wind turbine network connection construction, 4.5MW, onshore	GLO	scrap steel	iron scrap, unsorted
wood preservation facility construction, dipping/immersion tank	GLO	scrap steel	iron scrap, unsorted
wood preservation facility construction, flow coating equipment	GLO	scrap steel	iron scrap, unsorted
wood preservation facility construction, hot/cold dipping tank	GLO	scrap steel	iron scrap, unsorted

wood preservation facility construction, oscillating pressure vessel	GLO	scrap steel	iron scrap, unsorted
wood preservation facility construction, vacuum pressure vessel	GLO	scrap steel	iron scrap, unsorted

11.10 Other updates

For the new version 3.11, a couple of minor updates were implemented to address small issues identified in previous versions.

11.10.1 Water emission in markets for leachates

Market datasets modelling the transport of leachate to the treatment plant include transport losses happening from the pipes. The amount of losses is adjusted to account also for the water emitted to the Environment. The water emission is calculated according to the composition of each leachate and the percentage of losses happening in each country.

11.10.2 Activity links in cement, hydrated

In the datasets modelling the treatment of residual material landfill, there is the by-product of 'waste cement, hydrated'. This by-product accounts for hydrated cement used for the solidification of landfilled residual material.

Until v3.10, this waste was transported via a market dataset to another residual material landfill to model its own treatment. However, waste cement is treated in the same residual landfill as the waste it solidifies. Therefore, there is no need to add extra transport. So, the respective market datasets covering the transport of waste cement from one residual material landfill to another similar landfill are now replaced by an activity link. This activity link connects waste cement directly to its residual material landfill treatment without any further unnecessary transport distances.

12 Agriculture

12.1 General

This section covers the changes to the ecoinvent database regarding in the Agriculture, Fishery & Animal Husbandry sector between v3.10 and v3.11. This section describes new datasets added to the database and corrections in specific datasets. The latter consist in the addition of new datasets, in the deletion of outdated ones, and in the update, re-modelling, or corrections of some others.

12.2 New Data for Switzerland

v3.11 includes 136 new datasets for the Swiss regions related to organic and conventional production of several crops, vegetables, cereals, legumes and grapes. The collected data are categorized according to different cultivation zones: plain, hill, and mountain regions. This data project was a result of a collaboration between the ecoinvent Association and Agroscope Research Centre for Life Cycle Inventory creation, validation and finalization.

Table 82. New Datasets in v3.11 for agriculture in Switzerland.

Activity Name	Geography	Time Period	Product Name	Unit
apple production, conventional, plain region	CH	2017-2021	apple	kg
apple production, conventional, mountain region	CH	2017-2021	apple	kg
apple production, conventional, hill region	CH	2017-2021	apple	kg
apple production, organic, plain region	CH	2017-2021	apple, organic	kg
apple production, organic, hill region	CH	2017-2021	apple, organic	kg
barley grain production, winter, organic, plain region	CH	2017-2021	barley grain, organic	kg
barley grain production, winter, organic, mountain region	CH	2017-2021	barley grain, organic	kg
barley grain production, winter, organic, hill region	CH	2017-2021	barley grain, organic	kg
barley grain production, winter, conventional, plain region	CH	2017-2021	barley grain	kg
barley grain production, winter, conventional, mountain region	CH	2017-2021	barley grain	kg
barley grain production, winter, conventional, hill region	CH	2017-2021	barley grain	kg
bean production, conventional, plain region	CH	2017-2021	bean	kg
soybean production, conventional, plain region	CH	2017-2021	soybean	kg

soybean production, organic, plain region	CH	2017-2021	soybean, organic	kg
bean production, organic, plain region	CH	2017-2021	bean, organic	kg
broccoli production, conventional, plain region	CH	2017-2021	broccoli	kg
broccoli production, organic, plain region	CH	2017-2021	broccoli, organic	kg
carrot production, conventional, plain region	CH	2017-2021	carrot	kg
carrot production, organic, plain region	CH	2017-2021	carrot, organic	kg
cauliflower production, conventional, plain region	CH	2017-2021	cauliflower	kg
cauliflower production, organic, plain region	CH	2017-2021	cauliflower, organic	kg
field bean production as feed, organic, plain region	CH	2017-2021	field bean, feed, organic	kg
field bean production as feed, organic, hill region	CH	2017-2021	field bean, feed, organic	kg
field bean production as feed, conventional, plain region	CH	2017-2021	field bean, feed	kg
field bean production as feed, conventional, hill region	CH	2017-2021	field bean, feed	kg
protein pea production as feed, organic, plain region	CH	2017-2021	protein pea, feed, organic	kg
protein pea production as feed, organic, mountain region	CH	2017-2021	protein pea, feed, organic	kg
protein pea production as feed, organic, hill region	CH	2017-2021	protein pea, feed, organic	kg
protein pea production as feed, conventional, plain region	CH	2017-2021	protein pea, feed, Swiss integrated production	kg
protein pea production as feed, conventional, mountain region	CH	2017-2021	protein pea, feed, Swiss integrated production	kg
protein pea production as feed, conventional, hill region	CH	2017-2021	protein pea, feed, Swiss integrated production	kg
maize grain production, conventional, plain region	CH	2017-2021	maize grain	kg
maize grain production, conventional, hill region	CH	2017-2021	maize grain	kg
maize grain production, organic, hill region	CH	2017-2021	maize grain, organic	kg
maize grain production, organic, plain region	CH	2017-2021	maize grain, organic	kg

maize silage production, organic, plain region	CH	2017-2021	maize silage, organic	kg
maize silage production, organic, mountain region	CH	2017-2021	maize silage, organic	kg
maize silage production, organic, hill region	CH	2017-2021	maize silage, organic	kg
maize silage production, conventional, plain region	CH	2017-2021	maize silage	kg
maize silage production, conventional, mountain region	CH	2017-2021	maize silage	kg
maize silage production, conventional, hill region	CH	2017-2021	maize silage	kg
oat grain production, spring, organic, plain region	CH	2017-2021	oat grain, organic	kg
oat grain production, spring, organic, mountain region	CH	2017-2021	oat grain, organic	kg
oat grain production, spring, organic, hill region	CH	2017-2021	oat grain, organic	kg
oat grain production, spring, conventional, plain region	CH	2017-2021	oat grain	kg
oat grain production, spring, conventional, mountain region	CH	2017-2021	oat grain	kg
oat grain production, spring, conventional, hill region	CH	2017-2021	oat grain	kg
onion production, conventional, plain region	CH	2017-2021	onion	kg
onion production, organic, plain region	CH	2017-2021	onion, organic	kg
pea production, conventional, plain region	CH	2017-2021	pea	kg
pea production, conventional, mountain region	CH	2017-2021	pea	kg
pea production, conventional, hill region	CH	2017-2021	pea	kg
pea production, organic, plain region	CH	2017-2021	pea, organic	kg
pea production, organic, mountain region	CH	2017-2021	pea, organic	kg
pea production, organic, hill region	CH	2017-2021	pea, organic	kg
pear production, conventional, plain region	CH	2017-2021	pear	kg
pear production, conventional, mountain region	CH	2017-2021	pear	kg
pear production, conventional, hill region	CH	2017-2021	pear	kg
pear production, organic, plain region	CH	2017-2021	pear, organic	kg
pear production, organic, hill region	CH	2017-2021	pear, organic	kg

potato production, conventional, plain region	CH	2017-2021	potato	kg
potato production, conventional, mountain region	CH	2017-2021	potato	kg
potato production, conventional, hill region	CH	2017-2021	potato	kg
potato production, organic, plain region	CH	2017-2021	potato, organic	kg
potato production, organic, mountain region	CH	2017-2021	potato, organic	kg
potato production, organic, hill region	CH	2017-2021	potato, organic	kg
potato seed production, conventional, hill region	CH	2017-2021	potato seed	kg
potato seed production, conventional, mountain region	CH	2017-2021	potato seed	kg
potato seed production, conventional, plain region	CH	2017-2021	potato seed	kg
potato seed production, organic, hill region	CH	2017-2021	potato seed, organic	kg
potato seed production, organic, plain region	CH	2017-2021	potato seed, organic	kg
rape seed production, winter, organic, plain region	CH	2017-2021	rape seed, organic	kg
rape seed production, winter, organic, hill region	CH	2017-2021	rape seed, organic	kg
rape seed production, winter, conventional, plain region	CH	2017-2021	rape seed	kg
rape seed production, winter, conventional, mountain region	CH	2017-2021	rape seed	kg
rape seed production, winter, conventional, hill region	CH	2017-2021	rape seed	kg
rye grain production, winter, organic, plain region	CH	2017-2021	rye grain, organic	kg
rye grain production, winter, organic, mountain region	CH	2017-2021	rye grain, organic	kg
rye grain production, winter, organic, hill region	CH	2017-2021	rye grain, organic	kg
rye grain production, winter, conventional, plain region	CH	2017-2021	rye grain	kg
rye grain production, winter, conventional, mountain region	CH	2017-2021	rye grain	kg
rye grain production, winter, conventional, hill region	CH	2017-2021	rye grain	kg
spelt grain production, conventional, hill region	CH	2017-2021	spelt grain	kg

spelt grain production, conventional, mountain region	CH	2017-2021	spelt grain	kg
spelt grain production, conventional, plain region	CH	2017-2021	spelt grain	kg
spelt grain production, organic, hill region	CH	2017-2021	spelt grain, organic	kg
spelt grain production, organic, mountain region	CH	2017-2021	spelt grain, organic	kg
spelt grain production, organic, plain region	CH	2017-2021	spelt grain, organic	kg
spinach production, conventional, plain region	CH	2017-2021	spinach	kg
spinach production, organic, plain region	CH	2017-2021	spinach, organic	kg
sugar beet production, conventional, plain region	CH	2017-2021	sugar beet	kg
sugar beet production, organic, plain region	CH	2017-2021	sugar beet, organic	kg
sunflower production, conventional, hill region	CH	2017-2021	sunflower	kg
soybean production, conventional, hill region	CH	2017-2021	soybean	kg
sunflower production, conventional, plain region	CH	2017-2021	sunflower	kg
sunflower production, organic, plain region	CH	2017-2021	sunflower, organic	kg
sunflower production, organic, hill region	CH	2017-2021	sunflower, organic	kg
grape production, conventional, hill region	CH	2017-2021	grape	kg
grape production, conventional, mountain region	CH	2017-2021	grape	kg
grape production, conventional, plain region	CH	2017-2021	grape	kg
grape production, organic, hill region	CH	2017-2021	grape, organic	kg
grape production, organic, mountain region	CH	2017-2021	grape, organic	kg
grape production, organic, plain region	CH	2017-2021	grape, organic	kg
triticale grain production, winter, conventional, hill region	CH	2017-2021	triticale grain	kg
triticale grain production, winter, conventional, mountain region	CH	2017-2021	triticale grain	kg
triticale grain production, winter, conventional, plain region	CH	2017-2021	triticale grain	kg
triticale grain production, winter, organic, hill region	CH	2017-2021	triticale grain, organic	kg

triticale grain production, winter, organic, mountain region	CH	2017-2021	triticale grain, organic	kg
triticale grain production, winter, organic, plain region	CH	2017-2021	triticale grain, organic	kg
wheat grain production, spring, conventional, hill region	CH	2017-2021	wheat grain	kg
wheat grain production, spring, conventional, mountain region	CH	2017-2021	wheat grain	kg
wheat grain production, spring, conventional, plain region	CH	2017-2021	wheat grain	kg
wheat grain production, spring, organic, hill region	CH	2017-2021	wheat grain, organic	kg
wheat grain production, spring, organic, mountain region	CH	2017-2021	wheat grain, organic	kg
wheat grain production, spring, organic, plain region	CH	2017-2021	wheat grain, organic	kg
wheat grain production, winter, conventional, hill region	CH	2017-2021	wheat grain	kg
wheat grain production, winter, conventional, mountain region	CH	2017-2021	wheat grain	kg
wheat grain production, winter, conventional, plain region	CH	2017-2021	wheat grain	kg
wheat grain production, winter, organic, hill region	CH	2017-2021	wheat grain, organic	kg
wheat grain production, winter, organic, mountain region	CH	2017-2021	wheat grain, organic	kg
wheat grain production, winter, organic, plain region	CH	2017-2021	wheat grain, organic	kg
wheat grain, feed production, conventional, hill region	CH	2017-2021	wheat grain, feed	kg
wheat grain, feed production, conventional, mountain region	CH	2017-2021	wheat grain, feed	kg
wheat grain, feed production, conventional, plain region	CH	2017-2021	wheat grain, feed	kg
wheat grain, feed production, organic, hill region	CH	2017-2021	wheat grain, feed, organic	kg
wheat grain, feed production, organic, mountain region	CH	2017-2021	wheat grain, feed, organic	kg
wheat grain, feed production, organic, plain region	CH	2017-2021	wheat grain, feed, organic	kg
white cabbage production, conventional, plain region	CH	2017-2021	white cabbage	kg

white cabbage production, organic, plain region	CH	2017-2021	white cabbage, organic	kg
zucchini production, conventional, plain region	CH	2017-2021	zucchini	kg
zucchini production, organic, plain region	CH	2017-2021	zucchini, organic	kg

12.3 Other updates

Table 83 contains changes in activity name in datasets between v3.10 and v3.11 related to agricultural datasets. These changes aim to meet the official nomenclature and increase coherence throughout the database.

Table 83. Activities renamed from v3.10 to v3.11 in the agricultural sector.

Activity Name v3.10	Geography	Activity Name v3.11
beet sugar production	GLO	sugar beet production
beet sugar production	CH	sugar beet production
lettuce360 production, in heated greenhouse	GLO	lettuce production, in heated greenhouse
lettuce361 production	GLO	lettuce production
celery675 production	GLO	celery production
peanut production, reduced tillage	BR-SP	peanut production, in cropping system

In v3.10 there was an issue in the calculation of "Dinitrogen Monoxide" (N2O) emissions and its relative comment throughout the United States of America (US) datasets. For v3.11 the emissions are recalculated in collaboration with the data provider. As a result, the amounts of the "Dinitrogen Monoxide" elementary exchange is updated for the datasets in **Table 84**. The emissions follow the SBTi guidelines.

Table 84. Updated activities related to N2O emission corrections.

Activity Name	Geography	Old value of N2O in v3.10	New value of N2O in v3.11	Unit
maize grain production	US-IA	1.65E-04	3.98E-04	kg

maize grain production	US-IL	1.65E-04	4.52E-04	kg
maize grain production	US-IN	1.66E-04	4.63E-04	kg
maize grain production	US-MN	1.64E-04	4.27E-04	kg
maize grain production	US-NE	1.65E-04	4.60E-04	kg
maize grain production	US-SD	1.65E-04	4.28E-04	kg
maize grain production	US-WI	1.59E-04	3.91E-04	kg
potato production	US-CO	8.53E-05	1.35E-04	kg
potato production	US-ID	8.56E-05	1.86E-04	kg
potato production	US-MN	8.54E-05	1.42E-04	kg
potato production	US-ND	8.56E-05	1.79E-04	kg
potato production	US-OR	8.54E-05	1.48E-04	kg
potato production	US-WA	8.53E-05	1.24E-04	kg
potato production	US-WI	8.56E-05	1.82E-04	kg
soybean production	US-IA	1.77E-04	1.13E-04	kg
soybean production	US-IL	1.77E-04	1.18E-04	kg
soybean production	US-IN	1.77E-04	1.31E-04	kg
soybean production	US-MN	1.76E-04	1.15E-04	kg
soybean production	US-ND	1.77E-04	1.51E-04	kg
soybean production	US-NE	1.74E-04	1.23E-04	kg
soybean production	US-OH	1.77E-04	1.18E-04	kg
sweet corn production	US-CA	4.96E-05	1.74E-04	kg
sweet corn production	US-FL	4.97E-05	1.97E-04	kg
sweet corn production	US-MN	4.97E-05	1.95E-04	kg
sweet corn production	US-OR	4.98E-05	2.04E-04	kg
sweet corn production	US-WA	4.97E-05	2.02E-04	kg
sweet corn production	US-WI	5.03E-05	2.91E-04	kg

A significant positive impact on land use category for legumes datasets for Canada was identified due to the “Transformation, From unspecified” elementary exchange. **Table 85** reports the list of datasets affected. The land transformation was corrected to “Transformation, From Annual Crop, Non-Irrigated”.

Table 85. Updated activities related to the Land Transformation exchange.

Activity Name	Geography
fava bean production	CA-AB
fava bean production	CA-MB
fava bean production	CA-SK
lentil production	CA-AB
lentil production	CA-SK
navy bean production	CA-MB
navy bean production	CA-ON
pinto bean production	CA-AB
pinto bean production	CA-MB
protein pea production	CA-AB
protein pea production	CA-MB
protein pea production	CA-SK
red kidney bean production	CA-MB
red kidney bean production	CA-ON

In several Australian datasets for cereal in different regions, it was noticed a carbon imbalance derived from the modelling from burning residues due to emissions from soil. For the datasets reported in **Table 86**, the elementary exchange “Methane, From Soil or Biomass Stock” was substituted with “Methane, Non-Fossil” representing biogenic emissions (which are not stocked in the biomass nor the soil).The elementary exchange of “Carbon Monoxide, From Soil or Biomass Stock” was deleted and the values for “Carbon Monoxide, Non-Fossil” were updated because, similar to the methane flow, they describes the biogenic emissions of degradation of residues on field (which are not stocked in the biomass nor the soil).

Table 86. Updated activities where “Methane, From Soil or Biomass Stock” elementary exchange was substituted with “Methane, Non-Fossil”, and “Carbon Monoxide, Non-Fossil”.

Activity Name	Geography	Updated amount for Carbon Monoxide, Non-Fossil	Unit
barley grain production	AU-NSW	8.56E-03	kg
barley grain production	AU-QLD	2.35E-03	kg
barley grain production	AU-SA	4.70E-03	kg
barley grain production	AU-TAS	3.48E-03	kg
barley grain production	AU-VIC	8.16E-03	kg
barley grain production	AU-WA	2.34E-03	kg
maize grain production	AU-NSW	5.24E-03	kg
maize grain production	AU-QLD	3.81E-04	kg
maize grain production	AU-VIC	5.24E-03	kg
oat grain production	AU-NSW	9.39E-03	kg
oat grain production	AU-QLD	7.17E-04	kg
oat grain production	AU-SA	1.13E-03	kg
oat grain production	AU-TAS	5.13E-03	kg
oat grain production	AU-VIC	9.36E-03	kg
oat grain production	AU-WA	4.83E-03	kg
rape seed production	AU-NSW	1.55E-02	kg
rape seed production	AU-QLD	4.23E-03	kg
rape seed production	AU-SA	8.47E-03	kg
rape seed production	AU-VIC	1.48E-02	kg
rape seed production	AU-WA	4.22E-03	kg
wheat grain production	AU-NSW	1.04E-02	kg
wheat grain production	AU-QLD	5.75E-04	kg
wheat grain production	AU-SA	5.71E-03	kg
wheat grain production	AU-TAS	4.20E-03	kg

wheat grain production	AU-VIC	9.91E-03	kg
wheat grain production	AU-WA	2.85E-03	kg

The amount of glyphosate for the soybean production activity in Argentina (AR) is updated because there was an issue in the order of magnitude in comparison to other geographies. The issue was attributed to the fact that the reference amount was reported to be 2.34 kg/ha. However, in the database, each amount is recorded per kilogram of product, so the right amount to insert in the dataset for glyphosate is 0.0009 kg.

A specific issue was identified in relation to calculation of land occupation for Brazilian (BR) datasets since they were estimated in ha*year instead of m2 *year. **Table 87** shows which datasets are updated and their new values.

Table 87. Updated activities where Land Occupation was updated.

Activity Name	Geography	Old value of Land Occupation in v3.10	New value of Land Occupation in v3.11	Unit
maize grain production, first crop	BR-BA	2.05E-05	2.05E-01	m2*year
maize grain production, first crop	BR-GO	7.74E-06	7.70E-02	m2*year
maize grain production, first crop	BR-MA	1.67E-05	1.67E-01	m2*year
maize grain production, first crop	BR-MG	1.76E-05	1.76E-01	m2*year
maize grain production, first crop	BR-PI	2.03E-05	2.03E-01	m2*year
maize grain production, first crop	BR-PR	4.36E-06	4.40E-02	m2*year
maize grain production, first crop	BR-RS	2.34E-05	2.34E-01	m2*year
maize grain production, second crop	BR-GO	5.39E-05	5.39E-01	m2*year
maize grain production, second crop	BR-MA	3.69E-05	3.69E-01	m2*year
maize grain production, second crop	BR-MG	6.74E-05	6.74E-01	m2*year
maize grain production, second crop	BR-MS	9.28E-05	9.28E-01	m2*year
maize grain production, second crop	BR-MT	6.91E-05	6.91E-01	m2*year

maize grain production, second crop	BR-PR	6.26E-05	6.26E-01	m2*year
maize grain production, second crop	BR-SP	1.02E-04	1.02E+00	m2*year
maize grain production, second crop	BR-TO	2.10E-05	2.10E-01	m2*year
soybean production	BR-BA	2.32E-04	2.32E+00	m2*year
soybean production	BR-GO	1.71E-04	1.71E+00	m2*year
soybean production	BR-MA	2.38E-04	2.38E+00	m2*year
soybean production	BR-MG	1.16E-04	1.16E+00	m2*year
soybean production	BR-MS	1.48E-04	1.48E+00	m2*year
soybean production	BR-MT	1.51E-04	1.51E+00	m2*year
soybean production	BR-PI	2.89E-04	2.89E+00	m2*year
soybean production	BR-PR	1.17E-04	1.17E+00	m2*year
soybean production	BR-RS	1.33E-04	1.33E+00	m2*year
soybean production	BR-SP	1.44E-04	1.44E+00	m2*year
soybean production	BR-TO	1.93E-04	1.93E+00	m2*year
sugarcane production	BR-GO	1.60E-05	1.60E-01	m2*year
sugarcane production	BR-MG	1.40E-05	1.40E-01	m2*year
sugarcane production	BR-MS	1.80E-05	1.80E-01	m2*year
sugarcane production	BR-MT	1.80E-05	1.80E-01	m2*year
sugarcane production	BR-PR	1.61E-05	1.61E-01	m2*year
sugarcane production	BR-SP	1.39E-05	1.39E-01	m2*year

In addition, for soybean production, BR-GO (Brazil, state of Goiás) there was an issue regarding the emission amounts of Chlorpyrifos. In accordance with the data provider, the values are updated as reported in **Table 88**.

Table 88. Updated values of Chlorpyrifos exchange for soybean production, BR-GO per compartment.

Exchange Name	Compartment	Old value in v3.10	New value in v3.11	Unit
Chlorpyrifos	Air, non-urban air or from high stacks	2.28E-03	3.41E-06	kg
Chlorpyrifos	Soil, agricultural	2.02E-02	3.01E-05	kg
Chlorpyrifos	Soil, forestry	6.17E-05	9.19E-08	kg
Chlorpyrifos	Water, ground-	3.95E-06	5.90E-09	kg
Chlorpyrifos	Water, unspecified	3.23E-06	4.82E-09	kg

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

- For sugarcane production, GLO (Global); Land occupation and transformation is changed, “To Permanent” since sugarcane production lasts from 5 to 7 years in the field and it is a permanent crop.

- For Palm fruit bunch production, CO (Colombia); Land transformation was updated from “Transformation, From Forest, Intensive” to “Transformation, From Grassland” and from “Transformation, To Forest, Intensive" to “Transformation, To Permanent Crop” to comply with the GHG protocols.

13 Wood and Forestry

The updates in the Wood & Forestry sector focused on revising existing data, particularly the production volumes of forestry activities.

13.1 Updated production volumes of forestry activities

The production volumes of the forestry activities listed in **Table 89** have been updated based on 5-year averages (2017–2021), except for the activity “hardwood forestry, eucalyptus ssp., planted forest management”, where a 3-year average (2019–2021) was applied. The data for production volumes was sourced from national statistics and FAOSTAT, and detailed documentation of these updates is provided in the production volume comment for each affected activity (APCOR, 2021; BAFU, 2022; Destatis, 2023; FAOSTAT, 2023; IBGE, 2022a; IBGE, 2022b; Skogsstyrelsen, 2023; Statistics Canada, 2023). The updates of production volumes have affected the market shares of the respective products, resulting in changes to the scores of certain market activities.

Table 89. Updated forestry activities and affected markets.

Activity Name	Geography	Time Period	Product Name	Unit
cork forestry	PT; GLO	1996-2003	cork, raw; cleft timber, measured as dry mass	kg; kg
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	kg; m^3; m^3; kg
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	kg; kg; m^3; m^3; kg
hardwood forestry, eucalyptus ssp., planted forest management	BR-GO; BR-MG; BR-SP; GLO	2012-2016	cleft timber, measured as dry mass	kg
hardwood forestry, mixed species, sustainable forest management	CH	2010-2012	cleft timber, measured as dry mass; pulpwood, hardwood, measured as solid wood under bark;	kg; m^3; m^3; kg

			sawlog and veneer log, hardwood, measured as solid wood under bark; wood chips, wet, measured as dry mass	
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	kg; m^3; m^3; kg
softwood forestry, mixed species, boreal forest	CA-QC	2006-2012	sawlog and veneer log, softwood, measured as solid wood under bark	m^3
softwood forestry, mixed species, sustainable forest management	CH	2010-2012	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	kg; m^3; m^3; kg
softwood forestry, paraná pine, sustainable forest management	BR; GLO	2000-2005	sawlog and veneer log, paraná pine, measured as solid wood under bark	m^3
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	kg; kg; m^3; m^3; kg
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	kg; kg; m^3; m^3; kg
sawlog and veneer log, hardwood, measured as solid wood under bark, import from Europe without Switzerland	CH	2019-2019	sawlog and veneer log, hardwood, measured as solid wood under bark	m^3
pulpwood, softwood, measured as solid wood under	CH	2019-2019	pulpwood, softwood, measured as solid wood under bark	m^3

bark, import from Europe without Switzerland				
sawlog and veneer log, softwood, measured as solid wood under bark, import from Europe without Switzerland	CH	2019-2019	sawlog and veneer log, softwood, measured as solid wood under bark	m^3
market for bundle, energy wood, measured as dry mass	SE; GLO	2019-2019	bundle, energy wood, measured as dry mass	kg
market for cleft timber, measured as dry mass	BR; CH; Europe without Switzerland; GLO	2012-2016 [BR]; 2010-2012 [GLO]; 2019-2019 [others]	cleft timber, measured as dry mass	kg
market for cork, raw	PT; GLO	2019-2019	cork, raw	kg
market for pulpwood, hardwood, measured as solid wood under bark	CH; Europe without Switzerland; GLO	2011-2011 [GLO]; 2019-2019 [others]	pulpwood, hardwood, measured as solid wood under bark	m^3
market for pulpwood, softwood, measured as solid wood under bark	CH; Europe without Switzerland; GLO	2011-2011 [GLO]; 2019-2019 [others]	pulpwood, softwood, measured as solid wood under bark	m^3
market for sawlog and veneer log, hardwood, measured as solid wood under bark	CH; Europe without Switzerland; GLO	2011-2011 [GLO]; 2019-2019 [others]	sawlog and veneer log, hardwood, measured as solid wood under bark	m^3
market for sawlog and veneer log, paraná pine, measured as solid wood under bark	BR; GLO	2019-2019	sawlog and veneer log, paraná pine, measured as solid wood under bark	m^3
market for sawlog and veneer log, softwood, measured as solid wood under bark	CA-QC; CH; Europe without Switzerland; GLO	2006-2012 [CA-QC]; 2011-2011 [GLO]; 2019-2019 [others]	sawlog and veneer log, softwood, measured as solid wood under bark	m^3
market for wood chips, wet, measured as dry mass	CH; Europe without Switzerland; GLO	2011-2011 [GLO]; 2019-2019 [others]	wood chips, wet, measured as dry mass	kg

14 Pulp and Paper

The Pulp and Paper sector has been enhanced with new and updated data focused on paper packaging production in Europe.

14.1 Update of beverage carton converting in Europe

Beverage carton converting was updated with European industry data from 2019. The data is based on a study conducted by ifeu (Institut für Energie- und Umweltforschung) among the members of ACE (The Alliance for Beverage Cartons and the Environment). The study covered approximately 95% of European production in 2019, achieving a high level of representation of the region.

The updated datasets are shown in **Table 90**. The updated beverage carton converting dataset supplies three beverage carton production datasets that were introduced for v3.10.

Table 90. Updated beverage carton converting dataset.

Activity Name	Geography	Time Period	Product Name	Unit
beverage carton converting	RER; GLO	2019-2019	beverage carton converting	m^2
market for beverage carton converting	GLO	2019-2019	beverage carton converting	m^2

14.2 Update of kraft paper and paper sack production in Europe

Kraft paper production and paper sack production were updated with data from 2021. The data was collected by CEPI Eurokraft and Eurosac and provided to the ecoinvent database in collaboration with RISE (Research Institutes of Sweden). The updated datasets related to kraft paper and paper sack production are listed in **Table 91**.

In kraft paper production, fossil fuel consumption has decreased compared to data from 2018, resulting in lower environmental impact scores for kraft paper. Additionally, the amounts of valuable by-products from kraft paper production have changed: production of tall oil and turpentine decreased, while production of bark chips increased. These changes affected allocation factors in the attributional system models.

Although kraft paper is the primary raw material in paper sack production, the improved impact scores for kraft paper production were not fully reflected in the scores for paper sack production. This is partly due to an updated modelling approach of transportation of kraft paper from the producer to the consumer. In version 3.10, kraft paper was supplied to paper sack production via the market activity, using default transportation amounts. In the updated version 3.11, transportation of kraft paper to the paper sack mill is inventoried directly in the paper sack production dataset as reported by the data provider. A direct activity link for kraft paper used in paper sack production was introduced to highlight the connection between kraft paper production and paper sack manufacturing. This improved modelling approach in version 3.11 explains why the reduced scores in kraft paper production did not fully translate into lower scores for paper sack production.

Table 91. Updated kraft paper and paper sack datasets.

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

14.3 New data for single-use food packaging in Europe

Three new datasets were introduced for paper-based food packaging products frequently used in quick-service restaurants, shown in **Table 92**. The data represents average European production in 2022. The data provider is EPPA (European Paper Packaging Alliance) and the study was conducted by Ramboll (Castellani, et al., 2024).

The product “single use paper container, for food packaging, from partially recycled fibre” represents clamshells for serving of burgers and fry boxes for serving of fries. The product “single use paper cup, lid or container, for food packaging, from virgin fibre” models tableware such as cups for hot and cold beverages, lids for both types of cups, and salad boxes. The product “single use paper wrap, for food packaging, from virgin fibre” represents wraps and fry bags for serving of burgers and fries, respectively.

Table 92. New datasets for paper-based food packaging.

Activity Name	Geography	Time Period	Product Name	Unit
single use paper container production, for food packaging, from partially recycled fibre	RER	2022-2022	single use paper container, for food packaging, from partially recycled fibre	kg
single use paper cup, lid or container production, for food packaging, from virgin fibre	RER	2022-2022	single use paper cup, lid and container, for food packaging, from virgin fibre	kg
single use paper wrap production, for food packaging, from virgin fibre	RER	2022-2022	single use paper wrap, for food packaging, from virgin fibre	kg

market for single use paper container, for food packaging, from partially recycled fibre	RER	2022-2022	single use paper container, for food packaging, from partially recycled fibre	kg
market for single use paper cup, lid or container, for food packaging, from virgin fibre	RER	2022-2022	single use paper cup, lid and container, for food packaging, from virgin fibre	kg
market for single use paper wrap, for food packaging, from virgin fibre	RER	2022-2022	single use paper wrap, for food packaging, from virgin fibre	kg

14.4 Other updates in the sector

In addition to the new and updated data, various minor corrections were performed in the sector. The corrections that affected quantitative data are listed in **Table 93**. Most of the corrections concern properties and mass balances.

The activity "tissue paper production, virgin" previously only existed in the global geography. Since the origin of the data is European, the dataset was replicated for the European geography. Furthermore, corrections were introduced to the dataset to better align with the report used as a source. Additionally, "tissue paper production" was renamed to "tissue paper production, recycled" to better illustrate the difference between the tissue paper producing datasets.

Table 93. Minor corrections in the pulp and paper sector.

Activity Name	Geography	Time Period	Product Name	Type of correction
graphic paper production, 100% recycled	RER; GLO	2008-2014	graphic paper, 100% recycled	The water input amount was off by an order of magnitude of 10^3. Corrected the amount of water input.
beverage carton production, 1 L, for fresh milk (chilled)	RER	2017-2017	beverage carton, 1 L, for fresh milk (chilled)	Recalculated the properties of the reference product using the correct property set of liquid packaging board.
beverage carton production, 1 L, for juice (ambient)	RER	2017-2017	beverage carton, 1 L, for juice (ambient)	Recalculated the properties of the reference product using the correct property set of liquid packaging board.
beverage carton production, 1 L, for UHT milk (ambient)	RER	2017-2017	beverage carton, 1 L, for UHT milk (ambient)	Recalculated the properties of the reference product using the correct property set of liquid packaging board.
wood preservation, dipping/immersion,	RER; GLO	2012-2012	wood preservation,	Added missing properties for the preservative and corrected the

water-based preservative, indoor use, dry			dipping/immersion method, water-based, indoor use, dry	dilution calculation to balance the dataset for water.
wood preservation, dipping/immersion, water-based preservative, indoor use, occasionally wet	RER; GLO	2012-2012	wood preservation, dipping/immersion method, water-based, indoor use, occasionally wet	Added missing properties for the preservative to balance the dataset for water.
wood preservation, dipping/immersion, water-based preservative, outdoor use, no ground contact	RER; GLO	2012-2012	wood preservation, dipping/immersion method, water-based, outdoor use, no ground contact	Added missing properties for the preservative to balance the dataset for water.
wood preservation, spray tunnel/deluging, water-based preservative, indoor use, dry	RER; GLO	2012-2012	wood preservation, spray tunnel/deluging, water-based, indoor use, dry	Added missing properties for the preservative and corrected the dilution calculation to balance the dataset for water
wood preservation, spray tunnel/deluging, water-based preservative, indoor use, occasionally wet	RER; GLO	2012-2012	wood preservation, spray tunnel/deluging, water-based, indoor use, occasionally wet	Added missing properties for the preservative to balance the dataset for water.
wood preservation, spray tunnel/deluging, water-based preservative, outdoor use, no ground contact	RER; GLO	2012-2012	wood preservation, spray tunnel/deluging, water-based, outdoor use, no ground contact	Added missing properties for the preservative to balance the dataset for water.
tissue paper production, virgin	RER; GLO	2008-2008	tissue paper	Revised the exchange amounts according to the BREF report used as a source. Updated the production volume. Replicated the dataset from global to European geography.
tissue paper production, recycled	RER; GLO	2000-2000	tissue paper	Updated the production volumes. Renamed the activity from “tissue paper production” to “tissue paper production, recycled”.
cellulose fibre production	CH; GLO	2012-2012	cellulose fibre	The infrastructure input in the dataset is “building, hall, steel

		construction”. The land use is not inventoried in the activity supplying the infrastructure. Hence, occupation and transformation exchanges were added directly to the inventory of cellulose fibre production.

15 Transport

15.1 Overview of the changes

The transport sector brings for version 3.11 updates mainly in the air and road transport. More in details, the air transport has an update on aircraft maintenance, aiming to add consistency and transparency.

15.2 Circulating fleet of passenger car

To better represent the evolution of the circulating fleet of passenger car, an updated of the EURO mix of European and Global passenger car. The main sources for this update were (EUROSTAT) (OICA) (ACEA, 2024). The update does not cover new EURO classes, but it rather takes the EURO classes already available in the previous version of the database and updates the amounts to represent the current situation. The dataset affected by this update are reported in **Table 94.**

Table 94. Updated circulating fleet. “U” stands for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	V3.11
transport, passenger, car, fleet average	GLO	2012 - 2012	transport, passenger, car, fleet average	U
transport, passenger, car, fleet average	RER	2012 - 2012	transport, passenger, car, fleet average	U

15.3 Standardization of nomenclature in transport

The transport sector used to have a nomenclature slightly different for each transport mode (air, rail, …). To facilitate the search of transport datasets, a new naming structure has been set up for all the transport-related datasets. The structure is the following:

> “transport, + freight/passenger, + means of transport, + vehicle type, + size, + fuel type, + specification(s)”

The old and new names are provided in **Table 1**.

15.4 Aircraft maintenance

With version 3.11, we introduce new datasets for aircraft maintenance. The datasets build on published scientific studies and were created in collaboration with the study authors at DLR (the German Aerospace Center) (Rahn A. S., 2024) (Rahn A. W., 2022) (Pohya, 2021). The original inventories were established for Germany; but they are assumed to be representative of the maintenance operations in Europe. In a second step, the data was also extrapolated to the Global geography with uncertainties adjusted accordingly.

To obtain the maintenance dataset, a flight and maintenance schedule are generated for the different haulage of aircrafts based on (Rahn A. W., 2022) and (Rahn A. S., 2024). An average flight distance was chosen (500 km for very short haul, 1150 km for short haul, 2750 km for medium haul, 4000 km for long haul) and the service life of an aircraft over a 25-year period was simulated using the internal DLR tool LYFE (Pohya, 2021). It was assumed that the aircraft will fly a specific representative route throughout its life.

The maintenance schedule is based on a typical aircraft model with a passenger capacity of 150 passengers, an average load factor of 80% and 25 operating years. With these assumptions, the frequency of all the different maintenance checks was obtained. The inventories of the individual checks have then been aggregated (accounting for their frequency) to generate the overall maintenance datasets. The list of new datasets is presented in **Table 95**.

Table 95. New datasets for aircraft maintenance.

Activity Name	Geography	Time Period	Product Name	Unit
maintenance, aircraft, long haul, airframe	RoW, RER	2022-2024	maintenance, aircraft, long haul, airframe	unit
maintenance, aircraft, long haul, engine	RoW, RER	2022-2024	maintenance, aircraft, long haul, engine	unit
maintenance, aircraft, medium haul, airframe	RoW, RER	2022-2024	maintenance, aircraft, medium haul, airframe	unit
maintenance, aircraft, medium haul, engine	RoW, RER	2022-2024	maintenance, aircraft, medium haul, engine	unit
maintenance, aircraft, short haul, airframe	RoW, RER	2022-2024	maintenance, aircraft, short haul, airframe	unit
maintenance, aircraft, short haul, engine	RoW, RER	2022-2024	maintenance, aircraft, short haul, engine	unit
maintenance, aircraft, very short haul, airframe	RoW, RER	2022-2024	maintenance, aircraft, very short haul, airframe	unit
maintenance, aircraft, very short haul, engine	RoW, RER	2022-2024	maintenance, aircraft, very short haul, engine	unit
market for maintenance, aircraft, long haul, airframe	GLO	2024	maintenance, aircraft, long haul, airframe	unit
market for maintenance, aircraft, long haul, engine	GLO	2024	maintenance, aircraft, long haul, engine	unit
market for maintenance, aircraft, medium haul, airframe	GLO	2024	maintenance, aircraft, medium haul, airframe	unit
market for maintenance, aircraft, medium haul, engine	GLO	2024	maintenance, aircraft, medium haul, engine	unit

market for maintenance, aircraft, short haul, airframe	GLO	2024	maintenance, aircraft, short haul, airframe	unit
market for maintenance, aircraft, short haul, engine	GLO	2024	maintenance, aircraft, short haul, engine	unit
market for maintenance, aircraft, very short haul, airframe	GLO	2024	maintenance, aircraft, very short haul, airframe	unit
market for maintenance, aircraft, very short haul, engine	GLO	2024	maintenance, aircraft, very short haul, engine	unit

To ensure mass balance of the datasets, the scraps and wastes of the materials that are used in the maintenance tasks were added as waste and by-products of the datasets. Recycling was generally assumed for metal parts at end-of-life.

Markets were also created for these services, but they do not include any transport (as it is a service). It was assumed that the GLO market will have a share of 25% RER and 75% RoW.

These new maintenance datasets are then integrated in the *transport, passenger, aircraft* (for the different haulages) and the *transport, freight, aircraft, belly-freight* (for the different haulages) as seen in **Table 96**.

Table 96. Updated activities related to Global aircraft transport. "U" stands for "Updated Activity". The update is to include the maintenance.

Activity Name	Geography	Time Period	v3.11
transport, passenger, aircraft, short haul	GLO	2016-2016	U
transport, passenger, aircraft, very short haul	GLO	2016-2016	U
transport, passenger, aircraft, long haul	GLO	2016-2016	U
transport, passenger, aircraft, medium haul	GLO	2016-2016	U
transport, freight, aircraft, belly-freight, long haul	GLO	2016-2016	U
transport, freight, aircraft, belly-freight, medium haul	GLO	2016-2016	U
transport, freight, aircraft, belly-freight, short haul	GLO	2016-2016	U
transport, freight, aircraft, belly-freight, very short haul	GLO	2016-2016	U

The datasets have been updated to add the maintenance of the aircraft in the transport dataset. The rest of the transport datasets are not changed. It was assumed that the amount of maintenance is the same as the amount of aircraft production needed in the transport activity.

With the addition of the aircraft maintenance in the transport datasets, there is a slight modification of the impacts, but the contribution to the overall impact of transport by air stays insignificant for most environmental impacts. For global warming potential specifically, the maintenance represents less than 1% of the impacts. This is in line with the value from Rahn et al.,2024 that states an order of magnitude of 1%.

For *transport, passenger ,aircraft, xxx haul* (xxx being the different haulages) the contribution of the maintenance to the overall transport by air varies between less than 1% and 4%, depending on the indicators. The contribution of 4% is for the indicator *material resources: metals/minerals* for the *transport, passenger, aircraft, medium haul* datasets. The impacts are due to the engine maintenance. The impact in this category is higher for *maintenance, aircraft, medium haul, engine* than for the different types of haulages. This is because for a medium haul aircraft the checks to be done for a specific number of flight cycles are performed (which is not the case for the long-haul flights that do less flight cycles) and the checks that are done for numbers of flights hours are done more than for short and very short haul flights.

For the *transport, freight, aircraft, belly-freight, xxx haul* (xxx being the different haulages), the maintenance contributes from less than 1% to 4% in the different impact categories except for the category *material resources: metals/minerals* which brings a contribution of 8% of the impact for the *transport, freight, aircraft, belly-freight, medium haul.* Similarly, as previously, the impact is due to the engine maintenance.

16 Various Updates

16.1 Correction: Scaling factor of heat and power co-generation, natural gas, 160kW electrical, Jakobsberg, RoW

The scaling factor parameter for “heat and power co-generation, natural gas, 160kW electrical, Jakobsberg”, RoW was an order of magnitude too low, resulting in disproportionately low input and output exchanges relative to its reference product. This has been corrected.

Updated datasets related to this correction are shown in **Table 97**.

Table 97. Updated dataset for correction of the scaling factor of natural gas power plant (Jakobsberg). In the column v3.11, “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
heat and power co-generation, natural gas, 160kW electrical, Jakobsberg	GLO	2000-2000	heat, central or small-scale, natural gas, Jakobsberg	MJ	U

16.2 Correction: Efficiency of “electricity production, oil” in SE, NO and FI

The reference product amount in Undefined for these datasets was incorrectly set higher than 1 kWh for Sweden (SE), Norway (NO), and Finland (FI), which resulted in a too high efficiency for all system models: mainly for Finland and Norway. These have been corrected, and now the efficiency is correctly scaled according to the defined efficiency parameter in these datasets.

Updated datasets related to this correction are shown in **Table 98**.

Table 98. Updated dataset to correct the efficiency of oil power plants. In the column v3.11, “U” for “Updated Activity”.

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
electricity production, oil	FI; NO; SE	1980-2015	electricity, high voltage	kWh	U

16.3 Correction: Meta information of “electricity production, compressed air energy storage, adiabatic”

The storage capacity has been incorrectly expressed as MWh instead of GWh in the meta information for both geographies (RER and GLO/RoW). However, the inventories are correct, so this issue only matters if the information from the description is used to scale the system. Thanks to Lukas Torscht from Leiden University for noticing and explaining.

Updated datasets related to this correction are shown in **Table 99**.

Table 99. Updated dataset to correct the efficiency of oil power plants. In the column v3.11, "U" for "Updated Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
electricity production, compressed air energy storage, adiabatic	GLO; RER	1998-2015	electricity, high voltage	kWh	U

16.4 Correction: Window frame production and treatment

Corrections have been made to all existing window frame activities, which had some small modelling inconsistencies dating back to the methods applied in ecoinvent v2. While ecoinvent v2 employed cut-offs for the treatment of 100% recycled materials, version 3 uses specific cut-off activities for these cases. Therefore, these activities were introduced for aluminium cuttings. Additionally, other by-products in the production activities have been implemented, making the dataset now mass balanced. On the treatment side, some amounts were adjusted to fully align with the production activities. The treatment for aluminium frames and the corresponding market have now been created, which was not available in v2. Lastly, adjustments have been applied to the PVs of the by-products for both production and treatment activities.

Updated datasets related to window frames are shown in **Table 100**.

Table 100. Updated datasets for window frames. In the column v3.11, "N" for "New Activity", and "U" for "Updated Activity".

Activity Name	Geography	Time Period	Product Name	Unit	v3.11
market for used window frame, aluminium	GLO	2011-2011	used window frame, aluminium	m2	N
treatment of used window frame, aluminium, collection for final disposal	CH; GLO	1996-2004	used window frame, aluminium	m2	N
treatment of used window frame, plastic, collection for final disposal	CH; GLO	1996-2004	used window frame, plastic	m2	U
treatment of used window frame, wood, collection for final disposal	CH; GLO	1996-2004	used window frame, wood	m2	U
treatment of used window frame, wood-metal, collection for final disposal	CH; GLO	1996-2004	used window frame, wood-metal	m2	U

window frame production, aluminium, U=1.6 W/m2K	GLO	1996-2004	window frame, aluminium, U=1.6 W/m2K	m2	U
window frame production, aluminium, U=1.6 W/m2K	RER	1996-2004	window frame, aluminium, U=1.6 W/m2K	m2	U
window frame production, poly vinyl chloride, U=1.6 W/m2K	GLO; RER	1996-2004	window frame, poly vinyl chloride, U=1.6 W/m2K	m2	U
window frame production, wood, U=1.5 W/m2K	CA-QC; GLO	1996-2004	window frame, wood, U=1.5 W/m2K	m2	U
window frame production, wood, U=1.5 W/m2K	RER	1996-2004	window frame, wood, U=1.5 W/m2K	m2	U
window frame production, wood-metal, U=1.6 W/m2K	GLO; RER	1996-2004	window frame, wood-metal, U=1.6 W/m2K	m2	U

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18 Annex 1: Products with updated prices

acetic acid [kg]; acetone, liquid [kg]; ammonium sulfate [kg]; antimony [kg]; apple [kg]; barite [kg]; barley grain [kg]; barley grain, organic [kg]; bauxite [kg]; benzene [kg]; broccoli [kg]; cadmium [kg]; carrot [kg]; cast iron [kg]; cauliflower [kg]; chromite ore concentrate [kg]; chromium [kg]; cobalt [kg]; cobalt oxide [kg]; cobalt sulfate [kg]; copper, cathode [kg]; cumene [kg]; ethyl acetate [kg]; ferrochromium, high-carbon, 55% Cr [kg]; ferrochromium, high-carbon, 68% Cr [kg]; ferromanganese, high-coal, 74.5% Mn [kg]; ferronickel [kg]; ferroniobium, 66% Nb [kg]; ferrosilicon [kg]; formic acid [kg]; gallium, high-grade [kg]; gallium, in Bayer liquor from aluminium production [kg]; gold [kg]; gold-silver, ingot [kg]; hard coal [kg]; hard coal, run-of-mine [kg]; harvesting, by potato harvester [ha]; harvesting, by potato harvester [ha]; harvesting, use of harvesting cart [kg]; harvesting, use of harvesting cart [kg]; ilmenite, 54% titanium dioxide [kg]; indium [kg]; iron ore concentrate [kg]; kraft paper [kg]; lead [kg]; lead concentrate [kg]; lignite [kg]; lithium [kg]; lithium carbonate [kg]; lithium chloride [kg]; lithium hydroxide [kg]; lithium iron phosphate [kg]; lithium sulfate [kg]; magnesium [kg]; magnetite [kg]; maintenance, transmission network, electricity, high voltage direct current aerial line [km*year]; maintenance, transmission network, electricity, high voltage direct current land cable [km*year]; maintenance, transmission network, electricity, high voltage direct current subsea cable [km*year]; maize grain [kg]; maize grain, organic [kg]; maize silage [kg]; maize silage, organic [kg]; manganese concentrate [kg]; manganese dioxide [kg]; manganese sulfate [kg]; mercury [kg]; methyl ethyl ketone [kg]; methyl methacrylate [kg]; molybdenum [kg]; naphtha [kg]; natural gas, high pressure [m3]; natural gas, high pressure, vehicle grade [kg]; natural gas, liquefied [m3]; natural gas, low pressure [m3]; natural gas, low pressure, vehicle grade [kg]; natural gas, medium pressure, vehicle grade [kg]; nickel sulfate [kg]; nickel, class 1 [kg]; oat grain [kg]; onion [kg]; oxalic acid [kg]; palladium [kg]; paper sack [kg]; pear [kg]; petroleum [kg]; pig iron [kg]; platinum [kg]; potato [kg]; potato, organic [kg]; power adapter, for smartphone [unit]; propionic acid [kg]; pyrochlore concentrate [kg]; rhodium [kg]; rutile, 95% titanium dioxide [kg]; rye grain [kg]; rye grain, organic [kg]; silicon carbide [kg]; silver [kg]; silver, unrefined [kg]; sodium sulfate, anhydrite [kg]; soybean [kg]; soybean, organic [kg]; spinach [kg]; spodumene [kg]; steel, low-alloyed [kg]; sugar beet [kg]; synthetic graphite, battery grade [kg]; tellurium, semiconductor-grade [kg]; tillage, field cultivator [ha]; tillage, field cultivator [ha]; tillage, field cultivator with amendment [ha]; tillage, field cultivator with amendment [ha]; tin [kg]; tin concentrate [kg]; titania slag, 85% titanium dioxide [kg]; titania slag, 94% titanium dioxide [kg]; titanium dioxide [kg]; titanium sponge [kg]; titanium tetrachloride [kg]; transmission network, electricity, high voltage [km]; transmission network, electricity, high voltage direct current aerial line [km]; transmission network, electricity, high voltage direct current land cable [km]; transmission network, electricity, high voltage direct current subsea cable [km]; transmission network, electricity, medium voltage [km]; triethylene glycol [kg]; tungsten carbide powder [kg]; tungsten concentrate [kg]; wheat grain [kg]; wheat grain, feed [kg]; wheat grain, feed, organic [kg]; wheat grain, organic [kg]; white cabbage [kg]; zinc [kg]; zinc concentrate [kg]; zinc oxide [kg]; zircon [kg]; zucchini [kg]