Documentation of changes implemented in the ecoinvent database v3.6

(2019.09.12)

Moreno Ruiz E., Valsasina L., FitzGerald D., Brunner F., Symeonidis A., Bourgault G., Wernet, G.

ecoinvent Association

www.ecoinvent.org

Technoparkstrasse 1

8005 Zürich, Switzerland

Citation:

Moreno-Ruiz E., Valsasina L.., FitzGerald D., Brunner F., Symeonidis A., Bourgault G., Wernet G., (2019). Documentation of changes implemented in ecoinvent database v3.6. ecoinvent Association, Zürich, Switzerland.

Table of Contents

1 INTRODUCTION 6

2 DATABASE-WIDE CHANGES 7

2.1 Renamed activities and exchanges 7

2.1.1 Metal elementary exchanges 11

2.2 Changes in geography 15

2.3 Changes affecting allocation system models: classification and allocation 15

2.3.1 True value allocation 16

2.3.2 Changes in price 17

2.4 Changes affecting the consequential system model: Technology Level 17

2.5 Impact assessment methods 18

2.5.1 Obsolete methods 18

2.5.2 Renaming of resources elementary exchanges 19

2.5.3 New and updated elementary exchanges 19

3 AGRICULTURE 20

3.1 LUC in Brazil 20

3.1.1 Land uses and carbon stocks 21

3.1.2 Effects of land use change regionalised model in key crops 32

3.2 New or updated agriculture and forestry products 35

3.3 Animal husbandry 42

3.4 Packaging of fertilisers and pesticides 44

4 BUILDING AND CONSTRUCTION MATERIALS 50

4.1 Sand and gravel 50

4.2 Clinker, cement and concrete 51

4.2.1 Clinker 51

4.2.2 Cement 51

4.2.3 Concrete 54

4.3 Granulated and ground granulated blast furnace slag 57

4.4 Other building and construction materials 58

5 CHEMICALS 60

5.1 Plastics 60

5.2 Steam 60

5.3 Other updates 61

6 ELECTRICITY 63

6.1 New data for Latin American Electricity 63

6.2 Updates of the electricity market mixes in the attributional system models 63
6.2.1 Changes to production, trade and loss volumes 65
6.2.2 Changes other than production, trade and loss volumes 66
6.3 Other changes to the electricity sector 67
6.3.1 Inputs of power plant infrastructure 67
6.3.2 Geothermal supply chain 68
6.3.3 Concentrating Solar Power 68
6.4 New, updated and deleted datasets 71
7 FISH CAPTURE AND PROCESSING 76
8 METALS 78
8.1 Aluminium 80
8.1.1 Aluminium oxide: metallurgical and non-metallurgical 80
8.1.2 Constrained market 81
8.1.3 Additional minor changes in Aluminium 82
8.2 Copper 82
8.3 Gold and silver 84
8.4 Iron and steel 86
8.5 Platinum group metals 88
8.6 Tin 89
8.7 Titania 90
8.8 Zinc, cadmium and cobalt 90
8.9 Slags and tailings 91
8.9.1 Metal slags 91
8.9.2 Sulfidic tailings 92
9 PETROLEUM REFINING AND PETROLEUM PRODUCTS 95
9.1 Modelling before v3.6 95
9.2 Modelling in v3.6 95
9.2.1 Geographical coverage 96
9.2.2 Consequential modelling 96
9.2.3 Refined petroleum products 96
9.3 New and updated datasets 97
9.3.1 Petroleum refinery operation datasets 97
9.3.2 Market datasets 98
9.3.3 Import datasets 100
9.4 Synthetic fuel production 101

10 TEXTILES 102

11 TOURISM 109

12 TRANSPORT 111

12.1 Freight and passenger air transport 111

12.2 Freight rail transport 113

12.3 Freight road transport 114

12.3.1 Road maintenance 116

12.3.2 Other changes 119

12.4 Freight sea transport 119

12.4.1 Sea transport technology split database implementation 120

13 WASTE SECTOR 122

13.1 New waste treatments for domestic composting 122

13.2 Representing worst practices: Secondary Metals Recovery 122

13.3 e-waste plastic recycling 123

13.4 Other updates or corrections 123

14 WATER SUPPLY 126

14.1 Irrigation 126

14.2 Tap water 127

14.3 Process water 128

14.4 Rainwater harvesting 129

15 UPDATES IN THE REMAINING SECTORS 130

15.1 Infrastructure & Service Supply Chains 130

15.2 Miscellanea 131

REFERENCES 133

ANNEX 1: PRODUCTS WITH UPDATED PRICES 137

ANNEX 2: ACTIVITIES WITH CHANGES IN CONCRETE 148

ANNEX 3: ACTIVITIES WITH CHANGES IN TRANSPORT 150

ANNEX 4: DIRECT ACTIVITY LINKS TO SERVICES OR INFRASTRUCTURES 161

Activities for which direct links to services or immobile infrastructure were added 161

Activities for which direct links to mobile infrastructure were removed 164

1 Introduction

This report covers the changes to the ecoinvent database between version 3.5, released in 2018 and version 3.6, released in 2019. 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 update, re-modelling or corrections of others.

The **SRI programme**[1] has contributed greatly to the content of this version of the ecoinvent database, v3.6. The ecoinvent Association contributed as leader and coordinator of the component A (the SRI-LCI project)[2] related to regional Life Cycle Inventory creation, building capacities and local network generation and consolidation. All the reports mentioned and referenced in this document can be accessed in the section dedicated to documentation on the dedicated SRI webpage on the ecoinvent website [3].

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 the new version (v3.6) with the old one (v3.5).

For a full comparison between the versions of the database, containing a list of all added activities, as well as a detail record of all changes in existing activities (the fields affected by changes and the actual amounts changed), the Change Report Annex can be downloaded as an excel file from the “Files” section of the ecoQuery by license holders only.

Correspondence files for each system model, as well as for the Undefined database are provided together with this report; they can be checked for equivalences in case of deletion or disaggregation of activities.

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

[1] www.sustainable-recycling.org/about-sri/

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

[3] www.ecoinvent.org/about/projects/sri-project/sri-project-results/documentation/documentation.html

2 Database-wide changes

2.1 Renamed activities and exchanges

Some activities or products were renamed for version 3.6. The changes are listed in the following tables, and also treated in the sector-dedicated chapters if associated to a change in the modelling.

Table 1. Activities renamed for v3.6. *Most of the changes aim to better define the scope of the activity. More details of some changes are given in the corresponding chapters.*

Activity name in v3.5	Activity name in v3.6
aubergine production	aubergine production, in heated greenhouse
bell pepper production	bell pepper production, in heated greenhouse
cement production, blast furnace slag 25-70%, US only	cement production, blast furnace slag 25-70%
cement production, blast furnace slag 36-65%, non-US	cement production, blast furnace slag 36-65%
cement production, blast furnace slag 5-25%, US only	cement production, blast furnace slag 5-25%
cement production, blast furnace slag 66-80%, non-US	cement production, blast furnace slag 66-80%
cement production, blast furnace slag 70-100%, US only	cement production, blast furnace slag 70-100%
cement production, blast furnace slag 81-95%, non-US	cement production, blast furnace slag 81-95%
cement production, pozzolana and fly ash 11-35%, non-US	cement production, pozzolana and fly ash 11-35%
cement production, pozzolana and fly ash 15-40%, US only	cement production, pozzolana and fly ash 15-40%
cement production, pozzolana and fly ash 36-55%, non-US	cement production, pozzolana and fly ash 36-55%
cement production, pozzolana and fly ash 5-15%, US only	cement production, pozzolana and fly ash 5-15%
concentrated solar power plant, solar thermal parabolic trough, 50 MW	concentrated solar power plant construction, solar thermal parabolic trough, 50 MW
concrete production 20MPa, RNA only	concrete production 20MPa
concrete production 25MPa, RNA only	concrete production 25MPa
concrete production 30-32MPa, RNA only	concrete production 30-32MPa
concrete production 35MPa, RNA only	concrete production 35MPa
concrete production 50MPa, RNA only	concrete production 50MPa
cotton seed production, for sowing	cottonseed production, for sowing
diesel production, low-sulfur	diesel production, low-sulphur, petroleum refinery operation
electricity, high voltage, import from BR	electricity, high voltage, import from BR-Southern grid
fishmeal and fish oil production, 63-65% protein	fishmeal and fish oil production, 63-65% protein, from fresh anchovy
fruit tree seedling production, for plating	fruit tree seedling production, for planting
gold production	gold refinery operation
grass fibres to generic market for energy feed	grass fibre to generic market for energy feed
heat and power cogeneration unit construction, 1MWel, 6.4 MWth	heat and power co-generation unit construction, 1MWel, 6.4 MWth
jute production, rainfed	fibre production, jute, retting
kenaf production	fibre production, kenaf, retting
liquefied petroleum gas, import	liquefied petroleum gas, import from Europe

Activity name in v3.5	Activity name in v3.6
market for cement, blast furnace slag 25-70%, US only	market for cement, blast furnace slag 25-70%
market for cement, blast furnace slag 5-25%, US only	market for cement, blast furnace slag 5-25%
market for cement, blast furnace slag 70-100%, US only	market for cement, blast furnace slag 70-100%
market for cement, pozzolana and fly ash 15-40%, US only	market for cement, pozzolana and fly ash 15-40%
market for cement, pozzolana and fly ash 5-15%, US only	market for cement, pozzolana and fly ash 5-15%
market for cotton fibre	market for fibre, cotton
market for cotton seed, for sowing	market for cottonseed, for sowing
market for cotton seed	market for cottonseed
market for demersal fish	market for demersal fish, fresh
market for fishmeal, 63-65% protein, from anchovy	market for fishmeal, 63-65% protein
market for fishmeal, 65-67% protein, from anchovy	market for fishmeal, 65-67% protein
market for heat and power cogeneration unit, 1MWel, 6.4MWth	market for heat and power co-generation unit, 1MWel, 6.4MWth
market for heat and power cogeneration unit, organic Rankine cycle, 1MWe, 6.4 MWth	market for heat and power co-generation unit, organic Rankine cycle, 1MWe, 6.4 MWth
market for jute fibre	market for fibre, jute
market for kenaf fibre	market for fibre, kenaf
market for liquid crystal display	market for used liquid crystal display module
market for process-specific burden, sanitary landfill	market for process-specific burdens, sanitary landfill
market for purse seiner maintenance, wooden	market for purse seiner maintenance, wood
market for purse seiner, wooden	market for purse seiner, wood
market for rice	market for rice, non-basmati
market for sulfidic tailing, off-site	market for sulfidic tailings, generic
market for transport, freight, aircraft	market for transport, freight, aircraft, unspecified
market for transport, freight, sea, liquefied natural gas	market for transport, freight, sea, tanker for liquefied natural gas
market for transport, freight, sea, transoceanic ship with reefer, cooling	market for transport, freight, sea, container ship with reefer, cooling
market for transport, freight, sea, transoceanic ship with reefer, freezing	market for transport, freight, sea, container ship with reefer, freezing
market for transport, passenger, aircraft	market for transport, passenger, aircraft, unspecified
market for trout, from aquaculture	market for trout
market for used purse seiner, wooden	market for used purse seiner, wood
market for vinasse, from fermentation of sugarcane molasses	market for vinasse, from fermentation of sugarcane
market for viscose fibre	market for fibre, viscose
market for wastewater, bleaching and dyeing	market for wastewater from textile production
market for water, completely softened, from decarbonised water, at user	market for water, completely softened
market for water, decarbonised, at user	market for water, decarbonised
market for water, deionised, from tap water, at user	market for water, deionised
platinum group metal mine operation, ore with high rhodium content	platinum group metal, extraction and refinery operations
process-specific burden, sanitary landfill	process-specific burdens, sanitary landfill
process-specific burdens production, inert material landfill	process-specific burdens, inert material landfill
rice production	rice production, non-basmati

Activity name in v3.5	Activity name in v3.6
textile production, jute	textile production, jute, weaving
textile production, kenaf	textile production, kenaf, weaving
transport, freight, sea, liquefied natural gas	transport, freight, sea, tanker for liquefied natural gas
transport, freight, sea, transoceanic ship with reefer, cooling	transport, freight, sea, container ship with reefer, cooling
transport, freight, sea, transoceanic ship with reefer, freezing	transport, freight, sea, container ship with reefer, freezing
treatment of liquid crystal display, municipal incineration with fly ash extraction	treatment of used liquid crystal display module, municipal incineration with fly ash extraction
treatment of liquid crystal display, municipal waste incineration	treatment of used liquid crystal display module, municipal waste incineration
treatment of sulfidic tailing, off-site	treatment of sulfidic tailings, generic, tailings impoundment
treatment of used steel purse seiner	treatment of used purse seiner, steel
treatment of used steel trawler	treatment of used trawler, steel
treatment of used wooden purse seiner	treatment of used purse seiner, wood
viscose production	fibre production, viscose
water production and supply, decarbonised	water production, decarbonised
water production, completely softened, from decarbonised water, at user	water production, completely softened
water production, deionised, from tap water, at user	water production, deionised
zinc-lead mine operation	zinc mine operation

Table 2. Intermediate exchanges renamed for version 3.6. *Most of the changes aim to improve the product name, increasing precision. Several of the name changes reflect large remodelling changes, that are detailed in the corresponding chapters of this report. "*" read chapter 8.1.1 for full details on the renaming and split of this product.*

Name of exchange in version 3.5	Name of exchange in version 3.6
aluminium oxide	aluminium oxide, non-metallurgical*
cement, blast furnace slag 25-70%, US only	cement, blast furnace slag 25-70%
cement, blast furnace slag 36-65%, non-US	cement, blast furnace slag 36-65%
cement, blast furnace slag 5-25%, US only	cement, blast furnace slag 5-25%
cement, blast furnace slag, 66-80%, non-US	cement, blast furnace slag, 66-80%
cement, blast furnace slag 70-100%, non-US	cement, blast furnace slag 70-100%
cement, blast furnace slag 81-95%, non-US	cement, blast furnace slag 81-95%
cement, pozzolana and fly ash 11-35%, non-US	cement, pozzolana and fly ash 11-35%
cement, pozzolana and fly ash 15-40%, US only	cement, pozzolana and fly ash 15-40%
cement, pozzolana and fly ash 36-55%,non-US	cement, pozzolana and fly ash 36-55%
cement, pozzolana and fly ash 5-15%, US only	cement, pozzolana and fly ash 5-15%
copper, from solvent-extraction electro-winning	copper
cotton seed, for sowing	cottonseed, for sowing

Name of exchange in version 3.5	Name of exchange in version 3.6
cotton seed	cottonseed
fishmeal, 63-65% protein, from anchovy	fishmeal, 63-65% protein
fishmeal, 65-67% protein, from anchovy	fishmeal, 65-67% protein
heat and power cogeneration unit, organic Rankine cycle, 1MWe, 6.4 MWth	heat and power co-generation unit, organic Rankine cycle, 1MWe, 6.4 MWth
heat and power cogeneration unit, 1MWel, 6.4MWth	heat and power co-generation unit, 1MWel, 6.4MWth
jute fibre	fibre, jute
kenaf fibre	fibre, kenaf
cement, pozzolana and fly ash 11-35%, non-US	cement, pozzolana and fly ash 11-35%
cement, pozzolana and fly ash 15-40%, US only	cement, pozzolana and fly ash 15-40%
cement, pozzolana and fly ash 36-55%,non-US	cement, pozzolana and fly ash 36-55%
cement, pozzolana and fly ash 5-15%, US only	cement, pozzolana and fly ash 5-15%
cotton fibre	fibre, cotton
cotton seed	cottonseed
liquid crystal display	used liquid crystal display module
process-specific burden, sanitary landfill	process-specific burdens, sanitary landfill
purse seiner maintenance, wooden	purse seiner maintenance, wood
purse seiner, wooden	purse seiner, wood
rice	rice, non-basmati
sulfidic tailing, off-site	sulfidic tailings, generic
transport, freight, aircraft	transport, freight, aircraft, unspecified
transport, freight, sea, liquefied natural gas	transport, freight, sea, tanker for liquefied natural gas
transport, freight, sea, transoceanic ship with reefer, cooling	transport, freight, sea, container ship with reefer, cooling
transport, freight, sea, transoceanic ship with reefer, freezing	transport, freight, sea, container ship with reefer, freezing
transport, passenger, aircraft	transport, passenger, aircraft, unspecified
trout, from aquaculture	trout
used purse seiner, wooden	used purse seiner, wood
vinasse, from fermentation of sugarcane molasses	vinasse, from fermentation of sugarcane
viscose fibre	fibre, viscose
water, completely softened, from decarbonised water, at user	water, completely softened
water, decarbonised, at user	water, decarbonised
water, deionised, from tap water, at user	water, deionised

The **elementary exchange** "Fresh water (obsolete); water; surface water" was replaced with "Water; water; freshwater". This change concerns only the anode production activities.

2.1.1 Metal elementary exchanges

The naming convention of elementary exchanges that represent the extraction of metals from the ground has been revised. While up to version 3.5, the exchange names would include information regarding the metal content in the ores, the new exchange names only contain the name of the element, followed by the subcompartment. For exchanges that were using the old names, the information regarding the metal content has been inserted into the exchange comment in the datasets where these exchanges were used. The mapping of old names to new names is given in Table 3.

Some of the elementary exchanges that follow the new naming convention were already present in version 3.5, while others were created for version 3.6. Some additional elementary exchanges were added to the master data, either to be used for new exchanges that were added for version 3.6, or to be made available for future datasets. All elementary exchanges created for version 3.6 are indicated as new ("N") in Table 3.

Table 3. Old and new elementary exchanges that model the extraction of metals from the environment. *The table also includes a few non-metal elements that were updated in the same fashion, in order to maintain consistency for all materials that are extracted from the environment (with the group "FromEnvironment"). For all listed exchanges (both old and new) the compartment is "natural resources" and the subcompartment is either "in ground" or "in water" (as mentioned in the name of the exchange). All old and new exchanges have the unit "kg". In the v3.6 column, "N" indicates that the exchange is new for version 3.6, while "U" indicates that the properties were updated, which was the case for all elementary exchanges that already existed in version 3.5.*

Old name	New name	v3.6
	Actinium, in ground	N
Aluminium, 24% in bauxite, 11% in crude ore, in ground	Aluminium, in ground	U
Stibnite, in ground	Antimony, in ground	N
	Arsenic, in ground	N
	Astatine, in ground	N
Barite, 15% in crude ore, in ground	Barium, in ground	N
	Beryllium, in ground	N
	Bismuth, in ground	N
	Boron, in ground	N
Bromine, 0.23% in water	Bromine, in water	N
Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn, Ag, In, in ground	Cadmium, in ground	N
	Caesium, in ground	N
	Calcium, in ground	N
Cerium, 24% in bastnasite, 2.4% in crude ore, in ground	Cerium, in ground	N
Chromium, 25.5% in chromite, 11.6% in crude ore, in ground	Chromium, in ground	U
Cobalt, Co 5.0E-2%, in mixed ore, in ground	Cobalt, in ground	U
Copper, 0.52% in sulfide, Cu 0.27% and Mo 8.2E-3% in crude ore, in ground	Copper, in ground	U
Copper, 0.59% in sulfide, Cu 0.22% and Mo 8.2E-3% in crude ore, in ground		U
Copper, 0.97% in sulfide, Cu 0.36% and Mo 4.1E-2% in crude ore, in ground		U
Copper, 0.99% in sulfide, Cu 0.36% and Mo 8.2E-3% in crude ore, in ground		U
Copper, 1.13% in sulfide, Cu 0.76% and Ni 0.76% in crude ore, in ground		U
Copper, 1.18% in sulfide, Cu 0.39% and Mo 8.2E-3% in crude ore, in ground		U
Copper, 1.25% in sulfide, Cu 0.24% and Zn 0,1% in crude ore, in ground		U
Copper, 1.42% in sulfide, Cu 0.81% and Mo 8.2E-3% in crude ore, in ground		U
Copper, 2.19% in sulfide, Cu 1.83% and Mo 8.2E-3% in crude ore, in ground		U
Copper, Cu 0.2%, in mixed ore, in ground		U
Copper, Cu 0.38%, in mixed ore, in ground		U
Copper, Cu 6.8E-1%, in mixed ore, in ground		U
Cu, Cu 3.2E+0%, Pt 2.5E-4%, Pd 7.3E-4%, Rh 2.0E-5%, Ni 2.3E+0% in ore, in ground		U

Old name	New name	v3.6
Cu, Cu 5.2E-2%, Pt 4.8E-4%, Pd 2.0E-4%, Rh 2.4E-5%, Ni 3.7E-2% in ore, in ground		U
	Dysprosium, in ground	N
	Erbium, in ground	N
Europium, 0.06% in bastnasite, 0.006% in crude ore, in ground	Europium, in ground	N
Fluorine, 4.5% in apatite, 1% in crude ore, in ground	Fluorine, in ground	N
Fluorine, 4.5% in apatite, 3% in crude ore, in ground		N
Fluorspar, 92%, in ground	Fluorspar, in ground	N
Gadolinium, 0.15% in bastnasite, 0.015% in crude ore, in ground	Gadolinium, in ground	N
Gallium, 0.014% in bauxite, in ground	Gallium, in ground	U
	Germanium, in ground	N
Gold, Au 1.0E-7%, in mixed ore, in ground	Gold, in ground	U
Gold, Au 1.1E-4%, Ag 4.2E-3%, in ore, in ground		U
Gold, Au 1.3E-4%, Ag 4.6E-5%, in ore, in ground		U
Gold, Au 1.4E-4%, in ore, in ground		U
Gold, Au 1.8E-4%, in mixed ore, in ground		U
Gold, Au 2.1E-4%, Ag 2.1E-4%, in ore, in ground		U
Gold, Au 4.3E-4%, in ore, in ground		U
Gold, Au 4.9E-5%, in ore, in ground		U
Gold, Au 5.4E-4%, Ag 1.5E-5%, in ore, in ground		U
Gold, Au 6.7E-4%, in ore, in ground		U
Gold, Au 6.8E-4%, Ag 1.5E-4%, in ore, in ground		U
Gold, Au 7.1E-4%, in ore, in ground		U
Gold, Au 9.7E-4%, in mixed ore, in ground		U
Gold, Au 9.7E-5%, Ag 7.6E-5%, in ore, in ground		U
	Hafnium, in ground	N
Helium, 0.08% in natural gas, in ground	Helium, in natural gas, in ground	N
Molybdenum, 0.010% in sulfide, Mo 8.2E-3% and Cu 1.83% in crude ore, in ground	Holmium, in ground (*)	N
Molybdenum, 0.014% in sulfide, Mo 8.2E-3% and Cu 0.81% in crude ore, in ground		N
Molybdenum, 0.016% in sulfide, Mo 8.2E-3% and Cu 0.27% in crude ore, in ground		N
Molybdenum, 0.022% in sulfide, Mo 8.2E-3% and Cu 0.22% in crude ore, in ground		N
Molybdenum, 0.022% in sulfide, Mo 8.2E-3% and Cu 0.36% in crude ore, in ground		N
Molybdenum, 0.025% in sulfide, Mo 8.2E-3% and Cu 0.39% in crude ore, in ground		N
Molybdenum, 0.11% in sulfide, Mo 4.1E-2% and Cu 0.36% in crude ore, in ground		N
Indium, 0.005% in sulfide, In 0.003%, Pb, Zn, Ag, Cd, in ground	Indium, in ground	N
Iodine, 0.03% in water	Iodine, in water	N
	Iridium, in ground	N
Iron, 46% in ore, 25% in crude ore, in ground	Iron, in ground	U
Iron, 72% in magnetite, 14% in crude ore, in ground		U
Kaolinite, 24% in crude ore, in ground	Kaolinite, in ground	N
Kieserite, 25% in crude ore, in ground	Kieserite, in ground	N
Lanthanum, 7.2% in bastnasite, 0.72% in crude ore, in ground	Lanthanum, in ground	N
Lead, 5.0% in sulfide, Pb 3.0%, Zn, Ag, Cd, In, in ground	Lead, in ground	U
Lead, Pb 0.014%, in mixed ore, in ground		U
Lead, Pb 3.6E-1%, in mixed ore, in ground		U
Lithium, 0.15% in brine, in ground	Lithium, in ground	N
	Lutetium, in ground	N
Magnesite, 60% in crude ore, in ground	Magnesite, in ground	N
	Magnesium, in ground	U
Magnesium, 0.13% in water	Magnesium, in water	N
Manganese, 35.7% in sedimentary deposit, 14.2% in crude ore, in ground	Manganese, in ground	N
Cinnabar, in ground	Mercury, in ground	N

Old name	New name	v3.6
	Molybdenum, in ground	N
Neodymium, 4% in bastnasite, 0.4% in crude ore, in ground	Neodymium, in ground	N
Ni, Ni 2.3E+0%, Pt 2.5E-4%, Pd 7.3E-4%, Rh 2.0E-5%, Cu 3.2E+0% in ore, in ground	Nickel, in ground	U
Ni, Ni 3.7E-2%, Pt 4.8E-4%, Pd 2.0E-4%, Rh 2.4E-5%, Cu 5.2E-2% in ore, in ground		U
Nickel, 1.13% in sulfide, Ni 0.76% and Cu 0.76% in crude ore, in ground		U
Nickel, 1.98% in silicates, 1.04% in crude ore, in ground		U
Nickel, Ni 2.5E+0%, in mixed ore, in ground		U
	Niobium, in ground	N
	Osmium, in ground	N
Palladium, Pd 1.6E-6%, in mixed ore, in ground	Palladium, in ground	U
Pd, Pd 2.0E-4%, Pt 4.8E-4%, Rh 2.4E-5%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground		U
Pd, Pd 7.3E-4%, Pt 2.5E-4%, Rh 2.0E-5%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground		U
Phosphorus, 18% in apatite, 12% in crude ore, in ground	Phosphorus, in ground	N
Phosphorus, 18% in apatite, 4% in crude ore, in ground		N
Platinum, Pt 4.7E-7%, in mixed ore, in ground	Platinum, in ground	U
Pt, Pt 2.5E-4%, Pd 7.3E-4%, Rh 2.0E-5%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground		U
Pt, Pt 4.8E-4%, Pd 2.0E-4%, Rh 2.4E-5%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground		U
	Polonium, in ground	N
	Potassium, in ground	N
Praseodymium, 0.42% in bastnasite, 0.042% in crude ore, in ground	Praseodymium, in ground	N
	Protactinium, in ground	N
	Radium, in ground	N
Rhenium, in crude ore, in ground	Rhenium, in ground	N
Rh, Rh 2.0E-5%, Pt 2.5E-4%, Pd 7.3E-4%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Rhodium, in ground	U
Rh, Rh 2.4E-5%, Pt 4.8E-4%, Pd 2.0E-4%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground		U
Rhodium, Rh 1.6E-7%, in mixed ore, in ground		U
	Rubidium, in ground	N
	Ruthenium, in ground	N
Samarium, 0.3% in bastnasite, 0.03% in crude ore, in ground	Samarium, in ground	N
	Scandium, in ground	N
	Selenium, in ground	N
	Silicon, in ground	N
Silver, 0.007% in sulfide, Ag 0.004%, Pb, Zn, Cd, In, in ground	Silver, in ground	U
Silver, 0.01% in crude ore, in ground		U
Silver, 3.2ppm in sulfide, Ag 1.2ppm, Cu and Te, in crude ore, in ground		U
Silver, Ag 1.5E-4%, Au 6.8E-4%, in ore, in ground		U
Silver, Ag 1.5E-5%, Au 5.4E-4%, in ore, in ground		U
Silver, Ag 1.8E-6%, in mixed ore, in ground		U
Silver, Ag 2.1E-4%, Au 2.1E-4%, in ore, in ground		U
Silver, Ag 4.2E-3%, Au 1.1E-4%, in ore, in ground		U
Silver, Ag 4.6E-5%, Au 1.3E-4%, in ore, in ground		U
Silver, Ag 5.4E-3%, in mixed ore, in ground		U
Silver, Ag 7.6E-5%, Au 9.7E-5%, in ore, in ground		U
Silver, Ag 9.7E-4%, in mixed ore, in ground		U
	Sodium, in ground	N
strontium, in ground	Strontium, in ground	U
Sylvite, 25 % in sylvinite, in ground	Sylvite, in ground	N
Tantalum, 81.9% in tantalite, 1.6E-4% in crude ore, in ground	Tantalum, in ground	N
Tellurium, 0.5ppm in sulfide, Te 0.2ppm, Cu and Ag, in crude ore, in ground	Tellurium, in ground	N
	Terbium, in ground	N
	Thallium, in ground	N

Old name	New name	v3.6
	Thorium, in ground	N
	Thulium, in ground	N
Tin, 79% in cassiterite, 0.1% in crude ore, in ground	Tin, in ground	U
TiO2, 54% in ilmenite, 18% in crude ore, in ground	Titanium, in ground	U
TiO2, 54% in ilmenite, 2.6% in crude ore, in ground		U
TiO2, 95% in rutile, 0.40% in crude ore, in ground		U
	Tungsten, in ground	N
	Uranium, in ground	U
	Vanadium, in ground	N
	Ytterbium, in ground	N
	Yttrium, in ground	N
Zinc, 9.0% in sulfide, Zn 5.3%, Pb, Ag, Cd, In, in ground	Zinc, in ground	U
Zinc, Zn 0.63%, in mixed ore, in ground		U
Zinc, Zn 3.1%, in mixed ore, in ground		U
Zirconia, as baddeleyite, in ground	Zirconium, in ground	U
Zirconium, 50% in zircon, 0.39% in crude ore, in ground		U

(*) *The new elementary exchange "Holmium, in ground" was erroneously mapped to the old elementary exchanges that represent molybdenum. For the next release, this exchange will be replaced by "Molybdenum, in ground" in the datasets that had an input of molybdenum from the environment in version 3.5.*

Additionally, the properties of the metal elementary exchanges were revised. All exchanges now have the six mandatory properties defined. Also, exchanges that represent a single element have a property that quantifies the content of that element (the exceptions are Fluorspar, Kaolinite, Kieserite, Magnesite and Sylvite). The values for the seven properties are the same for all metal elementary exchanges and are listed in Table 4. The properties of the metal elementary exchanges listed as updated ("U") in Table 3 were updated accordingly in all the datasets where these exchanges are present.

Table 4. Properties for metal elementary exchanges. [element name] would show the name of the element that is given in the elementary exchange name.

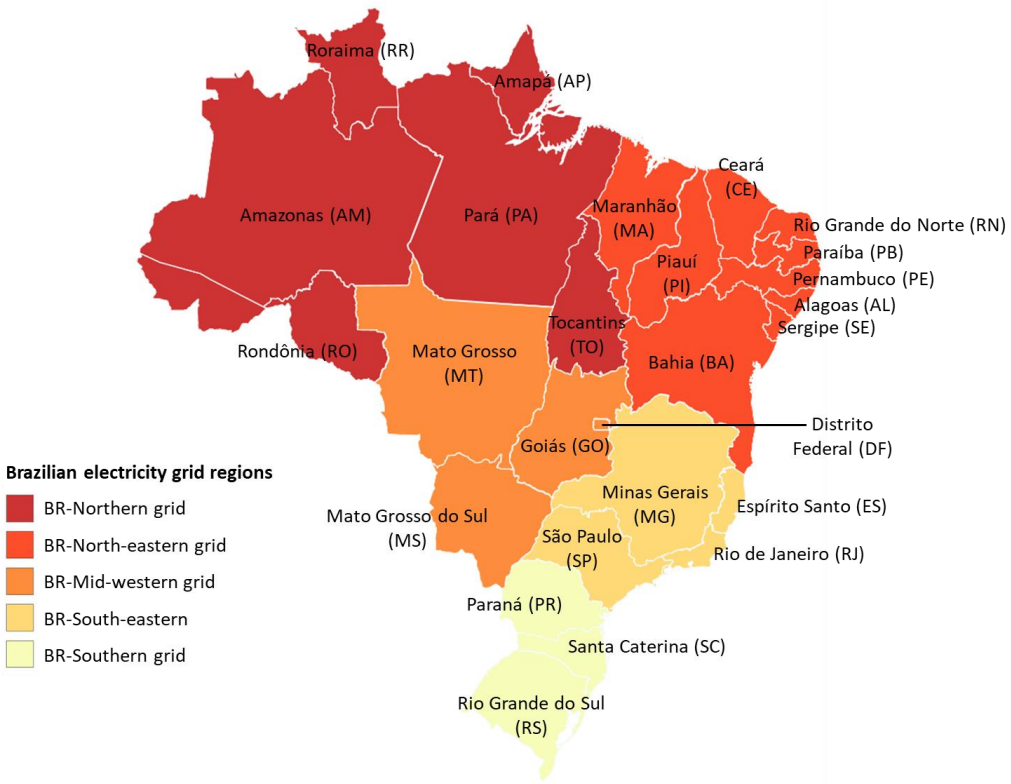
Property name	Amount	Unit name
carbon content, fossil	0	dimensionless
carbon content, non-fossil	0	dimensionless
dry mass	1	kg
water content	0	dimensionless
water in wet mass	0	kg
wet mass	1	kg
[element name] content	1	dimensionless

2.2 Changes in geography

The main change in geography has been the split of brazil into its 27 states: Acre, Alagoas, Amazonas, Amapá, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Pará, Paraíba, Pernambuco, Piauí, Paraná, Rio de Janeiro, Rio Grande do Norte, Rondônia, Roraima, Rio Grande do Sul, Santa Catarina, Sergipe, São Paulo, Tocantins. To that, it should be added the fact that the country was divided into the 5 electricity grids operating today.

This division affects both the Agriculture (chapter 3) and the Electricity sector (chapter 5.1). The map below features the 27 Brazilian states as well as the 5 electricity grids.

Figure 1. Map of the states and electricity grids in Brazil as present in v3.6 of the ecoinvent database. *The map was created with mapchart.net©.*



2.3 Changes affecting allocation system models: classification and allocation

Every product present in the ecoinvent database has to have two types of classification for the two attributional system models:

- Allocation, cut-off by classification (recyclable, waste, allocatable)
- Allocation, allocation at the point of substitution (APOS) (MFT or non-MFT)

The classification of the product is essential to determine how allocation will happen in those two system models, so changes in this regard can strongly affect the impact results. For the v3.6, several products were classified as non-MFT under the APOS system model, while they were classified as MFT until v3.5.

Table 5. Products where classification was changed from MFT to non-MFT for the APOS system model in v3.6.

Product name	Unit
1,1-dimethylcyclopentane	kg
2,3-dimethylbutan	kg
2-methylpentane	kg
ash, from combustion of bagasse from sugarcane	kg
coconut husk	kg
cottonseed	kg
fraction 1 from naphtha separation	kg
fraction 7 from naphtha separation	kg
fraction 8 from naphtha separation	kg
methylcyclopentane	kg
molasses, from sugar beet	kg
vinasse, from fermentation of sugar beet	kg
vinasse, from fermentation of sugar beet molasses	kg
vinasse, from fermentation of sugarcane	kg
vinasse, from fermentation of sweet sorghum	kg

2.3.1 True value allocation

In the ecoinvent attributional system models, the allocation is done using price, unless the property “true value relation” is specifically provided in the original dataset. One important example is the use of exergy to allocate between electricity and heat. Several activities were lacking this property and were not using exergy to calculate the allocation factor. This have been corrected for v3.6.

Table 6. Datasets co-producing electricity and heat modified to correct the allocation key.

Activity name	Geography	Time period
biogas, burned in micro gas turbine 100kWe	CH	2000-2005
biogas, burned in polymer electrolyte membrane fuel cell 2kWe, future	CH	2000-2005
biogas, burned in polymer electrolyte membrane fuel cell 2kWe, future	GLO	2000-2005
biogas, burned in solid oxide fuel cell 125kWe, future	CH	2000-2005
biogas, burned in solid oxide fuel cell, with micro gas turbine, 180kWe, future	CH	2000-2005
sulfate pulp production, from eucalyptus, bleached	RLA	2017-2020
sulfate pulp production, from hardwood, bleached	GLO	2011-2021
sulfate pulp production, from hardwood, bleached	RER	2017-2020
sulfate pulp production, from softwood, bleached	RER	2017-2020
sulfate pulp production, from softwood, unbleached	RER	2017-2020
treatment of waste packaging paper, sanitary landfill	GLO	2010-2017
treatment of waste plastic, consumer electronics, sanitary landfill, wet infiltration class (500mm)	GLO	2006-2012

2.3.2 Changes in price

Changes in price affect the results of the activities, when economic allocation is used. Several prices of products have been adjusted (sometimes only minorly) for the v3.6. The full list of products that experimented a price change can be found in Annex 1: products with updated prices.

2.4 Changes affecting the consequential system model: Technology Level

The Technology Level of an activity determines its behaviour in the consequential system model. Only a few activities changed Technology Levels for v3.6, and they were related to larger updates in the sector.

Table 7. Activities that changes Technology Level in v3.6.

Activity name	Geography	Technology Level in v3.5	Technology Level in v3.6
electricity production, hard coal	PE	Modern	Current
electricity production, hydro, reservoir, alpine region	PE	Modern	Old
electricity production, natural gas, combined cycle power plant	PE	Modern	Current

2.5 Impact assessment methods

All changes in Characterization Factors (CF) can be found in the spreadsheet “LCIA_implementation_3.6.xlsx”, available in the Files section on the ecoQuery website.

2.5.1 Obsolete methods

While ecoinvent keeps older versions of methods for legacy reasons, those methods are not maintained anymore. This means that:

- if an error is found in them, it will not be corrected;
- if a new elementary exchange is added to the ecoinvent database, obsolete methods will not be checked for a CF match with the new exchange.

For version 3.6, some methods have been renamed “obsolete”:

- CML 2001 (obsolete)
- CML 2001 w/o LT (obsolete)
- EDIP (obsolete)
- EDIP w/o LT (obsolete)
- EDIP2003 (obsolete)
- EDIP2003 w/o LT (obsolete)
- EPS 2000 (obsolete)
- ILCD 1.0.8 2016 midpoint (obsolete)
- ILCD 1.0.8 2016 midpoint no LT (obsolete)
- IMPACT 2002+ (Endpoint) (obsolete)
- IMPACT 2002+ (Midpoint) (obsolete)
- IPCC 2001 (obsolete)
- IPCC 2007 (obsolete)
- IPCC 2007 no LT (obsolete)
- ReCiPe Endpoint (E,A) (obsolete)
- ReCiPe Endpoint (E,A) w/o LT (obsolete)
- ReCiPe Endpoint (H,A) (obsolete)
- ReCiPe Endpoint (H,A) w/o LT (obsolete)
- ReCiPe Endpoint (I,A) (obsolete)
- ReCiPe Midpoint (E) (obsolete)
- ReCiPe Midpoint (E) w/o LT (obsolete)
- ReCiPe Midpoint (H) (obsolete)
- ReCiPe Midpoint (H) w/o LT (obsolete)
- ReCiPe Midpoint (I) (obsolete)

- TRACI (obsolete)
- USEtox (obsolete)
- USEtox w/o LT (obsolete)
- eco-indicator 99, (E,E) (obsolete)
- eco-indicator 99, (E,E) w/o LT (obsolete)
- eco-indicator 99, (H,A) (obsolete)
- eco-indicator 99, (H,A) w/o LT (obsolete)
- eco-indicator 99, (I,I) (obsolete)
- ecological scarcity 1997 (obsolete)
- ecological scarcity 2006 (obsolete)

2.5.2 Renaming of resources elementary exchanges

As described in section 2.1.1, mineral resources elementary exchanges have been renamed in a more simple and systematic manner. The newer exchange names will appear in the CF implementation file as having a new CF.

2.5.3 New and updated elementary exchanges

During the v3.6 update, it was discovered that **Gallium, in ground** was missing its CF for the CML, ILCD and CED methods. The CF was added, for all these methods.

The **Chromium** CF was missing for every archetype of the Recipe V1.13 method. It was added.

As with every release of ecoinvent, new elementary exchanges are created by data providers. The actively maintained methods are inspected to find potential CFs for the new exchanges.

For the 3.6 version, only 4 new exchanges had CFs in the maintained method: **Acrolein, Hexachlorobenzene, Pentachlorobenzene** and **Sulfuric acid**. The CFs were all part of the ILCD method and were therefore added.

3 Agriculture

The SRI-LCI project has driven most changes on the agricultural sector for v3.6, with the addition of new data relevant for key regions such as Brazil, Colombia, India and South Africa; coupled to the regionalisation of the LUC modelling in Brazil. Of course, results in this sector are also heavily influenced by modifications in the irrigation modelling, as described in chapter 14.1.

More information about underlying modelling for the whole chapter can be found in the reports by Folegatti-Matsuura and Picoli, 2018 (Life Cycle Inventories of Agriculture, Forestry and Animal Husbandry – Brazil), and by Russo *et al.* 2018, (Life Cycle Inventories of Agriculture and Animal Husbandry - South Africa)

3.1 LUC in Brazil

The current model in ecoinvent, described in Reinhard *et al.*, 2017 and summarized in Donke *et al.* (under review), follows the methodological principles recommended by PAS2050 to determine the expansion areas of land uses, considering a 20 years period. The model considers four pools of carbon (C), following indications by IPCC 2006: aboveground biomass (AGB), belowground biomass (BGB), dead organic matter (DOM) and soil organic carbon (SOC).

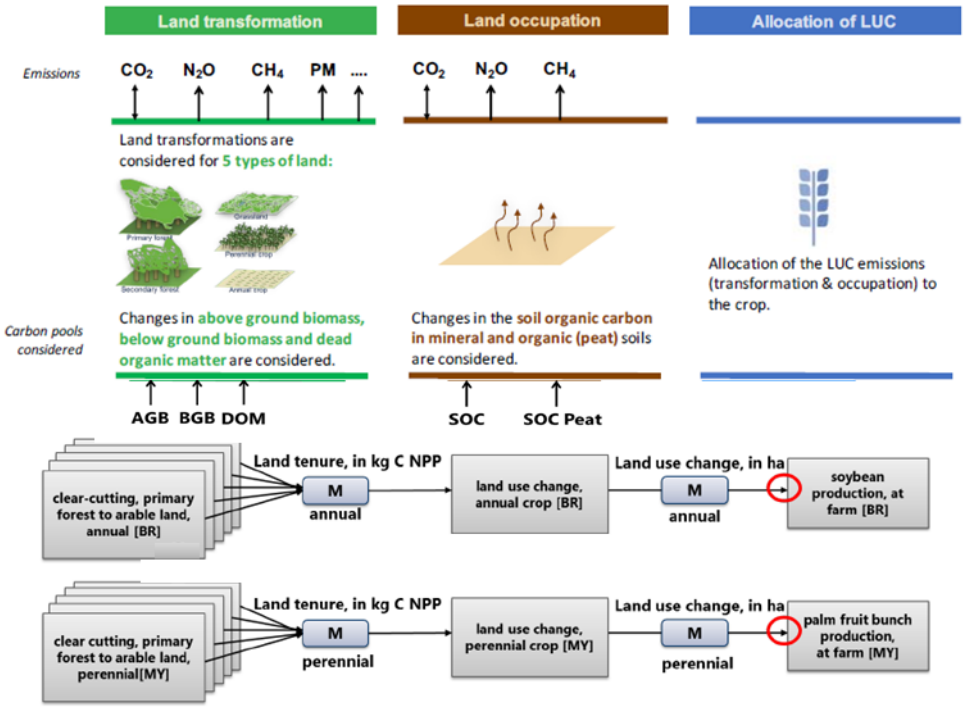
The structure considers LUC emissions separated in two different reference products: land tenure, measured in kg C net annual primary productivity (NPP), and land use change, measured in ha, which is allocated to the crop of interest, accordingly with its land expansion.

The land tenure product is supplied from clear-cutting or land already in use activities, which include the flows to account for changes in vegetal carbon pools, the non-CO2 emissions from biomass burning, the energy consumption for woodcut etc (Figure 2).

The land use change is a product supplied by same-name activities, which include the implementation and maintenance required by the soil for the continued use of land. These datasets include emissions from changes in SOC, such as CO2 and N2O (Figure 2).

For the v3.6, the LUC modelling has been adapted to accommodate a regional modelling for Brazil, described in Donke *et al.*, (under review), respecting the modelling principles to ecoinvent database, as those just mentioned above. The BRLUC method and tool (see Donke *et al.*, (under review) for details) are the main data source for Brazilian LUC modelling in ecoinvent v3.6. The method uses comprehensive and consistent direct LUC estimates and associated C stocks and exchange rates for the main land use types and crops in Brazil. The fact of having regionalised Brazil into its 27 states (see Figure 1) has allowed this spatial differentiation needed for a regional LUC implementation.

Figure 2. Land use change modelling in the ecoinvent database. *In Donke et al., (under review); modified from Reinhard et al., 2017.*



3.1.1 Land uses and carbon stocks

As described in Donke *et al.*, (under review), two main adaptations were done in order to properly include the regional aspects in the LUC in Brazil. First, two new land uses were added to the ecoinvent database, resulting in the addition of four new land related reference products. They relate to cultivated pastureland and forestry (e.g. cultivated Eucalyptus and Pinus forests), as those are very relevant activities in Brazil, in which they account for roughly 62% and 4% of total agricultural area and had a dynamic behavior in recent years. See Table 9 for details of added activities and products related to land use change modelling in Brazil.

The second important change was the fact of using biomass and soil carbon (C) stocks of natural lands from updated and regionalized data from the BRLUC (see Table 8 for a summary; see supplementary materials of Donke *et al*., (under review) for all values of C stocks). The BRLUC regionalize biomass stocks estimates of primary forests and grasslands. This regionalization consists of a weighted average of biomes and phytophysiognomies area in each state, and their respective biomass and soil carbon stocks (from Donke *et al.*, (under review)).

In Brazil, due to the diversity of ecosystems, the biomass carbon stocks can vary widely, ranging from an average of 194 tC.ha-1 in Amapá state to 18 tC.ha-1 in Paraíba state for primary forests, for example (see Table 8). Until v3.6, Brazil was modelled as a whole, assuming all Brazilian primary forests had the same carbon stock as the Amazon. In a similar line of thoughts, not all transformation of natural areas in Brazil had occurred over the humid forest; there is a large percentage that have happened in ecosystems with lower carbon stock, such as savannas and steppes vegetation types.

As explained in Donke *et al.*, (under review), BRLUC lists only CO2 emissions derived from carbon stock changes, all other emissions (emission flows resulting from burning and cutting of tree-covered land use types; upstream emissions and non-CO2 gases from soil) were adapted or taken from ecoinvent model in place:

-emissions of ethane, CO, CH4 and N2O from cutting and burning biomass and N2O from mineral soils: most of the estimations related to those exchanges were taken from ecoinvent, except for the woodcut and burned rates, which were updated, and the emissions related to organic soils, that were not accounted, as this kind of soil has a low representativeness in the agricultural areas of the country.

-different combustion factor (CF) values were calculated and used to estimate the emissions in different biomes (Donke *et al.*, (under review)), as the combustion of a forest is affected by several factors, such as the type of vegetation and climate (see Table 8 for a summary; see supplementary materials of Donke *et al*., (under review) for all values of C stocks in all C pools).

Table 8. Average total soil and biomass carbon stocks of the land use and combustion factors for Brazilian states, as in Donke et al., (under review).

Brazilian state (abbreviation)	Primary forest Combustion Factor (CF)	Primary forest[1]	Grassland[1]	Annual crop	Perennial crop	Pasture, man-made	Forest, intensive	Sugarcane
		tC . ha^{-1} . year^{-1}						
Rondônia (RO)	0.36	194	60	27	86	52	81	49
Acre (AC)	0.36	218	72	29	92	55	87	53
Amazonas (AM)	0.36	233	69	28	115	54	105	52
Roraima (RR)	0.36	213	61	27	86	53	82	50
Pará (PA)	0.36	223	60	27	102	53	94	50
Amapá (AP)	0.36	243	64	29	117	56	108	53
Tocantins (TO)	0.43	91	63	24	72	47	69	45
Maranhão (MA)	0.42	127	63	23	71	46	67	37
Piauí (PI)	0.44	57	47	18	48	34	55	30
Ceará (CE)	0.44	45	35	16	40	29	52	27
Rio Grande do Norte (RN)	0.43	46	34	16	38	28	51	27
Paraíba (PB)	0.43	44	30	17	40	30	53	28
Pernambuco (PE)	0.42	45	37	18	41	31	54	29
Alagoas (AL)	0.39	56	44	23	57	41	63	36
Sergipe (SE)	0.39	54	37	19	49	34	56	31
Bahia (BA)	0.42	84	54	22	50	37	60	35
Minas Gerais (MG)	0.41	133	61	24	66	45	68	44
Espírito Santo (ES)	0.36	196	66	28	76	54	74	52
Rio de Janeiro (RJ)	0.36	188	72	32	85	60	81	58
São Paulo (SP)	0.38	163	61	24	75	47	76	45
Paraná (PR)	0.36	193	77	38	107	64	129	62
Santa Catarina (SC)	0.36	213	82	46	131	68	138	68
Rio Grande do Sul (RS)	0.36	157	73	39	105	67	111	65
Mato Grosso do Sul (MS)	0.42	118	56	21	65	43	65	40
Mato Grosso (MT)	0.41	139	65	25	82	50	77	47
Goiás (GO)	0.43	97	64	24	70	48	72	46
Distrito Federal (DF)	0.44	98	66	28	70	48	66	49

Table 9. New and updated activities and products related to land use change modelling. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity". "*" signals that the product is also new to the database.*

Activity name	Geography	Time Period	Product	Unit	v3.6
clear-cutting, grassland to arable land, annual crop	GLO	2010-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N
clear-cutting, grassland to arable land, forest, intensive	BR-BA; BR-ES; BR-GO; BR-MA; BR-MT; BR-PA; BR-PI; BR-TO; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, forest, intensive	kg	N*
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, pasture, man made	kg	N*
clear-cutting, grassland to arable land, perennial crop	GLO	2010-2015	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	U
clear-cutting, grassland 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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N
clear-cutting, primary forest to arable land, annual crop	GLO	2010-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, forest, intensive	kg	N*
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, pasture, man made	kg	N*
clear-cutting, primary forest to arable land, perennial crop	GLO	2010-2015	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N

Activity name	Geography	Time Period	Product	Unit	v3.6
clear-cutting, secondary forest to arable land, annual crop	GLO	2010-2015	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	U
clear-cutting, secondary forest to arable land, perennial crop	GLO	2010-2015	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	U
land already in use, annual cropland to annual crop	GLO	2010-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, forest, intensive	kg	N*
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, pasture, man made	kg	N*
land already in use, annual cropland to perennial crop	GLO	2010-2015	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N
land already in use, forest, intensive to annual crop	BR-AP; BR-MG; BR-RS; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N
land already in use, forest, intensive to pasture, man made	BR-AP; BR-MG; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, pasture, man made	kg	N*
land already in use, forest, intensive to perennial crop	BR-AP; BR-MG; BR-RS; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N
land already in use, pasture, man made to annual crop	BR-DF; BR-GO; BR-MS; BR-PR; BR-RN; BR-RS; BR-SP; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N
land already in use, pasture, man made to forest, intensive	BR-GO; BR-MS; BR-PR; BR-SP; GLO	2014-2019	land tenure, arable land, measured as carbon net primary	kg	N*

Activity name	Geography	Time Period	Product	Unit	v3.6
			productivity, forest, intensive		
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N
land already in use, perennial cropland to annual crop	GLO	2010-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N
land already in use, perennial 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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, forest, intensive	kg	N*
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; GLO	2014-2019	land tenure, arable land, measured as carbon net primary productivity, pasture, man made	kg	N*
land already in use, perennial cropland to perennial crop	GLO	2010-2015	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	U
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	2014-2019	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N
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	2014-2019	land use change, annual crop	ha	N
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	2014-2019	land use change, forest, intensive	ha	N*
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	2014-2019	land use change, pasture, man made	ha	N*
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	2014-2019	land use change, perennial crop	ha	N
market for land tenure, arable land, measured as carbon net primary productivity, 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	2017-2017	land tenure, arable land, measured as carbon net primary productivity, annual crop	kg	N

Activity name	Geography	Time Period	Product	Unit	v3.6
market for land tenure, arable land, measured as carbon net primary productivity, 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	2017-2017	land tenure, arable land, measured as carbon net primary productivity, forest, intensive	kg	N*
market for land tenure, arable land, measured as carbon net primary productivity, 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	2017-2017	land tenure, arable land, measured as carbon net primary productivity, pasture, man made	kg	N*
market for land tenure, arable land, measured as carbon net primary productivity, 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	2017-2017	land tenure, arable land, measured as carbon net primary productivity, perennial crop	kg	N
market for 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	2017-2017	land use change, annual crop	ha	N
market for 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	2017-2017	land use change, forest, intensive	ha	N*
market for 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	2017-2017	land use change, pasture, man made	ha	N*
market for 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	2017-2017	land use change, perennial crop	ha	N
market group for land use change, annual crop	BR	2017-2017	land use change, annual crop	ha	N
market group for land use change, forest, intensive	BR	2017-2017	land use change, forest, intensive	ha	N*
market group for land use change, pasture, man made	BR	2017-2017	land use change, pasture, man made	ha	N
market group for land use change, perennial crop	BR	2017-2017	land use change, perennial crop	ha	N*

Both land tenure and land use change products have markets at the level of the states. To give a national representation for products that needed it (mango, beef), market groups were created for land use change.

The contribution of the different land tenures to the final composition of each state market for land tenure is given in the following figures.

Figure 3. Market composition for land tenure for annual crops, per state. *The composition is shown as the relative contribution of each activity to the final score of the product, using IPCC 2013 100a. Some states don't contribute significantly to this type of land tenure and have no market. The results of the Brazilian market in v3.5 is also shown for comparison purposes.*

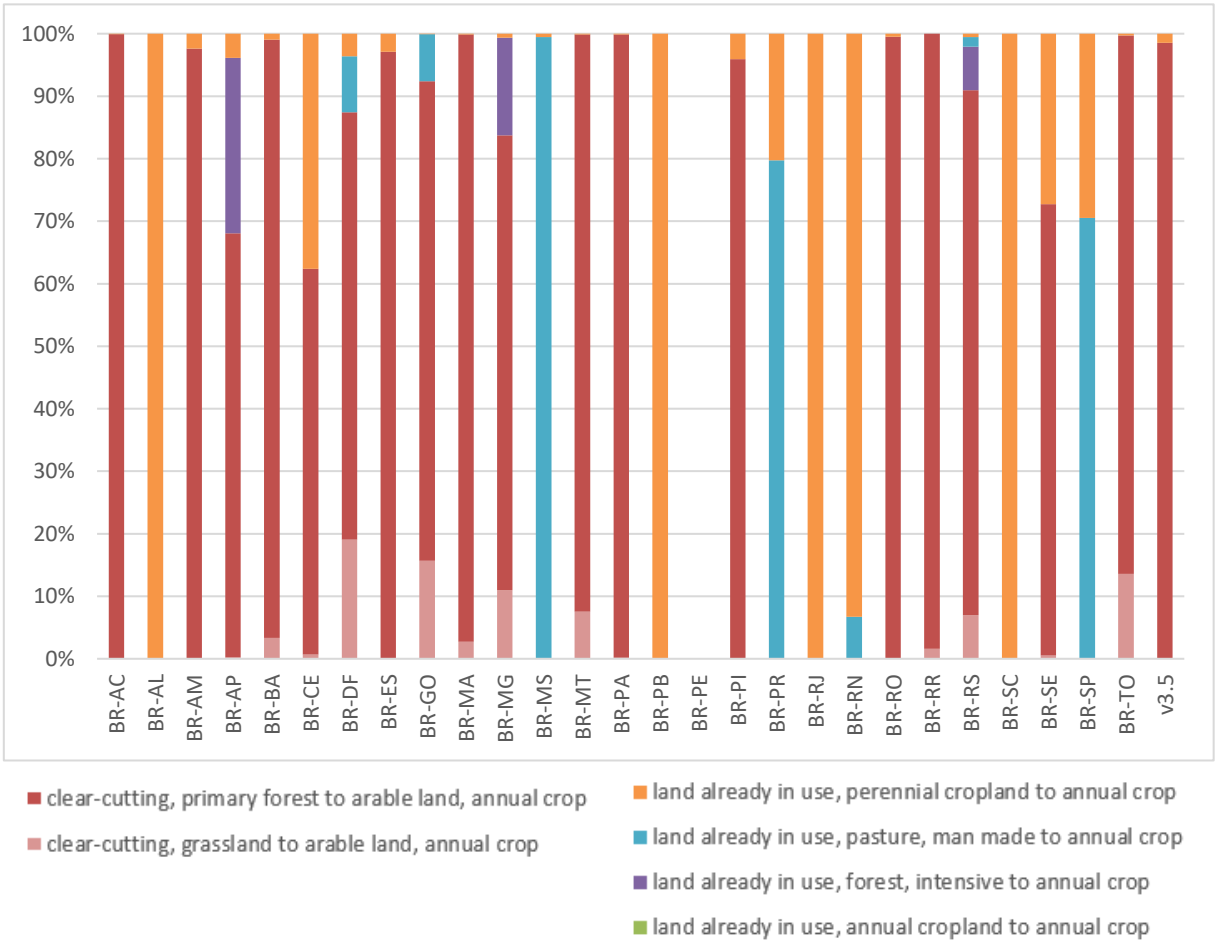
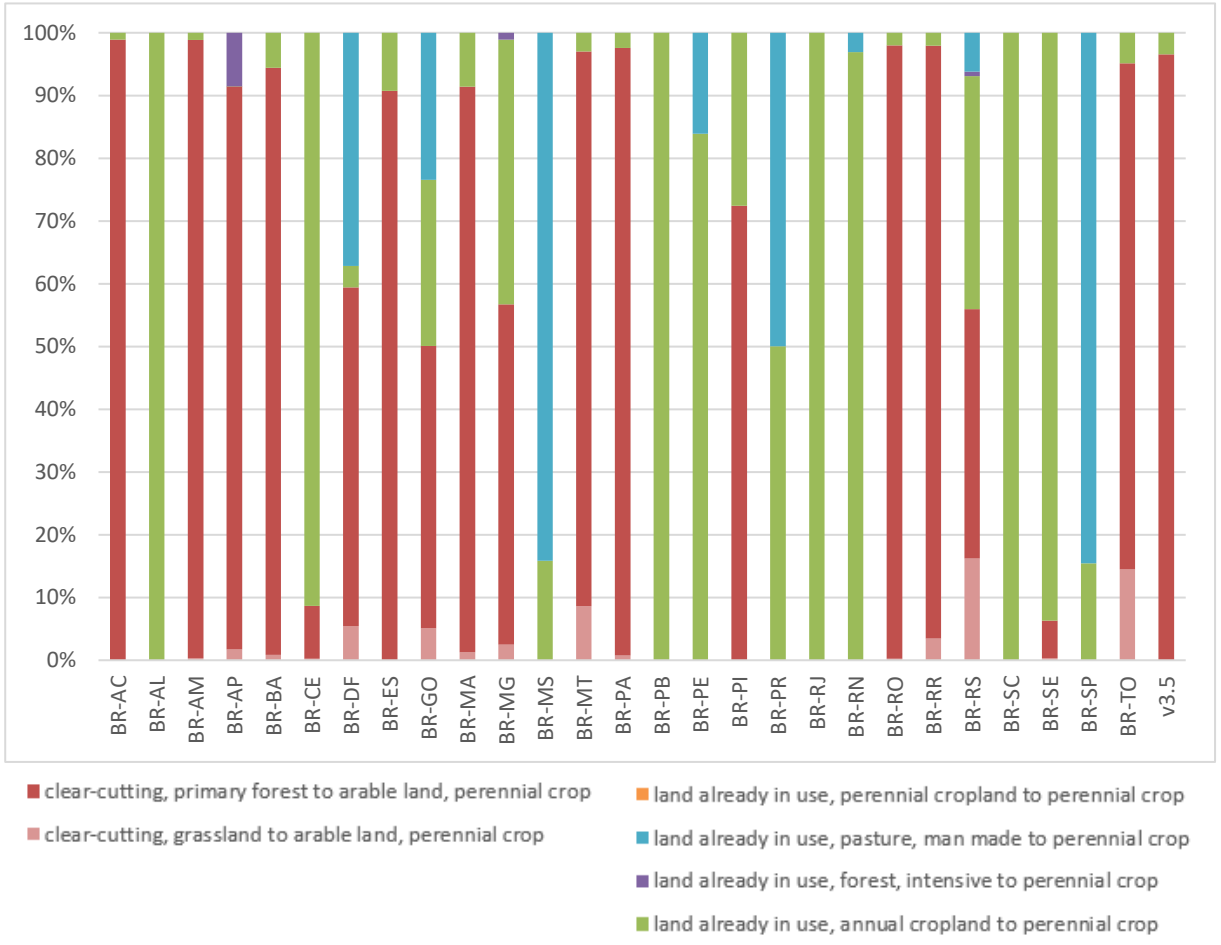


Figure 4. Market composition for land tenure for perennial crops, per state. *The composition is shown as the relative contribution of each activity to the final score of the product, using IPCC 2013 100a. The results of the Brazilian market in v3.5 is also shown for comparison purposes.*



The markets and products in the following Figure 5 and Figure 6 are new to the ecoinvent database, and represent land use changes in forest, intensive and pasture, man-made, respectively.

Figure 5. Market composition for land tenure for forest intensive, per state. *The composition is shown as the relative contribution of each activity to the final score of the product, using IPCC 2013 100a. Some states don't contribute significantly to this type of land tenure and have no market.*

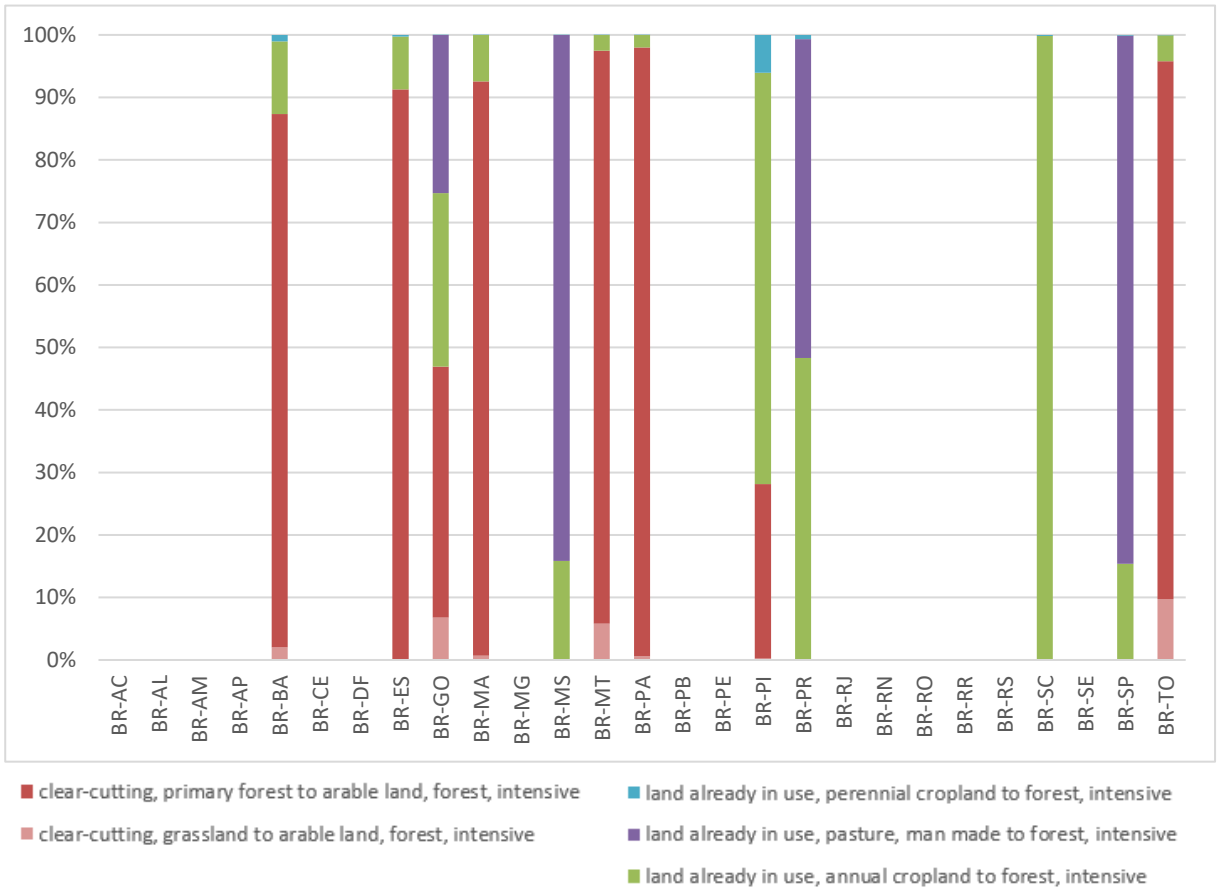
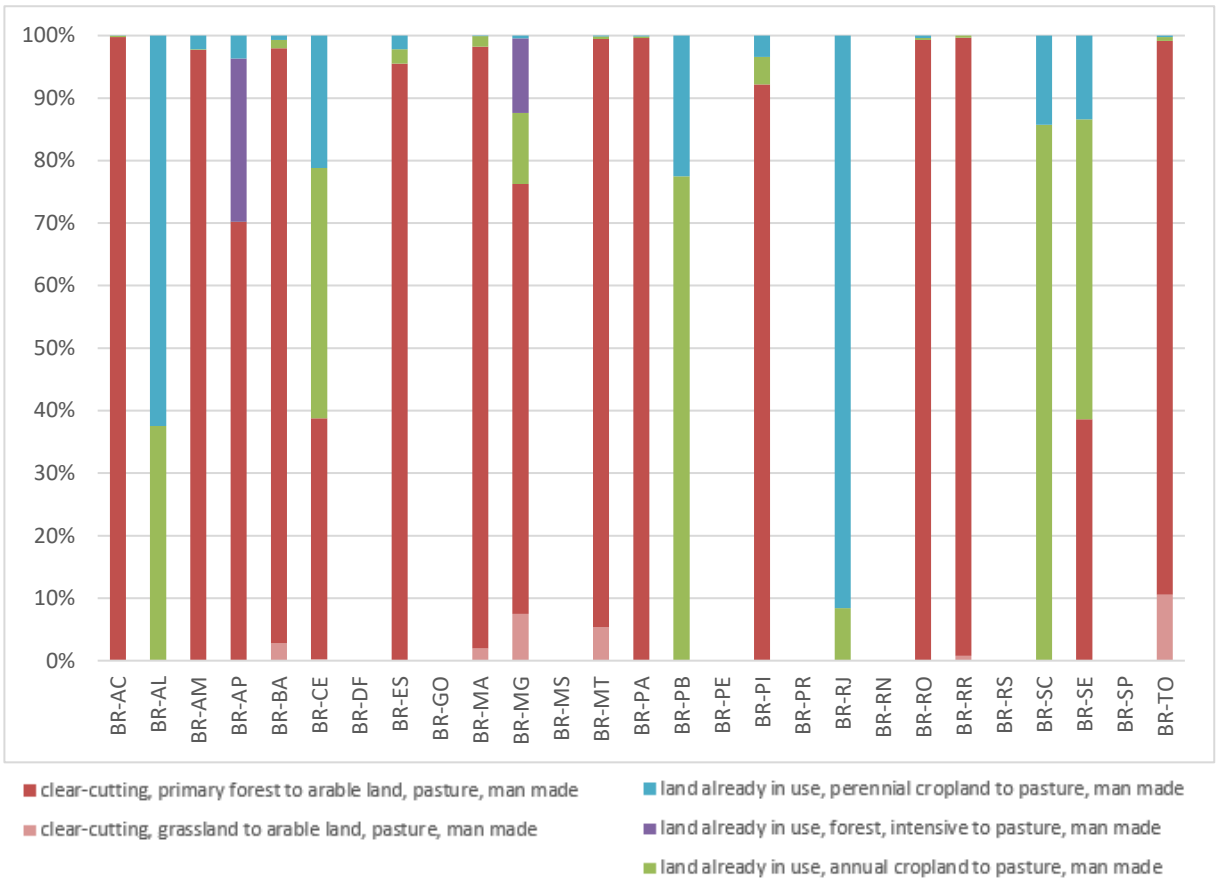


Figure 6. Market composition for land tenure for pasture, per state. *The composition is shown as the relative contribution of each activity to the final score of the product, using IPCC 2013 100a. Some states don't contribute significantly to this type of land tenure and have no market.*



Finally, several Global activities related to LUC have been excluded from the database. The LUC is model to be operated on a local scale; effects of changes in land use at a global level must be expressed with direct emissions in the crop production datasets. The deleted activities are the “market for land tenure, arable land, measured as carbon net primary productivity, annual crop, GLO”; “land tenure, arable land, measured as carbon net primary productivity, annual crop, GLO”; “market for land tenure, arable land, measured as carbon net primary productivity, perennial crop, GLO”; “land tenure, arable land, measured as carbon net primary productivity, perennial crop, GLO”; “land use change, perennial crop, GLO”; “market for land use change, annual crop, GLO”; “market for land use change, perennial crop, GLO”.

3.1.2 Effects of land use change regionalised model in key crops

Five Brazilian agriculture products had the LUC exchanges updated or added in the ecoinvent v3.6 database: soybean, sugarcane, cleft timber (from hardwood forestry, *Eucalyptus ssp.*), mango and beef cattle (for slaughtering, live weight). Brazilian maize production was also added in the database but it did not have LUC associated during the period (Donke *et al.*, (under review)). Changes in scores related to the update and regionalisation of the emission model as described above are studied in this section using soybean and sugarcane as examples.

In the case of soybean (Figure 7), the availability of regional-specific data enabled the correction of simplified assumptions and extrapolations from previous versions. For example, until ecoinvent v3.5, it was assumed that all Brazilian soybean expanded in the same way as in MT state, which is very different from the expansion patterns of other large producer states, such as PR and MS (Figure 7 and

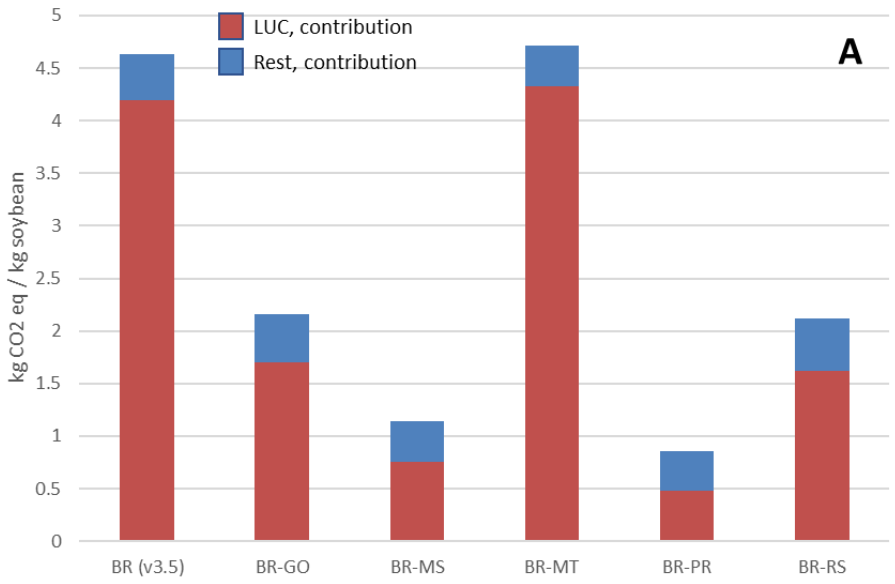
Figure 3, for contribution of the different land tenure activities to the LUC in each state for annual crops). In MT, 92% of the expansion happens over primary forest, while in PR and MS 79% and 99% of the expansion (respectively) happens over pasture.

The soybean production had impacts around 4.7 kg CO2 eq / kg soybean in v3.5, which are the results that can be retrieved in v3.6 in the MT state, even when the case of MT (as in other states, see Donke *et al.*, (under review)), the C stocks values are lower than the values used in v3.5. The impacts of soybean in the v3.6 Brazilian “market for soybean”, that averages all producers depending on their relative production volumes, is 2.7 kg CO2 eq / kg soybean, with MT being still the largest producer, contributing 36% to the market.

In the case of sugarcane, the results vary greatly from v3.5 (Figure 8). This is due, first, to the adjustment of the C stocks, and second, to the introduction of new categories of land use change (forestry, intensive and pasture, man-made), that allow now to better reflect the expansion of sugarcane over pastures, which is the pattern observed in recent years (Donke *et al.*, (under review)).The results of v3.5 considered a large expansion of sugarcane over primary forests, with carbon contents of a tropical humid forest, while sugarcane has low suitability in regions such as the Amazonian region.

The ecoinvent v3.5 considered that 54% of the sugarcane area in Brazil resulted from expansion, of which 83% from primary forest and 15% from annual crops. On the contrary, the state of SP, which is in v3.6 the largest producer with 60% of the market share, has a pattern of land use change considering 85% from pasture, and 15% from annual crops (see Figure 4 for contribution of the different land tenure activities to the LUC in each state for perennial crops). This drives a shift in the scores, from 0.24 kg CO2 eq / kg sugarcane in v3.5, to 0.0072 kg CO2 eq / kg sugarcane in the v3.6 Brazilian “market for sugarcane”, which represents the producer’s mix.

Figure 7. A: Climate impacts (kg CO2 eq/kg soybean) of soybean cultivation in Brazil in v3.6 and v3.5. B: The producers of soybean in the Brazilian context. *The regionalisation of the LUC model allows to reflect the differences between the different states.*



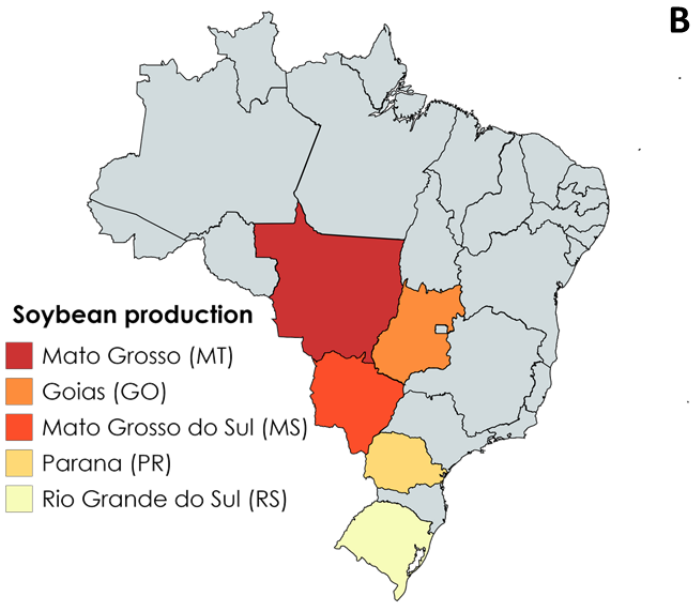
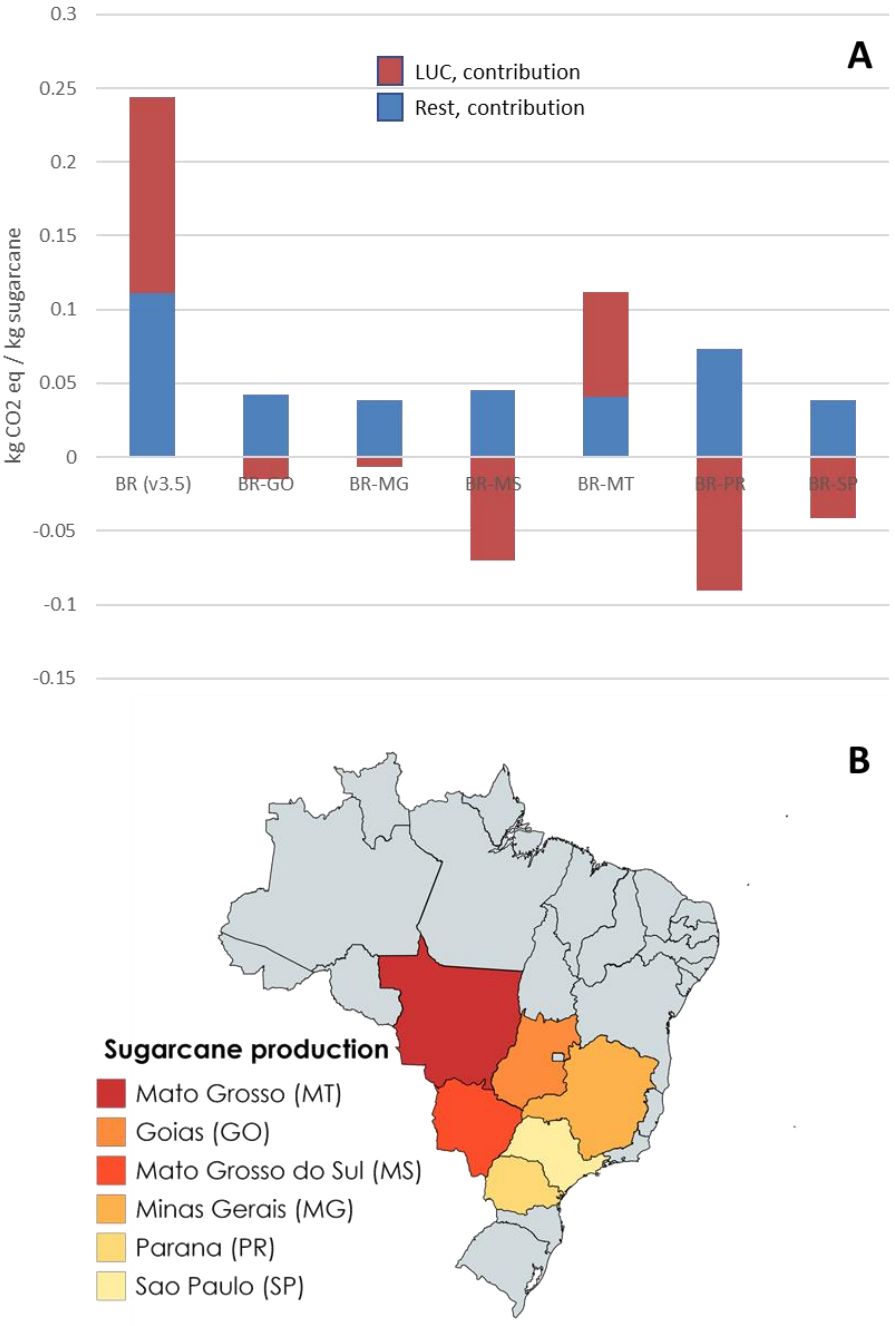


Figure 8. A: Climate impacts (kg CO2 eq/kg sugarcane) of sugarcane cultivation in Brazil in v3.6 and v3.5. B: The producers of sugarcane in the Brazilian context. *The regionalisation of the LUC model allows to reflect the differences between the different states.*



3.2 New or updated agriculture and forestry products

The update in the agriculture sector has resulted in the addition of several new products to the database. They represent new crops, or new agricultural services, that better reflect regional conditions. Also, several existing activities related to the sector were corrected or updated in some way; all changes and additions are listed in the following tables.

Table 10. New products related to crop production. *New crops and services added to the database are listed here.*

Product	Unit
cashew	kg
castor bean	kg
chickpea	kg
chilli	kg
coriander	kg
eucalyptus seedling, for planting	unit
fertilising, by rig fertiliser, sugarcane	ha
fertilising, by stool splitter, sugarcane	ha
field leveling, sugarcane	ha
filter cake, from sugarcane juice filtration	kg
furrow covering, sugarcane	ha
furrowing, sugarcane	ha
harvesting, sugarcane	ha
limestone and gypsum application, by spreader	ha
maize chop	kg
maize flour	kg
mandarin, fresh grade	kg
mandarin, processing grade	kg
mango	kg
mango seedling, for planting	unit
mango, conditioned	kg
millet	kg
mustard	kg
planting with starter fertiliser, by no till planter	ha
planting, sugarcane	ha
pomegranate	kg
rice, basmati	kg
sesame seed	kg
sugarcane loading, by loader	ha
sugarcane transfer, by dump cart	ha
sugarcane vinasse application, by wheel reel irrigation	ha

Product	Unit
tillage, harrowing, by offset disk harrow	ha
tillage, harrowing, by offset leveling disc harrow	ha
tillage, subsoiling, by subsoiler plow	ha
weed control, by brush cutter, pasture	ha
wheat bran	kg
wheat flour	kg

Table 11. New and updated activities related to crop production, forestry or agricultural services. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity". "U*" signals that the update lead to eliminate the creation of RoW by equalling regional and GLO production volumes.*

Activity Name	Geography	Time Period	v3.6
alfalfa/grass silage production	ZA	2016-2017	N
anaerobic digestion of manure	CH; GLO	2009-2009	U
apple production	ZA	2012-2016	N
application of plant protection product, by field sprayer	BR	2012-2014	N
application of plant protection product, by field sprayer	GLO	2012-2014	U
application of plant protection product, by field sprayer	ZA	2016-2016	N
apricot production	FR	2009-2012	U
aubergine production, in heated greenhouse	GLO	2010-2010	U
aubergine production, open field	GLO; IN	2015-2018	N
beet seed production, Swiss integrated production, for sowing	CH	1999-2002	U*
bell pepper production, in heated greenhouse	GLO	2010-2010	U
bell pepper production, open field	GLO; IN-MH; IN-UP	2015-2018	N
biogas production from grass	CH; GLO	2000-2003	U*
cabbage white production	IN-MH; IN-UP	2015-2018	N
carrot seed production, Swiss integrated production, at farm	GLO	2000-2012	U*
cashew production	GLO; IN	2015-2018	N
castor bean production	GLO; IN	2015-2018	N
catch crop growing, ryegrass, August-April, organic fertiliser 60 kg N, three cuts	GLO	2011-2011	U*
catch crop growing, ryegrass, August-April, organic fertiliser 80 kg N, three cuts	GLO	2011-2011	U*
catch crop growing, ryegrass, September-April, organic fertiliser 40 kg N, one cut	GLO	2011-2011	U*
catch crop growing, ryegrass, September-April, organic fertiliser 60 kg N, one cut	GLO	2011-2011	U*
catch crop growing, ryegrass-Egyptian&Persian clover-mixture, August-October, not fertilised, one cut	GLO	2011-2011	U*
catch crop growing, ryegrass-Egyptian&Persian clover-mixture, August-October, organic fertiliser 30 kg N, one cut	GLO	2011-2011	U*

Activity Name	Geography	Time Period	v3.6
catch crop growing, ryegrass-Egyptian&Persian clover-mixture, August-October, organic fertiliser 30 kg N, two cuts	GLO	2011-2011	U*
catch crop growing, ryegrass-Egyptian&Persian clover-mixture, August-October, organic fertiliser 60 kg N, two cuts	GLO	2011-2011	U*
catch crop growing, ryegrass-red&Egyptian clover-mixture, August-April, organic fertiliser 60 kg N, three cuts	GLO	2011-2011	U*
catch crop growing, ryegrass-red&Egyptian clover-mixture, August-April, organic fertiliser 80 kg N, three cuts	GLO	2011-2011	U*
catch crop growing, ryegrass-red&Egyptian clover-mixture, September-April, organic fertiliser 40 kg N, one cut	GLO	2011-2011	U*
catch crop growing, ryegrass-red&Egyptian clover-mixture, September-April, organic fertiliser 60 kg N, one cut	GLO	2011-2011	U*
chickpea production	GLO; IN	2015-2018	N
chilli production	GLO; IN-UP	2015-2018	N
clover seed production, Swiss integrated production, at farm	CH	2000-2000	U*
clover seed production, Swiss integrated production, for sowing	CH	1999-2002	U*
combine harvesting	BR	2012-2016	N
combine harvesting	ZA	2016-2016	N
coriander production	GLO	2015-2018	N
coriander production	IN	2015-2018	N
dewatering of ethanol from biomass, from 95% to 99.7% solution state	BR	2000-2006	U
diesel, burned in agricultural machinery	GLO	1999-2012	U
drying of maize grain	BR	2012-2016	N
ethanol production from grass	CH; GLO	2000-2004	U*
ethanol production from sugar beet	GLO	2000-2004	U
ethanol production from sugar beet molasses	GLO	1998-2006	U
eucalyptus seedling production, in heated greenhouse	BR	2010-2020	N
eucalyptus seedling production, in heated greenhouse	GLO	2010-2020	N
eucalyptus seedling production, in unheated greenhouse	BR	2010-2020	N
eucalyptus seedling production, in unheated greenhouse	GLO	2010-2020	N
fava bean production, Swiss integrated production, at farm	CH; GLO	1996-2003	U*
fava bean, feed production, Swiss integrated production	CH	1996-1999	U*
fertilising, by broadcaster	BR	2012-2016	N
fertilising, by broadcaster	ZA	2016-2016	N
fertilising, by rig fertiliser, sugarcane	BR	2012-2014	N
fertilising, by rig fertiliser, sugarcane	GLO	2012-2014	N
fertilising, by stool spliter, sugarcane	BR	2012-2014	N
fertilising, by stool spliter, sugarcane	GLO	2012-2014	N
field leveling, sugarcane	BR	2012-2014	N
field leveling, sugarcane	GLO	2012-2014	N
fodder beet production, Swiss integrated production, intensive	CH; GLO	1996-2003	U*
furrow covering, for sugarcane	BR; GO	2012-2014	N
furrowing, sugarcane	BR; GLO	2012-2014	N

Activity Name	Geography	Time Period	v3.6
grape production	IN	2015-2018	N
grass silage production, organic	GLO	1995-2005	U
green manure growing, Swiss integrated production, until April	CH	1996-2003	U*
green manure growing, Swiss integrated production, until February	CH	1996-2003	U*
green manure growing, Swiss integrated production, until January	CH	1996-2003	U*
green manure growing, Swiss integrated production, until March	CH	1996-2003	U*
hardwood forestry, eucalyptus ssp., planted forest management	BR-GO	2012-2016	N
hardwood forestry, eucalyptus ssp., planted forest management	BR-MG	2012-2016	N
hardwood forestry, eucalyptus ssp., planted forest management	BR-SP	2012-2016	N
hardwood forestry, eucalyptus ssp., planted forest management	GLO	2012-2016	N
harvesting, sugarcane	BR	2012-2014	N
harvesting, sugarcane	GLO	2012-2014	N
heat production, straw, at furnace 300kW	RER	1983-2007	N
heat production, straw, organic, at furnace 300kW	RER	1983-2007	N
import of wheat grain, RoW	ZA	2015-2016	N
limestone and gypsum application, by spreader	BR	2012-2014	N
limestone and gypsum application, by spreader	GLO	2012-2014	N
maize grain processing, dry milling	GLO; ZA	2016-2017	N
maize grain production	BR-GO	2012-2016	N
maize grain production	BR-MS	2012-2016	N
maize grain production	BR-MT	2012-2016	N
maize grain production	BR-PR	2012-2016	N
maize grain production	BR-RS	2012-2016	N
maize grain production	IN	2015-2018	N
maize grain production	ZA	2006-2013	N
maize grain production, rainfed	GLO	2006-2013	N
maize grain production, rainfed	ZA	2006-2013	N
maize grain, feed production	ZA	2016-2016	N
maize silage production	BR	2012-2016	N
maize silage production	ZA	2014-2016	N
mandarin production	ZA	2008-2008	N
mandarin production, sorted and graded	GLO;ZA	2015-2016	N
mango production	BR; GLO	2010-2016	N
mango production, conditioned, heat treatment	BR; GLO	2016-2017	N
mango production, conditioned, wax treatment	BR; GLO	2016-2017	N
mango seedling production, for planting	BR; GLO	2016-2017	N
market for alfalfa-grass mixture, Swiss integrated production	CH	2019-2019	N
market for ash, from combustion of bagasse from sugarcane	GLO	2011-2011	U
market for bagasse, from sugarcane	BR; CO	2018-2025	N

Activity Name	Geography	Time Period	v3.6
market for barley grain, feed, Swiss integrated production	CH	2019-2019	N
market for barley grain, Swiss integrated production	CH	2019-2019	N
market for cashew	GLO	2016-2017	N
market for castor bean	GLO	2015-2018	N
market for chickpea	GLO	2015-2018	N
market for chilli	GLO	2016-2017	N
market for cleft timber, measured as dry mass	BR	2012-2016	N
market for coconut husk	GLO	2010-2012	U
market for coriander	GLO	2015-2018	N
market for ethanol, without water, in 95% solution state, from fermentation	BR	2011-2011	N
market for eucalyptus seedling, for planting	GLO	2010-2020	N
market for fava bean, feed, Swiss integrated production	CH	2019-2019	N
market for fertilising, by rig fertiliser, sugarcane	GLO	2012-2014	N
market for fertilising, by stool splitter, sugarcane	GLO	2012-2014	N
market for field leveling, sugarcane	GLO	2012-2014	N
market for filter cake, from sugarcane juice filtration	GLO	2018-2018	N
market for furrow covering, sugarcane	GLO	2012-2014	N
market for furrowing, sugarcane	GLO	2012-2014	N
market for grass silage, Swiss integrated production	CH	2019-2019	N
market for green manure, Swiss integrated production, until April	CH	2019-2019	N
market for green manure, Swiss integrated production, until February	CH	2019-2019	N
market for green manure, Swiss integrated production, until January	CH	2019-2019	N
market for green manure, Swiss integrated production, until March	CH	2019-2019	N
market for harvesting, sugarcane	GLO	2012-2014	N
market for hay, Swiss integrated production, extensive	CH	2019-2019	N
market for hay, Swiss integrated production, intensive	CH	2019-2019	N
market for limestone and gypsum application, by spreader	GLO	2012-2014	N
market for maize chop	GLO; ZA	2016-2016	N
market for maize flour	GLO; ZA	2016-2016	N
market for maize grain	BR	2011-2011	N
market for maize grain	ZA	2016-2016	N
market for maize grain, feed	ZA	2016-2016	N
market for maize grain, feed, Swiss integrated production	CH	2019-2019	N
market for maize seed, Swiss integrated production, at farm	CH	2019-2019	N
market for maize silage	BR	2012-2016	N
market for maize silage, Swiss integrated production	CH	2019-2019	N
market for mandarin	ZA	2015-2016	N
market for mandarin, fresh grade	GLO	2015-2016	N
market for mandarin, processing grade	GLO	2015-2016	N

Activity Name	Geography	Time Period	v3.6
market for mango	BR	2010-2016	N
market for mango	GLO	2010-2016	N
market for mango seedling, for planting	GLO	2016-2017	N
market for mango, conditioned	GLO	2016-2017	N
market for millet	GLO	2015-2018	N
market for mustard	GLO	2015-2018	N
market for planting with starter fertiliser, by no till planter	GLO	2012-2016	N
market for planting, sugarcane	GLO	2012-2014	N
market for pomegranate	GLO	2015-2018	N
market for potato seed, Swiss integrated production, at farm	CH	2019-2019	N
market for potato, Swiss integrated production	CH	2019-2019	N
market for poultry manure, dried	GLO	2012-2012	U
market for protein pea, feed, Swiss integrated production	CH	2019-2019	N
market for protein pea, Swiss integrated production	CH	2019-2019	N
market for rice seed, for sowing	GLO	2011-2011	U
market for rice, basmati	GLO	2015-2018	N
market for rice, non-basmati	GLO	2001-2006	U
market for rye grain, feed, Swiss integrated production	CH	2019-2019	N
market for rye grain, Swiss integrated production	CH	2019-2019	N
market for sesame seed	GLO	2015-2018	N
market for soybean	BR	2011-2011	N
market for soybean meal	BR	2011-2011	N
market for soybean, Swiss integrated production	CH	2019-2019	N
market for straw	RER	2019-2019	N
market for straw, organic	RER	2019-2019	N
market for straw, stand-alone production	RER	2019-2019	N
market for sugarcane	BR	2012-2014	U
market for sugarcane	CO	2012-2014	N
market for sugarcane loading, by loader	GLO	2012-2014	N
market for sugarcane transfer, by dump cart	GLO	2012-2014	N
market for sugarcane vinasse application, by wheel reel irrigation	GLO	2012-2014	N
market for sunflower seed, Swiss integrated production	CH	2019-2019	N
market for tillage, harrowing, by offset disk harrow	GLO	2012-2014	N
market for tillage, harrowing, by offset leveling disc harrow	GLO	2012-2014	N
market for tillage, subsoiling, by subsoiler plow	GLO	2012-2014	N
market for transport, tractor and trailer, agricultural	CH	2011-2011	N
market for vinasse, from fermentation of sugar beet	GLO	2012-2012	U
market for vinasse, from fermentation of sugar beet molasses	GLO	2012-2012	U
market for vinasse, from fermentation of sugarcane	GLO	2012-2012	U

Activity Name	Geography	Time Period	v3.6
market for vinasse, from fermentation of sweet sorghum	GLO	2012-2012	U
market for weed control, by brush cutter, pasture	GLO	2012-2016	N
market for wheat bran	GLO; ZA	2016-2017	N
market for wheat flour	GLO; ZA	2016-2017	N
market for wheat grain	ZA	2016-2017	N
market for wheat grain, feed, Swiss integrated production	CH	2019-2019	N
market for wheat grain, Swiss integrated production	CH	2019-2019	N
market for wood chips, wet, measured as dry mass	CH; Europe without CH	2014-2014	U
market for wood chips, wet, measured as dry mass	GLO	2011-2011	U
millet production	GLO; IN	2015-2018	N
mustard production	GLO; IN	2015-2018	N
oat seed production, Swiss integrated production, at farm	GLO	1996-2012	U*
onion production	IN	2015-2018	N
orange production, fresh grade	ZA	2015-2015	U
pear production	ZA	2012-2016	N
planting with starter fertiliser, by no till planter	BR; GLO	2012-2016	N
planting, sugarcane	BR; GLO	2012-2014	N
pomegranate production	GLO; IN	2015-2018	N
rice production, basmati	GLO; IN	2015-2018	N
rice production, non-basmati	CN; US	2009-2012	U
rice production, non-basmati	GLO	2001-2006	U
rice production, non-basmati	IN	2015-2018	U
rice seed production, for sowing	GLO	1997-2006	U
rice seed production, for sowing	US	1997-2006	U
sesame seed production	GLO; IN	2015-2018	N
sowing	BR	2012-2016	N
sowing	ZA	2016-2016	N
soybean production	BR-GO; BR-MS; BR-MT; BR-PR; BR-RS	2012-2014	N
soybean production	IN	2015-2018	N
soybean production	GLO	2004-2006	U
soybean production, Swiss integrated production, intensive	CH; GLO	1996-2003	U*
soybean meal and crude oil production	BR	2015-2015	U
sugar beet production	GLO	1996-2003	U
sugarcane loading, by loader	BR; GLO	2012-2014	N
sugarcane processing, modern annexed plant	GLO	2012-2014	N
sugarcane processing, modern annexed plant	BR	2012-2014	N
sugarcane processing, modern autonomous plant	GLO	2012-2014	N
sugarcane processing, modern autonomous plant	BR	2012-2014	N

Activity Name	Geography	Time Period	v3.6
sugarcane processing, traditional annexed plant	BR	2012-2014	N
sugarcane processing, traditional annexed plant	CO	2012-2014	N
sugarcane processing, traditional annexed plant	GLO	2012-2014	N
sugarcane processing, traditional autonomous plant	BR	2012-2014	N
sugarcane processing, traditional autonomous plant	GLO	2012-2014	N
sugarcane production	BR-GO; BR-MG; BR-MS; BR-MT; BR-PR; BR-SP	2012-2014	N
sugarcane production	CO	2005-2013	N
sugarcane production	IN	2015-2018	U
sugarcane transfer, by dump cart	BR; GLO	2012-2014	N
sugarcane vinasse application, by wheel reel irrigation equipment	BR; GLO	2012-2014	N
tea production, dried	IN-HP	2015-2018	N
tillage, harrowing, by offset disk harrow	BR; GLO	2012-2014	N
tillage, harrowing, by offset leveling disc harrow	BR; GLO	2012-2014	N
tillage, ploughing	ZA	2016-2016	N
tillage, rotary cultivator	ZA	2016-2016	N
tillage, subsoiling, by subsoiler plow	BR; GLO	2012-2014	N
tomato production, fresh grade, open field	IN-MH; IN-UP	2015-2018	N
tomato production, fresh grade, open field	GLO	2009-2012	U
weed control, by brush cutter, pasture	BR; GLO	2012-2016	N
wheat grain processing, dry milling	GLO; ZA	2016-2017	N
wheat production	IN	2015-2018	N
wheat production	ZA	2016-2016	N

3.3 Animal husbandry

The v3.6 offers cattle production in Brazil and South Africa, covering different technologies (Folegatti-Matsuura and Picoli, 2018; Russo *et al.*, 2018). A summary of the new products added, and the new activities included in the database can be found in the following tables.

Table 12. New products related to animal husbandry. *The table lists all products added new to the database related to animal husbandry.*

Product	Unit
mineral supplement, for beef cattle	kg
salt	kg
weaned calves, live weight	kg
weaned heifers, live weight	kg

Table 13. New activities related to animal husbandry. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

ActivityName	Geography	Time Period	v3.6
beef cattle production on pasture	BR; GLO	2006-2015	N
beef cattle production on pasture	ZA	2016-2016	N
beef cattle production on pasture and feedlot	BR; GLO	2006-2015	N
beef cattle production on pasture and proteic supplement	BR; GLO	2006-2015	N
fattening of calves for beef cattle production, on pasture	BR; GLO	2006-2015	N
fattening of calves for beef production, feedlot	GLO; ZA	2016-2016	N
fattening of heifers for beef cattle production, on pasture	BR; GLO	2006-2015	N
fattening of heifers for beef production, feedlot	GLO; ZA	2016-2016	N
intensive beef cattle production on pasture	BR; GLO	2006-2015	N
intensive beef cattle production, fat steers only, on pasture	BR; GLO	2006-2015	N
market for cattle for slaughtering, live weight	BR; ZA	2017-2017	N
market for cattle for slaughtering, live weight	GLO	2017-2017	U
market for mineral supplement, for beef cattle	GLO	2019-2019	N
market for salt	GLO	2019-2019	N
market for weaned calves, live weight	BR; GLO; ZA	2017-2017	N
market for weaned heifers, live weight	BR; GLO; ZA	2017-2017	N
milk production, from cow	GLO	2009-2011	U
milk production, from cow	ZA	2016-2016	N
mineral supplement production, for beef cattle	GLO	2019-2019	N
salt production from seawater, evaporation pond	GLO	2019-2019	N
weaned calves production on native and planted pasture, Pantanal	BR; GLO	2006-2015	N
weaned calves production on native pasture, Pantanal	BR; GLO	2006-2015	N
weaned calves production on pasture	BR; GLO	2006-2015	N
weaned calves production on pasture	ZA	2016-2016	N

3.4 Packaging of fertilisers and pesticides

Packaging for fertilizers and pesticides was included in some datasets of the database and has now be expanded to all. Also, the assumptions have been refined, considering that fertilisers by default solid and pesticides, liquid, needing each of them distinct and specific packaging. Hence, two new datasets were generated that consider the production of those types of packaging, one for solid fertilisers and one for liquid pesticides. Pesticide/liquid packaging is using only HDPE input while the fertiliser/solid is using PE.

Modifications were made in all groups of datasets. The amount of packaging necessary for each dataset was calculated based on the total amounts of active substances present in the dataset. This amount was later scaled by a factor of 2 in order to consider a dilution rate of the substances. 2 new products were introduced for this update: “packaging, for fertilisers” (kg) and “packaging, for pesticides” (kg).

Table 14. New activities introduced for the update of the packaging of fertilisers or pesticides.

Activity name	Geography	Time period
market for packaging, for fertilisers	GLO	2009-2015
market for packaging, for pesticides	GLO	2009-2015
packaging production for fertiliser, per kilogram of packed product	GLO	2009-2015
packaging production for pesticide, per kilogram of packed product	GLO	2009-2015

Table 15. Datasets affected by the packaging update for fertilisers and/or pesticides. *The column Packaging update refers to exact update: "Fertiliser" and "Pesticide" implies that updates took place only for packaging of fertilisers or pesticides respectively; "Both" reflects that both exchanges were updated.*

Activity name	Geography	Time period	Packaging update
alfalfa/grass silage production	CA-QC; GLO	2010-2012	Both
alfalfa-grass mixture production, Swiss integrated production	CH; GLO	2001-2001	Both
almond production	CN; GLO; US	2009-2012	Both
apple production	CL; CN; GLO; IT; US	2009-2012	Both
apricot production	GLO; TR	2002-2012	Both
apricot production	ES; FR; IT	2009-2012	Both
asparagus seedling production, for planting	FR; GLO	2009-2012	Both
aubergine production, in heated greenhouse	GLO	2010-2010	Both
avocado production	GLO	2010-2010	Both
banana production	CO; CR; IN	2009-2012	Fertiliser
banana production	EC; GLO	2009-2012	Both
barley production	DE; ES; FR; GLO	2000-2004	Both
barley production	CA-QC	2010-2012	Both
barley production, Swiss integrated production, extensive	CH; GLO	1996-2003	Both
barley production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
barley seed production, for sowing	GLO	1999-2002	Pesticide
barley seed production, Swiss integrated production, for sowing	CH; GLO	1999-2002	Pesticide
beet seed production, Swiss integrated production, for sowing	CH; GLO	1999-2002	Pesticide
bell pepper production, in heated greenhouse	GLO	2010-2010	Both
broccoli production	GLO	2010-2010	Both
cabbage red production	GLO	2010-2010	Both
cabbage white production	GLO	2010-2010	Both
carrot production	CN; GLO; IL; NL	2009-2012	Both
carrot seed production, Swiss integrated production, at farm	CH; GLO	2000-2012	Both
cauliflower production	GLO	2010-2010	Both
celery675 production	GLO	2010-2010	Both
clover seed production, Swiss integrated production, at farm	CH; GLO	2000-2000	Both
cocoa bean production, sun-dried	CI; GH; GLO; ID	2009-2012	Both
coconut production, dehusked	GLO; ID; PH	2009-2012	Both
coconut production, dehusked	IN	2010-2012	Both
coffee green bean production, arabica	BR	2001-2012	Both
coffee green bean production, arabica	GLO	2001-2014	Both
coffee green bean production, arabica	CO; HN; IN	2012-2014	Both
coffee green bean production, robusta	BR; GLO; ID; VN	2012-2014	Both
coffee green bean production, robusta	IN	2012-2014	Fertiliser
cottonseed production, for sowing	GLO; US	1997-2006	Pesticide

Activity name	Geography	Time period	Packaging update
cucumber production	GLO	2010-2010	Both
establishing orchard	CH; GLO	2011-2011	Both
fava bean production, Swiss integrated production, at farm	CH; GLO	1996-2003	Both
fava bean seed production, for sowing	CH; GLO	1999-2002	Pesticide
fennel production	GLO	2010-2010	Both
fodder beet production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
fodder beet seed production, for sowing	GLO	1999-2002	Pesticide
fruit tree seedling production, for planting	CH; GLO	2000-2012	Both
grape production	GLO	2010-2010	Both
grass production, permanent grassland, Swiss integrated production, extensive	CH; GLO	1995-2005	Pesticide
grass production, permanent grassland, Swiss integrated production, intensive	CH; GLO	2000-2005	Both
grass production, Swiss integrated production, intensive	CH; GLO	1995-2005	Both
grass seed production, Swiss integrated production, at farm	CH; GLO	2000-2000	Both
grass silage production, Swiss integrated production, intensive	CH; GLO	1995-2005	Both
green asparagus production	GLO	2010-2010	Both
hay production	CA-QC; GLO	2010-2012	Both
hay production, organic, intensive	CH; GLO	2005-2005	Fertiliser
hay production, Swiss integrated production, intensive	CH; GLO	2005-2005	Both
iceberg lettuce production	GLO	2010-2010	Both
jatropha seed production	GLO	2005-2014	Both
jute production, irrigated	GLO; IN	2015-2016	Both
jute production, rainfed	GLO	2016-2017	Fertiliser
kiwi production	GLO	2010-2010	Both
lemon production	ES; GLO; MX; TR	2009-2012	Both
lettuce360 production	GLO	2010-2010	Both
lettuce361 production	GLO	2010-2010	Both
linseed production	CA; GLO	2003-2012	Both
linseed production	RU	2007-2012	Both
linseed seed production, at farm	CH; GLO	1996-2012	Both
maize grain production	GLO; US	2004-2006	Both
maize grain production	AR	2009-2012	Both
maize grain production	CA-QC	2010-2012	Both
maize grain production, Swiss integrated production	CH; GLO	1996-2003	Both
maize seed production, at farm	GLO	2000-2000	Both
maize seed production, for sowing	GLO	1999-2002	Pesticide
maize seed production, Swiss integrated production, at farm	CH; GLO	2000-2000	Both
maize seed production, Swiss integrated production, for sowing	CH; GLO	1999-2002	Pesticide
maize silage production	CA-QC; GLO	2010-2012	Both
maize silage production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both

Activity name	Geography	Time period	Packaging update
mandarin production	CN; ES; GLO	2009-2012	Both
melon production	GLO	2010-2010	Both
mint production	GLO; IN	1999-2012	Both
mint production	US	2007-2008	Both
mint seedling production, for planting	GLO; US	2009-2012	Both
miscanthus production	DE; GLO	2005-2005	Both
miscanthus rhizome production, for planting	DE; GLO	2005-2005	Both
oat production	Canada without Quebec; FI	2009-2012	Both
oat production	CA-QC; GLO	2010-2012	Both
oat seed production, for sowing	CH; GLO	1999-2012	Pesticide
oat seed production, Swiss integrated production, at farm	CH; GLO	1996-2012	Both
olive production	GLO; IT	2001-2012	Both
olive production	ES	2009-2012	Both
onion production	GLO	2004-2012	Both
onion production	CN	2009-2010	Both
onion production	NL; NZ	2009-2012	Both
onion production	IN	2015-2018	Both
onion seedling production, for planting	GLO; NZ	2009-2012	Both
orange production, fresh grade	ES	2000-2012	Both
orange production, fresh grade	GLO	2000-2014	Both
orange production, fresh grade	US	2010-2014	Both
orange production, fresh grade	ZA	2015-2015	Both
orange production, processing grade	BR	2000-2012	Both
orange production, processing grade	GLO	2000-2014	Both
orange production, processing grade	US	2010-2014	Both
palm date production	GLO	2012-2012	Both
palm date production, organic	GLO	2012-2012	Pesticide
palm fruit bunch production	CO	2001-2011	Both
palm fruit bunch production	GLO; MY	2002-2006	Both
palm fruit bunch production	ID	2009-2012	Both
papaya production	GLO	2010-2010	Both
paris market carrot production	GLO	2010-2010	Both
pea seed production, for sowing	CH; GLO	1999-2002	Pesticide
peach production	CN; ES; GLO; IT	2009-2012	Both
peanut production	AR	2009-2012	Pesticide
peanut production	CN	2009-2012	Fertiliser
peanut production	GLO; IN	2009-2012	Both
peanut seed production, at farm	GLO; IN	1996-2012	Both
peanut seed production, for sowing	GLO; IN	1999-2012	Pesticide

Activity name	Geography	Time period	Packaging update
pear production	AR; BE; CN; GLO	2009-2012	Both
pineapple production	GLO	2010-2010	Both
potato production	IN	2000-2012	Both
potato production	GLO; US	2001-2006	Both
potato production	CN	2003-2013	Both
potato production	RU; UA	2009-2012	Both
potato production	CA-QC	2010-2012	Both
potato production, organic	CH; GLO	1996-2003	Pesticide
potato production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
potato seed production, at farm	GLO	1996-2003	Both
potato seed production, for setting	GLO	1999-2002	Pesticide
potato seed production, organic, at farm	CH; GLO	1996-2003	Pesticide
potato seed production, Swiss integrated production, at farm	CH; GLO	1996-2003	Both
potato seed production, Swiss integrated production, for setting	CH; GLO	1999-2002	Pesticide
protein pea production	DE; ES; FR	2000-2004	Both
protein pea production	ES	2000-2004	Pesticide
protein pea production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
radish production	GLO	2010-2010	Fertiliser
rape seed production	DE; FR; GLO	2000-2004	Both
rape seed production	US	2001-2006	Both
rape seed production	Canada without Quebec	2009-2012	Both
rape seed production	CA-QC	2010-2012	Both
rape seed production, Swiss integrated production, extensive	CH; GLO	1996-2003	Both
rape seed production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
rice production, non-basmati	GLO	2001-2006	Both
rice production, non-basmati	IN	2015-2018	Both
rice seed production, for sowing	GLO; US	1997-2006	Pesticide
rye production	GLO; RER	2002-2006	Both
rye production, Swiss integrated production, extensive	CH; GLO	1996-2003	Both
rye production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
rye seed production, for sowing	GLO	1999-2002	Pesticide
rye seed production, Swiss integrated production, for sowing	CH; GLO	1999-2002	Pesticide
soybean production	CH	1996-2012	Both
soybean production	GLO	2004-2006	Both
soybean production	US	2004-2007	Both
soybean production	AR	2009-2012	Both
soybean production	CA-QC	2010-2012	Both
soybean production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
soybean seed production, for sowing	CH; GLO	1999-2002	Pesticide

Activity name	Geography	Time period	Packaging update
spinach production	GLO	2010-2010	Both
strawberry production, in heated greenhouse	CH; GLO	2009-2012	Both
strawberry production, in unheated greenhouse	CH; GLO	2009-2012	Both
strawberry production, open field, macro tunnel	ES; GLO	2006-2012	Both
strawberry production, open field, macro tunnel	US	2010-2010	Both
sugar beet production	CH; GLO	1996-2003	Both
sugar beet production	FR	2006-2012	Both
sugar beet production	DE; RU; US	2009-2012	Both
sugar beet seed production, for sowing	GLO	1999-2002	Pesticide
sugarcane production	GLO	1996-2006	Both
sugarcane production	IN	2015-2018	Both
sunflower production	ES; GLO	2000-2004	Pesticide
sunflower production	UA	2000-2012	Both
sunflower production	FR	2006-2012	Both
sunflower production	HU; RU	2009-2012	Both
sunflower production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
sweet corn production	GLO; HU; US	2006-2012	Both
sweet corn production	TH	2010-2011	Both
sweet sorghum production	CN; GLO	2000-2006	Both
tea production, dried	CN; GLO; KE; LK	2009-2012	Both
tomato production, fresh grade, in heated greenhouse	GLO; NL	2009-2012	Both
tomato production, fresh grade, in unheated greenhouse	ES; GLO	2006-2012	Both
tomato production, fresh grade, open field	GLO; MX	2009-2012	Both
tomato production, processing grade, open field	GLO	2007-2011	Both
tomato production, processing grade, open field	IT	2011-2011	Both
tree seedling production, in heated greenhouse	GLO; RER	2002-2002	Fertiliser
tree seedling production, in unheated greenhouse	GLO; RER	2002-2002	Fertiliser
wheat production	DE; ES; FR	2000-2004	Both
wheat production	GLO; US	2001-2006	Both
wheat production	AU; Canada without Quebec	2009-2012	Both
wheat production	CA-QC	2010-2012	Both
wheat production, Swiss integrated production, extensive	CH; GLO	1996-2003	Both
wheat production, Swiss integrated production, intensive	CH; GLO	1996-2003	Both
wheat seed production, for sowing	GLO	1999-2002	Pesticide
wheat seed production, Swiss integrated production, for sowing	CH; GLO	1999-2002	Pesticide
white asparagus production	CN; FR; GLO; PE	2009-2012	Both
willow production, short rotation coppice	DE; GLO	2005-2005	Both
willow stem cutting production, for planting	DE; GLO	2005-2005	Pesticide
zucchini production	GLO	2010-2010	Both

4 Building and construction materials

In the context of the SRI-LCI project, new building and construction related data was created both at global and at regional (Brazil, Colombia, Peru, South Africa and India) level. The details about data collection and creation can be found in the following reports: Gmünder *et al.* 2018; Kiran Ananth *et al.*, 2018; Muigai and Pradhan, 2018; Silva *et al.,* 2018. In this section of the change report, a summary of the new data and its impact on the ecoinvent database is presented.

4.1 Sand and gravel

New data for sand and gravel in India and Brazil is published in version 3.6. Worth mentioning is the addition of a new technology in the ecoinvent database, "sand quarry operation, extraction from river bed". Because of the inclusion of new data, the supply chains of the existing geographies were reviewed, this resulted in the addition of a Québécois market for crushed gravel and a Swiss market for sand. Regional markets are created when commodities are traded within a country rather than at global level. For example, the regional market for sand in Switzerland was deemed appropriate as, according to Federal Office of Topography swisstopo (2017), Switzerland is fundamentally independent when it comes to mineral commodities. In addition to supply chains, production volumes of existing datasets were reviewed and updated where necessary.

Table 16. List of all new and updated activities related to sand and gravel. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	v3.6
gravel and sand quarry operation	GLO	1997-2001	U
gravel and sand quarry operation	CH	1997-2001	U
gravel production, crushed	CA-QC; GLO	1997-2001	U
gravel production, crushed	CH	2013-2013	U
gravel production, crushed	IN	2014-2017	N
gravel production, crushed	BR	2015-2016	N
gravel/sand quarry construction	CH	1997-2001	U
sand quarry operation, extraction from river bed	IN	2014-2017	N
sand quarry operation, extraction from river bed	BR; GLO	2015-2015	N
sand quarry operation, open pit mine	BR; GLO	2016-2016	N
market for gravel, crushed	GLO	2011-2011	U
market for gravel, crushed	CA-QC	2011-2011	N
market for gravel, crushed	IN	2014-2017	N
market for gravel, crushed	BR	2015-2016	N
market for gravel, round	GLO	2011-2011	U
market for sand	GLO	2011-2011	U
market for sand	CH	2011-2018	N
market for sand	IN	2014-2017	N
market for sand	BR	2015-2016	N

4.2 Clinker, cement and concrete

The SRI-LCI project delivered regional data for clinker and the most common types of cement and concrete for Brazil, Colombia, Peru, South Africa and India. The addition of a such large number of datasets resulted in the need of restructuring this part of the building and construction sector.

4.2.1 Clinker

The transforming and market activities for clinker are published for all the geographies mentioned above. The production of clinker varies greatly from region to region, it was therefore decided to recalculate the global (Rest of the World after linking) dataset as a weighted average of all the available geographies, i.e. CH, CA-QC, Europe without Switzerland, US, BR, CO, PE, ZA and IN.

***Table 17. List of all new and updated clinker related activities**. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	v3.6
clinker production	GLO	1998-2017	U
clinker production	CO; IN; PE	2014-2017	N
clinker production	BR	2016-2016	N
clinker production	ZA	2017-2017	N
market for clinker	BR	2014-2014	N
market for clinker	CO; IN; PE	2014-2017	N
market for clinker	ZA	2017-2017	N

4.2.2 Cement

In total 23 regional cement types are published in v3.6, 7 for Brazil, 2 for Colombia, 3 for Peru, 8 for South Africa and 3 for India. Of these, 17 are new cement types introduced in the ecoinvent database. These add to the already existing 28 cement production datasets for the geographies of Switzerland, Québec, Europe without Switzerland and US.

Cement is a regional specific product, for this reason up to version 3.5, activities representing the same technology in different geographies where marked with a "US only" and "non-US" in the activity name and reference product. This ensured that each activity had a representative global dataset and that the reference products would not get mixed in the same market.

For version 3.6, because of the increasing amount of data included, the structure of the sector was changed. "US only" and "non-US" were deleted from activity name and reference product names (see Table 1 and Table 2). The global datasets were recalculated as weighted averages, if necessary. In version 3.6, a single global activity is available for each cement type available.

***Table 18. List of all new and update cement related activities**. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity". For "*" check the renaming section of this report. The symbol "**" indicates the updated of the production volume of the by-product "scrap steel".*

Activity name	Geography	Time period	v3.6
cement production, Portland	CA-QC; GLO	2005-2009	U**
cement production, Portland	IN; PE	2014-2017	N
cement production, Portland	BR	2016-2016	N
cement production, Portland	ZA	2017-2017	N
cement production, alternative constituents 21-35%	GLO	2005-2009	U
cement production, alternative constituents 21-35%	CO	2014-2017	N
cement production, alternative constituents 45%	CO; GLO	2014-2017	N
cement production, alternative constituents 6-20%	GLO	2005-2009	U
cement production, blast furnace slag 18-30% and 18-30% other alternative constituents	GLO	2005-2009	U
cement production, blast furnace slag 21-35%	GLO; ZA	2017-2017	N
cement production, blast furnace slag 25-70%	GLO	2005-2009	U
cement production, blast furnace slag 31-50% and 31-50% other alternative constituents	GLO	2005-2009	U
cement production, blast furnace slag 35-70%	BR; GLO	2016-2016	N
cement production, blast furnace slag 36-65%	CH; Europe without Switzerland	2005-2009	U
cement production, blast furnace slag 36-65%	GLO	2005-2009	N
cement production, blast furnace slag 36-65%	ZA	2017-2017	N
cement production, blast furnace slag 40-70%	GLO; IN	2014-2017	N
cement production, blast furnace slag 5-25%	US	2005-2009	U*
cement production, blast furnace slag 5-25%	GLO	2005-2009	U
cement production, blast furnace slag 6-20%	GLO; ZA	2017-2017	N
cement production, blast furnace slag 6-34%	BR; GLO	2016-2016	N
cement production, blast furnace slag 66-80%	CH; Europe without Switzerland	2005-2009	U*
cement production, blast furnace slag 66-80%	GLO	2005-2009	U
cement production, blast furnace slag 70-100%	US	2005-2009	U*
cement production, blast furnace slag 70-100%	GLO	2005-2009	U
cement production, blast furnace slag 81-95%	CH; Europe without Switzerland	2005-2009	U*
cement production, blast furnace slag 81-95%	GLO	2005-2009	U
cement production, fly ash 21-35%	GLO; ZA	2017-2017	N
cement production, fly ash 6-20%	GLO; ZA	2017-2017	N
cement production, limestone 21-35%	GLO; PE	2014-2017	N
cement production, limestone 21-35%	ZA	2017-2017	N
cement production, limestone 6-10%	BR; GLO	2016-2016	N
cement production, limestone 6-20%	GLO; ZA	2017-2017	N
cement production, pozzolana and fly ash 11-35%	CH; Europe without Switzerland	2005-2009	U*
cement production, pozzolana and fly ash 11-35%	GLO	2005-2009	U
cement production, pozzolana and fly ash 15-40%	GLO	2005-2009	U
cement production, pozzolana and fly ash 15-50%	BR; GLO	2016-2016	N
cement production, pozzolana and fly ash 25-35%	GLO; IN	2014-2017	N
cement production, pozzolana and fly ash 36-55%	CH; Europe without Switzerland	2005-2009	U*
cement production, pozzolana and fly ash 36-55%	GLO	2005-2009	N
cement production, pozzolana and fly ash 36-55%	PE	2014-2017	N
cement production, pozzolana and fly ash 5-15%	US	2005-2009	U*

Activity name	Geography	Time period	v3.6
cement production, pozzolana and fly ash 5-15%	GLO	2005-2009	U
cement production, pozzolana and fly ash 6-14%	BR; GLO	2016-2016	N
cement production, sulphate resistant	BR; GLO	2016-2016	N
market for cement, Portland	CA-QC	2006-2006	N
market for cement, Portland	BR	2013-2014	N
market for cement, Portland	IN; PE	2014-2017	N
market for cement, Portland	ZA	2017-2017	N
market for cement, alternative constituents 21-35%	CO	2014-2017	N
market for cement, alternative constituents 45%	CO; GLO	2014-2017	N
market for cement, alternative constituents 6-20%	CA-QC	2006-2006	N
market for cement, blast furnace slag 21-35%	GLO; ZA	2017-2017	N
market for cement, blast furnace slag 35-70%	BR; GLO	2013-2014	N
market for cement, blast furnace slag 36-65%	CH; Europe without Switzerland	2005-2009	U
market for cement, blast furnace slag 36-65%	GLO	2017-2017	U
market for cement, blast furnace slag 36-65%	ZA	2017-2017	N
market for cement, blast furnace slag 40-70%	GLO; IN	2014-2017	N
market for cement, blast furnace slag 5-25%	GLO; US	2005-2009	U*
market for cement, blast furnace slag 6-20%	GLO; ZA	2017-2017	N
market for cement, blast furnace slag 6-34%	BR; GLO	2013-2014	N
market for cement, blast furnace slag 70-100%	GLO; US	2005-2009	U*
market for cement, limestone 21-35%	GLO; PE	2014-2017	N
market for cement, limestone 6-10%	BR; GLO	2013-2014	N
market for cement, limestone cement 6-20%	GLO; ZA	2017-2017	N
market for cement, portland fly ash cement 21-35%	GLO; ZA	2017-2017	N
market for cement, portland fly ash cement 6-20%	GLO; ZA	2017-2017	N
market for cement, pozzolana and fly ash 15-50%	BR; GLO	2013-2014	N
market for cement, pozzolana and fly ash 25-35%	GLO; IN	2014-2017	N
market for cement, pozzolana and fly ash 5-15%	GLO; US	2005-2009	U*
market for cement, pozzolana and fly ash 6-14%	BR; GLO	2013-2014	N
market for cement, sulphate resistant	BR; GLO	2016-2016	N

To supply on the generic product “cement, unspecified” a single renaming activity per geography was generated in v3.6, changing the previous structure with multiple renaming activities. The renaming activities group all technologies based on production volume and produce a generic product "cement, unspecified", which feeds into the relevant regional market to then converge into a global market group.

Table 19. List of all new and update renaming activities and generic products related to cement*. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	v3.6
cement, all types to generic market for cement, unspecified	BR; CA-QC; CH; CO; Europe without Switzerland; GLO; IN; PE; US; ZA	2013-2013	N
market for cement, unspecified	GLO	2005-2009	U
market for cement, unspecified	CH; Europe without Switzerland	2013-2013	U
market for cement, unspecified	BR; CA-QC; CO; IN; PE; US; ZA	2019-2019	N
market group for cement, unspecified	GLO	2019-2019	N

4.2.3 Concrete

In total 33 regional concrete types are published, 13 for Brazil, 3 for Colombia, 9 for Peru, 7 for South Africa and 1 for India. These add to the alredy existing 22 concrete production datasets for the geographies of Switzerland, Québec, and Rest of North America. All new concrete products are differentiated based on strength in MPa. This matches the way the North American datasets are built, while for Switzerland, concrete types follow the specific country nomenclature convention.

Up until version 3.5, the data for the Rest of North America was marked as "RNA only" in the activity name but appeared available with the geography global. These activities together with the ones for Québec converged into a GLO market for concrete *X* MPa. For version 3.6, "RNA only" was deleted from the activity name (see Table 1 and Table 2) and the geography was changed to "North America without Quebec". These datasets together with the Québécois now converge in a Region North America (RNA) market.

Table 20. List of all new and update concrete related activities*. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity". For "*" check the renaming section of this report. The symbol "**" indicates the updated of the production volume of the by-product "scrap steel".*

Activity name	Geography	Time period	v3.6
concrete production 20MPa	GLO; ZA	2017-2017	N
concrete production 25-30MPa	GLO; IN	2014-2017	N
concrete production 25MPa	GLO; ZA	2017-2017	N
concrete production 30-32MPa	GLO	2006-2006	N
concrete production 30MPa	GLO; ZA	2017-2017	N
concrete production 35MPa	GLO; ZA	2017-2017	N
concrete production 40MPa	GLO; ZA	2017-2017	N
concrete production 45MPa	GLO; ZA	2017-2017	N
concrete production 50MPa	GLO; ZA	2017-2017	N
concrete production, 20MPa, ready-mix, with Portland cement	GLO; PE	2014-2017	N
concrete production, 20MPa, ready-mix, with cement, alternative constituents 21-35%	CO; GLO	2014-2017	N
concrete production, 20MPa, ready-mix, with cement, limestone 21-35%	GLO; PE	2014-2017	N
concrete production, 20MPa, ready-mix, with cement, pozzolana and fly ash 36-55%	GLO; PE	2014-2017	N

Activity name	Geography	Time period	v3.6
concrete production, 20MPa, self, construction, with cement, pozzolana and fly ash 36-55%	GLO; PE	2014-2017	N
concrete production, 20MPa, self-construction, with Portland cement	GLO; PE	2014-2017	N
concrete production, 20MPa, self-construction, with cement, alternative constituents 45%	CO; GLO	2014-2017	N
concrete production, 20MPa, self-construction, with cement, limestone 21-35%	GLO; PE	2014-2017	N
concrete production, 25MPa, ready-mix, with cement blast furnace slag 35-70%	BR; GLO	2015-2017	N
concrete production, 25MPa, ready-mix, with cement blast furnace slag 6-34%	BR; GLO	2015-2017	N
concrete production, 25MPa, ready-mix, with cement limestone 6-10%	BR; GLO	2015-2017	N
concrete production, 30MPa, ready-mix, with cement blast furnace slag 35-70%	BR; GLO	2015-2017	N
concrete production, 30MPa, ready-mix, with cement blast furnace slag 6-34%	BR; GLO	2015-2017	N
concrete production, 30MPa, ready-mix, with cement limestone 6-10%	BR; GLO	2015-2017	N
concrete production, 35MPa, ready-mix, with cement blast furnace slag 35-70%	BR; GLO	2015-2017	N
concrete production, 35MPa, ready-mix, with cement blast furnace slag 6-34%	BR; GLO	2015-2017	N
concrete production, 35MPa, ready-mix, with cement limestone 6-10%	BR; GLO	2015-2017	N
concrete production, 40MPa, ready-mix, with Portland cement	GLO; PE	2014-2017	N
concrete production, 40MPa, ready-mix, with cement blast furnace slag 35-70%	BR; GLO	2015-2017	N
concrete production, 40MPa, ready-mix, with cement blast furnace slag 6-34%	BR; GLO	2015-2017	N
concrete production, 40MPa, ready-mix, with cement limestone 6-10%	BR; GLO	2015-2017	N
concrete production, 40MPa, ready-mix, with cement, alternative constituents 21-35%	CO; GLO	2014-2017	N
concrete production, 40MPa, ready-mix, with cement, limestone 21-35%	GLO; PE	2014-2017	N
concrete production, 40MPa, ready-mix, with cement, pozzolana and fly ash 36-55%	GLO; PE	2014-2017	N
concrete production, for building construction, with cement CEM II/A	GLO	2013-2013	U
concrete production, for building construction, with cement CEM II/B	GLO	2013-2013	U
concrete production, for civil engineering, with cement CEM I	GLO	2013-2013	U
concrete production, for civil engineering, with cement CEM II/A	GLO	2013-2013	U
concrete production, for civil engineering, with cement CEM II/B	GLO	2013-2013	U
concrete production, for drilled piles, with cement CEM I	GLO	2013-2013	U
concrete production, for drilled piles, with cement CEM II/A	GLO	2013-2013	U
concrete production, for drilled piles, with cement CEM II/B	GLO	2013-2013	U
fibre-reinforced concrete production, steel	BR; GLO	2016-2016	N
lean concrete production, with cement CEM II/A	GLO	2013-2013	U
lean concrete production, with cement CEM II/B	GLO	2013-2013	U
market for concrete, 20MPa	RNA	2006-2006	N
market for concrete, 20MPa	CO; PE	2014-2017	N
market for concrete, 20MPa	ZA	2017-2017	N
market for concrete, 25-30MPa	GLO; IN	2014-2017	N
market for concrete, 25MPa	RNA	2006-2006	N
market for concrete, 25MPa	BR	2015-2017	N
market for concrete, 25MPa	ZA	2017-2017	N
market for concrete, 30-32MPa	RNA	2006-2006	N
market for concrete, 30MPa	BR	2015-2017	N
market for concrete, 30MPa	GLO; ZA	2017-2017	N
market for concrete, 35MPa	RNA	2006-2006	N
market for concrete, 35MPa	BR	2015-2017	N
market for concrete, 35MPa	ZA	2017-2017	N
market for concrete, 40MPa	CO; PE	2014-2017	N
market for concrete, 40MPa	BR	2015-2017	N
market for concrete, 40MPa	GLO; ZA	2017-2017	N
market for concrete, 45MPa	GLO; ZA	2017-2017	N
market for concrete, 50MPa	RNA	2006-2006	N

Activity name	Geography	Time period	v3.6
market for concrete, 50MPa	ZA	2017-2017	N
market for fibre-reinforced concrete, steel	BR; GLO	2016-2016	N
unreinforced concrete production, with cement CEM II/A	GLO	2013-2013	U
unreinforced concrete production, with cement CEM II/B	GLO	2013-2013	U

As in the cement case, all concrete types are grouped per region with the aid of a renaming activity. The share of contribution of each concrete type is set based on production volumes. The renaming activities are available for two generic products: "concrete, normal" and "concrete, medium strength". Normal concrete includes strengths from 20 to 35 MPa, this type of concrete is used for conventional projects, such as foundation, columns, beams and slabs in a typical reinforced concrete building. Medium strength concrete includes strength from 40 to 50 MPa, and it used for example for construction of bridges. A regional market for each of the generic product is available. The regional markets then converge in a global market group.

Table 21. List of all new and update renaming activities and generic products related to concrete*. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	v3.6
concrete, all types to generic market for concrete, medium strength	BR; CO; GLO; PE; RNA; ZA	2019-2019	N
concrete, all types to generic market for concrete, normal strength	BR; CO; GLO; IN; PE; RNA; ZA	2019-2019	N
market for concrete, medium strength	BR; CO; GLO; PE; RNA; ZA	2019-2019	N
market for concrete, normal	GLO	2019-2019	U
market for concrete, normal	BR; CO; IN; PE; RNA; ZA	2019-2019	N
market group for concrete, medium strength	GLO	2019-2019	N
market group for concrete, normal	GLO	2019-2019	N

In version 3.6 all regional transforming activities have a corresponding global dataset, which after linking represents the Rest of the World. This is valid for all geographies but Switzerland, this choice was made because of the different system used to identify concrete types.

4.2.3.1 Concrete normal and medium strength: implementation

Up until version 3.5, the demand of Rest of the World concrete was supplied by the global activities using the Swiss nomenclature. In version 3.6, the Swiss products are replaced by either concrete normal or medium strength in all non-swiss datasets. To implement this change, the Swiss products were matched to the two generic products as shown in the table below. For the full list of datasets affected by this change, see Annex 2: activities with changes in concrete.

Table 22. Matching of version 3.5 and 3.6 concrete products. *The unit of all the reference products is m3.*

Activity name v3.5	Reference product v3.5	Concrete strength	Strength according to SIA 262 - EN 206	Reference product v3.6
unreinforced concrete production, with cement CEM II/A	concrete, normal	B 35/25	C 25/30	concrete, normal
unreinforced concrete production, with cement CEM II/B	concrete, normal	B 35/25	C 25/30	concrete, normal
concrete production, for civil engineering, with cement CEM II/A	concrete, sole plate and foundation	B 35/25	C 25/30	concrete, normal
concrete production, for civil engineering, with cement CEM I	concrete, sole plate and foundation	B 35/26	C 25/31	concrete, normal
concrete production, for civil engineering, with cement CEM II/B	concrete, sole plate and foundation	B 35/27	C 25/32	concrete, normal
concrete production, for drilled piles, with cement CEM II/A	concrete, for de-icing salt contact	B 45/35 FT	C 30/37	concrete, normal
concrete production, for drilled piles, with cement CEM I	concrete, for de-icing salt contact	B 45/35 FT	C 30/37	concrete, normal
concrete production, for drilled piles, with cement CEM II/B	concrete, for de-icing salt contact	B 45/35 FT	C 30/37	concrete, normal
concrete production, for building construction, with cement CEM II/A	concrete, high exacting requirements	B 60/50	C 45/55	concrete, medium strength
concrete production, for building construction, with cement CEM II/B	concrete, high exacting requirements	B 60/50	C 45/55	concrete, medium strength

4.3 Granulated and ground granulated blast furnace slag

Granulated and ground granulated blast furnace slag (GBFS and GGBFS) are obtained by processing blast furnace slag, a by-product of iron production. The markets for these products are therefore set as constrained, i.e. the increase in demand cannot be met by an increase in supply.

In version 3.5 the "market for ground granulated blast furnace slag" was already constrained with the activity “cement production, alternative constituents 6-20%” set as the marginal consumer. This modelling applies only to the Consequential system model. Granulated blast furnace slag, on the other hand, is a new product in the ecoinvent database.

For version 3.6, the constrained market modelling is changed. A renaming activity was created for both GBFS and GGBFS, these activities supply the generic product "supplementary cementitious materials". A "market for supplementary cementitious materials" is created for both Brazil and global. Supplementary cementitious materials (SCMs) are materials used to substitute clinker in cement production. SCMs do not usually have an elastic demand as they are mostly produced as by-products. Examples of SCMs are fly ash, by-product of coal-fired electricity, and blast furnace slag, by-product of iron and steel production. According to Scrivener *et al.*, 2018 and Visedo and Pecchio, 2019 clay is one of the materials that could supply an increased demand for SCMs. For this reason, the marginal supplier for the global geography was set to "clay", while in Brazil to "calcined clay". This modelling is valid only in the Consequential system model.

Table 23. List of all new and updated renaming activities and generic products related to concrete*. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	v3.6
granulated blast furnace slag production	BR; GLO	2015-2019	N
ground granulated blast furnace slag production	IN	2014-2017	N
ground granulated blast furnace slag production	ZA	2017-2017	N
market for granulated blast furnace slag	BR; GLO	2015-2019	N
market for ground granulated blast furnace slag	GLO	2012-2012	U
market for ground granulated blast furnace slag	US	2012-2012	N
market for ground granulated blast furnace slag	IN	2014-2017	N
market for ground granulated blast furnace slag	ZA	2017-2017	N
calcined clay to generic market for supplementary cementitious materials	BR; GLO	2019-2019	N
clay to generic market for supplementary cementitious materials	GLO	2019-2019	N
granulated blast furnace slag to generic market for supplementary cementitious materials	BR; GLO	2019-2019	N
ground granulated blast furnace slag to generic market for supplementary cementitious materials	GLO; IN; US; ZA	2019-2019	N
market for supplementary cementitious materials	BR; GLO	2019-2019	N

4.4 Other building and construction materials

In this section the additional new and update datasets in this sector are listed. New data for mortar, plaster, blocks, etc. have been created for the SRI regions. The inclusion of this data resulted in the review of the supply chains and the production volumes of existing datasets.

***Table 24. List of all new and update activities related to concrete**. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity". The symbol "*" indicates that the only change was an update of the activity link.*

Activity name	Geography	Time period	v3.6
autoclaved aerated concrete block production	CH; GLO	1995-2000	U
autoclaved aerated concrete block production	IN	2014-2017	N
calcined clay production	BR; GLO	2015-2018	N
cement mortar production	GLO	1994-2001	U
cement mortar production	CH	1994-2001	U
cement mortar production, hand-mixed, on-site	GLO; IN	2014-2017	N
cement plaster production, hand-mixed on site	GLO; IN	2014-2017	N
concrete block production	DE; GLO	1997-2001	U
concrete block production	BR	2012-2013	N
concrete slab	GLO; IN	2014-2017	N
flyash brick production	GLO; IN	2014-2017	N
glass wool mat production, Saint-Gobain ISOVER SA	GLO	2009-2009	U*
gypsum quarry operation	IN	2014-2017	N
gypsum quarry operation	ZA	2017-2017	N
kaolin production	GLO; RER	2000-2000	U
laterite quarry operation	GLO; IN	2014-2017	N
limestone production, crushed, for mill	IN	2014-2017	N
limestone quarry operation	GLO	1992-2002	U
limestone quarry operation	IN	2014-2017	N
vermiculite mine operation	GLO	2000-2000	U
vermiculite mine operation	ZA	2000-2000	U
market for autoclaved aerated concrete block	CH	2011-2011	N
market for autoclaved aerated concrete block	IN	2014-2017	N
market for calcined clay	BR; GLO	2015-2018	N
market for cement mortar	IN	2014-2017	N
market for cement plaster	GLO; IN	2014-2017	N
market for concrete block	DE	2011-2011	N
market for concrete block	BR	2012-2013	N
market for concrete slab	GLO; IN	2014-2017	N
market for flat glass, coated	RER	2016-2016	N
market for flat glass, uncoated	RER	2016-2016	N
market for flyash brick	GLO; IN	2014-2017	N
market for gypsum, mineral	IN	2014-2017	N
market for gypsum, mineral	RER	2003-2003	N
market for gypsum, mineral	ZA	2017-2017	N
market for laterite	GLO; IN	2014-2017	N
market for lightweight concrete block, pumice	DE	2011-2011	N
market for limestone, crushed, for mill	IN	2014-2017	N
market for limestone, unprocessed	IN	2014-2017	N
market for soil, contaminated	GLO	1998-2003	N
market for waste foundry sand	GLO	1998-2003	N

5 Chemicals

5.1 Plastics

New data for plastics is published, the data was provided by PlasticsEurope that commissioned IFEU to create and submit the datasets. These datasets substitute older activities, which were available only at aggregated level.

Table 25. List of updated activities and products for plastics. *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	Product name	Unit
polyethylene production, high density, granulate	GLO; RER	2011-2016	polyethylene, high density, granulate	kg
polyethylene production, linear low density, granulate	GLO; RER	2011-2016	polyethylene, linear low density, granulate	kg
polyethylene production, low density, granulate	GLO; RER	2011-2016	polyethylene, low density, granulate	kg
polyethylene terephthalate production, granulate, bottle grade	GLO; RER	2015-2020	polyethylene terephthalate, granulate, bottle grade	kg
polypropylene production, granulate	GLO; RER	2011-2016	polypropylene, granulate	kg
polyvinylchloride production, emulsion polymerisation	GLO; RER	2013-2018	polyvinylchloride, emulsion polymerised	kg
polyvinylchloride production, suspension polymerisation	GLO; RER	2013-2018	polyvinylchloride, suspension polymerised	kg
purified terephthalic acid production	GLO; RER	2011-2017	purified terephthalic acid	kg
vinyl chloride production	GLO; RER	2013-2018	vinyl chloride	kg

5.2 Steam

For version 3.6, the production volumes of the two activities "steam production, as energy carrier, in chemical industry" and "steam production, in chemical industry" (available for the geographies GLO and RER) were updated. Additionally, an RER version of the activity "market for steam, in chemical industry" was created to make activities located within the geography RER which demand the product "steam, in chemical industry" be supplied by the RER steam production datasets.

The prices of the two steam products "heat, from steam, in chemical industry" and "steam, in chemical industry" were also updated (see Annex 1: products with updated prices). The time periods of all datasets were updated to better reflect the time period of the data used for defining the exchange amounts and production volumes.

The list of datasets related to steam production available in version 3.6 is given in Table 26.

Table 26. transforming activities and market activities related to steam production in version 3.6. *Column v3.6 indicates if the dataset is new ("N") or what was updated ("PV" = production volume).*

Activity name	Geography	Time period	Reference product	Unit	v3.6
market for heat, from steam, in chemical industry	GLO; RER	2010-2016	heat, from steam, in chemical industry	MJ	price updated
market for steam, in chemical industry	GLO	2010-2016	steam, in chemical industry	kg	price updated
market for steam, in chemical industry	RER	2010-2016	steam, in chemical industry	kg	N
steam production, as energy carrier, in chemical industry	GLO; RER	2010-2017	heat, from steam, in chemical industry	MJ	PV and price updated
steam production, in chemical industry	GLO; RER	2010-2017	steam, in chemical industry	kg	PV and price updated

5.3 Other updates

Several chemicals were reclassified from being MFT to being non-MFT in v3.6 (see chapter 2.3 for details), affecting the subsequent markets and consuming activities. Additionally, several activities and markets were updated or added to improve regionalisation of supply chains, or for consistency reasons.

Finally, one new chemical product was added to the database (“3-methylpyridine”).

Table 27. List of new and updated activities due to change in product classification from mft to a non-mft. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", and "N" stands for "New activity". The symbol "*" stands for adjusted stoichiometry. The symbol "**" stands for change in PV.*

Activity name	Geography	Time period	Product name	Unit	v3.6
1,1-dimethylcyclopentane to generic market for solvent, organic	GLO	2012-2012	solvent, organic	kg	U
2,3-dimethylbutan to generic market for solvent, organic	GLO	2012-2012	solvent, organic	kg	U
2-methylpentane to generic market for solvent, organic	GLO	2012-2012	solvent, organic	kg	U
fraction 1 from naphtha separation to generic market for chemical, organic	GLO	2012-2012	chemical, organic	kg	U
fraction 7 from naphtha separation to generic market for chemical, organic	GLO	2012-2012	chemical, organic	kg	U
fraction 8 from naphtha separation to generic market for chemical, organic	GLO	2012-2012	chemical, organic	kg	U
methylcyclopentane to generic market for solvent, organic	GLO	2012-2012	solvent, organic	kg	U
market for 1,1-dimethylcyclopentane	GLO	2012-2012	1,1-dimethylcyclopentane	kg	U
market for 2,3-dimethylbutan	GLO	2012-2012	2,3-dimethylbutan	kg	U
market for 2-methylpentane	GLO	2012-2012	2-methylpentane	kg	U
market for fraction 1 from naphtha separation	GLO	2012-2012	fraction 1 from naphtha separation	kg	U
market for fraction 7 from naphtha separation	GLO	2012-2012	fraction 7 from naphtha separation	kg	U
market for fraction 8 from naphtha separation	GLO	2012-2012	fraction 8 from naphtha separation	kg	U
market for methylcyclopentane	GLO	2012-2012	methylcyclopentane	kg	U
3-methylpyridine production	GLO; RER	2010-2010	3-methylpyridine	kg	N
market for 3-methylpyridine	GLO	2010-2010	3-methylpyridine	kg	N
market for 3-methylpyridine	RER	2018-2018	3-methylpyridine	kg	N
N-methyl-2-pyrrolidone production	GLO; RER	2015-2020	N-methyl-2-pyrrolidone		U*
citric acid production	RER	2009-2011	citric acid		U
citric acid production	CN; GLO; RNA	2010-2011	citric acid		U
epoxy resin production, liquid	GLO; RER	2015-2020	epoxy resin, liquid		U*
ethylene production, average	GLO; RER	1999-2001	ethylene, average		U**
foam glass production, electricity, label-certified	GLO	2005-2005	foam glass, electricity, label-certified		U**
phosphorus oxychloride production	GLO	2015-2020	phosphorus oxychloride		U**
triphenyl phosphate production	GLO	2015-2020	triphenyl phosphate		U
market for nylon 6	RER	2016-2016	nylon 6		N
market for nylon 6-6	RER	2016-2016	nylon 6-6		N
market for phenol	RER	2016-2016	phenol		N

6 Electricity

6.1 New data for Latin American Electricity

Within the frame of the SRI-LCI project, new data could be collected for the electricity production in Argentina, Brazil, Colombia and Peru. In the case of Brazil, datasets related to electricity production are now available on a higher geographical resolution, i.e. on the level of the five electricity grid regions(BR-Mid-western grid, BR-North-eastern grid, BR-Northern grid, BR-South-eastern grid, BR-Southern grid); they replace the previous electricity related activities on national (BR) level (see Figure 1). Table 31 presents the new datasets. For Peru country specific electricity generation datasets were already available in pervious ecoinvent versions. These were updated by the local data providers based on national/local data sources; they are listed in Table 32.

The detailed documentation on the data collection, methodology and data sources underlying the new and updated electricity datasets in Argentina, Brazil, Colombia and Peru can be found in the report "*Life Cycle Inventories of Electricity Production - Latin America"* by Suppen *et al.*, 2018, accessible through the SRI section of the ecoinvent webpage.

With the update of the electricity market mixes in the attributional system models (see section 6.2) the production volumes of electricity production in Argentina, Colombia and Peru were updated in line with the other geographies (using IEA data), technology and import splits were applied as provided by the SRI-LCI project (see also section 6.2.2).

6.2 Updates of the electricity market mixes in the attributional system models

The production volumes, trade volumes and loss volumes of electricity supply in the attributional system models, cut-off and APOS, were updated to represent the 2016 electricity mixes. Not included in this update are the electricity mixes in India and China, these represent the year 2012. Since electricity supply in these geographies is regionalized to the level of regional electricity grids, statistical data are not readily available in IEA or national databases.

The Rest of the World (RoW) markets for electricity are no longer generated in the attributional system models. 100% of statistically covered global electricity supply is covered with specific mixes; no data is available for the remaining geographies, mostly small countries and island states.

The following sections describe the updates, underlying data sources and calculation procedures underlying the updates of the electricity market mixes. Table 28 shows for which geographies the electricity market mixes were updated or added in any of the three system models.

Table 28. New and updated market mixes for electricity in the three system models. *If several geographies of the same activity with the same time period and system model exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", and "N" stands for "New activity".*

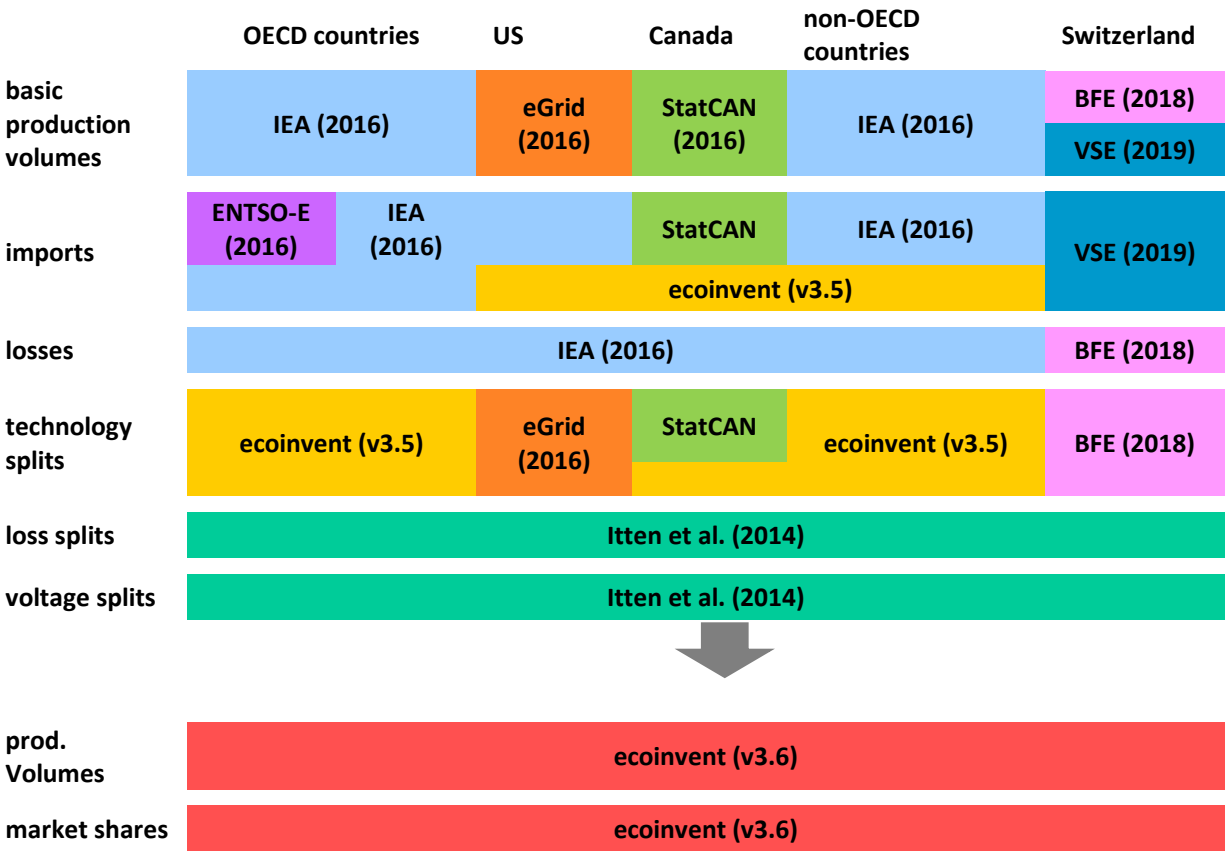
Activity name	Time period	System model	Geography	v3.6
market for electricity, high voltage	2014-2017	Allocation, cut-off; Allocation, APOS	AE; AL; AM; AO; AR; ASCC; AT; AU; AZ; BA; BD; BE; BG; BH; BJ; BN; BO; BW; BY; CA-AB; CA-BC; CA-MB; CA-NB; CA-NF; CA-NS; CA-NT; CA-NU; CA-ON; CA-PE; CA-QC; CA-SK; CA-YK; CD; CG; CH; CI; CL; CM; CO; CR; CSG; CU; CW; CY; CZ; DE; DK; DO; DZ; EC; EE; EG; ER; ES; ET; FI; FR; FRCC; GA; GB; GE; GH; GI; GLO; GR; GT; HICC; HK; HN; HR; HT; HU; ID; IE; IL; IQ; IR; IS; IT; JM; JO; JP; KE; KG; KH; KP; KR; KW; KZ; LB; LK; LT; LU; LV; LY; MA; MD; ME; MK; MM; MN; MRO, US only; MT; MU; MX; MY; MZ; NA; NE; NG; NI; NL; NO; NP; NPCC, US only; NZ; OM; PA; PE; PH; PK; PL; PT; PY; QA; RFC; RO; RS; RU; SA; SD; SE; SERC; SG; SGCC; SI; SK; SN; SPP; SS; SV; SY; TG; TH; TJ; TM; TN; TR; TRE; TT; TW; TZ; UA; UY; UZ; VE; VN; WECC, US only; XK; YE; ZA; ZM; ZW;	U
market for electricity, high voltage	2014-2017	Consequential	AR; CO; CR; KE; NI; NZ; PH; SV; UA;	U
market for electricity, high voltage	2014-2017	Allocation, cut-off; Allocation, APOS	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid;	N
market for electricity, high voltage	2014-2017	Consequential	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid;	N
market for electricity, high voltage, label-certified	2011-2015	Allocation, cut-off; Allocation, APOS	CH	U
market for electricity, low voltage	2014-2017	Allocation, cut-off; Allocation, APOS	AE; AL; AM; AO; AR; ASCC; AT; AU; AZ; BA; BD; BE; BG; BH; BJ; BN; BO; BW; BY; CA-AB; CA-BC; CA-MB; CA-NB; CA-NF; CA-NS; CA-NT; CA-NU; CA-ON; CA-PE; CA-QC; CA-SK; CA-YK; CD; CG; CH; CI; CL; CM; CO; CR; CSG; CU; CW; CY; CZ; DE; DK; DO; DZ; EC; EE; EG; ER; ES; ET; FI; FR; FRCC; GA; GB; GE; GH; GI; GLO; GR; GT; HICC; HK; HN; HR; HT; HU; ID; IE; IL; IQ; IR; IS; IT; JM; JO; JP; KE; KG; KH; KP; KR; KW; KZ; LB; LK; LT; LU; LV; LY; MA; MD; ME; MK; MM; MN; MRO, US only; MT; MU; MX; MY; MZ; NA; NE; NG; NI; NL; NO; NP; NPCC, US only; NZ; OM; PA; PE; PH; PK; PL; PT; PY; QA; RFC; RO; RS; RU; SA; SD; SE; SERC; SG; SGCC; SI; SK; SN; SPP; SS; SV; SY; TG; TH; TJ; TM; TN; TR; TRE; TT; TW; TZ; UA; UY; UZ; VE; VN; WECC, US only; XK; YE; ZA; ZM; ZW;	U
market for electricity, low voltage	2014-2017	Allocation, cut-off; Allocation, APOS	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid;	N
market for electricity, low voltage	2014-2017	Consequential	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid;	N
market for electricity, medium voltage	2014-2017	Allocation, cut-off; Allocation, APOS	AE; AL; AM; AO; AR; ASCC; AT; AU; AZ; BA; BD; BE; BG; BH; BJ; BN; BO; BW; BY; CA-AB; CA-BC; CA-MB; CA-NB; CA-NF; CA-NS; CA-NT; CA-NU; CA-ON; CA-PE; CA-QC; CA-SK; CA-YK; CD; CG; CH; CI; CL; CM; CO; CR; CU; CW; CY; CZ; DE; DK; DO; DZ; EC; EE; EG; ER; ES; ET; FI; FR; FRCC; GA; GB; GE; GH; GI; GLO; GR; GT; HICC; HK; HN; HR; HT; HU; ID; IE; IL; IQ; IR; IS; IT; JM; JO; JP; KE; KG; KH; KP; KR; KW; KZ; LB; LK; LT; LU; LV; LY; MA; MD; ME; MK; MM; MN; MRO, US only; MT; MU; MX; MY; MZ; NA; NE; NG; NI; NL;	U

Activity name	Time period	System model	Geography	v3.6
			NO; NP; NPCC, US only; NZ; OM; PA; PE; PH; PK; PL; PT; PY; QA; RFC; RO; RS; RU; SA; SD; SE; SERC; SG; SI; SK; SN; SPP; SS; SV; SY; TG; TH; TJ; TM; TN; TR; TRE; TT; TW; TZ; UA; UY; UZ; VE; VN; WECC, US only; XK; YE; ZA; ZM; ZW;	
market for electricity, medium voltage	2014-2017	Allocation, cut-off; Allocation, APOS	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid;	N
market for electricity, medium voltage	2014-2017	Consequential	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid;	N

6.2.1 Changes to production, trade and loss volumes

A visual overview of these data sources applied for the update of electricity market mixes from ecoinvent v3.5 to v3.6 is presented in Figure 9.

Figure 9. Visual overview of main data sources used for updating electricity markets from ecoinvent v3.5 to v3.6. *Does not apply to the electricty markets of China and India (not updated).*



Data sources were applied as described in the following list:

- National production volumes for OECD and non-OECD countries: IEA extended World Energy Balances (IEA, 2018), for pumped hydro power IEA World Energy Statistics (IEA, 2017a)
- US grid region production volumes: eGrid (EIA, 2018)
- CA grid region production volumes: StatCAN (2019a-c)
- OECD electricity imports/ exports with OECD and non-OECD countries: OECD electricity imports/ exports (IEA, 2017a-b)
- European electricity imports/ exports: ENTSO-E (2019)
- National transmission and transformation losses: IEA extended World Energy Balances (IEA, 2018)
- Technology split factors: previous ecoinvent version (v3.5) (based on older versions of IAEA (2019), NREL (2019), S&P Global (2018), The Windpower (2019) and others)
- Loss split factors: same as previous ecoinvent versions (based on Itten *et al.*, 2014)
- Voltage level split factors: previous ecoinvent version (v3.5) (based on Itten *et al.*, 2014)
- Canada internal electricity trade split factors: data provided by (Tirado, 2019)
- The Swiss electricity mixes in version 3.6 are valid for the year 2017. They had in the past been based on reports issued for Paul Scherrer Institute (PSI) and the Swiss Federal office for Environment (SFOEN), respectively (Itten *et al.*, 2014; Messmer and Frischknecht, 2016). No such report was available to update the Swiss electricity mix data to the year 2017, so that these have been collected by ecoinvent in-house. BFE (2018) and VSE (2019) served as the main data sources.

6.2.2 Changes other than production, trade and loss volumes

Together with the update of production, trade and loss volumes to generate electricity market mixes, some other minor changes were made; they are described in this section.

The average gross-to-net loss of geothermal power plants was updated for 2016 to 9% (up from 4%) based on IEA (2017d).

The gross-to-net loss of pumped storage hydro power plants were set to 1% based (up from 0%) based on the fact that gross production amounts are used as input data while output is in net production amounts as well as the documentation of WBES (IEA, 2017a).

The gross-to-net losses of all combustion plants that before had a loss of 0% were updated to the value of all other combustion plants (i.e. biogas, waste or wood combustion have the same gross-to-net losses that coal, oil or gas combustion have). Thus, the current logic of applying losses to convert from gross to net generation also covers these fuels and is furthermore consistent with the IEA fuel classification in IEA (2018).

Electricity production volumes in ecoinvent versions prior to 3.6 included the net electricity supply per region, which was calculated as sum of net electricity generation and imports and by subtracting transmission and transformation losses. That leads to slight double counting of traded electricity amounts when calculating total global electricity-related impacts because imports are accounted for in both the importing and exporting country. Thus, in v3.6, the production volumes additionally subtract the exported electricity amounts to avoid double-counting. The national and electricity grid-level inventories per kWh of electricity are unaffected by this change except for the case of market groups, where production volumes are used to calculate super-regional average inventories, and the case of loss calculations, where the updated reference value ("production volume") slightly changes and losses therefore increase or decrease. This is a minor effect unless a country is heavily exporting electricity.

Imports from Mexico to the US were allocated to the WECC and TRE subregions based on the ratio of respective grid interconnector capacities that have been reported in Lee & Ganster (2012). Thus, 80.58% are imported to "WECC, US only" (1000 MW capacity) and 19.42% are imported to "TRE" (241 MW capacity).

In previous versions of the ecoinvent database, US electricity market data was based on EIA electricity data browser (EIA, undated) information per US NERC grid region and US-wide technology splits from IEA statistics (IEA, 2018) and US-wide WEPP data (S&P global, 2018). Much more detailed data per power plant is available from an eGrid publication (EIA, 2018) which is used in v3.6 instead. Thus, technology shares and production volumes within each US grid region change substantially and become substantially more accurate. Individual power plants were matched to ecoinvent datasets, based on their technology. The most notable change concerns coal power production, where EIA electricity data does not distinguish hard coal and brown coal and thus had been disaggregated from national IEA data for each US grid region in previous ecoinvent versions. Thus, the hard coal to brown coal ratio in each US grid region was identical while US eGrid data shows that these ratios widely differ from grid region to grid region. This considered in v3.6 with correct ratios.

Concentrated solar thermal power includes “auto-producers” and “main activity producers” (as defined by IEA), which is in line with the merging of auto-producer and main activity producer data for solar PV.

Technology and import splits for Argentina, Colombia and Peru were been updated with the more recent production volumes that were collected by local LCI experts during the SRI-LCI project instead of using the older production volumes from ecoinvent v3.5. Production volumes per activity are still obtained from IEA data.

The ENTSO-E country electricity trade data in v3.6 is directly obtained from ENTSO-E staistics and only supplemented by IEA statistics where data gaps occur.

Matching of IEA Extended World Balances data to ecoinvent datasets was taken over from previous ecoinvent versions but extended to treat

- "Patent fuel", "Coke oven coke", "Gas coke" and "Coal tar" as hard coal,
- "Charcoal" as brown coal/ lignite, and
- "Motor gasoline excl. biofuels" as oil.

The production volumes for bio gas, coal gas, blast furnace gas and wood biomass co-generative power production and non-co-generative peat and waste electricity generation are calculated from the sums of the respective non-co-generative and co-generative production volumes Thus, missing non-co-generative/ co-generative ecoinvent datasets alter the regional fuels mix of power generation as little as possible.

6.3 Other changes to the electricity sector

6.3.1 Inputs of power plant infrastructure

The mathematical formulas determining the amounts of infrastructure (power plant) input were updated in three electricity producing activities.

The infrastructure requirements of the activity “electricity production, nuclear, pressure water reactor, heavy water moderated” in all geographies in v3.5 and earlier was calculated based on the annual production volume of the dataset, i.e. based on the amount of electricity generated from all heavy water moderated nuclear plants (PHWR) in the geography. This underestimated infrastructure inputs in geographies with large PHWR fleets. For a lack of data on geographically specific load factors of PHWR plants, a generic infrastructure formula was implemented. It assumes an average lifetime of 30 years for PHWR plants and an average load factor for nuclear power plants of 73% (IEAE, 2018).

The input of “gas power plant, combined cycle, 400MW electrical” to the activities “electricity production, natural gas, combined cycle power plant” and in all geographies was corrected in v3.6. An error had occurred in the conversion of the infrastructure input amount from the original ecoinvent v2 dataset to ecoinvent v3. It is now calculated based on the capacity (400MW) and full load hours during the lifetime (180000h) of the respective plant.

6.3.2 Geothermal supply chain

The electricity required for the drilling of deep geothermal wells can be a significant contributor to the impacts of electricity generated from geothermal power. To assure regional supply chains with region-specific electricity inputs in the geographies where geothermal power contributes with more than 5% to the 2016 electricity mix, new datasets were created: The activity “deep well drilling, for deep geothermal power” and “geothermal power plant construction” were added for the geographies PH, CR, KE, NI, NZ, SV; the activity “electricity production, deep geothermal” was added for PH, CR, NI and NZ. Direct links to the geography specific infrastructure input were set in the electricity production activity, avoiding the global market.

The production volumes of the geothermal power plant production datasets is approximated with the amount of power plant input required to provide deep geothermal electricity production of the respective geography according to IEA statistics for the year 2016 until better data become available.

6.3.3 Concentrating Solar Power

With ecoinvent v3.5 datasets for electricity production in concentrated solar power (CSP) plants were first published in the ecoinvent database. While the data are specific to South Africa they are also used as first approximation for electricity from CSP plants in other countries. The thermal storage system of these plants requires large amounts of so-called solar salts. Specific data for the production of these salts were not yet available for v3.5 and could be added in v3.6. Moreover, the datasets on the construction of the CSP plants and their components were further improved in terms of mass balance and water balance, geography specific supply chains, prices and documentation.

6.3.3.1 Solar Salts

In v3.5 synthetically produced sodium nitrate and potassium nitrate was used to approximate the input of solar salts required in the thermal storage system of CSP plants. Synthetically produced, these nitrates are commonly used in fertiliser production where the purity may be much lower than 50%. The purity required for solar thermal applications is >99%. Nitrate salts of this purity are produced from caliche ore and salar brines, two natural sources which are found in Northern Chile. Data were collected for the production of high purity sodium and potassium nitrate (“technical grade”). For potassium nitrate this goes hand in hand with the production of lower purity grades (“agricultural grade of about 50% purity and “industrial grade” of >95% purity).

Datasets for the natural production route in Chile function in parallel to the datasets synthetic production route. The salt inputs in the thermal storage construction datasets were replaced with an input of “nitrate salts production, for solar power application”. This product was introduced as the mixture of 60% “sodium nitrate, technical grade” and 40% “potassium nitrate, technical grade” used in CSP plants.

At the point of dataset creation, no information was available regarding the losses and end-of-life scenario of solar salts at the decommissioning of a CSP plant. Real world data is expected to become available once the first-generation of CSP plants reaches its end-of-life, presumably in a few decades.

Nonetheless, to provide database users with a potential end-of-life scenario of first-generation solar salts / a supply scenario for salts in second-generation CSP plants, experts were consulted on what they evaluate as likely and feasible option. It is anticipated that the actual end-of-life scenario will depend on site-specific conditions. For example, reuse of the salts as fertilisers is technically possible, but not everywhere the most (economically) viable solution. The reuse of the salts in new CSP plants is currently seen to be the most probable scenario. While, it may depend on the temporal and spatial development of new CSP projects in the region, dataset for this reuse scenario were created for ecoinvent v3.6.

It is estimated that 15% of the solar salts are lost during plant operation or dismantling. This amount is assumed to require treatment as “hazardous waste for incineration”.

At the end of the plant's life, it is estimated that the remaining 85% of the salts are liberated as "used nitrate salts, for solar power application". This product feeds the activity "used nitrate salts, for solar power application to nitrate salts, for solar power application" which transforms used salts into unused salts in a ratio of 1:1; it feeds the "market for nitrate salts, for solar power application" with 85%. The remaining 15% of the market are supplied from primary production ("nitrate salt production, for solar power application"). If the user wants to model second-generation CSP plants, where no site-specific information is available on the supply of solar salts, we recommend the use this market. As the current ecoinvent datasets model construction and operation of first-generation CSP plants, they avoid the market but are directly linked to the primary salt production datasets, i.e. CSP plants are **by default supplied from primary production** of solar salts.

New datasets related to the supply of solar salts are presented in Table 29.

Table 29. New activities related to concentrated solar power. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column.*

Activity name	Geography	Time Period
market for nitrate salts, for solar power application	GLO	2015-2018
market for potassium chloride, industrial grade	GLO	2015-2018
market for potassium nitrate, agricultural grade	GLO	2015-2018
market for potassium nitrate, industrial grade	GLO	2015-2018
market for potassium nitrate, technical grade	GLO	2015-2018
market for purge gas, rich in sodium nitrate	CL; GLO	2019-2019
market for sodium nitrate, technical grade	GLO	2015-2018
market for sodium nitrate, unrefined	GLO	2015-2018
market for used nitrate salts, for solar power application	GLO	2015-2020
nitrate salts production, for solar power application	GLO	2015-2018
potassium chloride production, from salar brine	CL; GLO	2015-2018
potassium nitrate production, agricultural grade	CL; GLO	2015-2018
potassium nitrate production, industrial grade	CL; GLO	2015-2018
potassium nitrate production, technical grade	CL; GLO	2015-2018
purge gas, rich in sodium nitrate to market for sodium nitrate, unrefined	CL; GLO	2019-2019
sodium nitrate production, technical grade	CL; GLO	2015-2018
sodium nitrate production, unrefined from caliche ore mining	CL; GLO	2015-2018
used nitrate salts, for solar power application to market for nitrate salts, for solar power application	GLO	2015-2018

6.3.3.2 Updates to CSP infrastructure datasets

In the following activities (available in ZA and GLO) the amount of municipal solid waste output in v3.5 was incorrect, it was deleted. The amount of hazardous waste output was set equivalent to the input amount of "silicone product", which represents transformer oil and oil for initial filling. The excess amount of hazardous waste in the v3.5 datasets was found incorrect. These changes close the mass balance for the listed datasets. An additional exchange "wastewater, unpolluted" was introduced with an amount equivalent to the incoming tap water, to model the disposal of the water consumption of the pumps and close the water balance.

- heat transport fluid system construction, solar thermal parabolic trough, 50 MW
- power block installation, solar thermal parabolic trough, 50 MW
- power block installation, solar tower power plant, 20 MW

- receiver system construction, solar tower power plant, 20 MW
- steam generation system construction, solar tower power plant, 20 MW

The production volume of the global (GLO) activities for CSP plant and components were updated with an informed estimate of the number of currently constructed CSP plants worldwide. This means, Rest of the World (RoW) datasets for these activities are now available in the system models and supply the CSP supply chains in regions outside South-Africa.

The activity "concentrated solar power plant, solar thermal parabolic trough, 50 MW" was renamed to "concentrated solar power plant construction, solar thermal parabolic trough, 50 MW".

The prices of all CSP plant components and the entire plant were updated from previously calculated values based on material inputs to real prices.

Table 29 lists the updated datasets related to concentrating solar power. For more details please see the documentation directly in the dataset, in particular the General Comment and comments to the relevant exchanges.

Table 30. Updated activities related to concentrated solar power. *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
collector field area construction, solar thermal parabolic trough, 50 MW	GLO; ZA	2010-2020
collector field area construction, solar tower power plant, 20 MW	GLO; ZA	2010-2020
concentrated solar power plant construction, solar tower power plant, 20 MW	GLO; ZA	2010-2020
concentrated solar power plant construction, solar thermal parabolic trough, 50 MW	GLO; ZA	2010-2020
heat transport fluid system construction, solar thermal parabolic trough, 50 MW	GLO; ZA	2010-2020
power block installation, solar thermal parabolic trough, 50 MW	GLO; ZA	2010-2020
power block installation, solar tower power plant, 20 MW	GLO; ZA	2010-2020
receiver system construction, solar tower power plant, 20 MW	GLO; ZA	2010-2020
steam generation system construction, solar tower power plant, 20 MW	GLO; ZA	2010-2020
thermal storage system construction, solar thermal parabolic trough, 50 MW	GLO; ZA	2010-2020
thermal storage system construction, solar tower power plant, 20 MW	GLO; ZA	2010-2020

6.4 New, updated and deleted datasets

Table 31. New activities related to electricity. *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
deep well drilling, for deep geothermal power	CR; KE; NI; NZ; PH; SV	2015-2015
electricity production, deep geothermal	CR; KE; NI; NZ; PH; SV	2015-2015
electricity production, hard coal	AR	2000-2017
electricity production, hard coal	BR-North-eastern grid; BR-Southern grid; CO	2014-2017
electricity production, hydro, pumped storage	AR	2012-2017
electricity production, hydro, reservoir, alpine region	AR	2012-2017
electricity production, hydro, reservoir, non-alpine region	AR	2012-2017
electricity production, hydro, reservoir, tropical region	AR	2012-2017
electricity production, hydro, reservoir, tropical region	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid; CO	2014-2017
electricity production, hydro, run-of-river	AR	1945-2017
electricity production, hydro, run-of-river	CO	2014-2017
electricity production, lignite	PL	1993-2005
electricity production, natural gas, combined cycle power plant	AR	2012-2017
electricity production, natural gas, combined cycle power plant	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid; CO	2014-2017
electricity production, natural gas, conventional power plant	AR	2012-2017
electricity production, natural gas, conventional power plant	BR-Mid-western grid; BR-North-eastern grid; BR-South-eastern grid; CO	2014-2017
electricity production, natural gas, conventional power plant	LU	1990-2000
electricity production, nuclear, pressure water reactor, heavy water moderated	AR	2012-2017
electricity production, oil	AR	2012-2017
electricity production, oil	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid; CO	2014-2017
electricity production, photovoltaic, 570kWp open ground installation, multi-Si	AR	2012-2017
electricity production, wind, <1MW turbine, onshore	AR	2012-2017
electricity production, wind, >3MW turbine, onshore, label-certified	CH; GLO	2016-2018
electricity production, wind, 1-3MW turbine, onshore	AR	2012-2017
electricity production, wind, 1-3MW turbine, onshore	BR-North-eastern grid; BR-Southern grid; CO	2014-2017
electricity voltage transformation from high to medium voltage	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid	2014-2017
electricity voltage transformation from medium to low voltage	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid	2014-2017

Activity name	Geography	Time period
electricity, high voltage, biofuels, import from Germany	CH	2010-2010
electricity, high voltage, hydro, import from CA-NF	CA-QC	2016-2016
electricity, high voltage, hydro, import from PY	AR	2012-2017
electricity, high voltage, hydro, import from UY	AR	2012-2017
electricity, high voltage, import from BR-Mid-western grid	BR-South-eastern grid	2014-2014
electricity, high voltage, import from BR-North-eastern grid	BR-South-eastern grid	2014-2014
electricity, high voltage, import from BR-Northern grid	BR-North-eastern grid; BR-South-eastern grid	2014-2014
electricity, high voltage, import from BR-South-eastern grid	BR-North-eastern grid	2014-2014
electricity, high voltage, import from BR-Southern grid	BR-South-eastern grid	2014-2014
electricity, high voltage, import from BR-Southern grid	UY	2016-2016
electricity, high voltage, import from CL	AR	2012-2012
electricity, high voltage, import from CSG	VN	2016-2016
electricity, high voltage, import from EC	PE	2016-2016
electricity, high voltage, import from FI	RU	2012-2012
electricity, high voltage, import from GH	CI	2016-2016
electricity, high voltage, import from HU	SK	2012-2012
electricity, high voltage, import from IR	PK	2016-2016
electricity, high voltage, import from IT	MT	2016-2016
electricity, high voltage, import from JO	EG	2016-2016
electricity, high voltage, import from LT	PL; SE	2012-2012
electricity, high voltage, import from MK	BG	2012-2012
electricity, high voltage, import from MX	TRE; WECC, US only	2012-2012
electricity, high voltage, import from OM	AE	2016-2016
electricity, high voltage, import from PL	LT	2012-2012
electricity, high voltage, import from RAS	VN	2016-2016
electricity, high voltage, import from RS	BG	2012-2012
electricity, high voltage, import from SA	AE	2016-2016
electricity, high voltage, import from SE	LT	2012-2012
electricity, high voltage, import from TR	SY	2012-2012
electricity, high voltage, import from VE	BR-Northern grid; BR-Southern grid	2014-2017
electricity, low voltage, photovoltaic, import from Germany	CH	2010-2017
geothermal power plant construction	CR; IS; KE; NI; NZ; PH; SV	2015-2015
heat and power co-generation, hard coal	CO	2014-2017
heat and power co-generation, natural gas, conventional power plant, 100MW electrical	AR	2012-2017
heat and power co-generation, natural gas, conventional power plant, 100MW electrical	CO	2014-2017
market for electricity, high voltage	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid	2014-2017
market for electricity, low voltage	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid	2014-2017

Activity name	Geography	Time period
market for electricity, medium voltage	BR-Mid-western grid; BR-North-eastern grid; BR-Northern grid; BR-South-eastern grid; BR-Southern grid	2014-2017
market group for electricity, high voltage	BR	2015-2015
market group for electricity, low voltage	BR	2015-2015
market group for electricity, medium voltage	BR	2015-2015
sugarcane processing, modern annexed plant	BR; GLO	2012-2014
sugarcane processing, modern autonomous plant	BR; GLO	2012-2014
treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal	BR-Mid-western grid; BR-North-eastern grid; BR-South-eastern grid; BR-Southern grid; CO	2014-2017

Table 32. Updated activities related to electricity. *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
electricity production, hard coal	CL; KR; MY	1980-2015
electricity production, hard coal	PE	2012-2017
electricity production, high voltage, for Swiss Federal Railways	CH; GLO	2011-2017
electricity production, hydro, reservoir, alpine region	PE	2012-2017
electricity production, hydro, reservoir, tropical region	GLO	1970-2015
electricity production, natural gas, combined cycle power plant	ASCC; AT; AU; BE; CA-AB; CA-BC; CA-MB; CA-NB; CA-NS; CA-NT; CA-ON; CA-SK; CL; CN-AH; CN-BJ; CN-CQ; CN-FJ; CN-GD; CN-GS; CN-GX; CN-GZ; CN-HA; CN-HB; CN-HE; CN-HL; CN-HN; CN-HU; CN-JL; CN-JS; CN-JX; CN-LN; CN-NM; CN-NX; CN-QH; CN-SA; CN-SC; CN-SD; CN-SH; CN-SX; CN-TJ; CN-XJ; CN-XZ; CN-YN; CN-ZJ; CZ; DE; ES; FI; FR; FRCC; GB; GLO; GR; HR; HU; ID; IE; IN-AP; IN-AS; IN-DL; IN-GA; IN-GJ; IN-HR; IN-KL; IN-MH; IN-PY; IN-RJ; IN-TN; IN-TR; IN-UP; IR; IT; JP; KR; MRO, US only; MX; MY; NO; NPCC, US only; PT; RFC; SA; SERC; SK; SPP; TH; TR; TRE; TW; UA; WECC, US only	2000-2015
electricity production, natural gas, combined cycle power plant	PE	2012-2017
electricity production, natural gas, combined cycle power plant	BG; CH; CY; LU; LV; MT; NL; PL; RO; RU; SE; SI; ZA	2016-2018
electricity production, natural gas, conventional power plant	PE	2012-2017
electricity production, nuclear, pressure water reactor	BR-South-eastern grid	2014-2017
electricity production, nuclear, pressure water reactor, heavy water moderated	CA-NB; CA-ON; CN-ZJ; GLO; IN-GJ; IN-KA; IN-MH; IN-RJ; IN-TN; IN-UP; JP; KR; RO; RU	2010-2015

Activity name	Geography	Time period
electricity production, nuclear, pressure water reactor, heavy water moderated	CA-QC	2010-2015
electricity production, oil	PE	2012-2017
electricity production, wind, 1-3MW turbine, onshore	PE	2012-2017
electricity, high voltage, import from AR	BR-Southern grid	2014-2017
electricity, high voltage, import from BR-Southern grid	AR	2012-2017
electricity, high voltage, import from PY	BR-Southern grid	2014-2017
electricity, high voltage, import from UY	BR-Southern grid	2014-2017
energy use and operation emissions, electric bicycle, label-certified electricity	GLO	2009-2009
geothermal power plant construction	GLO	2015-2015
heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical	ASCC; AT; AU; BE; BG; DE; DK; ES; FI; FRCC; GB; GLO; GR; HR; HU; IR; IT; KR; LT; LU; LV; MK; MRO, US only; NL; NO; NPCC, US only; PL; PT; RFC; RO; RU; SA; SERC; SK; SPP; TR; TRE; WECC, US only	2000-2015
market for electricity, high voltage	AR; PE	2014-2017
market for electricity, high voltage	CO	2014-2017
market for electricity, low voltage	AR; PE	2014-2017
market for electricity, low voltage	CO	2014-2017
operation, internet access equipment, label-certified electricity	GLO	2005-2009
treatment of bagasse, from sugarcane, in heat and power co-generation unit, 6400kW thermal	GLO	2000-2001

Table 33. Deleted activities related to electricity. *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
electricity, high voltage, import from AT	CH	2012-2012
electricity, high voltage, import from AZ	TR	2012-2012
electricity, high voltage, import from BY	LT	2012-2012
electricity, high voltage, import from CA-SK	CA-MB	2013-2013
electricity, high voltage, import from DE	CH	2011-2011
electricity, high voltage, import from EE	LT; RU	2012-2012
electricity, high voltage, import from FR	CH	2011-2011
electricity, high voltage, import from GT	MX	2012-2012
electricity, high voltage, import from IN-Northern grid	IN-Southern grid	2012-2015
electricity, high voltage, import from IN-Southern grid	IN-North-eastern grid; IN-Northern grid	2012-2015
electricity, high voltage, import from IN-Western grid	IN-North-eastern grid	2012-2015
electricity, high voltage, import from IQ	TR	2012-2012
electricity, high voltage, import from IT	CH	2012-2012
electricity, high voltage, import from RO	UA	2012-2012
electricity, high voltage, import from RU	EE; GE; LT; LV	2012-2012
electricity, high voltage, import from TH	VN	2012-2012
electricity, high voltage, import from TM	TR	2012-2012
electricity, high voltage, import from UA	RU	2012-2012

7 Fish capture and processing

This sector was newly introduced for the v3.5, it is described in detail in Avadí and Rowe, 2019.

For the v3.6, new datasets have been introduced, covering capture in new geographies. The sector has been further expanded with the addition of all needed activities to model the processing of hake into fish sticks. Existing datasets have also been corrected, to adjust some values. Namely, several markets have had transport distances and/or means adjusted.

Table 34. New product added to the database v3.6, related to fish capture and processing.

Product	Unit
breadcrumbs	kg
fish block, hake	kg
frozen fish sticks, hake	kg
landed anchovy by-catch, fresh	kg
long liner maintenance, steel	kg
long liner, steel	kg
used long liner, steel	kg

Table 35. New and updated activities in the fish sector. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	v3.6
anchovy, capture by steel purse seiner and landing whole, fresh	ES	2015-2015	N
anchovy, capture by steel purse seiner and landing whole, fresh	GLO	2010-2020	U
batter wheat mix production	RER; GLO	2011-2011	N
breadcrumbs production	RER; GLO	2011-2011	N
fishmeal and fish oil production, 63-65% protein, from fish residues	PE; GLO	2010-2020	U
fishmeal and fish oil production, 63-65% protein, from fresh anchovy	PE; GLO	2010-2020	U
fishmeal and fish oil production, 63-65% protein, from fresh anchovy and fish residues	PE; GLO	2010-2020	U
fishmeal and fish oil production, 65-67% protein	PE; GLO	2010-2020	U
floating collar net cage for aquaculture 25 m construction and maintenance	GLO	2010-2020	U
floating hexagonal metal cage for aquaculture 6 m construction and maintenance	GLO	2017-2017	U
frozen fish sticks production, hake	RER; GLO	2011-2011	N
hake, capture by long liner and landing whole, fresh	RER; GLO	2009-2009	N
hake, capture by trawler and landing whole, fresh	ES	2008-2009	N

Activity name	Geography	Time period	v3.6
hake, capture by trawler and landing whole, fresh	GLO	2010-2020	U
hake, capture by trawler and landing whole, fresh	NA	2011-2011	N
landed anchovy by-catch, fresh to generic market for marine fish	GLO	2017-2017	N
long liner construction, steel	RER; GLO	2009-2009	N
long liner maintenance, steel	RER; GLO	2009-2009	N
market for breadcrumbs	GLO	2011-2011	N
market for fish block, hake	GLO	2011-2011	N
market for fish oil	GLO	2016-2016	U
market for fish residues	GLO	2017-2017	U
market for fishmeal, 63-65% protein	GLO	2017-2017	U
market for fishmeal, 65-67% protein	GLO	2017-2017	U
market for floating collar cage	GLO	2017-2017	U
market for floating hexagonal metal cage	GLO	2017-2017	U
market for frozen fish sticks, hake	GLO	2011-2011	N
market for landed anchovy by-catch, fresh	GLO	2017-2017	N
market for landed tuna, frozen, EPO	GLO	2017-2017	U
market for long liner maintenance, steel	GLO	2017-2017	N
market for long liner, steel	GLO	2017-2017	N
market for marine electric motor	GLO	2017-2017	U
market for marine engine	GLO	2017-2017	U
market for tilapia	GLO	2014-2017	U
market for tilapia feed, 24-28% protein	GLO	2012-2013	U
market for trout	GLO	2012-2013	U
market for trout feed, 42% protein	GLO	2012-2013	U
market for used long liner, steel	GLO	2017-2017	N
market for used purse seiner, steel	GLO	2017-2017	U
market for used purse seiner, wood	GLO	2017-2017	U
market for used trawler, steel	GLO	2017-2017	U
market for wheat flour mix	GLO	2011-2011	N
patagonian grenadier, capture by trawler and landing in fish blocks, frozen	RLA; GLO	2011-2011	N
treatment of used long liner, steel	GLO	2010-2020	N

8 Metals

Replacement on the elementary exchanges of metals was done, as reported in chapter 2.1.1. The list of datasets affected by this update is given in Table 36. For the datasets that contained several different elementary exchanges that represent the same metal, the exchange amounts were summed for the new elementary exchange. The information contained in other fields was merged. For the uncertainty pedigree matrix, the highest scores among those found in the merged exchanges were assigned to the pedigree scores of the new exchange.

Table 36. Activities in which at least one of the old elementary exchanges listed in Table 3 was replaced by the corresponding new elementary exchange. *The datasets that were updated are grouped by activity name and time period.*

Activity name	Geography	Time period
[thio]carbamate-compound production	GLO; RER	2000-2010
acetamide-anillide-compound production, unspecified	GLO; RER	2000-2010
acetone cyanohydrin production	GLO; RER	1992-2001
acetone production, liquid	GLO; RER	1992-2001
acrylonitrile-butadiene-styrene copolymer production	GLO; RER	1996-2001
barite production	CA-QC; GLO; RER	1978-2007
benzene production	GLO; RER	1999-2002
benzo[thia]diazole-compound production	GLO; RER	2000-2010
benzoic-compound production	GLO; RER	2000-2010
bipyridylium-compound production	GLO; RER	2000-2010
bromine production	GLO; RER	2010-2010
butadiene production	GLO; RER	1997-2001
butene production, mixed	GLO; RER	1997-2001
carbon tetrachloride production	GLO; RER	1997-1997
chromite ore concentrate production	GLO	1994-2003
copper mine operation, sulfide ore	AU; GLO; RAS; RER; RLA; RNA	1994-2003
copper production, solvent-extraction electro-winning	GLO	1994-2003
cyclic N-compound production	GLO; RER	2000-2010
diazine-compound production	GLO; RER	2000-2010
diazole-compound production	GLO; RER	2000-2010
dichloromethane production	GLO; RER	1997-1997
electrolytic refining of primary copper	GLO	1994-2003
ethylene production, average	GLO; RER	1999-2001
ethylene production, pipeline system	GLO; RER	1999-2001
ferrochromium production, high-carbon, 68% Cr	GLO	1994-2003
ferromanganese production, high-coal, 74.5% Mn	GLO; RER	1994-2003
ferronickel production, 25% Ni	GLO	1994-2003
fluorescent whitening agent production, DAS1, triazinylaminostilben type	GLO; RER	1997-1997
fluorescent whitening agent production, distyrylbiphenyl type	GLO; RER	1999-1999
fluorspar production, 97% purity	GLO	1976-1991
gallium, in Bayer liquor from aluminium production	GLO	2005-2005
gold production	AU; GLO	2001-2006
gold production	CA; TZ; US	2003-2006
gold refinery operation	ZA	2017-2017
gold-silver mine operation with refinery	PG	2000-2006

Activity name	Geography	Time period
gold-silver mine operation with refinery	GLO	2004-2006
gold-silver mine operation with refinery	CA-QC	2012-2012
gold-silver-zinc-lead-copper mine operation and refining	GLO; SE	2004-2006
gold-silver-zinc-lead-copper mining and benefication	CA-QC; GLO	2012-2012
heavy mineral sand quarry operation	AU; GLO	2000-2005
hydrogen cracking, APME	GLO; RER	1999-2001
hydrogen cyanide production	GLO; RER	1992-2001
ilmenite - magnetite mine operation	GLO	2000-2015
iodine production	GLO; RER	2010-2010
iron mine operation and iron ore beneficiation to 65% Fe	CA-QC; GLO	2011-2011
iron mine operation, crude ore, 46% Fe	GLO	1999-2000
kaolin production	GLO; RER	2000-2000
latex production	GLO; RER	1995-1995
lithium brine inspissation	GLO	2009-2010
magnesium oxide production	GLO; RER	2000-2000
magnesium sulfate production	GLO; RER	2000-2000
manganese concentrate production	GLO	1994-2003
mercury production	GLO	2000-2000
methyl methacrylate production	GLO; RER	1996-2001
methylchloride production	GLO; WEU	1997-1997
mining and benefication of nickel ore	CA-QC; GLO	2010-2010
molybdenite mine operation	GLO	1994-2003
napropamide production	GLO; RER	2000-2010
nickel mine operation, sulfidic ore	GLO	1994-2003
nitrile-compound production	GLO; RER	2000-2020
nitro-compound production	GLO; RER	2000-2010
nylon 6 production	GLO; RER	1993-2001
nylon 6 production, glass-filled	GLO; RER	1993-2001
nylon 6-6 production	GLO; RER	1996-2001
nylon 6-6 production, glass-filled	GLO; RER	1996-2001
orbencarb production	GLO; RER	2000-2010
pentane production	GLO; RER	2001-2001
pesticide production, unspecified	GLO; RER	2000-2010
petroleum refinery operation	CH; GLO	1980-2000
phosphate rock beneficiation, dry	GLO; MA	1986-2001
phosphate rock beneficiation, wet	GLO; US	1986-2001
phthalimide-compound production	GLO; RER	2000-2010
platinum group metal mine operation, ore with high palladium content	GLO; RU	1995-2002
platinum group metal, extraction and refinery operations	GLO; ZA	2015-2015
polybutadiene production	GLO; RER	2001-2002
polycarbonate production	GLO; RER	1996-2001
polyethylene production, high density, granulate	GLO; RER	2011-2016
polyethylene production, linear low density, granulate	GLO; RER	2011-2016
polyethylene production, low density, granulate	GLO; RER	2011-2016
polymethyl methacrylate production, beads	GLO; RER	1996-2001
polymethyl methacrylate production, sheet	GLO; RER	1996-2001
polyol production	GLO; RER	1995-2001
polypropylene production, granulate	GLO; RER	2011-2016
polystyrene production, expandable	GLO; RER	2001-2003
polystyrene production, general purpose	GLO; RER	2001-2002
polystyrene production, high impact	GLO; RER	2001-2002

Activity name	Geography	Time period
polyvinylchloride production, emulsion polymerisation	GLO; RER	2013-2018
polyvinylchloride production, suspension polymerisation	GLO; RER	2013-2018
polyvinylidenchloride production, granulate	GLO; RER	1994-2001
portafer production	CA-QC; GLO; RER	2000-2000
potassium chloride production	CA-SK; GLO; RER	2000-2000
propylene production	GLO; RER	1999-2001
propylene production, pipeline system	GLO; RER	1999-2001
pyrethroid-compound production	GLO; RER	2000-2010
pyridazine-compound production	GLO; RER	2000-2010
rare earth concentrate production, 70% REO, from bastnäsite	CN; GLO	2000-2005
silver-gold mine operation with refinery	CL; GLO	2002-2006
stibnite mine operation, 70% stibnite	CA-QC; CN; GLO	1994-2003
styrene-acrylonitrile copolymer production	GLO; RER	1996-2001
tantalum production, powder, capacitor-grade	GLO	2000-2003
tetrachloroethylene production	GLO; WEU	1997-1997
tin production	GLO	2010-2016
toluene diisocyanate production	GLO; RER	1995-2001
toluene production, liquid	GLO; RER	2001-2002
vermiculite mine operation	GLO; ZA	2000-2000
vinyl chloride production	GLO; RER	2013-2018
xylene production	GLO; RER	2001-2002
zinc mine operation	GLO	2012-2017

8.1 Aluminium

8.1.1 Aluminium oxide: metallurgical and non-metallurgical

For version 3.6, the product "aluminium oxide" has been split into "aluminium oxide, metallurgical" and "aluminium oxide, non-metallurgical". The split was made in accordance with European Aluminium (EA) and the International Aluminium Association (IAI). The reason of this split is the different purposes of these products. As the name suggests, "aluminium oxide, metallurgical" is used to produce aluminium, while "aluminium oxide, non-metallurgical" has other applications, for example it used in the chemical industry and as a refractory material. The application was the criterion used to determine with which product to substitute "aluminium oxide" in the demanding activities. All activities related to aluminium production receive an input of “aluminium oxide, metallurgical” (“aluminium production, primary, liquid, Söderberg”, “aluminium production, primary, liquid, prebake”). The rest, use “aluminium oxide, non-metallurgical”, as specified in Table 2.

In the ecoinvent database both grades of aluminium oxide result from the activity "aluminium oxide production". The activity formerly produced "aluminium oxide", while now it has "aluminium oxide, metallurgical" as reference product and "aluminium oxide, non-metallurgical" as by-product. The production ratios for the different available regions were taken from the dedicated section of the International Aluminium Institute website (IAI 2019), except for the data for Europe which was directly provided by EA. An additional important change made in accordance with EA and IAI, was the replacement of the reference product of the treatment activities of aluminium scrap at refiner from "aluminium oxide" to "aluminium oxide, non-metallurgical".

In ecoinvent each different product requires a dedicated market. In version 3.5 the market for aluminium oxide was available only at global level. In version 3.6, for both grades of aluminium oxide, a European market is also available. The EA provided the specific market composition for "aluminium oxide, metallurgical" including import activities (modelled as net imports). Similarly, the treatment activities producing non-metallurgical aluminium oxide are available only at global and European level, therefore a European market for "aluminium oxide, non-metallurgical" was introduced.

Table 37. New market and import activities for metallurgical and non-metallurgical aluminium oxide. *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	Product name	Unit
aluminium oxide, metallurgical, import from Northern America	IAI Area, EU27 & EFTA	2015-2015	aluminium oxide, metallurgical	kg
aluminium oxide, metallurgical, import from Rest of Europe	IAI Area, EU27 & EFTA	2015-2015	aluminium oxide, metallurgical	kg
aluminium oxide, metallurgical, import from South America	IAI Area, EU27 & EFTA	2015-2015	aluminium oxide, metallurgical	kg
market for aluminium oxide, metallurgical	GLO; IAI Area, EU27 & EFTA	2015-2015	aluminium oxide, metallurgical	kg
market for aluminium oxide, non-metallurgical	GLO; IAI Area, EU27 & EFTA	2015-2015	aluminium oxide, non-metallurgical	kg

8.1.2 Constrained market

Non-metallurgical aluminium oxide is produced solely as a by-product in the ecoinvent database, the market is therefore constrained. A constrained market indicates that an increase in demand cannot be met by an increase in supply. The constraint is set to the renaming activity "aluminium oxide, non-metallurgical to generic market for refractory material, acid" which feeds into the "market for refractory material, acid" together with "kaolin to generic market for refractory material, acid". The constrain to refractory materials was picked as the most common application of non-metallurgical aluminium oxide. Because kaolin production is not constrained, it can supply an increase in demand of "refractory material, acid". Constrained markets are only valid in the Consequential system model.

In the attributional system models, users can choose to use specific acid refractory materials, i.e. "aluminium oxide, non-metallurgical" and "kaolin", or to rely on a more generic product "refractory material, acid".

Table 38. New transforming and market activities for refractory material, acid. *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	Product name	Unit
aluminium oxide, non-metallurgical to generic market for refractory material, acid	GLO; IAI Area, EU27 & EFTA	2019-2019	refractory material, acid	kg
kaolin to generic market for refractory material, acid	GLO	2019-2019	refractory material, acid	kg
market for refractory material, acid	GLO	2019-2019	refractory material, acid	kg

8.1.3 Additional minor changes in Aluminium

The electricity datasets for the region "IAI Area, South America" have been updated to include the split of Brazil into regions (see chapter 6.1). Additionally, the production volume of the activity "electricity voltage transformation from high to medium voltage, aluminium industry" has been corrected.

Table 39. List of updated activities related to electricity for the aluminium industry. *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	Product name	Unit
electricity production, hydro, aluminium industry	IAI Area, South America	2015-2015	electricity, high voltage, aluminium industry	kWh
electricity production, natural gas, aluminium industry	IAI Area, South America	2015-2015	electricity, high voltage, aluminium industry	kWh
electricity voltage transformation from high to medium voltage, aluminium industry	GLO	2015-2015	electricity, medium voltage, aluminium industry	kWh

8.2 Copper

For version 3.6, the copper sector was slightly restructured. There are two main production pathways for copper: the pyrometallurgical route, modelled in the database by the two activities "copper mine operation, sulfide ore" and "copper production, primary", and the hydrometallurgical route, modelled by the activity "copper production, solvent-extraction electro-winning".

Up to version 3.5, the reference product of the activity "copper production, solvent-extraction electro-winning" was named "copper, from solvent-extraction electro-winning". As this product represents refined copper that can be used for the manufacturing of semi-fabricated products, which is also the case of the product named "copper" (that is produced by the activity "copper production, primary" as well as other activities in the database), the product "copper, from solvent-extraction electro-winning" was replaced by "copper" in version 3.6.

Despite that the activity "copper production, primary" produces "copper", up to version 3.5 certain geographies also had an input of "copper, from solvent-extraction electro-winning". This had been done in the original version of those datasets to model the mix of technologies that is used in each specific geography. However, the methodology of version 3 of the ecoinvent database specifies that market activities have the role of mixing the different technologies that are available within the geography of the market for a given product. Therefore, the input of "copper, from solvent-extraction electro-winning" was removed from the datasets that were using it to model a mix of technologies. The exchange amounts in those datasets were then scaled in order to maintain an output amount of copper equal to 1 kg. These datasets are listed in Table 40, along with the scaling factors that were applied to scale the exchange amounts.

Table 40. Datasets in which the input of "copper, from solvent-extraction electro-winning", was removed and the amounts were scaled. *The input amount and the scaling factor, with which the exchanges amount of all other exchanges in the dataset were multiplied by, are shown in the last two columns respectively.*

Activity name	Geography	Time period	Input amount of "copper, from solvent-extraction electro-winning" (kg)	Scaling factor (-)
copper production, primary	AU	1994-2003	0.0877	1.096
copper production, primary	GLO	1994-2003	0.0942	1.104
copper production, primary	RLA	1994-2003	0.176	1.214
copper production, primary	RNA	1994-2003	0.176	1.214
treatment of copper cake	GLO	1994-2003	0.0942	1.104

In the activity "treatment of copper cake", the copper content of the reference product "copper cake" (which is treated) was updated following the update of the activity that produces it, i.e. "primary zinc production from concentrate" (see Section 0 for more details concerning the update of the zinc sector). Therefore, the amount of the reference product was adjusted, as the exchanges amounts in that dataset are normalized to 1 kg of by-product copper that is recovered.

The other datasets in which the exchange "copper, from solvent-extraction electro-winning" was replaced by "copper" are listed in Table 41. With this replacement, the global "market for copper, from solvent-extraction electro-winning " (time period 2011-2011) is no longer needed and was therefore removed for version 3.6.

Table 41. Datasets in which the intermediate exchange "copper, from solvent-extraction electro-winning" was replaced by "copper". *The group of the exchange is given in the last column.*

Activity name	Geography	Time period	Group
copper production, solvent-extraction electro-winning	GLO	1994-2003	ReferenceProduct
treatment of non-Fe-Co-metals, from used Li-ion battery, hydrometallurgical processing	GLO	2000-2005	ByProduct

The production volumes of copper in all datasets that produce it were revised. Additionally, the production volumes of "copper, blister-copper" and "copper concentrate, sulfide ore" were revised for specific datasets. The datasets in which the production volume of a copper-containing product was updated for version 3.6 are listed in Table 42. Additionally, some copper production volumes were modified with the update of the gold and silver production volumes. The datasets for which this was done are shown in Table 44 in Section 8.3.

Table 42. Datasets in which the production volume of a copper-containing product was updated. *If the production volume of the reference product or another non-waste by-product was updated as well, that product is also listed in the column "Production volume updated". 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	Production volume updated
copper production, blister-copper	GLO; RER	1994-2003	copper, blister-copper
copper production, primary	AU; GLO; RAS; RER; RLA; RNA	1994-2003	copper
copper production, solvent-extraction electro-winning	GLO	1994-2003	copper & sulfuric acid
molybdenite mine operation	GLO	1994-2003	copper concentrate, sulfide ore
platinum group metal mine operation, ore with high palladium content	GLO; RU	1995-2002	copper
treatment of copper cake	GLO	2012-2012	copper & copper cake
treatment of copper scrap by electrolytic refining	GLO; RER	1994-2003	copper & copper scrap, sorted, pressed

The update of the copper production volumes resulted in the amount of the by-products of "copper slag" and "wastewater, unpolluted" in the global dataset for "copper production, primary" to be adjusted.

Some copper production datasets had an output of "nickel smelter slag", which was replaced by "copper slag" for version 3.6. This replacement is described in more detail in Section 8.9.

The global activities "nickel mine operation, sulfidic ore" and "smelting and refining of nickel ore" both had a by-product of "copper" up to version 3.5. It was replaced by "copper by copper concentrate, sulfide ore" for version 3.6, as the nickel supply chain typically does not produce refined copper. The exchange amounts and production volume amounts of these by-products were recalculated accordingly.

8.3 Gold and silver

New datasets were introduced for the gold and silver sectors within the SRI-LCI project. New datasets were created for gold and silver mining and extraction in Peru. A dataset which modelled the mining and refining of gold and silver in Peru ("gold-silver mine operation with refinery", which produced the products "gold" and "silver") was already present in previous versions of the database. For version 3.6, it is replaced by two datasets, one which models the mining of gold and one which models the mining of silver. The product coming out of the gold mining activity is "gold-silver, ingot" instead of "gold", while the silver mining activity produces "silver, unrefined" instead of "silver" (as silver is not refined in Peru).

The activity "gold production" in South Africa (ZA) in version 3.5 is replaced for version 3.6 by two activities; "gold mine operation and gold production, unrefined", which produces "gold, unrefined" and "gold refinery operation", which produces "gold". As these datasets provide a higher level of detail of the gold supply chain, the global copies of these two datasets are used to represent the global gold production chain (instead of the global "gold production" activity).

The list of datasets that were introduced or updated for the gold and silver sectors is given in Table 43.

Table 43. New and updated datasets for the gold and silver sectors in version 3.6*. The new market activities are listed at the bottom of the table. If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	Reference product	Unit	v3.6
gold mine operation and gold production, unrefined	GLO; ZA	2012-2016	gold, unrefined	kg	N
gold mine operation with extraction	GLO; PE	2010-2016	gold-silver, ingot	kg	N
gold refinery operation	GLO; ZA	2017-2017	gold	kg	N
mine construction, gold	ZA	2002-2006	mine infrastructure, gold	unit	U
mine infrastructure construction, treatment of sulfidic tailing, off-site, high gold content	GLO; ZA	2012-2016	mine infrastructure, treatment of sulfidic tailing, off-site, high gold content	unit	N
silver mine operation with extraction	GLO; PE	2010-2016	silver, unrefined	kg	N
treatment of sulfidic tailing, off-site, high gold content	GLO; ZA	2012-2016	sulfidic tailing, off-site, high gold content	kg	N
market for gold, unrefined	GLO	2016-2016	gold, unrefined	kg	N
market for mine infrastructure, treatment of sulfidic tailing, off-site, high gold content	GLO	2012-2016	mine infrastructure, treatment of sulfidic tailing, off-site, high gold content	unit	N
market for silver, unrefined	GLO	2010-2016	silver, unrefined	kg	N
market for sulfidic tailing, off-site, high-gold content	ZA	2015-2015	sulfidic tailing, off-site, high gold content	kg	N
market for sulfidic tailing, off-site, high-gold content	GLO	2016-2016	sulfidic tailing, off-site, high gold content	kg	N

With the introduction of these new datasets, the production volumes of all activities in the database that produce gold or silver were revised. The datasets in which the production volume of gold or silver was updated are shown in Table 44 (the production volume of any other output to the technosphere in those datasets was updated accordingly). Although the GLO dataset for "gold production" is still present in version 3.6, its production volume is set equal to that of the sum of the production volumes of the local geographies. It is therefore removed during the linking, and instead the activities "gold mine operation and gold production, unrefined" and "gold refinery operation" model the gold supply chain at the global level.

Table 44. Datasets in which the production volume of gold or silver was updated for version 3.6. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The last column indicates which product had its production volume updated. Reference products and non-waste by-products other than gold and silver are listed if their production volume was also updated for version 3.6.*

Activity name	Geography	Time period	Production volume updated
gold production	GLO	2001-2006	gold
gold production	AU	2001-2006	gold
gold production	CA; TZ; US	2003-2006	gold
gold-silver mine operation with refinery	PG	2000-2006	silver
gold-silver mine operation with refinery	GLO	2004-2006	gold & silver
gold-silver-zinc-lead-copper mine operation and refining	GLO (*); SE	2004-2006	gold, silver, zinc, lead & copper
processing of anode slime, primary copper production	GLO	2000-2005	silver & copper telluride cement
silver-gold mine operation with refinery	GLO	2002-2006	gold & silver
silver-gold mine operation with refinery	CL	2002-2006	gold
treatment of crust from Parkes process for lead production	GLO	2000-2005	silver & crust from Parkes process for lead production
treatment of precious metal from electronics scrap, in anode slime, precious metal extraction	GLO; SE	2000-2005	gold, silver, palladium & precious metal from electronics scrap, in anode slime
treatment of waste x-ray film	GLO	2011-2015	silver & waste x-ray film

(*) The production volumes of the outputs in the GLO dataset were set equal to those in the SE dataset.

For the GLO dataset "gold-silver mine operation with refinery", the exchange amounts the by-products "iron scrap, unsorted" and "waste wood, untreated" and the input of "chromium" from technosphere were also updated, as they are scaled based on the ratio of the production volumes of the GLO and CA-QC datasets.

8.4 Iron and steel

In the context of the SRI-LCI project new datasets for the production of iron and steel in India were introduced for version 3.6. The addition of these datasets required the update of some values in the global datasets for those activities; certain production volumes were updated, and by-products that are produced in the Indian datasets were added to the global datasets. For those by-products, the amounts were scaled based on the ratio of global and Indian production volumes, so that their production volumes are equal to those in the Indian datasets.

In the GLO dataset "steel production, electric, low-alloyed" some exchanges represent material flows that are specific to that activity in the geography CA-QC. The amounts of these exchanges in the GLO dataset are calculated by scaling the original amounts in the CA-QC dataset based on the ratio of the production volumes of both datasets. This ratio was recalculated for version 3.6, which resulted in a reduction of the amounts of these exchanges in the GLO dataset.

The list of updated GLO datasets and new Indian datasets added for version 3.6 is given in Table 45.

Table 45. Activities added and updated in the iron and steel sector. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity". "N*" signals that the GLO and IN production Volumes are identical, eliminating the creation of RoW activities in the system models*

Activity name	Geography	Time period	Reference product	Unit	v3.6
iron mine operation, crude ore, 46% Fe	GLO	1999-2000	iron ore, crude ore, 46% Fe	kg	U
iron mine operation, crude ore, 63% Fe	GLO; IN	2000-2017	iron ore, crude ore, 63% Fe	kg	N*
iron ore beneficiation to 65% Fe	GLO	1998-2000	iron ore, beneficiated, 65% Fe	kg	U
iron ore beneficiation to 65% Fe	IN	2007-2017	iron ore, beneficiated, 65% Fe	kg	N
iron pellet production	GLO	1999-2002	iron pellet	kg	U
iron pellet production	IN	2010-2017	iron pellet	kg	N
pig iron production	GLO	1999-2002	pig iron	kg	U
pig iron production	IN	2010-2017	pig iron	kg	N
sinter production, iron	GLO	1999-2002	sinter, iron	kg	U
sinter production, iron	IN	2007-2017	sinter, iron	kg	N
sponge iron production	GLO; IN	2000-2017	sponge iron	kg	N*
steel production, converter, low-alloyed	GLO	2001-2001	steel, low-alloyed	kg	U
steel production, converter, low-alloyed	IN	2010-2017	steel, low-alloyed	kg	N
steel production, electric, low-alloyed	GLO	2001-2001	steel, low-alloyed	kg	U
steel production, electric, low-alloyed	IN	2010-2017	steel, low-alloyed	kg	N
market for iron ore, crude ore, 63% Fe	GLO	2000-2017	iron ore, crude ore, 63% Fe	kg	N
market for sponge iron	GLO	2000-2017	sponge iron	kg	N

New datasets were also added for the production of ferrochromium in South Africa in the context of the SRI-LCI project. The details regarding the data collection and modelling are provided in Charikinya *et al.*, 2019. The new datasets introduced in version 3.6 for ferrochromium production are listed in Table 46.

Table 46. New datasets introduced in version 3.6 for the production of ferrochromium with 55% chromium content.

Activity name	Geography	Time period	Reference product	Unit
ferrochromium production, high carbon, 55% Cr	GLO; ZA	2012-2016	ferrochromium, high carbon, 55% Cr	kg
market for ferrochromium, high carbon, 55% Cr	GLO	2015-2015	ferrochromium, high carbon, 55% Cr	kg

8.5 Platinum group metals

In the context of the SRI-LCI project, the dataset that modelled the mining and production of platinum group metals in South Africa (ZA) in version 3.5 ("platinum group metal mine operation, ore with high rhodium content") has been replaced by two new activities in version 3.6: "platinum group metal, mine and concentration operations", which produces "platinum group metal concentrate" as reference product, and "platinum group metal, extraction and refinery operations", which has "platinum" as reference product. Although both activities were introduced in version 3.6 with the geographies GLO and ZA, similarly to the previous dataset in version 3.5, the production volumes of the two new global datasets have been set equal to those of the ZA datasets, which means that only the ZA datasets are available after linking. The details concerning the data and modelling of the new datasets for the platinum group metals sector in ZA are provided in Charikinya *et al.*, 2019.

As the intermediate product "platinum group metal concentrate" did not exist in previous versions of the database, a market activity was created for it for version 3.6.

One of the main differences with the previous dataset that modelled the production of platinum group metals in ZA, is that the reference product of the refining stage is platinum, while the reference product of the previous dataset was rhodium. The consequence of this change in reference product is that, in version 3.6, rhodium is only produced as by-product, as there is no other activity in the database that produces rhodium as reference product. This means that the market for rhodium is constrained in version 3.6.

An unconstrained supplier of rhodium was therefore introduced for version 3.6. The metals palladium, platinum and rhodium are all commonly used as catalysts in catalytic converters used in vehicles. The intermediate exchange "metal catalyst for catalytic converter" was thus created for version 3.6. Its global market is supplied by the three aforementioned metals through the activities "[metal name] to generic market for metal catalyst for catalytic converter". In the market for rhodium, a by-product with an activity link to the activity "rhodium to generic market for metal catalyst for catalytic converter" has been added, which allows this market to be supplied by the "market for metal catalyst for catalytic converter" in the consequential system model. This entails that, in the consequential system model, an activity that produces rhodium as by-product avoids the production of a mix of platinum and palladium.

In version 3.5, the market for platinum was constrained, as platinum was not produced as reference product by any activity in the database. Since it is the reference product of the new dataset "platinum group metal, extraction and refinery operations", that market is no longer constrained, and its by-product was removed for version 3.6.

The list of new and updated datasets for the platinum group metals sector is given in Table 47.

Table 47. New and updated transforming activities and market activities for the platinum group metals sector in version 3.6. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	Reference product	Unit	v3.6
platinum group metal, extraction and refinery operations	GLO; ZA	2015-2015	platinum	kg	N
platinum group metal, mine and concentration operations	GLO; ZA	2015-2015	platinum group metal concentrate	kg	N
market for platinum group metal concentrate	GLO; ZA	2015-2015	platinum group metal concentrate	kg	N
market for platinum	GLO	2019-2019	platinum	kg	U
market for rhodium	GLO	2011-2011	rhodium	kg	U
palladium to generic market for metal catalyst for catalytic converter	GLO	2019-2019	metal catalyst for catalytic converter	kg	N
platinum to generic market for metal catalyst for catalytic converter	GLO	2019-2019	metal catalyst for catalytic converter	kg	N
rhodium to generic market for metal catalyst for catalytic converter	GLO	2019-2019	metal catalyst for catalytic converter	kg	N
market for metal catalyst for catalytic converter	GLO	2019-2019	metal catalyst for catalytic converter	kg	N

8.6 Tin

Version 3.5 contained the activity "tin production", which modelled the production of tin, including all the steps from mining to refining. In the context of the SRI-LCI project, two datasets were added for the production of tin in Peru; "tin mine operation", which models the mining of tin and produces "tin concentrate", and "tin production", which models the refining of "tin concentrate" to "tin". Since these datasets provide a higher level of detail of the tin supply chain, the global version of these two datasets are used as replacement of the previous GLO "tin production" dataset. All datasets that model the tin supply chain (including market activities) are listed in Table 48. Version 3.5 contained the activity "tin production" with the geography RER (Europe). This dataset has been removed for version 3.6, as tin is currently not mined or refined in Europe.

Table 48. List of datasets that model the tin supply chain (from the extraction of the ore to the production of refined tin) in version 3.6. *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	Reference product	Unit
market for tin	GLO	2011-2011	tin	kg
market for tin concentrate	GLO	2010-2017	tin concentrate	kg
tin mine operation	GLO; PE	2010-2017	tin concentrate	kg
tin production	GLO; PE	2010-2016	tin	kg

8.7 Titania

In the context of the SRI-LCI project, a dataset that models the mining of heavy mineral sands in South Africa was created for version 3.6. Its reference product is "titania slag, 85% titanium dioxide" and the other main valuable by-products are "pig iron", "zircon, 50% zirconium" and "rutile, 95% titanium dioxide". As the reference product did not exist in previous versions of the database, a global market for it has been created for version 3.6. Additional information regarding these datasets can be found in Charikinya *et al.*, 2019. The list of new datasets for heavy mineral sands introduced in version 3.6 is given in Table 49.

Table 49. New datasets introduced in version 3.6 for the mining of heavy mineral sands. *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	Reference product	Unit
heavy mineral sand quarry operation and titania slag production	GLO; ZA	2015-2015	titania slag, 85% titanium dioxide	kg
market for titania slag, 85% titanium dioxide	GLO	2015-2015	titania slag, 85% titanium dioxide	kg

8.8 Zinc, cadmium and cobalt

The global zinc supply chain was fully updated for version 3.6. It is modelled in two stages; the dataset "zinc mine operation" (previously named "zinc-lead mine operation") models the mining, comminution, and floatation steps, which produce zinc concentrate as the main product, while the dataset "primary zinc production from concentrate" models the smelting and refining stages, which produce zinc with a purity of 99.99% (named "special high grade zinc" by the industry). The data for both datasets were provided by the International Zinc Association (IZA) and are meant to represent the average global zinc supply. Background information concerning the data collection can be found in PE INTERNATIONAL (2014). Additionally, the market for zinc concentrate was also updated with transport modes and distances based on data collected by IZA.

With the update of the two zinc production datasets, many by-products were added. One of them is the "bulk lead-zinc concentrate", for which no activity is currently available in the database to model the extraction of lead and zinc from it. Therefore, a global renaming activity was created ("bulk lead-zinc concentrate to generic markets for zinc concentrate and lead concentrate"), which splits the bulk lead-zinc concentrate into lead concentrate and zinc concentrate, which supply their respective market activities. A GLO market for bulk lead-zinc concentrate was also introduced with the default transport modes and amounts given in the Default Transport Assumptions Excel file available on the ecoinvent website.

One of the other main by-products of the zinc supply chain is cadmium. It was already present as by-product in the previous version of the primary zinc production dataset, under the name "cadmium sludge from zinc electrolysis". This product is sent to the activity "cadmium production, primary" which models its processing to produce refined cadmium (named "cadmium" in the database). The new version of the primary zinc production dataset has both refined cadmium and cadmium sludge as outputs, since, some of the production sites included in the study on which is based this dataset, extract and refine the cadmium onsite.

With the addition of the cadmium by-product, the total production volume of cadmium contained in the two cadmium-containing by-products of the primary zinc production dataset increased compared to the previous version of that dataset. The production volumes of the GLO and CA-QC datasets for "cadmium production, primary" were adjusted accordingly. Additionally, the input amount of cadmium sludge in those two datasets was adjusted to be consistent with the cadmium content reported for that product in the zinc primary production dataset.

Another significant change in the cadmium supply chain concerns the prices of the various cadmium-containing intermediate exchanges. Particularly, the price of the cadmium sludge was quite low up to version 3.5 in comparison to the amount of contained cadmium. This was revised for version 3.6.

One of the other by-products of the activity "primary zinc production from concentrate" is cobalt. The production volume of the global activity "cobalt production" was updated to ensure that the sum of all production volumes of cobalt in the database does not exceed the actual total annual amount of cobalt that is produced worldwide.

Additionally, for the activity "primary zinc production from concentrate", the already-existing dataset with the geography CA-QC was modified to be more consistent with the new version of the GLO dataset: the two by-products "scrap copper" and "scrap steel" were replaced by the products "copper scrap, sorted, pressed" and "iron scrap, unsorted". The first two products are sent to disposal, while the latter two are sent to recycling. Based on the original comments for those exchanges in the CA-QC dataset, those materials are sent to recycling.

All datasets that were updated and added for the zinc, cadmium and cobalt sectors are listed in Table 50.

Table 50. Transforming activities and market activities updated and added for the zinc, cadmium and cobalt sectors in version 3.6. *In the column v3.6, "N" stands for "New Activity" and "U" stands for "Updated Activity".*

Activity name	Geography	Time period	Reference product	Unit	v3.6
zinc mine operation	GLO	2012-2017	zinc concentrate	kg	U
market for zinc concentrate	GLO	2012-2017	zinc concentrate	kg	U
primary zinc production from concentrate	CA-QC	2011-2012	zinc	kg	U
primary zinc production from concentrate	GLO	2015-2017	zinc	kg	U
market for zinc	GLO	2011-2011	zinc	kg	U
bulk lead-zinc concentrate to generic markets for zinc concentrate and lead concentrate	GLO	2012-2017	zinc concentrate	kg	N
market for bulk lead-zinc concentrate	GLO	2012-2017	bulk lead-zinc concentrate	kg	N
cadmium production, primary	CA-QC	2000-2013	cadmium	kg	U
cadmium production, primary	GLO	2000-2013	cadmium	kg	U
cobalt production	GLO	2000-2000	cobalt	kg	U

8.9 Slags and tailings

8.9.1 Metal slags

Three new intermediate exchanges for slags specific to the production of certain metals were added for version 3.6: copper slag, tin slag and zinc slag. Their disposal in a residual material landfill is modelled in the three treatment activities listed in Table 51. These activities were created using the model described in Doka (2009) based on slag compositions found in literature.

Table 51. Transforming activities and market activities created for the three new metal-specific slags introduced in version 3.6.

Activity name	Geography	Time period	Reference product	Unit
treatment of copper slag, residual material landfill	GLO	2017-2018	copper slag	kg
treatment of tin slag, residual material landfill	GLO	2017-2018	tin slag	kg
treatment of zinc slag, residual material landfill	GLO	2017-2018	zinc slag	kg
market for copper slag	GLO	2018-2018	copper slag	kg
market for tin slag	GLO	2018-2018	tin slag	kg
market for zinc slag	GLO	2018-2018	zinc slag	kg

Other types of slags were already available in previous versions of the database, in particular "nickel smelter slag", which was among the by-products of many datasets in the metals sector. Nickel smelter slag was in some cases used as a proxy for another type of slag for which no treatment activity was yet available. The choice of slag was reviewed for version 3.6; for several datasets, the by-product of "nickel smelter slag" was replaced by "copper slag". The datasets in which this replacement was done for version 3.6 are listed in Table 52.

Table 52. Datasets in which the by-product "nickel smelter slag" was replaced by "copper slag" for version 3.6. *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
copper production, blister-copper	GLO; RER	1994-2003
copper production, primary	AU; GLO; RAS; RER; RLA; RNA	1994-2003
process-specific burdens, import of copper to Switzerland	DE; GLO	1994-2003
treatment of copper cake	GLO	2012-2012
treatment of electronics scrap, metals recovery in copper smelter	GLO; SE	2000-2005

8.9.2 Sulfidic tailings

In version 3.5, the sulfidic tailings, which are a waste by-product of mining activities, were modelled with the intermediate exchange "sulfidic tailing, off-site". One GLO treatment activity was available ("treatment of sulfidic tailing, off-site"), which modelled the disposal of sulfidic tailings, along with one GLO market ("market for sulfidic tailing, off-site").

For version 3.6, 43 datasets that model the disposal of sulfidic tailings produced during the beneficiation of seven metal sulfide ores in 18 major mining countries, as well as globally, were introduced. These new datasets were modelled considering specific tailings composition and regional climate, using the sulfidic tailings disposal model developed by Doka (2017). The datasets are described in Turner *et al.*, 2019.

The list of all new datasets that model the disposal of sulfidic tailings is given in Table 53.

Table 53. New transforming activities that model the disposal of sulfidic tailings. *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	Reference product	Unit
treatment of sulfidic tailings, from cinnabar mine operation, tailings impoundment	CN; GLO	2015-2019	sulfidic tailings, from cinnabar mine operation	kg
treatment of sulfidic tailings, from copper mine operation, tailings impoundment	AU; CA; CL; CN; GLO; ID; KZ; PE; RU; US; ZM	2015-2019	sulfidic tailings, from copper mine operation	kg
treatment of sulfidic tailings, from gold mine operation, tailings impoundment	AR; AU; BR; CA; CN; CO; GLO; KZ; MX; PE; PG; RU; US	2015-2019	sulfidic tailings, from gold mine operation	kg
treatment of sulfidic tailings, from nickel mine operation, tailings impoundment	CA; GLO; RU; ZA	2015-2019	sulfidic tailings, from nickel mine operation	kg
treatment of sulfidic tailings, from silver mine operation, tailings impoundment	AU; GLO; MX; US	2015-2019	sulfidic tailings, from silver mine operation	kg
treatment of sulfidic tailings, from zinc-lead mine operation, tailings impoundment	AU; CN; GLO; IN; KZ; MX; PE; US	2015-2019	sulfidic tailings, from zinc-lead mine operation	kg
treatment of sulfidic tailings, generic, tailings impoundment	GLO	2015-2019	sulfidic tailings, generic	kg

Each geography for which a treatment activity was created has a market activity for the corresponding type of sulfidic tailings. These are listed in Table 54.

Table 54. Market activities for the new exchanges of sulfidic tailings.

Activity name	Geography	Time period	Reference product	Unit
market for sulfidic tailings, from cinnabar mine operation	CN; GLO	2015-2019	sulfidic tailings, from cinnabar mine operation	kg
market for sulfidic tailings, from copper mine operation	AU; CA; CL; CN; GLO; ID; KZ; PE; RU; US; ZM	2015-2019	sulfidic tailings, from copper mine operation	kg
market for sulfidic tailings, from gold mine operation	AR; AU; BR; CA; CN; CO; GLO; KZ; MX; PE; PG; RU; US	2015-2019	sulfidic tailings, from gold mine operation	kg
market for sulfidic tailings, from nickel mine operation	CA; GLO; RU; ZA	2015-2019	sulfidic tailings, from nickel mine operation	kg
market for sulfidic tailings, from silver mine operation	AU; GLO; MX; US	2015-2019	sulfidic tailings, from silver mine operation	kg
market for sulfidic tailings, from zinc-lead mine operation	AU; CN; GLO; IN; KZ; MX; PE; US	2015-2019	sulfidic tailings, from zinc-lead mine operation	kg
market for sulfidic tailings, generic	GLO	2015-2019	sulfidic tailings, generic	kg

Datasets that previously had the exchange "sulfidic tailing, off-site" as by-product were updated for version 3.6 so that they now use either one of the more specific types of sulfidic tailings, or the generic one, in case none of specific ones are suitable for the given type of activity. The replacement of the old sulfidic tailings by the new exchanges is shown in Table 55.

Table 55. Replacement of the exchange "sulfidic tailing, off-site" in all datasets that had it as by-product in version 3.5 and which are still present in version 3.6. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. The column "Sulfidic tailings exchange name in v3.6" indicates which of the new sulfidic tailings exchanges replaces the old one.*

Activity name	Geography	Time period	Sulfidic tailings exchange name in v3.6
copper mine operation, sulfide ore	AU; GLO; RAS; RER; RLA; RNA	1994-2003	sulfidic tailings, from copper mine operation
copper production, solvent-extraction electro-winning	GLO	1994-2003	sulfidic tailings, from copper mine operation
gold production	AU; GLO	2001-2006	sulfidic tailings, from gold mine operation
gold production	CA; TZ; US	2003-2006	sulfidic tailings, from gold mine operation
gold-silver mine operation with refinery	PG	2000-2006	sulfidic tailings, from gold mine operation
gold-silver mine operation with refinery	GLO	2004-2006	sulfidic tailings, from gold mine operation
gold-silver mine operation with refinery	CA-QC	2012-2012	sulfidic tailings, from gold mine operation
gold-silver-zinc-lead-copper mine operation and refining	GLO; SE	2004-2006	sulfidic tailings, generic
gold-silver-zinc-lead-copper mining and benefication	CA-QC; GLO	2012-2012	sulfidic tailings, generic
mining and benefication of nickel ore	CA-QC; GLO	2010-2010	sulfidic tailings, from nickel mine operation
molybdenite mine operation	GLO	1994-2003	sulfidic tailings, from copper mine operation
nickel mine operation, sulfidic ore	GLO	1994-2003	sulfidic tailings, from nickel mine operation
platinum group metal mine operation, ore with high palladium content	GLO; RU	1995-2002	sulfidic tailings, generic
rare earth oxides production from bastnäsite concentrate	CN; GLO	2000-2005	sulfidic tailings, generic
silver-gold mine operation with refinery	CL; GLO	2002-2006	sulfidic tailings, from silver mine operation
stibnite mine operation, 70% stibnite	CA-QC; CN; GLO	1994-2003	sulfidic tailings, generic
zinc mine operation (*)	GLO	2012-2017	sulfidic tailings, from zinc-lead mine operation

(*) This activity was named "zinc-lead mine operation" and had the time period 1994-2003 in version 3.5. Refer to Section 0 for more information concerning the update of the zinc sector.

9 Petroleum Refining and Petroleum Products

Within the context of the SRI-LCI project, the *Institut für Energie- und Umweltforschung (ifeu), Heidelberg*, was commissioned to create new datasets for petroleum refining in Brazil, Colombia, India, Peru and South Africa. Additionally, petroleum refinery operation in Europe, without Switzerland, was updated by the ecoinvent Association, using a simplified LCI tool based on ifeu's modelling approach. Swiss petroleum refinery operations remain unchanged between ecoinvent version 3.01 and version 3.6.

9.1 Modelling before v3.6

The model used for petroleum refinery operation datasets until and including version 3.5 of the ecoinvent database considered the refinery as 'black box', that is, without reflecting the complexity of the highly interlinked refinery process networks explicitly. In a top-down manner, data on refinery inputs and outputs were compiled per tonne of crude oil processed and subsequently allocated to the different refinery products with the use of (mass-based) allocation factors (as described by Jungbluth *et al.*, 2007).

9.2 Modelling in v3.6

The petroleum refinery model that underpins the petroleum refining datasets for Brazil, Colombia India, Europe without Switzerland, Peru and South Africa in ecoinvent v3.6 (see Table 56) takes a bottom-up approach. First developed by ifeu, the model was originally designed in the early 1990s to represent crude oil processing in Germany, for which data provided by the German Mineralölwirtschaftsverband e.V., the IKARUS project (Hedden, Jess 1994) plus data obtained directly from mineral oil companies and refinery operators served as basis. Since then, it evolved to represent the technical characteristics of the archetypical European refinery configurations as described in the European Commission's Best Available Techniques (BAT) Reference document (BREF) for the Refining of Mineral Oil and Gas (Barthe *et al.* 2015). Complemented with primary data from the refining industry, it makes a robust, comprehensive model of state-of-the-art refining in Europe.

The inventories of the individual refinery processes, e.g. atmospheric distillation, vacuum distillation, visbreaking, hydrocracking etc., are calculated individually. This allows subdivision of inputs (energy and resource requirements) and outputs (emissions, wastes, etc.) for each process step among those refinery product(s). For example, hydrocracking is required to increase the yield of lighter, more valuable and thus more desired product fractions such as diesel, kerosene and naphtha. Assigning the burdens of hydrocracking directly to these lighter fractions, rather than distributing them over all refinery products, better reflects actual causality in the life cycle inventories of individual products.

In the ifeu model, supply of energy utilities such as steam, heat and electricity is considered internal to the refinery operation. This differs from earlier modelling approaches, which had, for example, process heat supplied from separate datasets representing the combustion of refinery gas or heavy fuel oil. In the background, the ifeu model deals with a highly complex network of integrated multi-output processes, which are aggregated per refinery product and eventually provided to the database user as subdivided single-output processes. For more information on the underlying model see Fehrenbach *et al.*, 2017.

The **Swiss petroleum refinery operation** was not updated with the modelling approach from ifeu, and hence the multi-output process "petroleum refinery operation" in CH remains available (see Table 57). Currently, only one petroleum refinery, at Cressier, is operating in Switzerland. The mentioned activity reflects the specific conditions at Cressier and Collombey (Jungbluth, 2007), but the second site was taken out of operation in 2015. Given the

specificity REQUIRED to reflect this particular situation adequately, it was decided not to apply the simplified LCI tool based on the ifeu refinery model to the Swiss model for v3.6.

Updates to the Swiss petroleum refinery operation activity include the reintroduction of “refinery gas” as by-product to the Swiss petroleum refinery operation dataset. It supplies the process “refinery gas, burned in industrial furnace, CH”, which in turn supplies the heat to the CH petroleum refinery operation dataset, closing the loop.

The activity “diesel production, low-sulfur”, accounting for the energy requirements (estimated) for diesel desulfurisation, is no longer needed in geographies other than CH. Low-sulfur diesel is now instead supplied in other geographies and the RoW by the activity “diesel production, low-sulphur, petroleum refinery operation” directly.

9.2.1 Geographical coverage

Within the SRI-LCI project, ifeu applied its model to generate datasets on petroleum refinery operation in Brazil, Colombia, India, Peru and South Africa. Additionally, data for Europe, without Switzerland, were updated by the ecoinvent Association using a simplified LCI tool for petroleum refinery operation based on ifeu’s modelling approach. To reflect the specific conditions of these regions, ifeu’s refinery model was adapted by the following key parameters:

- **Crude oil sulfur content**: The average sulfur content of refinery feedstock in each geography was calculated based on the composition (origin) of the processed crude oil mix.
- **Crude oil API gravity**: The average API gravity of refinery feedstock in each geography was calculated based on the composition (origin) of the processed crude oil mix.
- **Refinery configuration**: The model distinguishes three refinery archetypes by complexity (Type II, Type III and Type IV), in line with the refinery configurations defined in the European Commission’s Best Available Techniques (BAT) Reference document (BREF) for the Refining of Mineral Oil and Gas (Barthe *et al.* 2015).

The average crude oil composition in combination with the capacity shares of the archetypes results in the average petroleum refinery conditions per geography.

9.2.2 Consequential modelling

Ifeu’s modelling approach for refinery operation assigns average (rather than marginal) burdens per unit of product. For feasibility and practicality, it does not preserve the complex technical interdependencies nor reflect day-to-day economic optimization choices between the various co-products of the petroleum refinery processes. For this reason, the petroleum refinery operation datasets in v3.6 of the ecoinvent database should be considered only as proxies when used in consequential LCA.

9.2.3 Refined petroleum products

With the new modelling approach new refinery products were added, some of which are new products in the ecoinvent database. Table 56 gives an overview of new activities and products related to petroleum refining. A description is provided for products which are new to the ecoinvent database in v3.6.

9.3 New and updated datasets

9.3.1 Petroleum refinery operation datasets

Table 56 shows the new petroleum refinery operation activities introduced for Brazil, Colombia India, Europe without Switzerland, Peru, South Africa and global under the modelling approach described in chapter 0. The time period for all datasets is 2014 to 2017. A brief description is provided for the products which are new to the ecoinvent database in v3.6.

Table 56. New activities related to petroleum refinery operation. *The listed activities are new in the geographies BR; CO; Europe without Switzerland; GLO; IN; PE and ZA; their time period is 2014-2017. *Product descriptions are shown only for products which are new in ecoinvent v3.6.*

Activity name	Reference product	Unit	Product description *
base oil production, petroleum refinery operation	base oil	kg	Base oil is a component of several petroleum products. It is mainly used in lubricants because of its technical features (e.g. viscosity index), as well as in motor oil and metal processing fluids.
C3 hydrocarbon production, mixture, petroleum refinery operation	C3 hydrocarbon mixture	kg	A gaseous mixture of hydrocarbons with carbon (chain) number of 3 (e.g. C3H8, C3H6 etc.). Gas mixture is here assumed to consist of 68% propene (also known as propylene or methyl ethylene) and 32% propane.
diesel production, low-sulphur, petroleum refinery operation	diesel, low-sulfur	kg	
diesel production, petroleum refinery operation	diesel	kg	
electricity production, medium voltage, petroleum refinery operation	electricity, medium voltage	kWh	
heavy fuel oil production, petroleum refinery operation	heavy fuel oil	kg	
hydrogen production, gaseous, petroleum refinery operation	hydrogen, gaseous	kg	Hydrogen is a colourless, odourless, tasteless, highly flammable gas. It is also the lightest-weight gas. There are several production routes for hydrogen. Only refineries of higher complexity produce hydrogen for sale, by recovering it from refinery gas in several subsequent condensation and purification processes. As hydrogen is the lightest-weight gas, it is not easily stored in gaseous form. It is therefore, most commonly stored in liquid form, compressed at very low temperature.
kerosene production, petroleum refinery operation	kerosene	kg	
light fuel oil production, petroleum refinery operation	light fuel oil	kg	
liquefied petroleum gas production, petroleum refinery operation	liquefied petroleum gas	kg	
naphtha production, petroleum refinery operation	naphtha	kg	
petrol production, unleaded, petroleum refinery operation	petrol, unleaded	kg	
petroleum coke production, petroleum refinery operation	petroleum coke	kg	
petroleum slack wax production, petroleum refinery operation	petroleum slack wax	kg	Petroleum slack wax is a mix of wax and oil with a yellow to brown appearance. Slack wax is commonly used in adhesives, sealants, polishes, lubricants, greases, inks, dust suppressants or controlled-release agents for

Activity name	Reference product	Unit	Product description *
			various chemical and fertilizers. Also, it is often pro-cessed to paraffin wax, which serves multiple applications.
pitch production, petroleum refinery operation	pitch	kg	
refinery gas production, petroleum refinery operation	refinery gas	kg	
reformate production, petroleum refinery operation	reformate	kg	Reformate (gasoline) is the main output of a (catalytic) reforming process generating primarily blendstock with a high-octane rating (95 - 100). It is a mixture of different products (e.g. toluene, cyclohexane or methylcyclohexane). Aromatics can be extracted from reformate, which serve as feedstock for petrochemicals.
sulfur production, petroleum refinery operation	sulfur	kg	
white spirit production, petroleum refinery operation	white spirit	kg	White spirit (also referred to as mineral turpentine) is a clear liquid which is insoluble in water. It is commonly used as extraction solvent, cleaning agent as well as solvent in aerosols, paints, wood preservatives, lacquers, varnishes and asphalt products.

As described in chapter 9.2, the Swiss refinery operation activity is the only one which was not recreated under the ifeu modelling approach. It was subject to some minor updates alongside other related activities, listed in Table 57.

Table 57. Updated activities related to petroleum refinery operation. *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
petrol production, low-sulfur	Europe without Switzerland; GLO	2005-2005
petroleum refinery operation	CH; GLO	1980-2000
refinery gas, burned in furnace	CH; Europe without Switzerland; GLO	1980-2000
white spirit production	GLO; RER	2000-2020
petrol production, low-sulfur	Europe without Switzerland; GLO	2005-2005

9.3.2 Market datasets

With the above described changes to the petroleum refinery sector, the market datasets for refined petroleum products were updated or added. Table 58 gives an overview of new and updated market datasets related to petroleum refining.

Table 58. New and updated market activities related to petroleum refining. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", and "N" stands for "New activity".*

Activity name	Geography	Time period	v3.6
market for base oil	GLO	2014-2017	N
market for C3 hydrocarbon mixture	GLO	2014-2017	N
market for diesel	GLO	2011-2011	U
market for diesel	BR; CO; IN; PE	2014-2017	N
market for diesel	ZA	2016-2016	N
market for diesel, low-sulfur	GLO	2011-2011	U
market for diesel, low-sulfur	BR; CO; IN; PE	2014-2017	N
market for diesel, low-sulfur	ZA	2016-2016	N
market for ethylene, average	ZA	2018-2018	N
market for heavy fuel oil	CH; Europe without Switzerland	1989-2000	U
market for heavy fuel oil	GLO	2011-2011	U
market for heavy fuel oil	BR; CO; IN; PE; ZA	2014-2017	N
market for hydrogen, gaseous	GLO	2014-2017	N
market for kerosene	Europe without Switzerland	1989-2000	U
market for kerosene	GLO	2011-2011	U
market for kerosene	BR; CO; IN; PE; ZA	2014-2017	N
market for light fuel oil	Europe without Switzerland	1989-2000	U
market for light fuel oil	GLO	2011-2011	U
market for light fuel oil	BR; CO; IN; PE; ZA	2014-2017	N
market for liquefied petroleum gas	GLO	1980-2010	U
market for liquefied petroleum gas	BR; Europe without Switzerland; IN; PE; ZA	2014-2017	N
market for naphtha	GLO	2011-2011	U
market for naphtha	BR; CO; IN; PE; ZA	2014-2017	N
market for petrol, two-stroke blend	GLO	2011-2011	U
market for petrol, unleaded	GLO	2011-2011	U
market for petrol, unleaded	BR; CO; IN; PE	2014-2017	N
market for petrol, unleaded	ZA	2016-2016	N
market for petroleum slack wax	GLO	2014-2017	N
market for pitch	BR; CO; IN; PE; ZA	2014-2017	N
market for pitch	Europe without Switzerland	2016-2016	N
market for refinery gas	GLO	2011-2011	U
market for reformate	GLO	2014-2017	N
market for white spirit	GLO	2011-2011	U
market group for liquefied petroleum gas	GLO	2014-2017	N

9.3.3 Import datasets

Whereas India and Peru are net exporters of refined petroleum products, Brazil, Colombia and South Africa are net importers (Fehrenbach *et al.*, 2017). Information on the specific geographic origin of the imports were either not available from the used statistics, or not covered by the petroleum refinery activities in the database. The import datasets to the regional markets for refined petroleum products in the respective countries are hence assumed to be supplied by petroleum refinery operation in Rest-of-the-World (RoW). The transport requirements (expressed in tkm) with tanker ship was assumed to 10'000 km by sea by default. No product losses or other aspects, besides transport requirements have been included. These import activities represent rough proxies with large uncertainties and should hence be revised accordingly if their contribution is expected to be important. (Fehrenbach *et al.*, 2017).

Table 59. New and updated import activities related to petroleum refining. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", and "N" stands for "New activity".*

Activity name	Geography	Time period	v3.6
diesel, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
diesel, low-sulfur, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
heavy fuel oil, import from unspecified	BR; CO; IN; ZA	2014-2017	N
kerosene, import from Europe	CH	2010-2010	U
kerosene, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
light fuel oil, import from Europe	CH	2010-2010	U
light fuel oil, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
liquefied petroleum gas, import from Europe	CH	2010-2010	U
liquefied petroleum gas, import from unspecified	BR; Europe without Switzerland; IN; PE; ZA	2014-2017	N
naphtha, import from unspecified	IN	2014-2017	N
petrol, unleaded, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
diesel, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
diesel, low-sulfur, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
heavy fuel oil, import from unspecified	BR; CO; IN; ZA	2014-2017	N
kerosene, import from Europe	CH	2010-2010	U
kerosene, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
light fuel oil, import from Europe	CH	2010-2010	U
light fuel oil, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N
liquefied petroleum gas, import from Europe	CH	2010-2010	U
liquefied petroleum gas, import from unspecified	BR; Europe without Switzerland; IN; PE; ZA	2014-2017	N
naphtha, import from unspecified	IN	2014-2017	N
petrol, unleaded, import from unspecified	BR; CO; IN; PE; ZA	2014-2017	N

9.4 Synthetic fuel production

With ecoinvent v3.6, an important alternative production route for several refined petroleum products in South Africa (ZA) was added. South Africa is a country with abundant coal and renewable energy resources, but very little crude oil. About one third of the liquid fuels consumed in country are made synthetically from coal and natural gas.

For ecoinvent v3.6, the Environmental and Process System Engineering (E&PSE) research group at the University of Cape Town modelled the production of synthetic fuels at the Secunda Synfuel Operations plant (see Table 60). This plant is owned by Sasol, the biggest synfuels producer in South Africa, which produces synthetic fuels through the gasification of coal followed by a proprietary Fischer-Tropsch process. Sasol Synfuels are mainly coal-based, but they also use some natural gas to produce gasoline, diesel, other fuels (LPG, fuel oils and a methane-rich gas) and a range of industrial chemicals. This dataset was developed from information available in the public domain and from expert estimates. For more details please download the report "Life Cycle Inventories of Synthetic Fuel Production from Coal and Domestic Fuel Markets - South Africa" by Russo and Bolttnitz (2018) from the SRI section of the ecoinvent webpage.

Table 60. New activities related to the production of synthetic fuels. *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
synthetic fuel production, from coal, high temperature Fisher-Tropsch operations	GLO; ZA	2016-2017
market for propylene	ZA	2018-2018

10 Textiles

The whole sector of textiles has been largely remodelled to gain on coverage (at the level of materials), accuracy and regional data. Regional data was generated from primary data collection in India and Bangladesh, in the framework of the SRI-LCI project (Faist Emmenegger *et al.*, 2018), while global data to represent the cotton supply chains was obtained from Cotton Inc. The global activities in the cotton supply chain reflect then an average of United States of America, India and China data, constituting data representative at a global level., in addition to granular national data.

New products and services were introduced in the sector, to increase the coverage, they are listed in Table 61. Services are provided per kg of the fibre, yarn or textile that needs to be processed. New and updated activities are represented in Table 63.

Table 61. New products and services in the textile sector. *Services are marked with "*", and they have to be used with an input of some textile (fibre, yarn or textile) depending on the service provided.*

Product	Unit
batch dyeing, fibre, cotton*	kg
bleaching and dyeing, yarn*	kg
bleaching, textile*	kg
cocoons	kg
continuous dyeing, fibre, cotton*	kg
cottonseed, organic	kg
cottonseed, organic, for sowing	kg
fibre, cotton, organic	kg
fibre, flax	kg
fibre, polyester	kg
fibre, silk, short	kg
finishing, textile, knit cotton*	kg
finishing, textile, woven cotton*	kg
flax husks	kg
flax plant, harvested	kg
jute plant, harvested	kg
kenaf plant, harvested	kg
mercerizing, textile*	kg
mulberry leaves	kg
reeled raw silk hank	kg
sanforizing, textile	kg
seed-cotton	kg
seed-cotton, organic	kg
sunn hemp plant, harvested	kg

Product	Unit
textile, non-woven polyester	kg
textile, non-woven polypropylene	kg
textile, silk	kg
waste yarn and waste textile	kg
yarn, cotton	kg
yarn, silk	kg

Table 62. Supply chain of the major components of the textile sector, categorised in materials for the different production levels of each origin.

Origin	Material	Material extraction	Fibre production	Yarn production	Textile production
Plant	Cotton	seed-cotton production, conventional	fibre production, cotton, ginning	yarn production, cotton, open end spinning yarn production, cotton, ring spinning yarn production, cotton, ring spinning, for knitting yarn production, cotton, ring spinning, for weaving	textile production, cotton, air jet loom weaving textile production, cotton, circular knitting textile production, cotton, weaving
	Organic cotton	seed-cotton production, organic	fibre production, cotton, organic, ginning	-	-
	Flax	flax production	fibre production, flax, retting	-	-
	Jute	jute production, irrigated jute production, rainfed	fibre production, jute, retting	yarn production, jute	textile production, jute, weaving
	Kenaf	kenaf production, irrigated	fibre production, kenaf, retting	yarn production, kenaf	textile production, kenaf, weaving
Protein	Silk	cocoon production, silkworm rearing	reeled raw silk hank production	yarn production, silk, long fibre yarn production, silk, short fibre	textile production, silk
Synthetic	Polypropylene	polypropylene production, granulate	-	-	textile production, non woven polypropylene, spun bond
	Polyester	polyethylene terephthalate production, granulate, amorphous	polyester fibre^{n} production, finished	-	textile production, non woven polyester, needle punched
	Viscose	market for sodium hydroxide, and market for sodium hypochlorite	fibre production, viscose	-	-

Table 63. Changes in the textile sector. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", "N" stands for "New activity", and "D" stands for "Deleted Activity".*

Activity name	Geography	Time period	v3.6
batch dyeing, fibre, cotton	BD	2017-2017	N
batch dyeing, fibre, cotton	GLO	2016-2016	N
batch dyeing, fibre, cotton	IN	2016-2017	N
bleaching and dyeing, yarn	BD; GLO	2017-2017	N
bleaching and dyeing, yarn	IN	2016-2017	N
bleaching, textile	BD; GLO	2017-2017	N
bleaching, textile	IN	2015-2016	N
cocoon production, silkworm rearing	IN; GLO	2015-2016	N
continuous dyeing, fibre, cotton	GLO	2016-2016	N
cottonseed oil mill operation	GLO	2012-2012	U
cottonseed oil mill operation	IN	2012-2012	N
cottonseed production, for sowing	US; GLO	1997-2006	U
cottonseed production, for sowing, organic	IN-OR; GLO	1997-2006	N
cottonseed to generic market for energy feed	BD; IN; GLO	2016-2017	N
cottonseed, organic to generic market for energy feed	IN; GLO	2016-2017	N
direct disposal of wastewater from textile production	GLO	2017-2018	N
fibre production, cotton, ginning	IN; BD	2016-2017	N
fibre production, cotton, ginning	GLO	2016-2016	N
fibre production, cotton, organic, ginning	IN; GLO	2016-2017	N
fibre production, flax, retting	IN; GLO	2016-2017	N
fibre production, jute, retting	BD; GLO	2016-2017	N
fibre production, jute, retting	IN	2016-2017	U
fibre production, kenaf, retting	IN; GLO	2016-2017	U
finishing, textile, knit cotton	GLO	2016-2016	N
finishing, textile, woven cotton	GLO	2016-2016	N
flax production	IN; GLO	2016-2017	N
jute production, irrigated	IN; GLO	2015-2016	U
jute production, rainfed	BD	2016-2017	N
jute production, rainfed	GLO	2016-2017	U
kenaf production, irrigated	IN; GLO	2016-2017	N
market for batch dyeing, fibre, cotton	GLO	2017-2017	N
market for bleaching and dyeing, yarn	GLO	2017-2017	N
market for bleaching, textile	GLO	2017-2017	N
market for cocoons	IN; GLO	2015-2016	N

Activity name	Geography	Time period	v3.6
market for continuous dyeing, fibre, cotton	GLO	2017-2017	N
market for cottonseed	IN; BD	2015-2018	N
market for cottonseed	GLO	2015-2018	U
market for cottonseed oil, crude	GLO	2015-2018	U
market for cottonseed oil, refined	GLO	2015-2018	U
market for cottonseed, for sowing	GLO	2011-2011	U
market for cottonseed, organic	IN; GLO	2015-2018	N
market for cottonseed, organic, for sowing	GLO	1997-2006	N
market for fibre, cotton	GLO	2011-2011	U
market for fibre, cotton, organic	GLO	2015-2018	N
market for fibre, flax	GLO	2016-2017	N
market for fibre, polyester	GLO	2007-2022	N
market for fibre, silk, short	GLO	2010-2018	N
market for finishing, textile, knit cotton	GLO	2016-2016	N
market for finishing, textile, woven cotton	GLO	2016-2016	N
market for flax husks	GLO	2017-2017	N
market for flax plant, harvested	GLO	2016-2017	N
market for jute plant, harvested	GLO	2016-2017	N
market for kenaf plant, harvested	GLO	2016-2017	N
market for mercerizing, textile	GLO	2017-2017	N
market for mulberry leaves	GLO	2016-2017	N
market for reeled raw silk hank	GLO	2015-2016	N
market for sanforizing, textile	GLO	2016-2016	N
market for seed-cotton	GLO	2015-2016	N
market for seed-cotton, organic	GLO	2015-2018	N
market for spinning, bast fibre	GLO	2011-2011	D
market for sunn hemp plant, harvested	GLO	2016-2017	N
market for textile, jute	GLO	2011-2011	U
market for textile, kenaf	GLO	2011-2011	U
market for textile, knit cotton	GLO	2005-2009	U
market for textile, non woven polyester	GLO	2014-2015	N
market for textile, non woven polypropylene	GLO	2013-2014	N
market for textile, silk	GLO	2016-2017	N
market for textile, woven cotton	GLO	2011-2011	U
market for waste yarn and waste textile	GLO	2010-2017	N
market for weaving, bast fibre	GLO	2011-2011	D
market for yarn, cotton	GLO	2015-2016	N
market for yarn, jute	GLO	2011-2011	U

Activity name	Geography	Time period	v3.6
market for yarn, kenaf	GLO	2011-2011	U
market for yarn, silk	GLO	2015-2016	N
mercerizing, textile	IN; GLO	2016-2017	N
mulberry production	IN; GLO	2014-2017	N
reeled raw silk hank production	IN; GLO	2015-2016	N
sanforizing, textile	GLO	2016-2016	N
seed-cotton production, conventional	BD	2016-2017	N
seed-cotton production, conventional	GLO	2016-2016	N
seed-cotton production, conventional	IN-GJ	2015-2016	N
seed-cotton production, organic	IN-OR; GLO	2015-2018	N
spinning, bast fibre	IN; GLO	2000-2007	D
sunn hemp production	IN; GLO	2016-2017	N
textile production, cotton, air jet loom weaving	IN; GLO	2015-2016	N
textile production, cotton, circular knitting	BD	2017-2017	N
textile production, cotton, circular knitting	GLO	2016-2016	N
textile production, cotton, circular knitting	IN	2015-2016	N
textile production, cotton, weaving	BD	2017-2017	N
textile production, cotton, weaving	GLO	2016-2016	N
textile production, jute, weaving	BD	2017-2017	N
textile production, jute, weaving	GLO	2016-2017	N
textile production, jute, weaving	IN	2016-2017	U
textile production, kenaf, weaving	IN; GLO	2016-2017	U
textile production, knit cotton, batch dyed	GLO	2005-2009	D
textile production, knit cotton, yarn dyed	GLO	2005-2009	D
textile production, non woven polyester, needle punched	IN; GLO	2014-2015	N
textile production, non woven polypropylene, spun bond	IN; GLO	2013-2014	N
textile production, silk	IN; GLO	2016-2017	N
treatment of biowaste, open dump	IN; GLO	2010-2017	N
treatment of stalk, in wood heater 6kW	IN	2017-2017	N
treatment of waste yarn and waste textile, unsanitary landfill	IN; GLO	2010-2017	N
weaving of synthetic fibre, for industrial use	GLO	2018-2019	N
weaving, bast fibre	IN; GLO	2003-2007	D
yarn production, cotton, open end spinning	IN; GLO	2015-2016	N
yarn production, cotton, ring spinning	BD	2017-2017	N
yarn production, cotton, ring spinning	IN; GLO	2015-2016	N
yarn production, cotton, ring spinning, for knitting	GLO	2016-2016	N
yarn production, cotton, ring spinning, for weaving	GLO	2016-2016	N
yarn production, jute	BD	2017-2017	N

Activity name	Geography	Time period	v3.6
yarn production, jute	GLO	2017-2017	U
yarn production, jute	IN	2015-2016	U
yarn production, kenaf	IN; GLO	2014-2015	U
yarn production, silk, long fibre	IN; GLO	2015-2016	N

11 Tourism

For the first time in ecoinvent, data related to tourism is published. The data was developed in the context of the SRI-LCI project for the geographies of Brazil and Peru, and it covers construction and operation of tourist accommodation services, including needed household appliances. The project is documented in "Filimonau V., Santa Rosa M., Santana Franca L., Cánovas Creus A., Mattos Ribeiro G., Molnarova J., Geldres Piumatti R., 2018, Tourism and accommodation services. ecoinvent Association, Zürich, Switzerland".

The activities created for the construction and operation of buildings in the geographies of Brazil and Peru are listed below. Four types of accommodation are modelled: hostel, budget hotel, upmarket hotel and luxury hotel.

Table 64. New activities and products for construction and operation of tourist accommodation facilities. *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	Product name	Unit
building construction, budget hotel	BR; PE	2017-2018	building, budget hotel	unit
building construction, hostel	BR; PE	2017-2018	building, hostel	unit
building construction, luxury hotel	BR; PE	2017-2018	building, luxury hotel	unit
building construction, upmarket hotel	PE	2017-2018	building, upmarket hotel	unit
building operation, budget hotel	BR; PE	2017-2018	building operation, budget hotel	guest night
building operation, hostel	BR; PE	2017-2018	building operation, hostel	guest night
building operation, luxury hotel	BR; PE	2017-2018	building operation, luxury hotel	guest night
building operation, upmarket hotel	PE	2017-2018	building operation, upmarket hotel	guest night
market for building, budget hotel	GLO	2017-2018	building, budget hotel	unit
market for building, hostel	GLO	2017-2018	building, hostel	unit
market for building, luxury hotel	GLO	2017-2018	building, luxury hotel	unit
market for building, upmarket hotel	GLO	2017-2018	building, upmarket hotel	unit
market for building operation, budget hotel	GLO	2017-2018	building operation, budget hotel	guest night
market for building operation, hostel	GLO	2017-2018	building operation, hostel	guest night
market for building operation, luxury hotel	GLO	2017-2018	building operation, luxury hotel	guest night
market for building operation, upmarket hotel	GLO	2017-2018	building operation, upmarket hotel	guest night

In addition to the buildings, several consumer goods and services necessary to the operation of an accommodation are published together with their respective markets.

Table 65. New consumer goods and services for the operation of tourist accommodation facilities. *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	Product name	Unit
cleaning consumables, without water, in 13.6% solution state	GLO	2011-2013	cleaning consumables, without water, in 13.6% solution state	kg
coffee maker production	GLO	2009-2018	coffee maker	unit
compact fluorescent lamp	GLO	2012-2018	compact fluorescent bulb	unit
cookstove production, gas or electric	GLO	1997-2018	cookstove	unit
dishwasher production	GLO	2007-2018	dishwasher	unit
dryer production	GLO	2007-2018	dryer	unit
electric kettle production	GLO	2014-2017	electric kettle	unit
elevator production, hydraulic	GLO	2010-2018	elevator, hydraulic	unit
furniture production, wooden	GLO	2011-2017	furniture, wooden	kg
hair dryer production	GLO	2009-2018	hair dryer	unit
mattress production, pocket spring	GLO	2012-2017	mattress	unit
mattress production, polyurethane foam	GLO	2012-2017	mattress	unit
microwave oven production	GLO	2018-2018	microwave oven	unit
refrigerator production	GLO	2015-2017	refrigerator	unit
television production	GLO	2008-2017	television	unit
vacuum cleaner production	GLO	2016-2018	vacuum cleaner	unit
washing machine production	GLO	2004-2018	washing machine	unit
washing, drying and finishing laundry	GLO	2013-2018	washing, drying and finishing laundry	kg
market for cleaning consumables, without water, in 13.6% solution state	GLO	2011-2013	cleaning consumables, without water, in 13.6% solution state	kg
market for coffee maker	GLO	2018-2018	coffee maker	unit
market for compact fluorescent lamp	GLO	2018-2018	compact fluorescent bulb	unit
market for cookstove	GLO	2018-2018	cookstove	unit
market for dishwasher	GLO	2018-2018	dishwasher	unit
market for dryer	GLO	2018-2018	dryer	unit
market for electric kettle	GLO	2018-2018	electric kettle	unit
market for elevator, hydraulic	GLO	2018-2018	elevator, hydraulic	unit
market for furniture	GLO	2017-2017	furniture, wooden	kg
market for hair dryer	GLO	2018-2018	hair dryer	unit
market for mattress	GLO	2017-2017	mattress	unit
market for microwave oven production	GLO	2018-2018	microwave oven	unit
market for refrigerator	GLO	2018-2018	refrigerator	unit
market for television	GLO	2018-2018	television	unit
market for vacuum cleaner	GLO	2018-2018	vacuum cleaner	unit
market for washing machine	GLO	2018-2018	washing machine	unit
market for washing, drying and finishing laundry	GLO	2013-2018	washing, drying and finishing laundry	kg

12 Transport

In the context of the SRI-LCI project new transport data was created both at global and at national level for selected geographies (South Africa and India). The details about data collection and inventory generation can be found in Notten *et al.*, 2018 a, b, c and d. In this section of the change report, a summary of the new data and its impact on the ecoinvent database is presented.

12.1 Freight and passenger air transport

New data for both freight and passenger air transport as well as the necessary infrastructure are published in version 3.6. The main changes introduced are the split of the freight technology/mode into belly- and dedicated freight. For each technology, four different flight distances are available: very short (<800km), short (800-1500km), medium (1500-4000km), and long (>4000km). The transport service activities replace version 3.5 intracontinental (500km) and intercontinental (6000km) flights (i.e. "transport, passenger, aircraft, intracontinental", " transport, freight, aircraft, intracontinental", " transport, passenger, aircraft, intercontinental" and " transport, freight, aircraft, intercontinental"). In version 3.6, the data for air transport is available only at global level. The data listed below therefore substitutes both the GLO and RER activities available up until version 3.5.

In version 3.5, freight and passenger intra- and inter- continental transport services produced the same reference product, "transport, freight, aircraft" and "transport, passenger, aircraft", respectively. Similarly, in version 3.6, the different hauling distances (with distance-specific reference products) are grouped into generic markets "market for transport, freight, aircraft, unspecified" and "market for transport, passenger, aircraft, unspecified". The grouping is done using renaming activities ("transport, freight, aircraft, all distances to generic market for transport, freight, aircraft, unspecified" and "transport, passenger, aircraft, all distances to generic market for transport, passenger, aircraft, unspecified") based on production volumes.

Table 66. New activities and products for air transport. *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	Product name	Unit
transport, freight, aircraft, all distances to generic market for transport, freight, aircraft, unspecified	GLO	2016-2016	transport, freight, aircraft, unspecified	metric ton*km
transport, freight, aircraft, belly-freight, long haul	GLO	2016-2016	transport, freight, aircraft, long haul	metric ton*km
transport, freight, aircraft, belly-freight, medium haul	GLO	2016-2016	transport, freight, aircraft, medium haul	metric ton*km
transport, freight, aircraft, belly-freight, short haul	GLO	2016-2016	transport, freight, aircraft, short haul	metric ton*km
transport, freight, aircraft, belly-freight, very short haul	GLO	2016-2016	transport, freight, aircraft, very short haul	metric ton*km
transport, freight, aircraft, dedicated freight, long haul	GLO	2016-2016	transport, freight, aircraft, long haul	metric ton*km
transport, freight, aircraft, dedicated freight, medium haul	GLO	2016-2016	transport, freight, aircraft, medium haul	metric ton*km
transport, freight, aircraft, dedicated freight, short haul	GLO	2016-2016	transport, freight, aircraft, short haul	metric ton*km
transport, freight, aircraft, dedicated freight, very short haul	GLO	2016-2016	transport, freight, aircraft, very short haul	metric ton*km
transport, passenger, aircraft, all distances to generic market for transport, passenger, unspecified	GLO	2016-2016	transport, passenger, aircraft, unspecified	person*km
transport, passengers, passenger aircraft, long haul	GLO	2016-2016	transport, passengers, aircraft, long haul	person*km
transport, passengers, passenger aircraft, medium haul	GLO	2016-2016	transport, passengers, aircraft, medium haul	person*km
transport, passengers, passenger aircraft, short haul	GLO	2016-2016	transport, passengers, aircraft, short haul	person*km
transport, passengers, passenger aircraft, very short haul	GLO	2016-2016	transport, passengers, aircraft, very short haul	person*km
aircraft production, belly-freight aircraft, long haul	GLO	2016-2016	aircraft, belly freight, long haul	unit
aircraft production, belly-freight aircraft, medium haul	GLO	2016-2016	aircraft, belly freight, medium haul	unit
aircraft production, belly-freight aircraft, short haul	GLO	2016-2016	aircraft, belly freight, short haul	unit
aircraft production, belly-freight aircraft, very short haul	GLO	2016-2016	aircraft, belly freight, very short haul	unit
aircraft production, dedicated freight aircraft, long haul	GLO	2016-2016	aircraft, dedicated freight, long haul	unit
aircraft production, dedicated freight aircraft, medium haul	GLO	2016-2016	aircraft, dedicated freight, medium haul	unit
aircraft production, dedicated freight aircraft, short haul	GLO	2016-2016	aircraft, dedicated freight, short haul	unit
aircraft production, dedicated freight aircraft, very short haul	GLO	2016-2016	aircraft, dedicated freight, very short haul	unit
aircraft production, passenger aircraft, long haul	GLO	2016-2016	aircraft, passenger, long haul	unit
aircraft production, passenger aircraft, medium haul	GLO	2016-2016	aircraft, passenger, medium haul	unit
aircraft production, passenger aircraft, short haul	GLO	2016-2016	aircraft, passenger, short haul	unit
aircraft production, passenger aircraft, very short haul	GLO	2016-2016	aircraft, passenger, very short haul	unit
market for transport, freight, aircraft, long haul	GLO	2016-2016	transport, freight, aircraft, long haul	metric ton*km
market for transport, freight, aircraft, medium haul	GLO	2016-2016	transport, freight, aircraft, medium haul	metric ton*km
market for transport, freight, aircraft, short haul	GLO	2016-2016	transport, freight, aircraft, short haul	metric ton*km

Activity name	Geography	Time period	Product name	Unit
market for transport, freight, aircraft, very short haul	GLO	2016-2016	transport, freight, aircraft, very short haul	metric ton*km
market for transport, passengers, aircraft, long haul	GLO	2016-2016	transport, passengers, aircraft, long haul	person*km
market for transport, passengers, aircraft, medium haul	GLO	2016-2016	transport, passengers, aircraft, medium haul	person*km
market for transport, passengers, aircraft, short haul	GLO	2016-2016	transport, passengers, aircraft, short haul	person*km
market for transport, passengers, aircraft, very short haul	GLO	2016-2016	transport, passengers, aircraft, very short haul	person*km
market for aircraft, belly freight, long haul	GLO	2016-2016	aircraft, belly freight, long haul	unit
market for aircraft, belly freight, medium haul	GLO	2016-2016	aircraft, belly freight, medium haul	unit
market for aircraft, belly freight, short haul	GLO	2016-2016	aircraft, belly freight, short haul	unit
market for aircraft, belly freight, very short haul	GLO	2016-2016	aircraft, belly freight, very short haul	unit
market for aircraft, dedicated freight, long haul	GLO	2016-2016	aircraft, dedicated freight, long haul	unit
market for aircraft, dedicated freight, medium haul	GLO	2016-2016	aircraft, dedicated freight, medium haul	unit
market for aircraft, dedicated freight, short haul	GLO	2016-2016	aircraft, dedicated freight, short haul	unit
market for aircraft, dedicated freight, very short haul	GLO	2016-2016	aircraft, dedicated freight, very short haul	unit
market for aircraft, passenger, long haul	GLO	2016-2016	aircraft, passenger, long haul	unit
market for aircraft, passenger, medium haul	GLO	2016-2016	aircraft, passenger, medium haul	unit
market for aircraft, passenger, short haul	GLO	2016-2016	aircraft, passenger, short haul	unit
market for aircraft, passenger, very short haul	GLO	2016-2016	aircraft, passenger, very short haul	unit
carbon fibre reinforced plastic, injection moulded	GLO	2016-2016	carbon fibre reinforced plastic, injection moulded	kg
market for carbon fibre reinforced plastic, injection moulded	GLO	2016-2016	carbon fibre reinforced plastic, injection moulded	kg

12.2 Freight rail transport

New activities for freight rail transport (diesel and electric) are introduced for India and South Africa. Regional market activities are created for both countries.

Table 67. New activities and products for freight rail transport. *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	Product name	Unit
transport, freight train, diesel	IN; ZA	2016-2017	transport, freight train	metric ton*km
transport, freight train, electricity	IN; ZA	2016-2017	transport, freight train	metric ton*km
market for transport, freight train	IN; ZA	2016-2018	transport, freight train	metric ton*km

12.3 Freight road transport

New activities for freight road transport are introduced for South Africa. The data covers the same lorry sizes (3.5-7.5t, 7.5-16t, 16-32t, >32t) already included in the ecoinvent database for other geographies (RER/GLO) but introduces new emission classes. The emissions of the South African fleet were compared to the European emissions standards and matched to the before EURO1 (unregulated), EURO1 and EURO2 classes. This distinction is also applied to the light commercial vehicle transport service.

As for Europe and global (Rest of the World), the different activities are first grouped by EURO class based on production volumes. They are then all combined into the regional "market for transport, freight, lorry, unspecified". This market contributes together with the European and Rest of the World markets to the global " market group for transport, freight, lorry, unspecified".

Table 68. New activities and products for freight road transport. *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	Product name	Unit
transport, freight, light commercial vehicle, EURO1	GLO; ZA	2017-2017	transport, freight, light commercial vehicle, EURO1	metric ton*km
transport, freight, light commercial vehicle, EURO2	GLO; ZA	2017-2017	transport, freight, light commercial vehicle, EURO2	metric ton*km
transport, freight, light commercial vehicle, all, to generic market for transport, freight, light commercial vehicle	GLO; ZA	2019-2019	transport, freight, light commercial vehicle	metric ton*km
transport, freight, light commercial vehicle, unregulated	GLO; ZA	2017-2017	transport, freight, light commercial vehicle, unregulated	metric ton*km
transport, freight, lorry 16-32 metric ton, EURO1	GLO; ZA	2017-2017	transport, freight, lorry 16-32 metric ton, EURO1	metric ton*km
transport, freight, lorry 16-32 metric ton, EURO2	GLO; ZA	2017-2017	transport, freight, lorry 16-32 metric ton, EURO2	metric ton*km
transport, freight, lorry 16-32 metric ton, unregulated	GLO; ZA	2017-2017	transport, freight, lorry 16-32 metric ton, unregulated	metric ton*km
transport, freight, lorry 3.5-7.5 metric ton, EURO1	GLO; ZA	2017-2017	transport, freight, lorry 3.5-7.5 metric ton, EURO1	metric ton*km
transport, freight, lorry 3.5-7.5 metric ton, EURO2	GLO; ZA	2017-2017	transport, freight, lorry 3.5-7.5 metric ton, EURO2	metric ton*km
transport, freight, lorry 3.5-7.5 metric ton, unregulated	GLO; ZA	2017-2017	transport, freight, lorry 3.5-7.5 metric ton, unregulated	metric ton*km
transport, freight, lorry 7.5-16 metric ton, EURO1	GLO; ZA	2017-2017	transport, freight, lorry 7.5-16 metric ton, EURO1	metric ton*km
transport, freight, lorry 7.5-16 metric ton, EURO2	GLO; ZA	2017-2017	transport, freight, lorry 7.5-16 metric ton, EURO2	metric ton*km
transport, freight, lorry 7.5-16 metric ton, unregulated	GLO; ZA	2017-2017	transport, freight, lorry 7.5-16 metric ton, unregulated	metric ton*km
transport, freight, lorry >32 metric ton, EURO1	GLO; ZA	2017-2017	transport, freight, lorry >32 metric ton, EURO1	metric ton*km
transport, freight, lorry >32 metric ton, EURO2	GLO; ZA	2017-2017	transport, freight, lorry >32 metric ton, EURO2	metric ton*km
transport, freight, lorry >32 metric ton, unregulated	GLO; ZA	2017-2017	transport, freight, lorry >32 metric ton, unregulated	metric ton*km
transport, freight, lorry, all sizes, EURO1 to generic market for transport, freight, lorry, unspecified	GLO; ZA	2019-2019	transport, freight, lorry, unspecified	metric ton*km
transport, freight, lorry, all sizes, EURO2 to generic market for transport, freight, lorry, unspecified	GLO; ZA	2019-2019	transport, freight, lorry, unspecified	metric ton*km

Activity name	Geography	Time period	Product name	Unit
transport, freight, lorry, all sizes, unregulated to generic market for transport, freight, lorry, unspecified	GLO; ZA	2019-2019	transport, freight, lorry, unspecified	metric ton*km
market for transport, freight, light commercial vehicle	ZA	2019-2019	transport, freight, light commercial vehicle	metric ton*km
market for transport, freight, light commercial vehicle, EURO1	GLO	2017-2017	transport, freight, light commercial vehicle, EURO1	metric ton*km
market for transport, freight, light commercial vehicle, EURO1	ZA	2019-2019	transport, freight, light commercial vehicle, EURO1	metric ton*km
market for transport, freight, light commercial vehicle, EURO2	GLO	2017-2017	transport, freight, light commercial vehicle, EURO2	metric ton*km
market for transport, freight, light commercial vehicle, EURO2	ZA	2019-2019	transport, freight, light commercial vehicle, EURO2	metric ton*km
market for transport, freight, light commercial vehicle, unregulated	GLO	2017-2017	transport, freight, light commercial vehicle, unregulated	metric ton*km
market for transport, freight, light commercial vehicle, unregulated	ZA	2019-2019	transport, freight, light commercial vehicle, unregulated	metric ton*km
market for transport, freight, lorry 16-32 metric ton, EURO1	GLO	2017-2017	transport, freight, lorry 16-32 metric ton, EURO1	metric ton*km
market for transport, freight, lorry 16-32 metric ton, EURO1	ZA	2019-2019	transport, freight, lorry 16-32 metric ton, EURO1	metric ton*km
market for transport, freight, lorry 16-32 metric ton, EURO2	GLO	2017-2017	transport, freight, lorry 16-32 metric ton, EURO2	metric ton*km
market for transport, freight, lorry 16-32 metric ton, EURO2	ZA	2019-2019	transport, freight, lorry 16-32 metric ton, EURO2	metric ton*km
market for transport, freight, lorry 16-32 metric ton, unregulated	GLO	2017-2017	transport, freight, lorry 16-32 metric ton, unregulated	metric ton*km
market for transport, freight, lorry 16-32 metric ton, unregulated	ZA	2019-2019	transport, freight, lorry 16-32 metric ton, unregulated	metric ton*km
market for transport, freight, lorry 3.5-7.5 metric ton, EURO1	GLO	2017-2017	transport, freight, lorry 3.5-7.5 metric ton, EURO1	metric ton*km
market for transport, freight, lorry 3.5-7.5 metric ton, EURO1	ZA	2019-2019	transport, freight, lorry 3.5-7.5 metric ton, EURO1	metric ton*km
market for transport, freight, lorry 3.5-7.5 metric ton, EURO2	GLO	2017-2017	transport, freight, lorry 3.5-7.5 metric ton, EURO2	metric ton*km
market for transport, freight, lorry 3.5-7.5 metric ton, EURO2	ZA	2019-2019	transport, freight, lorry 3.5-7.5 metric ton, EURO2	metric ton*km
market for transport, freight, lorry 3.5-7.5 metric ton, unregulated	GLO	2017-2017	transport, freight, lorry 3.5-7.5 metric ton, unregulated	metric ton*km
market for transport, freight, lorry 3.5-7.5 metric ton, unregulated	ZA	2019-2019	transport, freight, lorry 3.5-7.5 metric ton, unregulated	metric ton*km
market for transport, freight, lorry 7.5-16 metric ton, EURO1	GLO	2017-2017	transport, freight, lorry 7.5-16 metric ton, EURO1	metric ton*km
market for transport, freight, lorry 7.5-16 metric ton, EURO1	ZA	2019-2019	transport, freight, lorry 7.5-16 metric ton, EURO1	metric ton*km
market for transport, freight, lorry 7.5-16 metric ton, EURO2	GLO	2017-2017	transport, freight, lorry 7.5-16 metric ton, EURO2	metric ton*km
market for transport, freight, lorry 7.5-16 metric ton, EURO2	ZA	2019-2019	transport, freight, lorry 7.5-16 metric ton, EURO2	metric ton*km
market for transport, freight, lorry 7.5-16 metric ton, unregulated	GLO	2017-2017	transport, freight, lorry 7.5-16 metric ton, unregulated	metric ton*km
market for transport, freight, lorry 7.5-16 metric ton, unregulated	ZA	2019-2019	transport, freight, lorry 7.5-16 metric ton, unregulated	metric ton*km
market for transport, freight, lorry >32 metric ton, EURO1	GLO	2017-2017	transport, freight, lorry >32 metric ton, EURO1	metric ton*km
market for transport, freight, lorry >32 metric ton, EURO1	ZA	2019-2019	transport, freight, lorry >32 metric ton, EURO1	metric ton*km
market for transport, freight, lorry >32 metric ton, EURO2	GLO	2017-2017	transport, freight, lorry >32 metric ton, EURO2	metric ton*km
market for transport, freight, lorry >32 metric ton, EURO2	ZA	2019-2019	transport, freight, lorry >32 metric ton, EURO2	metric ton*km

Activity name	Geography	Time period	Product name	Unit
market for transport, freight, lorry >32 metric ton, unregulated	GLO	2017-2017	transport, freight, lorry >32 metric ton, unregulated	metric ton*km
market for transport, freight, lorry >32 metric ton, unregulated	ZA	2019-2019	transport, freight, lorry >32 metric ton, unregulated	metric ton*km
market for transport, freight, lorry, unspecified	ZA	2019-2019	transport, freight, lorry, unspecified	metric ton*km

12.3.1 Road maintenance

The exchange "road maintenance" has been reintroduced in all road transport datasets, freight and passenger. The service of road maintenance includes salt and gravel for de-icing, marking of lines, weed control, electricity used for lighting of highways and tunnels, and the transport of personnel to the site. These services relate to unit vehicle-kilometre (vkm), i.e. they are not dependant on the gross vehicle weight. The amount of the exchanges is therefore calculated based on vkm and then divided by the average load factor to related it to the transport service reference unit of tonne*kilometre (tkm). In the table below the new datasets created for maintenance are presented. Additionally, all datasets where road maintenance was added are listed as updated ("U").

Table 69. List of all new activities created for road maintenance and all updated activities with the addition of road maintenance. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", and "N" stands for "New activity".*

Activity name	Geography	Time period	v3.6
road maintenance	Europe without Switzerland	1990-2000	N
market for road maintenance	RER	1990-2000	N
transport, freight, light commercial vehicle	CH; Europe without Switzerland; GLO	2005-2005	U
transport, freight, lorry 16-32 metric ton, EURO3	GLO; RER	2009-2013	U
transport, freight, lorry 16-32 metric ton, EURO4	GLO; RER	2009-2013	U
transport, freight, lorry 16-32 metric ton, EURO5	GLO; RER	2009-2013	U
transport, freight, lorry 16-32 metric ton, EURO6	GLO; RER	2009-2013	U
transport, freight, lorry 28 metric ton, vegetable oil methyl ester 100%	CH; GLO	2000-2004	U
transport, freight, lorry 3.5-7.5 metric ton, EURO3	GLO; RER	2009-2013	U
transport, freight, lorry 3.5-7.5 metric ton, EURO4	GLO; RER	2009-2013	U
transport, freight, lorry 3.5-7.5 metric ton, EURO5	GLO; RER	2009-2013	U
transport, freight, lorry 3.5-7.5 metric ton, EURO6	GLO; RER	2009-2013	U
transport, freight, lorry 7.5-16 metric ton, EURO3	GLO; RER	2009-2013	U
transport, freight, lorry 7.5-16 metric ton, EURO4	GLO; RER	2009-2013	U
transport, freight, lorry 7.5-16 metric ton, EURO5	GLO; RER	2009-2013	U
transport, freight, lorry 7.5-16 metric ton, EURO6	GLO; RER	2009-2013	U
transport, freight, lorry >32 metric ton, EURO3	GLO; RER	2009-2013	U
transport, freight, lorry >32 metric ton, EURO4	GLO; RER	2009-2013	U
transport, freight, lorry >32 metric ton, EURO5	GLO; RER	2009-2013	U

Activity name	Geography	Time period	v3.6
transport, freight, lorry >32 metric ton, EURO6	GLO; RER	2009-2013	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, cooling	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, freezing	GLO	2010-2014	U
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, cooling	GLO	2010-2014	U

Activity name	Geography	Time period	v3.6
transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, freezing	GLO	2010-2014	U
transport, passenger car, large size, diesel, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, large size, diesel, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, large size, diesel, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, large size, natural gas, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, large size, natural gas, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, large size, natural gas, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, large size, petrol, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, large size, petrol, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, large size, petrol, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, medium size, diesel, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, medium size, diesel, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, medium size, diesel, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, medium size, liquefied petroleum gas (LPG), EURO 5	GLO	2012-2012	U
transport, passenger car, medium size, natural gas, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, medium size, natural gas, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, medium size, natural gas, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, medium size, petrol, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, medium size, petrol, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, medium size, petrol, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, small size, diesel, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, small size, diesel, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, small size, diesel, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, small size, natural gas, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, small size, natural gas, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, small size, natural gas, EURO 5	GLO; RER	2012-2012	U
transport, passenger car, small size, petrol, EURO 3	GLO; RER	2012-2012	U
transport, passenger car, small size, petrol, EURO 4	GLO; RER	2012-2012	U
transport, passenger car, small size, petrol, EURO 5	GLO; RER	2012-2012	U
transport, passenger coach	CH; GLO	2005-2005	U
transport, passenger, motor scooter	GLO	2005-2009	U
transport, passenger, motor scooter	CH	2005-2009	U
transport, regular bus	CH; GLO	2005-2005	U
transport, trolleybus	CH; GLO	2000-2000	U

12.3.2 Other changes

The datasets listed below have been introduced to improve the European supply chain of lorry 16 metric ton.

Table 70. List of all new activities created for lorry maintenance. *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	v3.6
maintenance, lorry 16 metric ton	Europe without Switzerland	1990-1995	N
market for maintenance, lorry 16 metric ton	RER	2011-2011	N

12.4 Freight sea transport

As for air transport, new technologies are available for sea transport. In version 3.5, two activities for transport by tanker were available: one for transport of liquefied natural gas (LNG; "transport, freight, sea, liquefied natural gas") and a generic tanker ("transport, freight, sea, transoceanic tanker"). In version 3.6, the transport of LNG is updated, a new activity for the transport of petroleum is added and the generic tanker is updated accordingly. Similarly, the transport of dry goods is split from a single technology, " transport, freight, sea, transoceanic ship", into bulk carrier and container ship. Lastly, for version 3.6, a new activity for freight transport by ferry is available. The new data is available for both the transport service and the necessary infrastructure.

Table 71. New activities and products for freight sea transport. *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	Product name	Unit
transport, freight, sea, bulk carrier for dry goods	GLO	2007-2012	transport, freight, sea, bulk carrier for dry goods	metric ton*km
transport, freight, sea, container ship	GLO	2007-2012	transport, freight, sea, container ship	metric ton*km
transport, freight, sea, ferry	GLO	2007-2012	transport, freight, sea, ferry	metric ton*km
transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	GLO	2007-2012	transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	metric ton*km
transport, freight, sea, tanker for petroleum	GLO	2007-2012	transport, freight, sea, tanker for petroleum	metric ton*km
bulk carrier production, for dry goods	GLO	2007-2012	bulk carrier, for dry goods	unit
container ship production	GLO	2007-2012	container ship	unit
ferry production	GLO	2007-2012	ferry	unit
tanker production, for liquefied natural gas	GLO	2007-2012	tanker, for liquefied natural gas	unit
tanker production, for liquid goods other than petroleum and liquefied natural gas	GLO	2007-2012	tanker, for liquid goods other than petroleum and liquefied natural gas	unit
tanker production, for petroleum	GLO	2007-2012	tanker, for petroleum	unit
maintenance, bulk carrier, for dry goods	GLO	2007-2012	maintenance, bulk carrier, for dry goods	unit

Activity name	Geography	Time period	Product name	Unit
maintenance, container ship	GLO	2007-2012	maintenance, container ship	unit
maintenance, ferry	GLO	2007-2012	maintenance, ferry	unit
maintenance, tanker, for liquefied natural gas	GLO	2007-2012	maintenance, tanker, for liquefied natural gas	unit
maintenance, tanker, for liquid goods other than petroleum and liquefied natural gas	GLO	2007-2012	maintenance, tanker for liquid goods other than petroleum and liquefied natural gas	unit
maintenance, tanker, for petroleum	GLO	2007-2012	maintenance, tanker, for petroleum	unit
market for transport, freight, sea, bulk carrier for dry goods	GLO	2007-2012	transport, freight, sea, bulk carrier for dry goods	metric ton*km
market for transport, freight, sea, container ship	GLO	2007-2012	transport, freight, sea, container ship	metric ton*km
market for transport, freight, sea, ferry	GLO	2007-2012	transport, freight, sea, ferry	metric ton*km
market for transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	GLO	2007-2012	transport, freight, sea, tanker for liquid goods other than petroleum and liquefied natural gas	metric ton*km
market for transport, freight, sea, tanker for petroleum	GLO	2007-2012	transport, freight, sea, tanker for petroleum	metric ton*km
market for bulk carrier, for dry goods	GLO	2007-2012	bulk carrier, for dry goods	unit
market for container ship	GLO	2007-2012	container ship	unit
market for ferry	GLO	2007-2012	ferry	unit
market for tanker, for liquefied natural gas	GLO	2007-2012	tanker, for liquefied natural gas	unit
market for tanker, for liquid goods other than petroleum and liquefied natural gas	GLO	2007-2012	tanker, for liquid goods other than petroleum and liquefied natural gas	unit
market for tanker, for petroleum	GLO	2007-2012	tanker, for petroleum	unit
market for maintenance, bulk carrier, for dry goods	GLO	2007-2012	maintenance, bulk carrier, for dry goods	unit
market for maintenance, container ship	GLO	2007-2012	maintenance, container ship	unit
market for maintenance, ferry	GLO	2007-2012	maintenance, ferry	unit
market for maintenance, tanker for liquid goods other than petroleum and liquefied natural gas	GLO	2007-2012	maintenance, tanker for liquid goods other than petroleum and liquefied natural gas	unit
market for maintenance, tanker, for liquefied natural gas	GLO	2007-2012	maintenance, tanker, for liquefied natural gas	unit
market for maintenance, tanker, for petroleum	GLO	2007-2012	maintenance, tanker, for petroleum	unit
bronze scrap, post-consumer to generic market for bronze	GLO	2018-2018	bronze scrap, post-consumer	kg
zinc scrap, post-consumer to generic market for zinc	GLO	2018-2018	zinc scrap, post-consumer	kg
market for bronze scrap, post-consumer	GLO	2018-2018	bronze scrap, post-consumer	kg
market for zinc scrap, post-consumer	GLO	2018-2018	zinc scrap, post-consumer	kg

12.4.1 Sea transport technology split database implementation

The split of sea transport modes had to be integrated in all market activities in ecoinvent. The changes made to transport by tanker were straightforward to implement: the updated transport services for LNG and generic tanker replaced the corresponding version 3.5 activities, while the new dataset "transport, freight, sea, tanker for petroleum" was applied to the relevant markets.

The differentiation between transport by bulk carrier and container ship, on the other hand, was more complicated. According to the United Nations Conference on Trade and Development (UNCTAD, 2018) in 2017 67.7% of dry goods were shipped in bulk, 24.3% in containers and the remaining as other dry cargo. Of bulk transport, 62% of the volume is covered by coal, iron ore, and grain, i.e., products defined as "Major dry bulk commodities". The remaining is covered by products defined as "Minor bulks". Products listed as minor bulks in UNCTAD/RMT/2018 (UNCTAD, 2018) and UNCTAD/RMT/2017 (UNCTAD, 2017) are: bauxite, steel products, forest products, scrap, nickel ore, cement, petroleum coke, and sugar.

This information was matched to the ecoinvent product classification. ecoinvent classifies all products according to the UNSD Central Product Classification (CPC) and all activities according to UNSD International Standard Industrial Classification of All Economic Activities (ISIC). CPC and ISIC classifications can be too coarse, therefore, this information was integrated with product specific research based on the following freight shipping related websites CargoHandbook and Transport Information Service (TIS) from the German Insurance Association (GDV e.V.).

The matching with the ISIC classification was then used to update the ecoinvent Default Transport Assumptions, available in the Documents and files section of the ecoinvent website. This file provides default assumptions for transport modes and distances when no specific information is available.

The implementation of this change also resulted in the review and remodelling of the transport means in several markets. All affected markets are listed in Annex 3: activities with changes in transport. This annex includes:

- Markets affected by the changes already reported in the chapter (e.g. transoceanic ship replacement with bulk carrier and container ship)
- Markets corrected during the implementation of the split of sea transport (e.g. transoceanic transport replaced by transport by refrigerated container).
- Markets where transport activities were added and/or deleted.

13 Waste sector

13.1 New waste treatments for domestic composting

These datasets represent a data provision from the French Environment & Energy Management Agency (ADEME); more can be found under the report by APESA OLENTICA and BIO IS (2015). This update adds two new products to the database: “biowaste, garden waste” and “biowaste, kitchen and garden waste”.

Table 72. New activities related to domestic composting added to the v3.6. *If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column.*

Activity name	Geography	Time period
market for biowaste, garden waste	GLO	2014-2015
market for biowaste, kitchen and garden waste	GLO	2014-2015
treatment of garden biowaste, home composting in heaps	FR; GLO	2014-2015
treatment of kitchen and garden biowaste, home composting in heaps and containers	FR; GLO	2014-2015

13.2 Representing worst practices: Secondary Metals Recovery

The datasets in this section were developed in the framework of the SRI-LCI project, they are described in detail in Safaei *et al.*, 2018. The new datasets describe selected worst practices in developing countries for treating certain wastes. Similarly, the wastes produced by those activities and their waste treatments – necessary for the supply chains to function - have also been added as new data to the database.

Table 73. New activities added in v.3.6 of selected worst practices. *If several geographies of the same activity with the same time period exist, all of them are listed in the “Geography” column.*

Activity name	Geography	Time period
market for used domestic refrigerator	GLO	2018-2018
market for used refrigerant R-12	GLO	2010-2014
market for used refrigerant R-600a	GLO	2010-2014
market for waste, electrical and electronic cables	GLO	2010-2017
market for waste, pneumatic tyres	GLO	2010-2017
treatment of used domestic refrigerator, controlled dismantling	GH; GLO	2018-2018
treatment of used domestic refrigerator, uncontrolled dismantling	GH; GLO	2018-2018
treatment of used refrigerant R-12, final disposal	GLO	2010-2014
treatment of used refrigerant R-12, venting	GLO	2010-2014
treatment of used refrigerant R-600a, final disposal	GLO	2010-2014
treatment of used refrigerant R-600a, venting	GLO	2010-2014

Activity name	Geography	Time period
treatment of waste, electrical and electronic cables, open burning	GH; GLO	2010-2017
treatment of waste, pneumatic tyres, open burning	GH; GLO	2010-2017

13.3 e-waste plastic recycling

New data for formal and informal recycling of e-waste plastic is now available in version 3.6. The details can be found in Gangane and Samuel, 2018. The activities created are listed below.

Table 74. List of new activities and products for e-waste plastic recycling. *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	Product name	Unit
plastic flake production, consumer electronics, for recycling, by grinding/shredding, formal sector	GLO; IN	2017-2017	plastic flake, consumer electronics, for recycling	kg
plastic flake production, consumer electronics, for recycling, by grinding/shredding, informal sector	GLO; IN	2017-2017	plastic flake, consumer electronics, for recycling	kg
plastic granulate production, unspecified, recycled, formal sector	GLO; IN	2017-2017	plastic granulate, unspecified, recycled	kg
plastic granulate production, unspecified, recycled, informal sector	GLO; IN	2017-2017	plastic granulate, unspecified, recycled	kg
treatment of waste plastic, consumer electronics, dismantling, sorting and cleaning, formal sector	GLO; IN	2017-2017	waste plastic, consumer electronics, sorted	kg
treatment of waste plastic, consumer electronics, manual dismantling, sorting and cleaning, informal sector	GLO; IN	2017-2017	waste plastic, consumer electronics, sorted	kg
treatment of waste plastic, consumer electronics, municipal incineration with fly ash extraction	CH	2006-2012	waste plastic, consumer electronics	kg
treatment of waste plastic, consumer electronics, sanitary landfill, wet infiltration class (500mm)	GLO	2006-2012	waste plastic, consumer electronics	kg
market for plastic granulate, unspecified, recycled	GLO; IN	2017-2017	plastic granulate, unspecified, recycled	kg
market for plastic flake, consumer electronics, for recycling	GLO	2017-2017	plastic flake, consumer electronics, for recycling	kg
market for waste plastic, consumer electronics, sorted	GLO	2017-2017	waste plastic, consumer electronics, sorted	kg
market for waste plastic, consumer electronics, unsorted	GLO; IN	2017-2017	waste plastic, consumer electronics, unsorted	kg

13.4 Other updates or corrections

Energy exchanges (electricity and heat) in waste treatments was corrected in several datasets, listed in Table 75. Most of the changes concern the replacement of the exchanges of "electricity, high voltage" and "heat, district or industrial, other than natural gas" were replaced with "electricity, for reuse in municipal waste incineration only"

and “heat, for reuse in municipal waste incineration only” respectively, respecting the amounts. Additionally, the by-products of energy from waste incineration (MSW) in Canada were set to 0 in all provinces.

The rest of the changes to that sector are summarized in Table 76. Apart from some minor corrections, two new regional markets were added new, together with one treatment activity. Note that some activities and markets were also deleted from the database.

Table 75. Treatment activities updated on their energy production or consumption. *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
treatment of municipal solid waste, incineration	CA-AB; CA-NB; CA-NS; CA-ON; CA-PE; CA-QC	2006-2012
treatment of aluminium in car shredder residue, municipal incineration	CH	1994-2000
treatment of coating from waste cathode ray tube display, municipal waste incineration	CH	1994-2000
treatment of copper in car shredder residue, municipal incineration	CH	1994-2000
treatment of hard coal ash, municipal incineration	CH	1994-2000
treatment of hard coal ash, sanitary landfill	CH	1994-2000
treatment of lead in car shredder residue, municipal incineration	CH	1994-2000
treatment of lignite ash, municipal incineration	CH	1994-2000
treatment of lignite ash, sanitary landfill	CH	1994-2000
treatment of municipal solid waste, sanitary landfill	CH	1994-2000
treatment of raw sewage sludge, municipal incineration	CH	1994-2000
treatment of refinery sludge, sanitary landfill	CH	1994-2000
treatment of residue from cooling tower, sanitary landfill	CH	1994-2000
treatment of scrap aluminium, municipal incineration	CH	1994-2000
treatment of scrap copper, municipal incineration	CH	1994-2000
treatment of scrap steel, municipal incineration	CH	1994-2000
treatment of scrap tin sheet, municipal incineration	CH	1994-2000
treatment of scrap tin sheet, sanitary landfill	CH	1994-2000
treatment of sludge from pulp and paper production, sanitary landfill	CH	1994-2000
treatment of spent cation exchange resin from potable water production, municipal incineration	CH	1994-2000
treatment of steel in car shredder residue, municipal incineration	CH	1994-2000
treatment of used liquid crystal display module, municipal waste incineration	CH	1994-2000
treatment of waste aluminium, sanitary landfill	CH	1994-2000
treatment of waste asphalt, sanitary landfill	CH	1994-2000
treatment of waste bitumen, sanitary landfill	CH	1994-2000
treatment of waste emulsion paint, sanitary landfill	CH	1994-2000
treatment of waste glass, municipal incineration	CH	1994-2000
treatment of waste graphical paper, sanitary landfill	CH	1994-2000
treatment of waste gypsum, sanitary landfill	CH	1994-2000

Activity name	Geography	Time period
treatment of waste paint, sanitary landfill	CH	1994-2000
treatment of waste paperboard, sanitary landfill	CH	1994-2000
treatment of waste plastic plaster, sanitary landfill	CH	1994-2000
treatment of waste plastic, mixture, sanitary landfill	CH	1994-2000
treatment of waste polyethylene terephthalate, sanitary landfill	CH	1994-2000
treatment of waste polyethylene, sanitary landfill	CH	1994-2000
treatment of waste polypropylene, sanitary landfill	CH	1994-2000
treatment of waste polystyrene, sanitary landfill	CH	1994-2000
treatment of waste polyurethane, sanitary landfill	CH	1994-2000
treatment of waste polyvinylchloride, sanitary landfill	CH	1994-2000
treatment of waste wood, untreated, sanitary landfill	CH	1994-2000
treatment of wood ash mixture, pure, municipal incineration	CH	1994-2000
treatment of wood ash mixture, pure, sanitary landfill	CH	1994-2000
treatment of zinc in car shredder residue, municipal incineration	CH	1994-2000
treatment of wastewater from vegetable oil refinery	GLO	2000-2001

Table 76. Activities added new, updated or deleted in the rest of the waste sector. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In the column v3.6, "N" stands for "New Activity", "U" stands for "Updated Activity" and "D" stands for "Deleted Activity".*

Activity name	Geography	Time period	v3.6
market for sewage sludge, dried	GLO	2009-2013	U
market for waste paint, collection for hazardous waste incineration	GLO	2011-2011	D
market for wastewater, unpolluted, from residence	CH	2011-2011	N
treatment of biowaste, open dump	IN; GLO	2010-2017	N
treatment of nickel smelter slag, residual material landfill	CH; GLO	1994-2000	U
treatment of used cable	GLO	2005-2005	U
treatment of waste x-ray film	GLO	2011-2015	U
treatment of wastewater from vegetable oil refinery	GLO	2000-2001	N
treatment of wastewater, from residence, capacity 1.1E10l/year	CH	1994-2000	U
treatment of wastewater, unpolluted, capacity 5E9l/year	CH	1994-2000	U
treatment of wastewater, unpolluted, from residence, capacity 1.1E10l/year	CH	1994-2000	U
waste paint, collection for hazardous waste incineration	CH; GLO	1994-2002	D

14 Water supply

All activities related to water supply have been updated and remodelled for v3.6, within the SRI-LCI project. More details about the background methodology can be found in Gmünder *et al.*, 2019 (Life Cycle Inventories of Water Supply and Distribution).

14.1 Irrigation

The irrigation sector was completely updated for version 3.6. Activities that model three types of irrigation technologies in 17 geographies were introduced as replacement of the activity "irrigation" that was available in version 3.5. The irrigation technologies available in version 3.6 are surface irrigation, sprinkler irrigation and drip irrigation. A market activity was introduced for each geography that did not have a market for irrigation in version 3.5. The list of new datasets is given in Table 77. The dataset modelling is described in Gmünder *et al.*, 2019.

Table 77. New irrigation datasets added for version 3.6, grouped by activity name. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. All datasets have the reference product "irrigation" with the unit "m3". "*" Those markets existed already, only the Time period was changed to 2015-2017.*

Activity name	Geography	Time period
irrigation, drip	BR; CA-QC; CH; CN; CO; DE; ES; FR; GLO; IN; MA; MY; PE; PH; TN; US; ZA	2015-2017
irrigation, sprinkler	BR; CA-QC; CH; CN; CO; DE; ES; FR; GLO; IN; MA; PE; PH; TN; US; ZA	2015-2017
irrigation, surface	BR; CA-QC; CH; CN; CO; ES; FR; GLO; IN; MA; MY; PE; PH; TN; US; ZA	2015-2017
market for irrigation	CO; MA; PE; ZA	2015-2017
market for irrigation	*CA-QC; CH; CN; DE; ES; FR; GLO; IN; MY; PH; TN; US*	*2015-2017**

The new irrigation datasets require an input of pumping, which is supplied using either diesel energy or electric energy. The datasets that model the pumping, as well as the construction of the pump, are shown in Table 78. A pump operation dataset was created for each geography in which irrigation datasets were introduced, so that the energy input is supplied automatically by the energy market in that geography.

Table 78. new datasets created for version 3.6 that model the construction of a water pump, and its operation using either diesel or electricity as energy source. *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	Reference product	Unit
water pump operation, diesel	BR; CA-QC; CH; CN; CO; DE; ES; FR; GLO; IN; MA; MY; PE; PH; TN; US; ZA	2014-2018	water pump operation, diesel	MJ
water pump operation, electric	BR; CA-QC; CH; CN; CO; DE; ES; FR; GLO; IN; MA; MY; PE; PH; TN; US; ZA	2018-2018	water pump operation, electric	MJ
market for water pump operation, diesel	GLO	2014-2018	water pump operation, diesel	MJ

Activity name	Geography	Time period	Reference product	Unit
market for water pump operation, electric	GLO	2018-2018	water pump operation, electric	MJ
water pump production, 22kW	GLO	2007-2018	water pump, 22kW	unit
market for water pump, 22kW	GLO	2007-2018	water pump, 22kW	unit

14.2 Tap water

Tap water production is modelled in new geographies for version 3.6. Within the SRI-LCI project, tap water production datasets and markets with adjusted losses were created for Brazil, Columbia, India, Peru and South Africa. The data collection and modelling are described in Gmünder *et al.*, 2019. The list of new datasets is given in Table 79.

Table 79. new datasets created for tap water production for version 3.6. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. All have the reference product "tap water" with the unit "kg".*

Activity name	Geography	Time period
market for tap water	IN	2010-2017
market for tap water	PE; ZA	2012-2017
market for tap water	BR	2014-2017
market for tap water	CO	2017-2018
tap water production, conventional treatment	IN	2010-2017
tap water production, conventional treatment	CO; PE; ZA	2012-2017
tap water production, conventional treatment	BR	2015-2017
tap water production, conventional with biological treatment	CO	2012-2017
tap water production, direct filtration treatment	IN	2010-2017
tap water production, direct filtration treatment	CO; PE	2012-2017
tap water production, direct filtration treatment	BR	2015-2017
tap water production, underground water with chemical treatment	IN	2010-2017
tap water production, underground water with disinfection	CO; ZA	2012-2017
tap water production, underground water with disinfection	BR	2015-2017
tap water production, underground water without treatment	IN	2010-2017
tap water production, underground water without treatment	CO	2012-2017

Additionally, the losses in the global market for tap water were revised based on data published in Gmünder *et al.*, 2019.

14.3 Process water

For version 3.6, the datasets that model the treatment and supply of water used as input in production processes were updated within the context of the SRI-LCI project. For four types of process water—decarbonised, completely softened, deionised and ultrapure—the datasets were either partially or entirely revised. The details of what was updated for these types of process water are given in Gmünder *et al.*, 2019.

Additionally, in the activity "heavy water production", activity links for the input of "heat, from steam, in chemical industry" were removed, as they are no longer necessary given the current structure of the steam supply chain.

The list of datasets that were updated or added for the process water sector for version 3.6 is given in Table 80.

Table 80. Transforming activities and market activities for process water production that have been added or updated for version 3.6. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column. In column v3.6, "U" stands for "Updated Activity", and "N" stands for "New activity".*

Activity name	Geography	Time period	Reference product	Unit	v3.6
heavy water production	CA; GLO	2000-2000	heavy water	kg	U (activity link)
water production, completely softened	GLO; RER	2015-2017	water, completely softened	kg	U
water production, completely softened	US	2015-2017	water, completely softened	kg	N
water production, decarbonised	GLO	2010-2017	water, decarbonised	kg	U
water production, decarbonised	BR; CA; CH; CN; DE; ES; FR; GB; IN; RU; US; ZA	2010-2017	water, decarbonised	kg	N
water production, deionised	CH; Europe without Switzerland; GLO	2012-2017	water, deionised	kg	U
water production, ultrapure	CA-QC; GLO	2009-2017	water, ultrapure	kg	U
water production, ultrapure	RER	2009-2017	water, ultrapure	kg	N
market for heavy water	GLO	2000-2000	heavy water	kg	U
market for water, completely softened	GLO	2015-2017	water, completely softened	kg	U (time period)
market for water, completely softened	RER; US	2015-2017	water, completely softened	kg	N
market for water, decarbonised	GLO	2010-2017	water, decarbonised	kg	U (time period and technology level)
market for water, decarbonised	BR; CA; CH; CN; DE; ES; FR; GB; IN; RU; US; ZA	2010-2017	water, decarbonised	kg	N
market for water, harvested from rainwater	GLO	2010-2017	water, harvested from rainwater	kg	N
market for water, ultrapure	GLO	2009-2017	water, ultrapure	kg	U
market for water, ultrapure	CA-QC; RER	2009-2017	water, ultrapure	kg	N

14.4 Rainwater harvesting

The global activity "rainwater harvesting" (time period 2010-2017) was created for version 3.6. It models the collection and storage of rainwater and has as reference product "water, harvested from rainwater" with the unit "kg". As this product is new, a global market (without any transport inputs) was created for it.

15 Updates in the remaining sectors

15.1 Infrastructure & Service Supply Chains

Direct linking is considered the preferable solution for modelling inputs of services and immobile infrastructure to demanding activities with matching geographic scope (Moreno-Ruiz *et al.*, 2017). Whereas services represent immaterial exchanges, i.e., without a physical good changing ownership, immobile infrastructure are identified in the ecoinvent database primarily by one or more of the following aspects: (i) the term 'construction', rather than 'production', in the activity name, (ii) transformation and occupation of land are included in the inventory, and (iii) decommissioning at the end of service life is covered within the producing activity, i.e., the used product is 'treated' on the site of production, e.g., through demolition.

For mobile infrastructure, the above identified aspects of immobile infrastructure apply, except that no transformation and occupation of land are included in the inventory and the size, weight or modularity of the item implies that it can be transported and traded between producer and consumer. These products are hence modelled as traded via market datasets, i.e. direct links are not desired. For version 3.6 some activity links for mobile infrastructure were therefore removed (see under the Annex 4, in Activities for which direct links to mobile infrastructure were removed) and new local market datasets introduced (Table 82).

A large number of activity links between supplying and demanding activities, thereby bypassing the corresponding market activity, were already introduced for version 3.5 of the ecoinvent database, for instances when the geography of the demanding activity is enclosed within the geography of the supplying activity (Moreno Ruiz *et al.*, 2018). This improvement of infrastructure and service supply chain linking is continued in v3.6, with additional activity links.

A direct activity link is not introduced by default in case a supplying activity is confined within (but not equal to) the geography of the demanding activity. Similarly, no direct activity links are established between demanding activities confined within the geographic scope of a supplying activity in Rest-of-the-World (RoW). This is because the area covered by RoW is dynamic and may change with future submissions to the database. The market activities for services and immobile infrastructure should hence only exist with a global (GLO) scope, and merely consists of the input(s) of supply in RoW and any remaining capacity (i.e., otherwise unused) from regionally specific supplying activities.

Following the aforementioned approach, a total of 944 direct activity links were introduces and 239 links were removed for version 3.6. Table 81 shows the breakdown between service, immobile and mobile infrastructure. The Annex 4: direct activity links to services or infrastructures in this report contains a full list of activities which received activity links under the above approach (see section Activities for which direct links to services or immobile infrastructure were added); and a full fist of activities from which direct activity links were removed (see section Activities for which direct links to mobile infrastructure were removed).

Table 81. Summary of direct activity links introduced for the supply of services and immobile infrastructure and deleted for the supply of mobile infrastructure in ecoinvent v3.6.

	number of demanding datasets	number of supplying datasets	number of direct activity links established	number of direct activity links removed
immobile infrastructure	186	71	202	
service	359	46	742	
mobile infrastructure	193	5		239
Total			**944**	**239**

Table 82. New market activities related infrastructure and service supply chains. *If several geographies of the same activity with the same time period exist, all of them are listed in the "Geography" column.*

Activity name	Geography	Time Period
market for energy and auxilliary inputs, metal working factory	RER	2011-2011
market for compressed air, 1000 kPa gauge	RER	2011-2011
market for compressed air, 1200 kPa gauge	RER	2011-2011
market for compressed air, 600 kPa gauge	RER	2011-2011
market for compressed air, 700 kPa gauge	RER	2011-2011
market for compressed air, 800 kPa gauge	RER	2011-2011
market for furnace, logs, 6kW	CH	2012-2012
market for heat pump, diffusion absorption, 4kW, future	CH	2011-2011
market for industrial machine, heavy, unspecified	RER	2011-2011
market for metal working machine, unspecified	RER	2011-2011
market for steam, in chemical industry	RER	2010-2016

15.2 Miscellanea

This section groups corrections (normally small) done on datasets belonging to different sectors.

Table 83. Datasets subjected to minor changes for version 3.6.

Activity name	Geography	Time Period
heat, at cogen, with supporting oil furnace 60%, 160kWe Jakobsberg, allocation exergy	GLO	2000-2000
heat, non-market, at cogen 160kWe Jakobsberg, allocation exergy	GLO	2000-2000
market for floor heating from air-water heat pump	CH	1998-2000
market for floor heating from borehole heat pump	CH	1998-2000
permanent magnet production, for electric motor	GLO	1995-2002

Certain global datasets were wrongly using Swiss Integrated Production products in their inventories (see Table 11 for change in production volumes of GLO activities to avoid creation of RoW activities representing Swiss Integrated Production), and were substituted with regular products. The full list of datasets corrected that way is present in Table 84.

Table 84. Datasets adjusted to employ regular products instead of Swiss integrated production products. *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
door production, inner, glass-wood	GLO; RER	1997-2005
door production, inner, wood	GLO; RER	1997-2005
ethanol production from potatoes	GLO	2002-2006
maize starch production	DE; GLO	2002-2002
soybean meal and crude oil production	RER	1998-1998
potato starch production	DE; GLO	2002-2002

References

APESA, OLENTICA, BIO Intelligence Service. 2015. Impact sanitaire et environnementaux du compostage domestique – Rapport – Partie A - 182 pages.

Avadi A., Vázquez-Rowe I., Symeonidis A., Moreno-Ruiz E. (2019). First series of seafood datasets in ecoinvent: setting the pace for future development. The International Journal of Life Cycle Assessment. 10.1007/s11367-019-01659-x.

Avadí A., Vázquez-Rowe I. (2019) South America. Life Cycle Inventories of Wild Capture and Aquaculture, ecoinvent Association, Zürich, Switzerland

Barthe P., Chaugny M., Roudier S., Sancho L.D. (2015). Best Available Techniques (BAT) Reference Document for the Refining of Mineral Oil and Gas. European Integrated Pollution Prevention and Control Bureau (EIPPCB) of the European Commission's Joint Research Centre (JRC) [PDF file]. Retrieved June 2019 from http://eippcb.jrc.ec.europa.eu/reference/BREF/REF_BREF_2015.pdf

BFE. (2018). Schweizerische Elektrizitätsstatistik 2017 [PDF file]. Retrieved from https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/electricity-statistics.html. Supporting spreadsheet files Schweizerische Gesamtenergiestatistik 2017 - Tabellen (XLSX, 308 KB, 16.07.2018) ID: 7519, retrieved June 2019 from https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/electricity-statistics.html

CargoHandbook. (n.d.). Retrieved February to July, 2019, from https://cargohandbook.com/index.php/Welcome_to_CargoHandbook.

Charikinya E., Broadhurst J., Dlamini R., Goga T., Harding K., Russo V., Viljoen D. and von Blottnitz H. (2019). Life Cycle Inventories of Primary Production of Precious and Scarce Metals - South Africa.

Doka G. (2009) Life Cycle Inventories of Waste Treatment Services. ecoinvent report No. 13. Swiss Centre for Life Cycle Inventories, Dübendorf, 2009. Doka Life Cycle Assessments, Zurich, Switzerland. Available at http://www.doka.ch/publications.htm

Doka G. (2017). A model for waste-specific and climate-specific life cycle inventories of tailings impoundments. Doka Life Cycle Assessments, Zurich, Switzerland. Available at http://www.doka.ch/publications.htm

Donke A.C.G., Novaes R.M.L., Pazianotto R.A.A., Moreno-Ruiz E., Reinhard J., Picoli J.F, Folegatti-Matsuura M.I.S, (under review). Integrating 566 state-level Brazilian land use change datasets into the ecoinvent database: new data, premises and uncertainties have large effects in the results. The International Journal of Life Cycle Assessment.

EIA. (2018). eGRID 2016 database. Retrieved from https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

EIA. (n.d.). Electricity Data Browser. https://www.eia.gov/electricity/data/browser/

ENTSO-E. (2019). ENTSO-E Physical Energy & Power Flows. Retrieved from https://www.entsoe.eu/data/power-stats/physical-flows/

Faist Emmenegger M., Bajaj S., Datta A., Nigam M., Hossain M.M., Hossain M.N. (2018), Life Cycle Inventories of textile products - India and Bangladesh. ecoinvent Association, Zürich, Switzerland.

Federal Office of Topography swisstopo. (2017). The Swiss Geological Survey – the authority for subsurface. Retrieved from https://www.swisstopo.admin.ch/content/swisstopo-internet/en/topics/geology/_jcr_content/contentPar/tabs/items/publikationen_dokume/tabPar/downloadlist/downloadItems/22_1496408019055.download/Landesgeologie_A5_E.pdf

Fehrenbach H., Liebich A., Abdalla N., Biemann K., Fröhlich T., Simon B. (2017). Petroleum refinery industry and liquid fuels - Description of the ifeu refinery model and the calculation of LCI datasets for refinery products in Brazil, India, South Africa, Peru and Colombia. ecoinvent Association, Zürich, Switzerland.

Filimonau V., Santa Rosa M., Santana Franca L., Cánovas Creus A., Mattos Ribeiro G., Molnarova J., Geldres Piumatti R. (2018). Tourism and accommodation services.

Folegatti-Matsuura M.I.S., Picoli J.F. (2018) Life Cycle Inventories of Agriculture, Forestry and Animal Husbandry - Brazil, ecoinvent Association, Zürich, Switzerland.

Gangane P. and Samuel S. (2018). Life Cycle Inventories of Plastic Recycling - India

Gmünder S., Myers N., Laffely J., Silva F. (2018). Life Cycle Inventories of Cement, Concrete and Related Industries - Colombia and Peru

Gmünder S., Rubio L. Kounina A., Bunge J., Conza A., Soni H. and Notten P. (2019). Life Cycle Inventories of Water Supply and Distribution.

Hedden K., Jess A. (1994). Bereich Raffinerien und Ölveredelung; Bericht zum Teilprojekt 4 „Umwandlungssektor“ des Forschungsvorhabens „Instrumente für Klimagas-Reduktionsstrategien“, Förderkennzeichen BMFT ET 9188

IAEA. (2019). IEAE PRIS database. Retrieved from https://pris.iaea.org/PRIS/home.aspx

IAI. (2019). World Aluminium — Alumina Production. Retrieved August 21, 2019, from http://www.world-aluminium.org/statistics/alumina-production/#data

IEA. (2017a). World energy statistics (Edition 2017). Retrieved from https://www.oecd-ilibrary.org/energy/data/iea-world-energy-statistics-and-balances_enestats-data-en

IEA. (2017b). OECD - Electricity imports by origin (Edition 2017/1). Retrieved from https://www.oecd-ilibrary.org/energy/data/iea-electricity-information-statistics_elect-data-en

IEA. (2017c). OECD - Electricity exports by destination (Edition 2017/1). Retrieved from https://www.oecd-ilibrary.org/energy/data/iea-electricity-information-statistics_elect-data-en

IEA. (2017d). OECD - Electricity/heat supply and consumption (Edition 2017/1). Retrieved from https://www.oecd-ilibrary.org/energy/data/iea-electricity-information-statistics_elect-data-en

IEA. (2018). Extended world energy balances (Edition 2018). Retrieved from https://www.oecd-ilibrary.org/energy/data/iea-world-energy-statistics-and-balances_enestats-data-en

IEAE. (2018). Power Reactor Information System (PRIS), World Statistics, Load Factor, Retrieved from https://pris.iaea.org/PRIS/WorldStatistics/WorldTrendinAverageLoadFactor.aspx

Itten R., Frischknecht R., Stucki M. (2014) Life Cycle Inventories of Electricity Mixes and Grid, Version 1.3 [PDF file]. Retrieved from http://esu-services.ch/fileadmin/download/publicLCI/itten-2012-electricity-mix.pdf

Jungbluth N. (2007). Erdöl, in Dones R., Sachbilanzen von Energiesystemen. Final report No. 6 ecoinvent data v2.0, 6, Dübendorf and Villigen, CH.

Kiran Ananth P. V., Muralikrishanan K., Mundada P. (2017). Life Cycle Inventories of Cement, Concrete and Related Industries - India

Lee E., Ganster P. (2012). The U.S.-Mexican Border Environment: Progress and Challenges for Sustainability. San Diego University Press. Page 294.

Messmer A., Frischknecht R. (2016). Umweltbilanz Strommix Schweiz 2014, Version 589-Umweltbilanz-Strommix-Schweiz-2014-v3.0 [PDF file]. Retrieved from http://treeze.ch/fileadmin/user_upload/downloads/589-Umweltbilanz-Strommix-Schweiz-2014-v3.0.pdf

Moreno Ruiz E., Lévová T., Reinhard J., Valsasina L., Bourgault G., Wernet G. (2016). Documentation of changes implemented in ecoinvent database v3.3. Ecoinvent, Zürich, Switzerland.

Moreno Ruiz E., Valsasina L., Brunner F., Symeonidis A., FirtzGerald D., Treyer K., Bourgault G., Wernet G. (2018). Documentation of changes implemented in ecoinvent database v3.5. Ecoinvent. Zürich, Switzerland.

Moreno-Ruiz E., Lévová T., Valsasina L. (2017). Guidelines for data providers to the ecoinvent database. Ecoinvent, Zürich, Switzerland.

Muigai R., Pradhan A. (2018). Life Cycle Inventories of Cement, Concrete and Related Industries - South Africa

Notten P.J., Althaus H.-J. and Burke M. (2018a). Life cycle inventories of global air freight.

Notten P.J., Althaus H.-J., Burke M. and Läderach A. (2018b). Life cycle inventories of global shipping.

Notten P.J., Althaus H.-J., Jayaram N. and Burke M. (2018c). Life cycle inventories of rail freight in India and South Africa.

Notten P.J., Althaus H.-J., Jayaram N., Burke M. and Läderach A. (2018d). Life cycle inventories of road freight in India and South Africa.

NREL. (2019). Concentrating solar power projects database. Retrieved June 2019 from https://solarpaces.nrel.gov/sites/default/files/project-export.csv

OECD. (2018). Input-Output Tables. Retrieved January 15, 2019, from http://www.oecd.org/trade/input-outputtables.htm

PE INTERNATIONAL (2014). Primary Zinc Life Cycle Assessment. International Zinc Association.

Reinhard J., Moreno-Ruiz E., Gmünder S. (2017). Consideration of land use change in ecoinvent version 3.3: Method, Implementation and Illustration, ecoinvent Association, Switzerland.

Russo V., and von Blottnitz H. (2018). Life Cycle Inventories of Syntethic Fuel Production from Coal and Domestic Fuel Markets - South Africa, ecoinvent Association, Zürich, Switzerland.

Russo V., de Kock L., Muir K., Notten P., Patel I., Stucki M., Vienings E., von Blottnitz H. Wettstein S. (2018) Life Cycle Inventories of Agriculture and Animal Husbandry - South Africa, ecoinvent Association, Zürich, Switzerland

S&P Global. (2018). Platts WEPP database. Retrieved from https://www.spglobal.com/platts/en/products-services/electric-power/world-electric-power-plants-database

Safaei A., Symeonidis A., Valdivia S., Ottiger F. (2018). Life Cycle Assessments of Selected Worst Practices in Secondary Metals Recovery and Recommendations to Move Towards Good Practices. Sustainable Recycling Industries (SRI), ISBN: 978-3-906177-20-5

Safaei A., Symeonidis A., Valdivia S., Ottiger F. (2018). Life Cycle Assessments of Selected Worst Practices in Secondary Metals Recovery and Recommendations to Move Towards Good Practices. Sustainable Recycling Industries (SRI), ISBN: 978-3-906177-20-5

Scrivener *et al.* (2018). Calcined clay limestone cements (LC3). Cement and Concrete Research, 114, 49-56. https://doi.org/10.1016/j.cemconres.2017.08.017

Silva F. B., Oliveira L. A., Passuello A. C. B., Moraga G. L., Silva V. G., Silva M. G., Saade M. R. M., Gmünder S., Myers N. (2018). Life Cycle Inventories of Cement, Concrete and Related Industries - Latin America

SRI programme: can be accessed under www.sustainable-recycling.org/about-sri/

SRI-LCI project: can be accessed www.ecoinvent.org/about/projects/sri-project/sri-project.html

StatCAN. (2019a). Electricity from fuels, annual generation by electric utility thermal plants. Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2510001901

StatCAN. (2019b). Electric power, annual generation by class of producer. Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2510002001

StatCAN. (2019c). Electric power generation, monthly receipts, deliveries and availability. Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2510001601

State of Waste Management in Canada, Prepared for: Canadian Council of Ministers of Environment, 2014, Prepared by: Giroux Environmental Consulting.

Statistics Canada, Human Activity and the Environment, Waste management in Canada, 2012, Catalogue no. 16-201-X, ISSN 1923-6743

Suppen N., Arena P., Souza Junior H.R.A., Cherubini E., Civit B, Gmünder S., Gonzalez M., Naranjo C., Pro A., Roncancio P., Santa-Maria G., Zanghelini G.M., Soares S.R. (2018). Life Cycle Inventories of Electricity Production - Latin America, ecoinvent Association, Zürich, Switzerland.

The Windpower. (2019). Wind power market intelligence. Online access > Wind farms. Retrieved from https://www.thewindpower.net/windfarms_list_en.php

The World Bank. (2019). World Bank Open Data. Retrieved January 15, 2019, from https://data.worldbank.org/

Timmer M.P., Dietzenbacher E., Los B., Stehrer R., and de Vries G.J. (2015). An Illustrated User Guide to the World Input-Output Database: the Case of Global Automotive Production. Review of International Economics, 23(3), 575-605. http://doi.wiley.com/10.1111/roie.12178.

Tirado P. (2019). Personal communication 2019-07-05, CIRAIG, Montreal, Canada.

Transport Information Service (TIS). (n.d.). Retrieved February to July, 2019, from http://www.tis-gdv.de/tis_e/inhalt.html

Turner D. A., Hischier R. and Doka G. (2019). Life cycle inventories of sulfidic tailings disposal. Empa, St. Gallen, Switzerland.

UNCTAD. (2017). Review of maritime transport. UNCTAD/RMT/2017. Retrieved from https://unctad.org/en/PublicationsLibrary/rmt2017_en.pdf

UNCTAD. (2018). Review of maritime transport. UNCTAD/RMT/2018. Retrieved from https://unctad.org/en/PublicationsLibrary/rmt2018_en.pdf

United Nations Statistics Division. (2019). UN data, A world of information. Retrieved January 15, 2019, from http://data.un.org/

Verband Schweizerischer Elektrizitätsunternehme (VSE) and Pronovo AG. (2019). stromkennzeichnung.ch, Lieferantenmix Schweiz, 2017. Retrieved August 2019 from https://www.stromkennzeichnung.ch/de/suche/detail/powera/show/powersortyear/2016/supplier/lieferantenmix-schweiz.html

Visedo G., Pecchio M. (2019). ROADMAP tecnológico do cimento: potencial de redução das emissões de carbono da indústria do cimento brasileira até 2050 / coordenado por Gonzalo Visedo e Marcelo Pecchio. Rio de Janeiro: SNIC.

Weidema B. P., Bauer C., Hischier R., Mutel C., Nemecek T., Reinhard J., Vadenbo C. O., Wernet G. (2013). Overview and methodology. Data quality guideline for the ecoinvent database version 3. Ecoinvent Report 1(v3). St. Gallen: The ecoinvent Centre

Annex 1: products with updated prices

2,4-dichlorotoluene [kg]; 2,5-dimethylhexane-2,5-dihydroperoxide [kg]; 2-methyl-2-butanol [kg]; 2-pyridinol [kg]; 3-methyl-1-butyl acetate [kg]; 4-tert-butylbenzaldehyde [kg]; 4-tert-butyltoluene [kg]; DTPA, diethylenetriaminepentaacetic acid [kg]; EDTA, ethylenediaminetetraacetic acid [kg]; EUR-flat pallet [unit]; N,N-dimethylformamide [kg]; N-methyl-2-pyrrolidone [kg]; absorption chiller, 100kW [unit]; acetamide-anillide-compound, unspecified [kg]; acetanilide [kg]; acetoacetic acid [kg]; acetyl chloride [kg]; aclonifen [kg]; acrolein [kg]; acrylic dispersion, without water, in 65% solution state [kg]; agricultural machinery, unspecified [kg]; air compressor, screw-type compressor, 300kW [unit]; air compressor, screw-type compressor, 4kW [unit]; air distribution terminal panel, steel, 120 m3/h [unit]; air filter, central unit, 600 m3/h [unit]; air filter, in exhaust air valve [unit]; air input/output unit, heat and power co-generation unit, 160kW electrical [unit]; airport [unit]; alkyl sulphate (C12-14) [kg]; alkylbenzene sulfonate, linear, petrochemical [kg]; alkylketene dimer sizing agent, for paper production [kg]; alpha-picoline [kg]; aluminium around steel bi-metal stranded cable, 3x3.67mm external diameter wire [m]; aluminium chloride [kg]; aluminium removed by drilling, computer numerical controlled [kg]; aluminium removed by drilling, conventional [kg]; aluminium melting furnace [unit]; aluminium removed by milling, average [kg]; aluminium removed by milling, dressing [kg]; aluminium removed by milling, large parts [kg]; aluminium removed by milling, small parts [kg]; aluminium removed by turning, average, computer numerical controlled [kg]; aluminium removed by turning, average, conventional [kg]; aluminium removed by turning, primarily dressing, computer numerical controlled [kg]; aluminium removed by turning, primarily dressing, conventional [kg]; aluminium removed by turning, primarily roughing, computer numerical controlled [kg]; aluminium removed by turning, primarily roughing, conventional [kg]; amine oxide [kg]; ammonia, liquid [kg]; ammonium bicarbonate [kg]; ammonium nitrite [kg]; ammonium thiocyanate [kg]; anhydrite floor [kg]; anhydrite [kg]; anodising, aluminium sheet [m2]; application of plant protection product, by field sprayer [ha]; arsine [kg]; ascorbic acid [kg]; asparagus seedling, for planting [unit]; assembly of liquid crystal display, auxilliaries and energy use [kg]; atrazine [kg]; auxiliary heating unit, electric, 5kW [unit]; azodicarbonamide [kg]; bale loading [unit]; baling [unit]; barium carbonate [kg]; barium hydroxide [kg]; barium oxide [kg]; barium sulfide [kg]; barley grain, feed [kg]; barley grain, feed, Swiss integrated production [kg]; barley grain, feed, organic [kg]; barley seed, Swiss integrated production, for sowing [kg]; barley seed, for sowing [kg]; barley seed, organic, for sowing [kg]; battery separator [kg]; beet seed, Swiss integrated production, for sowing [kg]; bentonite quarry infrastructure [unit]; benzal chloride [kg]; benzaldehyde-2-sulfonic acid [kg]; benzimidazole-compound [kg]; benzyl chloride [kg]; beverage carton converting [m2]; bisphenol A epoxy based vinyl ester resin [kg]; bitumen adhesive compound, cold [kg]; bitumen adhesive compound, hot [kg]; bitumen seal, Alu80 [kg]; bitumen seal, V60 [kg]; blast furnace [unit]; blast oxygen furnace converter [unit]; blow moulding [kg]; blower and heat exchange unit, Avent E 97 [unit]; blower and heat exchange unit, GE 250 RH [unit]; blower and heat exchange unit, KWL 250 [unit]; blower and heat exchange unit, KWLC 1200 [unit]; blower and heat exchange unit, Storkair G 90 [unit]; blower and heat exchange unit, central, 600-1200 m3/h [unit]; blower and heat exchange unit, decentralized, 180-250 m3/h [unit]; borehole heat exchanger, 150m [unit]; boric acid, anhydrous, powder [kg]; boric oxide [kg]; boron trifluoride [kg]; brass removed by drilling, computer numerical controlled [kg]; brass removed by drilling, conventional [kg]; brass [kg]; brass removed by turning, average, computer numerical controlled [kg]; brass removed by turning, average, conventional [kg]; brass removed by turning, primarily dressing, computer numerical controlled [kg]; brass removed by turning, primarily dressing, conventional [kg]; brass removed by turning, primarily roughing, computer numerical controlled [kg]; brass removed by turning, primarily roughing, conventional [kg]; brick production facility [unit]; bromopropane [kg]; bronze [kg]; building, hall [m2]; building, hall, steel construction [m2]; building, hall, wood construction [m2]; building, multi-storey [m3]; building machine [unit]; butane-1,4-diol [kg]; cable, data cable in infrastructure [m]; cable, printer cable, without plugs [m]; cable, ribbon cable, 20-pin, with plugs [kg]; cable, three-conductor cable [m]; cadmium chloride, semiconductor-grade [kg]; cadmium [kg]; cadmium, semiconductor-grade [kg]; cadmium sludge from zinc electrolysis stockpiling [kg]; cadmium sulfide, semiconductor-grade [kg]; cadmium telluride, semiconductor-grade [kg]; calendering, rigid sheets [kg]; canal [m*year]; capacitor, auxilliaries and energy use [kg]; capacitor, electrolyte type, < 2cm height [kg]; capacitor, electrolyte type, > 2cm height [kg]; capacitor, film type, for through-hole mounting [kg]; capacitor, for surface-mounting [kg]; capacitor, tantalum-, for through-hole mounting [kg]; carboxymethyl cellulose, powder [kg]; carrot seed, Swiss integrated production, at farm [kg]; carrot seed, for sowing [kg]; cast iron removed by drilling, computer numerical controlled [kg]; cast iron removed by drilling, conventional [kg]; cast iron removed by milling, average [kg]; cast iron removed

by milling, dressing [kg]; cast iron removed by milling, large parts [kg]; cast iron removed by milling, small parts [kg]; cast iron removed by turning, average, computer numerical controlled [kg]; cast iron removed by turning, average, conventional [kg]; cast iron removed by turning, primarily dressing, computer numerical controlled [kg]; cast iron removed by turning, primarily dressing, conventional [kg]; cast iron removed by turning, primarily roughing, computer numerical controlled [kg]; cast iron removed by turning, primarily roughing, conventional [kg]; casting, aluminium, lost-wax [kg]; casting, brass [kg]; casting, bronze [kg]; casting, steel, lost-wax [kg]; catalytic converter, oxidation, 20 litre [unit]; catalytic converter, selective catalytic reduction, 200 litre [unit]; catalytic converter, three-way, 19.1l [unit]; catalytic converter, three-way, mini CHP plant [unit]; cathode-ray tube, cathode ray tube display [kg]; hard coal ash; cement, alternative constituents 21-35% [kg; kg]; hard coal ash; cement, alternative constituents 6-20%; blast furnace slag; silica fume, densified [kg; kg; kg; kg]; cement, blast furnace slag 18-30% and 18-30% other alternative constituents; hard coal ash; silica fume, densified [kg; kg; kg]; cement, blast furnace slag 25-70% [kg]; hard coal ash; cement, blast furnace slag 31-50% and 31-50% other alternative constituents; silica fume, densified [kg; kg; kg]; cement, pozzolana and fly ash 15-40%; hard coal ash [kg; kg]; cement, unspecified [kg]; ceramic factory [unit]; chassis, internet access equipment [kg]; chemical factory [kg]; chemical, inorganic [kg]; chimney [m]; chipper, stationary, electric [unit]; chlorine dioxide [kg]; chloroacetyl chloride [kg]; chloromethyl methyl ether [kg]; chloronitrobenzene [kg]; chloropropionic acid [kg]; chlorosulfonic acid [kg]; chlorothalonil [kg]; chlorotoluron [kg]; chopping, maize [ha]; chromium steel removed by drilling, computer numerical controlled [kg]; chromium steel removed by drilling, conventional [kg]; chromium steel removed by milling, average [kg]; chromium steel removed by milling, dressing [kg]; chromium steel removed by milling, large parts [kg]; chromium steel removed by milling, small parts [kg]; chromium steel removed by turning, average, computer numerical controlled [kg]; chromium steel removed by turning, average, conventional [kg]; chromium steel removed by turning, primarily dressing, computer numerical controlled [kg]; chromium steel removed by turning, primarily dressing, conventional [kg]; chromium steel removed by turning, primarily roughing, computer numerical controlled [kg]; chromium steel removed by turning, primarily roughing, conventional [kg]; clay pit infrastructure [unit]; clefting of energy wood [hour]; clover seed, Swiss integrated production, at farm [kg]; clover seed, Swiss integrated production, for sowing [kg]; coal stove, 5-15kW [unit]; coating powder [kg]; coating, with melamine impregnated paper [m2]; cobwork [kg]; cocamide diethanolamine [kg]; collector field area, solar thermal parabolic trough, 50 MW [unit]; collector field area, solar tower power plant, 20 MW [unit]; combine harvesting [ha]; compressed air, 1000 kPa gauge [m3]; compressed air, 1200 kPa gauge [m3]; compressed air, 600 kPa gauge [m3]; compressed air, 700 kPa gauge [m3]; compressed air, 800 kPa gauge [m3]; concentrated solar power plant, solar thermal parabolic trough, 50 MW [unit]; concentrated solar power plant, solar tower, 20 MW [unit]; concrete mixing factory [unit]; container, for collection of post-consumer waste plastic for recycling [unit]; contouring, brass [kg]; contouring, bronze [kg]; conveyor belt [m]; cooling energy [MJ]; cottonseed, for sowing [kg]; cyanoacetic acid [kg]; cyanogen chloride [kg]; cyanuric chloride [kg]; cyclic N-compound [kg]; dairy [m3]; decabromodiphenyl ether [kg]; deep drawing, steel, 10000 kN press, automode [kg]; deep drawing, steel, 10000 kN press, single stroke [kg]; deep drawing, steel, 3500 kN press, automode [kg]; deep drawing, steel, 3500 kN press, single stroke [kg]; deep drawing, steel, 38000 kN press, automode [kg]; deep drawing, steel, 38000 kN press, single stroke [kg]; deep drawing, steel, 650 kN press, automode [kg]; deep drawing, steel, 650 kN press, single stroke [kg]; deep well closure [m]; deep well, drilled, for geothermal power [m]; deep well, for geothermal power, onshore, 6000m [m]; degreasing, metal part in alkaline bath [m2]; delimbing/sorting, excavator-based processor [hour]; SOx retained, in lignite flue gas desulfurisation [kg]; diazine-compound [kg]; diazole-compound [kg]; dicyclopentadiene based unsaturated polyester resin [kg]; diesel, burned in agricultural machinery [MJ]; diesel, burned in diesel-electric generating set, 18.5kW [MJ]; diesel-electric generating set, 10MW [unit]; dimethenamide [kg]; dimethyl ether [kg]; dimethyl malonate [kg]; dimethyl sulfate [kg]; dimethyl sulfide [kg]; dimethyl sulfoxide [kg]; dimethylacetamide [kg]; dimethylamine borane [kg]; dimethyldichlorosilane [kg]; dinitroaniline-compound [kg]; diode, auxilliaries and energy use [kg]; dioxane [kg]; dipropyl amine [kg]; dipropylene glycol monomethyl ether [kg]; disk drive, CD/DVD, ROM, for desktop computer [unit]; drawing of pipe, steel [kg]; dried roughage store, air dried, solar [m3]; dried roughage store, cold-air dried, conventional [m3]; dried roughage store, non ventilated [m3]; drying of bread grain, seed and legumes [l]; drying of feed grain [l]; drying of grass [l]; drying of maize grain [l]; drying of maize straw and whole-plant [l]; drying, natural gas [m3]; dust collector, electrostatic precipitator, for domestic use [unit]; dust collector, electrostatic precipitator, for industrial use [unit]; dust collector, multicyclone [unit]; electric connector, peripheral component interconnect buss [kg]; electric connector, peripheral type buss [kg]; electric connector, wire clamp [kg]; electric parts, heat and power co-generation

unit, 160kW electrical [unit]; electric scooter, without battery [kg]; electrode, negative, LiC6 [kg]; electrode, negative, Ni [kg]; electrode, positive, LaNi5 [kg]; electronic component machinery, unspecified [unit]; electronic component, active, unspecified [kg]; electronic component, passive, unspecified [kg]; electronics, for control units [kg]; enamelling [m2]; energy and auxilliary inputs, metal working factory [kg]; energy and auxilliary inputs, metal working machine [kg]; energy requirement for assembly of heat and power co-generation unit, 160kW electrical [unit]; energy saving [MJ]; joist, engineered wood [m]; establishing orchard [unit]; esters of versatic acid [kg]; ethoxylated alcohol (AE11) [kg]; ethoxylated alcohol (AE3) [kg]; ethoxylated alcohol (AE7) [kg]; ethoxylated alcohol (AE>20) [kg]; ethylamine [kg]; evacuated tube collector [m2]; exhaust air outlet, steel/aluminium, 85x365 mm [unit]; exhaust air roof hood, steel, DN 400 [unit]; exhaust air valve, in-wall housing, plastic/steel, DN 125 [unit]; expansion vessel, 25l [unit]; expansion vessel, 80l [unit]; explosive, tovex [kg]; explosives factory [unit]; extrusion of plastic sheets and thermoforming, inline [kg]; extrusion, co-extrusion [kg]; extrusion, plastic film [kg]; extrusion, plastic pipes [kg]; fan, for power supply unit, desktop computer [kg]; fava bean seed, for sowing [kg]; fava bean seed, organic, for sowing [kg]; fertilising, by broadcaster [ha]; fish canning plant [unit]; fish canning, large fish [kg]; fish canning, small fish [kg]; fish curing plant [unit]; fish curing, small fish [kg]; fish freezing plant [unit]; fish freezing, small fish [kg]; fishmeal plant [unit]; flat glass factory [unit]; flat plate solar collector, Cu absorber [m2]; floating collar cage [m]; floating hexagonal metal cage [m]; foam glass factory [unit]; foam glass [kg]; foam glass, electricity, label-certified [kg]; fodder beet seed, for sowing [kg]; fodder loading, by self-loading trailer [m3]; forging, steel [kg]; forwarding, forwarder [hour]; frit, for ceramic tile [kg]; fruit tree seedling, for planting [unit]; fuel cell, polymer electrolyte membrane, 2kW electrical, future [unit]; fuel cell, solid oxide, 125kW electrical, future [unit]; fuel cell, solid oxide, with micro gas turbine, 180kW electrical, future [unit]; fuel cell, stack polymer electrolyte membrane, 2kW electrical, future [unit]; fuel cell, stack solid oxide, 125kW electrical, future [unit]; gallium, semiconductor-grade [kg]; garage, wood, non-insulated, fire-protected [m2]; gas power plant, 300MW electrical [unit]; gas power plant, combined cycle, 400MW electrical [unit]; gas turbine, 10MW electrical [unit]; generator, 200kW electrical [unit]; geothermal power plant, 5.5MWel [unit]; geothermal power plant, Hot-Dry-Rock [unit]; geothermal power plant, undefined type [unit]; glass etching factory [unit]; glass tube factory [unit]; glazing, double, U<1.1 W/m2K [m2]; glazing, double, U<1.1 W/m2K, laminated safety glass [m2]; glazing, triple, U<0.5 W/m2K [m2]; glyoxal [kg]; goods wagon [unit]; grass seed, Swiss integrated production, at farm [kg]; grass seed, Swiss integrated production, for sowing [kg]; grass seed, organic, for sowing [kg]; gravel/sand quarry infrastructure [unit]; green manure, Swiss integrated production, until April [ha]; green manure, Swiss integrated production, until February [ha]; green manure, Swiss integrated production, until January [ha]; green manure, Swiss integrated production, until March [ha]; green manure, organic, until April [ha]; green manure, organic, until February [ha]; green manure, organic, until January [ha]; green manure, organic, until March [ha]; greenhouse, glass walls and roof [m2*year]; greenhouse, plastic walls and roof [m2*year]; hard chromium coat, electroplating, steel substrate, 0.14 mm thickness [m2]; hard coal briquettes factory [unit]; hard coal coke factory [unit]; hard coal, run-of-mine [kg]; hard coal power plant [unit]; hard coal preparation plant [unit]; harvesting, by complete harvester, beets [ha]; harvesting, by complete harvester, ground crops [ha]; harvesting, forestry harvester [hour]; harvesting/bundling, energy wood harvester [hour]; hay [kg]; hay, Swiss integrated production, extensive [kg]; hay, Swiss integrated production, intensive [kg]; hay, organic, intensive [kg]; haying, by rotary tedder [ha]; hazardous waste incineration facility [unit]; heat and power co-generation unit, 160kW electrical, common components for heat+electricity [unit]; heat and power co-generation unit, 160kW electrical, components for electricity only [unit]; heat and power co-generation unit, 160kW electrical, components for heat only [unit]; heat and power co-generation unit, 1MW electrical, common components for heat+electricity [unit]; heat and power co-generation unit, 1MW electrical, components for electricity only [unit]; heat and power co-generation unit, 1MW electrical, components for heat only [unit]; heat and power co-generation unit, organic Rankine cycle, 1MWe, 6.4 MWth [unit]; heat and power co-generation unit, 1MWel, 6.4MWth [unit]; heat and power co-generation unit, 200kW electrical, common components for heat+electricity [unit]; heat and power co-generation unit, 200kW electrical, components for electricity only [unit]; heat and power co-generation unit, 200kW electrical, components for heat only [unit]; heat and power co-generation unit, 200kW electrical, diesel SCR, common components for heat+electricity [unit]; heat and power co-generation unit, 200kW electrical, diesel SCR, components for electricity only [unit]; heat and power co-generation unit, 200kW electrical, diesel SCR, components for heat only [unit]; heat and power co-generation unit, 500kW electrical, common components for heat+electricity [unit]; heat and power co-generation unit, 500kW electrical, components for electricity only [unit]; heat and power co-generation unit, 500kW electrical, components for heat only [unit]; heat and power co-generation unit, 50kW electrical, common

components for heat+electricity [unit]; heat and power co-generation unit, 50kW electrical, components for electricity only [unit]; heat and power co-generation unit, 50kW electrical, components for heat only [unit]; heat and power co-generation unit, 6400kW thermal, components for electricity only [unit]; heat and power co-generation unit, organic Rankine cycle, 1400kW thermal, components for electricity only [unit]; heat and power co-generation unit, organic Rankine cycle, 3MW electrical [unit]; heat transport fluid system, solar thermal parabolic trough, 50 MW [unit]; heavy fuel oil, burned in refinery furnace [MJ]; zircon, 50% zirconium [kg]; helium, crude stockpiling [kg]; hoeing [ha]; horticultural fleece [m2]; hot water tank factory [unit]; hot water tank, 600l [unit]; housing system, cattle, loose, per animal unit [unit]; housing system, cattle, tied, per animal unit [unit]; housing system, pig, fully-slatted floor, per pig place [unit]; housing system, pig, label-certified, per pig place [unit]; hydraulic digger [unit]; hydrogen sulfide [kg]; hydroxylamine [kg]; ilmenite, 54% titanium dioxide [kg]; imidazole [kg]; impact extrusion of aluminium, 1 stroke [kg]; impact extrusion of aluminium, 2 strokes [kg]; impact extrusion of aluminium, 3 strokes [kg]; impact extrusion of aluminium, 4 strokes [kg]; impact extrusion of aluminium, 5 strokes [kg]; impact extrusion of aluminium, cold, initial surface treatment [kg]; impact extrusion of aluminium, cold, tempering [kg]; impact extrusion of aluminium, deformation stroke [kg]; impact extrusion of steel, cold, 1 strokes [kg]; impact extrusion of steel, cold, 2 strokes [kg]; impact extrusion of steel, cold, 3 strokes [kg]; impact extrusion of steel, cold, 4 strokes [kg]; impact extrusion of steel, cold, 5 strokes [kg]; impact extrusion of steel, cold, deformation stroke [kg]; impact extrusion of steel, cold, initial surface treatment [kg]; impact extrusion of steel, cold, tempering [kg]; impact extrusion of steel, hot, 1 strokes [kg]; impact extrusion of steel, hot, 2 strokes [kg]; impact extrusion of steel, hot, 3 strokes [kg]; impact extrusion of steel, hot, 4 strokes [kg]; impact extrusion of steel, hot, 5 strokes [kg]; impact extrusion of steel, hot, deformation stroke [kg]; impact extrusion of steel, hot, initial warming [kg]; impact extrusion of steel, hot, tempering [kg]; impact extrusion of steel, warm, 1 strokes [kg]; impact extrusion of steel, warm, 2 strokes [kg]; impact extrusion of steel, warm, 3 strokes [kg]; impact extrusion of steel, warm, 4 strokes [kg]; impact extrusion of steel, warm, 5 strokes [kg]; impact extrusion of steel, warm, deformation stroke [kg]; impact extrusion of steel, warm, initial warming [kg]; indium tin oxide powder, nanoscale, for sputtering target [kg]; inductor, low value multilayer chip [kg]; inductor, miniature radio frequency chip [kg]; inductor, ring core choke type [kg]; industrial furnace, coal, 1-10MW [unit]; industrial furnace, natural gas [unit]; industrial machine, heavy, unspecified [kg]; inert material landfill [unit]; infrastructure, for regional distribution of oil product [unit]; injection moulding [kg]; insulation spiral-seam duct, rockwool, DN 400, 30 mm [m]; integrated circuit, logic type [kg]; integrated circuit, memory type [kg]; intermodal shipping container, 20-foot [unit]; intermodal shipping container, 40-foot [unit]; intermodal shipping container, 40-foot, high-cube [unit]; intermodal shipping container, 45-foot, high-cube [unit]; internet access equipment [unit]; internet access, videoconference, 0.7 Mbit/s [hour]; internet access, work, 0.2 Mbit/s [hour]; intral [kg]; inverter, 0.5kW [unit]; inverter, 2.5kW [unit]; inverter, 500kW [unit]; ion-exchanger for water treatment [unit]; iron pellet [kg]; isohexane [kg]; isophthalic acid based unsaturated polyester resin [kg]; isopropyl acetate [kg]; isopropylamine [kg]; isoproturon [kg]; jatropha seed [kg]; keyboard [unit]; laser machining, metal, with CO2-laser, 2000W power [hour]; laser machining, metal, with CO2-laser, 2700W power [hour]; laser machining, metal, with CO2-laser, 3200W power [hour]; laser machining, metal, with CO2-laser, 4000W power [hour]; laser machining, metal, with CO2-laser, 5000W power [hour]; laser machining, metal, with CO2-laser, 6000W power [hour]; laser machining, metal, with YAG-laser, 120W power [hour]; laser machining, metal, with YAG-laser, 200W power [hour]; laser machining, metal, with YAG-laser, 30W power [hour]; laser machining, metal, with YAG-laser, 330W power [hour]; laser machining, metal, with YAG-laser, 40W power [hour]; laser machining, metal, with YAG-laser, 500W power [hour]; laser machining, metal, with YAG-laser, 50W power [hour]; laser machining, metal, with YAG-laser, 60W power [hour]; layered sodium silicate, SKS-6, powder [kg]; lead concentrate stockpiling [kg]; light emitting diode [kg]; lightweight concrete block, expanded clay [kg]; lightweight concrete block, expanded perlite [kg]; lignite briquettes factory [unit]; lignite dust factory [unit]; lime, packed [kg]; limestone, crushed, for mill [kg]; limestone quarry infrastructure [unit]; linseed seed, at farm [kg]; linseed seed, for sowing [kg]; liquid crystal display, unmounted [kg]; liquid manure spreading, by vacuum tanker [m3]; liquid manure storage and processing facility [m3]; liquid storage tank, chemicals, organics [unit]; lithium brine, 6.7 % Li [kg]; lithium hexafluorophosphate [kg]; lithium manganese oxide [kg]; lorry with refrigeration machine, R134a as refrigerant, 16 metric ton [unit]; lorry with refrigeration machine, carbon dioxide, liquid as refrigerant, 16 metric ton [unit]; machine, for treatment of waste electric and electronic equipment [unit]; machine operation, diesel, < 18.64 kW, generators [hour]; machine operation, diesel, < 18.64 kW, high load factor [hour]; machine operation, diesel, < 18.64 kW, low load factor [hour]; machine operation, diesel, < 18.64 kW, steady-state [hour]; machine operation, diesel, < 18.64 kW, underground mining [hour]; machine operation, diesel, >= 18.64 kW and <

74.57 kW, generators [hour]; machine operation, diesel, >= 18.64 kW and < 74.57 kW, high load factor [hour]; machine operation, diesel, >= 18.64 kW and < 74.57 kW, low load factor [hour]; machine operation, diesel, >= 18.64 kW and < 74.57 kW, steady-state [hour]; machine operation, diesel, >= 18.64 kW and < 74.57 kW, underground mining [hour]; machine operation, diesel, >= 74.57 kW, generators [hour]; machine operation, diesel, >= 74.57 kW, high load factor [hour]; machine operation, diesel, >= 74.57 kW, low load factor [hour]; machine operation, diesel, >= 74.57 kW, steady-state [hour]; machine operation, diesel, >= 74.57, underground mining [hour]; magnesium factory [unit]; magnesium-alloy, AZ91 [kg]; magnesium-alloy, AZ91, diecast [kg]; maintenance, barge [unit]; maintenance, bicycle [unit]; maintenance, bus [unit]; maintenance, electric bicycle [unit]; maintenance, electric scooter, without battery [unit]; maintenance, goods wagon [unit]; maintenance, heat and power co-generation unit, 160kW electrical [unit]; maintenance, intermodal shipping container, 20-foot [unit]; maintenance, intermodal shipping container, 40-foot [unit]; maintenance, intermodal shipping container, 40-foot, high-cube [unit]; maintenance, intermodal shipping container, 45-foot, high-cube [unit]; maintenance, light commercial vehicle [unit]; maintenance, locomotive [unit]; maintenance, lorry 16 metric ton [unit]; maintenance, lorry 28 metric ton [unit]; maintenance, lorry 40 metric ton [unit]; maintenance, micro gas turbine, 100kW electrical [unit]; maintenance, mini CHP plant [unit]; maintenance, motor scooter [unit]; passenger car maintenance [unit]; maintenance, passenger car, electric, without battery [unit]; maintenance, polymer electrolyte membrane fuel cell, 2kW electrical [unit]; maintenance, reefer, intermodal shipping container, 40-foot, high-cube [unit]; maintenance, solid oxide fuel cell, 125kW electrical, future [unit]; maintenance, solid oxide fuel cell, with micro gas turbine, 180kW electrical, future [unit]; maintenance, stirling heat and power co-generation unit, 3kW electrical, wood pellet, future [unit]; maintenance, train, passenger, high-speed [unit]; maintenance, train, passenger, long distance [unit]; maintenance, train, passenger, regional [unit]; maintenance, tram [unit]; maize grain, feed, Swiss integrated production [kg]; maize grain, feed, organic [kg]; maize seed, Swiss integrated production, at farm [kg]; maize seed, Swiss integrated production, for sowing [kg]; maize seed, at farm [kg]; maize seed, for sowing [kg]; maize seed, organic, at farm [kg]; maize seed, organic, for sowing [kg]; maleic anhydride [kg]; maleic unsaturated polyester resin [kg]; malusil [kg]; mancozeb [kg]; manual dismantling of used electric passenger car [unit]; manual dismantling of electric scooter [unit]; manual dismantling of used passenger car with internal combustion engine [unit]; manual treatment facility, waste electric and electronic equipment [unit]; marine electric motor [unit]; marine engine [unit]; NOx retained, by selective catalytic reduction [kg]; cable yarder with sled winch [unit]; cable yarding [hour]; cadmium sludge from zinc electrolysis [kg]; cattle for slaughtering, live weight [kg]; cement, alternative constituents 21-35% [kg]; cement, alternative constituents 6-20% [kg]; cement, pozzolana and fly ash 15-40% [kg]; chipper, mobile, diesel [unit]; diesel [kg]; diesel, low-sulfur [kg]; electrostatic paint [kg]; energy wood harvester [unit]; ethanol, without water, in 99.7% solution state, from fermentation, at service station [kg]; evaporation of milk [kg]; forestry harvester [unit]; forwarder [unit]; heat carrier liquid, 40% C3H8O2 [m3]; heat, from steam, in chemical industry [MJ]; heavy fuel oil [kg]; kerosene [kg]; light fuel oil [kg]; liquefied petroleum gas [kg]; meat and bone meal [kg]; mechanical treatment facility, waste electric and electronic equipment [unit]; mecoprop [kg]; metal coating facility [unit]; metal working factory [unit]; metal working, average for aluminium product manufacturing [kg]; metal working, average for chromium steel product manufacturing [kg]; metal working, average for copper product manufacturing [kg]; metal working, average for metal product manufacturing [kg]; metal working, average for steel product manufacturing [kg]; metaldehyde [kg]; metalliferous hydroxide sludge [kg]; metallization paste, back side [kg]; metallization paste, back side, aluminium [kg]; metallization paste, front side [kg]; metamitron [kg]; methane sulfonic acid [kg]; methane, 96% by volume, from biogas, from high pressure network, at service station [kg]; methane, 96% by volume, from biogas, from low pressure network, at service station [kg]; methane, 96% by volume, from biogas, from medium pressure network, at service station [kg]; methane, 96% by volume, from biogas, high pressure, at user [MJ]; methanol factory [unit]; methanol, from biomass [kg]; methyl acrylate [kg]; methyl formate [kg]; methyl iodide [kg]; methyl tert-butyl ether [kg]; methyl-3-methoxypropionate [kg]; methylamine [kg]; methylene diphenyl diisocyanate [kg]; metolachlor [kg]; micro gas turbine, 100kW electrical [unit]; milking [kg]; milking parlour [unit]; mine infrastructure, bauxite [unit]; mine infrastructure, gold [unit]; mine infrastructure, gold and silver [unit]; mine infrastructure, gold-silver-zinc-lead-copper [unit]; mine infrastructure, iron [unit]; mine infrastructure, open cast, hard coal [unit]; mine infrastructure, open cast, ilmenite from hard-rock ore [unit]; mine infrastructure, open cast, non-ferrous metal [unit]; mine infrastructure, open cast, uranium [unit]; mine infrastructure, phosphate rock [unit]; mine infrastructure, steatite [unit]; mine infrastructure, underground, hard coal [unit]; mine infrastructure, underground, non-ferrous metal [unit]; mine infrastructure, underground, uranium [unit]; mine infrastructure, vermiculite [unit]; mini CHP plant,

common components for heat+electricity [unit]; mini CHP plant, components for electricity only [unit]; mini CHP plant, components for heat only [unit]; mint seedling, for planting [unit]; mischmetal [kg]; mobile cable yarder, trailer-mounted [unit]; mobile cable yarder, truck-mounted, incl. processor [unit]; molybdenum trioxide [kg]; mounting, through-hole technology, Pb-containing solder [m2]; mounting, through-hole technology, Pb-free solder [m2]; mowing, by motor mower [ha]; mowing, by rotary mower [ha]; mulching [ha]; multi-Si wafer [m2]; multi-Si wafer, ribbon [m2]; municipal waste collection service by 21 metric ton lorry [metric ton*km]; municipal waste incineration facility [unit]; naphtha [kg]; naphthalene sulfonic acid [kg]; napropamide [kg]; natural gas processing plant [unit]; natural gas, burned in gas motor, for storage [MJ]; nitrobenzene [kg]; nitrous dioxide [kg]; nitrous oxide [kg]; non-ferrous metal smelter [unit]; non-ionic surfactant [kg]; nuclear power plant, boiling water reactor 1000MW [unit]; nuclear power plant, pressure water reactor 1000MW [unit]; nuclear power plant, pressure water reactor, 650MW [unit]; nuclear spent fuel reprocessing facility [unit]; nuclear waste storage, final repository for high level radioactive waste [unit]; o-aminophenol [kg]; o-chlorobenzaldehyde [kg]; o-chlorotoluene [kg]; o-cresol [kg]; o-nitrophenol [kg]; oat grain, feed [kg]; oat seed, Swiss integrated production, at farm [kg]; oat seed, for sowing [kg]; offshore platform, natural gas [unit]; offshore well, oil/gas [m]; oil mill [unit]; onion seedling, for planting [unit]; onshore natural gas field infrastructure [unit]; onshore well, oil/gas [m]; operation, computer, desktop, home use [hour]; operation, computer, desktop, office use [hour]; operation, computer, desktop, with cathode ray tube display, active mode [hour]; operation, computer, desktop, with cathode ray tube display, off mode [hour]; operation, computer, desktop, with cathode ray tube display, standby mode [hour]; operation, computer, desktop, with liquid crystal display, active mode [hour]; operation, computer, desktop, with liquid crystal display, off mode [hour]; operation, computer, desktop, with liquid crystal display, standby mode [hour]; operation, computer, laptop, 23% active work [hour]; operation, computer, laptop, 68% active work [hour]; operation, computer, laptop, 68% active work with internet access 0.2 Mbit/s [hour]; operation, computer, laptop, 68% active work with internet access 0.2 Mbit/s, label-certified electricity [hour]; operation, computer, laptop, 68% active work, label-certified electricity [hour]; operation, computer, laptop, active mode [hour]; operation, computer, laptop, off mode [hour]; operation, computer, laptop, standby/sleep mode [hour]; operation, computer, laptop, video mode [hour]; operation, computer, laptop, video mode, label-certified electricity [hour]; operation, computer, laptop, videoconference [hour]; operation, computer, laptop, videoconference, label-certified electricity [hour]; operation, dried roughage store, air dried, solar [kg]; operation, dried roughage store, cold-air dried, conventional [kg]; operation, dried roughage store, non ventilated [kg]; operation, housing system, cattle, loose, per animal unit [unit]; operation, housing system, cattle, tied, per animal unit [unit]; operation, housing system, pig, fully-slatted floor, per pig place [unit]; operation, housing system, pig, label-certified, per pig place [unit]; operation, intermodal shipping container [kg*day]; operation, internet access equipment [hour]; operation, internet access equipment, label-certified electricity [hour]; operation, liquid manure storage and processing facility [m3]; operation, reefer, cooling [kg*day]; operation, reefer, freezing [kg*day]; orbencarb [kg]; orthophthalic acid based unsaturated polyester resin [kg]; ozone, liquid [kg]; p-chlorophenol [kg]; p-nitrophenol [kg]; p-nitrotoluene [kg]; packaging glass, brown [kg]; packaging glass, green [kg]; packaging glass, white [kg]; packaging, for fertilisers or pesticides [kg]; packing, fibre cement product [kg]; packing, lime product [kg]; palm date, conditioned and dried [kg]; palm date, conditioned and dried, organic [kg]; passenger car, electric, without battery [kg]; pea seed, for sowing [kg]; pea seed, organic, for sowing [kg]; peanut seed, at farm [kg]; peanut seed, for sowing [kg]; pendimethalin [kg]; permanent magnet, for electric motor [kg]; petrol, low-sulfur [kg]; petrol, unleaded [kg]; petrol, unleaded, burned in machinery [MJ]; phenoxy-compound [kg]; phosgene, liquid [kg]; phosphane [kg]; phosphorous chloride [kg]; phosphorus oxychloride [kg]; phosphorus pentachloride [kg]; phosphorus trichloride [kg]; phosphorus, white, liquid [kg]; phosphoryl chloride [kg]; photovoltaic cell, multi-Si wafer [m2]; photovoltaic cell, single-Si wafer [m2]; photovoltaic facade installation, 3kWp, multi-Si, laminated, integrated, at building [unit]; photovoltaic facade installation, 3kWp, multi-Si, panel, mounted, at building [unit]; photovoltaic facade installation, 3kWp, single-Si, laminated, integrated, at building [unit]; photovoltaic facade installation, 3kWp, single-Si, panel, mounted, at building [unit]; photovoltaic flat-roof installation, 3kWp, multi-Si, on roof [unit]; photovoltaic flat-roof installation, 3kWp, single-Si, on roof [unit]; photovoltaic laminate, ribbon-Si [m2]; photovoltaic module, building-integrated, for facade installation [m2]; photovoltaic module, building-integrated, for slanted-roof installation [m2]; photovoltaic mounting system, for 570kWp open ground module [m2]; photovoltaic mounting system, for facade installation [m2]; photovoltaic mounting system, for flat-roof installation [m2]; photovoltaic mounting system, for slanted-roof installation [m2]; photovoltaic panel factory [unit]; photovoltaic panel, CIS [m2]; photovoltaic panel, a-Si [m2]; photovoltaic plant, 570kWp, multi-Si, on open ground [unit];

photovoltaic slanted-roof installation, 3kWp, CIS, panel, mounted, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, CdTe, laminated, integrated, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, a-Si, laminated, integrated, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, a-Si, panel, mounted, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, multi-Si, laminated, integrated, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, multi-Si, panel, mounted, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, ribbon-Si, laminated, integrated, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, ribbon-Si, panel, mounted, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, single-Si, laminated, integrated, on roof [unit]; photovoltaic slanted-roof installation, 3kWp, single-Si, panel, mounted, on roof [unit]; photovoltaic plant, electric installation for 3kWp module [unit]; photovoltaic plant, electric installation for 570kWp open ground module [unit]; phthalimide [kg]; phthalimide-compound [kg]; pipeline, natural gas, high pressure distribution network [km]; piperidine [kg]; planning, cogen unit mini CHP plant [unit]; planning, heat and power co-generation unit, 160kW electrical [unit]; planting [ha]; planting tree [unit]; plaster mixing [kg]; plastic processing factory [unit]; plastic tunnel [m2]; plug, inlet and outlet, for computer cable [unit]; plug, inlet and outlet, for network cable [unit]; plug, inlet and outlet, for printer cable [unit]; pointing device, optical mouse, with cable [unit]; polarizer, liquid crystals and colour filters, for liquid crystal display [kg]; polyacrylamide [kg]; polyaluminium chloride [kg]; polycarboxylates, 40% active substance [kg]; polydimethylsiloxane [kg]; polymer foaming [kg]; polyphenylene sulfide [kg]; polyvinylfluoride [kg]; polyvinylfluoride, dispersion [kg]; polyvinylfluoride, film [kg]; port facilities [unit]; portafer [kg]; potassium perchlorate [kg]; potato grading [kg]; potato haulm cutting [ha]; potato planting [ha]; potato seed, Swiss integrated production, at farm [kg]; potato seed, Swiss integrated production, for setting [kg]; potato seed, at farm [kg]; potato seed, for setting [kg]; potato seed, organic, at farm [kg]; potato seed, organic, for setting [kg]; powder coat, aluminium sheet [m2]; powder coat, steel [m2]; power block, solar thermal parabolic trough, 50 MW [unit]; power block, solar tower power plant, 20 MW [unit]; power saw, with catalytic converter [unit]; power saw, without catalytic converter [unit]; power sawing, with catalytic converter [hour]; power sawing, without catalytic converter [hour]; power supply unit, for desktop computer [unit]; precious metal refinery [unit]; printed paper [kg]; printed wiring board mounting facility, surface mounting line [unit]; printed wiring board mounting facility, through-hole mounting line [unit]; printed wiring board, for power supply unit, desktop computer, Pb containing [kg]; printed wiring board, for power supply unit, desktop computer, Pb free [kg]; printed wiring board, for surface mounting, Pb containing surface [m2]; printed wiring board, for surface mounting, Pb free surface [m2]; printed wiring board, for through-hole mounting, Pb containing surface [m2]; printed wiring board, for through-hole mounting, Pb free surface [m2]; printed wiring board, mounted mainboard, desktop computer, Pb containing [kg]; printed wiring board, mounted mainboard, desktop computer, Pb free [kg]; printed wiring board, mounted mainboard, laptop computer, Pb containing [kg]; printed wiring board, mounted mainboard, laptop computer, Pb free [kg]; printed wiring board, surface mounted, unspecified, Pb containing [kg]; printed wiring board, surface mounted, unspecified, Pb free [kg]; printed wiring board, through-hole mounted, unspecified, Pb containing [kg]; printed wiring board, through-hole mounted, unspecified, Pb free [kg]; process-specific burdens, hazardous waste incineration plant [kg]; process-specific burdens, import of copper to Switzerland [kg]; process-specific burdens, inert material landfill [kg]; process-specific burdens, municipal waste incineration [kg]; process-specific burdens, residual material landfill [kg]; process-specific burdens, sanitary landfill [kg]; process-specific burdens, slag landfill [kg]; propanal [kg]; propane, burned in building machine [MJ]; propyl amine [kg]; propylene oxide, liquid [kg]; prosulfocarb [kg]; protein pea, feed, Swiss integrated production [kg]; purse seiner maintenance, steel [kg]; purse seiner maintenance, wood [kg]; purse seiner, steel [kg]; purse seiner, wood [kg]; pyrazole [kg]; pyrethroid-compound [kg]; pyridine-compound [kg]; railway track [m*year]; railway track, for high-speed train [m*year]; rainwater mineral oil storage [m3]; rape oil, crude [kg]; rape seed [kg]; rape seed, Swiss integrated production [kg]; rape seed, for sowing [kg]; rape seed, organic [kg]; rape seed, organic, for sowing [kg]; receiver system, solar tower power plant, 20 MW [unit]; recultivation, bauxite mine [m2]; recultivation, bentonite mine [m2]; recultivation, ilmenite mine [m2]; recultivation, iron mine [m2]; recultivation, limestone mine [m2]; recultivation, shale quarry [m2]; reefer, intermodal shipping container, 40-foot, high-cube, R134a as refrigerant [unit]; reefer, intermodal shipping container, 40-foot, high-cube, carbon dioxide, liquid as refrigerant [unit]; petroleum refinery [unit]; reinforcing steel [kg]; residual material landfill [unit]; resistor, metal film type, through-hole mounting [kg]; resistor, surface-mounted [kg]; resistor, wirewound, through-hole mounting [kg]; retention aid, for paper production [kg]; rice seed, for sowing [kg]; road [m*year]; road maintenance [m*year]; road vehicle factory [unit]; road, company, internal [m2*year]; rock crushing [kg]; room-connecting overflow element, steel, approx. 40 m3/h [unit]; rutile, 95% titanium dioxide [kg]; rye grain, feed, Swiss integrated production [kg]; rye

grain, feed, organic [kg]; rye seed, Swiss integrated production, for sowing [kg]; rye seed, for sowing [kg]; rye seed, organic, for sowing [kg]; sanitary landfill facility [unit]; sawmill [unit]; seal, natural rubber based [kg]; seawater reverse osmosis module [m2]; section bar rolling, steel [kg]; selective coat, aluminium sheet, nickel pigmented aluminium oxide [m2]; selective coat, copper sheet, black chrome [m2]; selective coat, copper sheet, black majic [m2]; selective coat, copper sheet, physical vapour deposition [m2]; selective coat, copper sheet, sputter deposition [m2]; selective coat, stainless steel sheet, black chrome [m2]; shed [m2]; shed, large, wood, non-insulated, fire-unprotected [m2]; sheet rolling, aluminium [kg]; sheet rolling, chromium steel [kg]; sheet rolling, copper [kg]; sheet rolling, steel [kg]; silencer, steel, DN 125 [unit]; silencer, steel, DN 315, 50 mm [unit]; silica fume, densified [kg]; silicon, multi-Si, casted [kg]; silicon, single crystal, Czochralski process, electronics [kg]; silicon, single crystal, Czochralski process, photovoltaics [kg]; single-Si wafer, for electronics [m2]; single-Si wafer, photovoltaic [m2]; sinter, iron [kg]; skidder [unit]; skidding, skidder [hour]; slag landfill [unit]; small pelagic fish, fresh [kg]; sodium aluminate, powder [kg]; sodium amide [kg]; sodium arsenide [kg]; sodium borates [kg]; sodium chloride, brine solution [kg]; sodium chloride, powder [kg]; sodium chloroacetate [kg]; sodium ethoxide [kg]; sodium hydrogen sulfite [kg]; sodium hydrosulfide [kg]; sodium metasilicate pentahydrate, 58% active substance, powder [kg]; sodium perborate, monohydrate, powder [kg]; sodium perborate, tetrahydrate, powder [kg]; sodium percarbonate, powder [kg]; sodium perchlorate [kg]; sodium persulfate [kg]; sodium phenolate [kg]; sodium pyrophosphate [kg]; soft solder, Sn97Cu3 [kg]; solar collector factory [unit]; solar collector glass tube, with silver mirror [kg]; solar collector system, Cu flat plate collector, multiple dwelling, hot water [unit]; solar collector system, with evacuated tube collector, one-family house, combined system [unit]; solder factory [unit]; solder, bar, Sn63Pb37, for electronics industry [kg]; solder, bar, Sn95.5Ag3.9Cu0.6, for electronics industry [kg]; solder, paste, Sn95.5Ag3.9Cu0.6, for electronics industry [kg]; solid manure loading and spreading, by hydraulic loader and spreader [kg]; sorting facility, for construction waste [unit]; sour gas, burned in gas turbine [MJ]; sowing [ha]; soybean seed, for sowing [kg]; soybean seed, organic, for sowing [kg]; spiral-seam duct, steel, DN 125 [m]; spiral-seam duct, steel, DN 400 [m]; spray-drying of milk [kg]; sputtering target, sintered, indium tin oxide [kg]; sputtering, indium tin oxide, for liquid crystal display [m3]; start-up, heat and power co-generation unit, 160kW electrical [unit]; steam generation system, solar tower power plant, 20 MW [unit]; steam, in chemical industry [kg]; steel removed by drilling, computer numerical controlled [kg]; steel removed by drilling, conventional [kg]; steel removed by milling, average [kg]; steel removed by milling, dressing [kg]; steel removed by milling, large parts [kg]; steel removed by milling, small parts [kg]; steel removed by turning, average, computer numerical controlled [kg]; steel removed by turning, average, conventional [kg]; steel removed by turning, primarily dressing, computer numerical controlled [kg]; steel removed by turning, primarily dressing, conventional [kg]; steel removed by turning, primarily roughing, computer numerical controlled [kg]; steel removed by turning, primarily roughing, conventional [kg]; stimulation, deep well [m3]; stirling heat and power co-generation unit, 3kW electrical, future [unit]; stone meal [kg]; stone wool factory [unit]; stone wool, packed [kg]; storage building, chemicals, solid [unit]; storage, 10'000 l [unit]; strawberry seedling, for planting [unit]; stretch blow moulding [kg]; sugar beet seed, for sowing [kg]; sulfamic acid [kg]; sulfite [kg]; sulfur dichloride [kg]; sulfur hexafluoride, liquid [kg]; sulfur stockpiling [kg]; sulfur trioxide [kg]; sulfuryl chloride [kg]; sunflower seed [kg]; sunflower seed, Swiss integrated production [kg]; sunflower seed, for sowing [kg]; supply air inlet, steel/SS, DN 75 [unit]; swath, by rotary windrower [ha]; sweet gas, burned in gas turbine [MJ]; sweetening, natural gas [m3]; switch, toggle type [kg]; tellurium, semiconductor-grade [kg]; tempering, flat glass [kg]; terrain chipper on forwarder [unit]; tert-butyl amine [kg]; tetraethyl orthosilicate [kg]; tetrafluoroethylene film, on glass [kg]; thermal plaster, outdoor [kg]; thermal storage system, solar thermal parabolic trough, 50 MW [unit]; thermal storage system, solar tower power plant, 20 MW [unit]; thermoforming of plastic sheets [kg]; thermoforming, with calendering [kg]; thionyl chloride [kg]; three layered laminated board [m3]; tillage, cultivating, chiselling [ha]; tillage, currying, by weeder [ha]; tillage, harrowing, by rotary harrow [ha]; tillage, harrowing, by spring tine harrow [ha]; tillage, hoeing and earthing-up, potatoes [ha]; tillage, ploughing [ha]; tillage, rolling [ha]; tillage, rotary cultivator [ha]; tin dioxide [kg]; tin plated chromium steel sheet, 2 mm [m2]; tin plating, pieces [m2]; titanium dioxide [kg]; titanium tetrachloride [kg]; tomato seedling, for planting [unit]; train, passenger, high speed [unit]; train, passenger, long-distance [unit]; tram track [m*year]; transistor, auxilliaries and energy use [kg]; transistor, surface-mounted [kg]; transistor, wired, big size, through-hole mounting [kg]; transistor, wired, small size, through-hole mounting [kg]; transmission network, long-distance [km]; transport, freight, aircraft with reefer, cooling [metric ton*km]; transport, freight, aircraft with reefer, freezing [metric ton*km]; transport, freight, aircraft, unspecified [metric ton*km]; transport, freight, conveyor belt [metric ton*km]; transport, freight, inland waterways, barge [metric ton*km]; transport, freight, inland waterways,

barge tanker [metric ton*km]; transport, freight, inland waterways, barge with reefer, cooling [metric ton*km]; transport, freight, inland waterways, barge with reefer, freezing [metric ton*km]; transport, freight, light commercial vehicle [metric ton*km]; transport, freight, lorry 16-32 metric ton, EURO3 [metric ton*km]; transport, freight, lorry 16-32 metric ton, EURO4 [metric ton*km]; transport, freight, lorry 16-32 metric ton, EURO5 [metric ton*km]; transport, freight, lorry 16-32 metric ton, EURO6 [metric ton*km]; transport, freight, lorry 28 metric ton, vegetable oil methyl ester 100% [metric ton*km]; transport, freight, lorry 3.5-7.5 metric ton, EURO3 [metric ton*km]; transport, freight, lorry 3.5-7.5 metric ton, EURO4 [metric ton*km]; transport, freight, lorry 3.5-7.5 metric ton, EURO5 [metric ton*km]; transport, freight, lorry 3.5-7.5 metric ton, EURO6 [metric ton*km]; transport, freight, lorry 7.5-16 metric ton, EURO3 [metric ton*km]; transport, freight, lorry 7.5-16 metric ton, EURO4 [metric ton*km]; transport, freight, lorry 7.5-16 metric ton, EURO5 [metric ton*km]; transport, freight, lorry 7.5-16 metric ton, EURO6 [metric ton*km]; transport, freight, lorry >32 metric ton, EURO3 [metric ton*km]; transport, freight, lorry >32 metric ton, EURO4 [metric ton*km]; transport, freight, lorry >32 metric ton, EURO5 [metric ton*km]; transport, freight, lorry >32 metric ton, EURO6 [metric ton*km]; transport, freight, lorry with reefer, cooling [metric ton*km]; transport, freight, lorry with reefer, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO3, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO4, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO5, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 3.5-7.5 ton, EURO6, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO3, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO4, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO5, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, R134a refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, freezing [metric ton*km]; transport, freight, lorry with refrigeration machine, 7.5-16 ton, EURO6, carbon dioxide, liquid refrigerant, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, cooling [metric ton*km]; transport, freight, lorry with refrigeration machine, freezing [metric ton*km]; transport, freight, lorry, unspecified [metric ton*km]; transport, freight, sea, container ship with reefer, cooling [metric ton*km]; transport, freight, sea, container ship with reefer, freezing [metric ton*km]; transport, freight, train with reefer, cooling [metric ton*km]; transport, freight, train with reefer, freezing [metric ton*km];

transport, helicopter [hour]; transport, helicopter, LTO cycle [unit]; transport, passenger car [km]; transport, passenger car with internal combustion engine [km]; transport, passenger car, EURO 3 [km]; transport, passenger car, EURO 4 [km]; transport, passenger car, EURO 5 [km]; transport, passenger car, electric [km]; transport, passenger car, large size, diesel, EURO 3 [km]; transport, passenger car, large size, diesel, EURO 4 [km]; transport, passenger car, large size, diesel, EURO 5 [km]; transport, passenger car, large size, natural gas, EURO 3 [km]; transport, passenger car, large size, natural gas, EURO 4 [km]; transport, passenger car, large size, natural gas, EURO 5 [km]; transport, passenger car, large size, petrol, EURO 4 [km]; transport, passenger car, large size, petrol, EURO 3 [km]; transport, passenger car, large size, petrol, EURO 5 [km]; transport, passenger car, medium size, diesel, EURO 3 [km]; transport, passenger car, medium size, diesel, EURO 4 [km]; transport, passenger car, medium size, diesel, EURO 5 [km]; transport, passenger car, medium size, liquefied petroleum gas, EURO 5 [km]; transport, passenger car, medium size, natural gas, EURO 3 [km]; transport, passenger car, medium size, natural gas, EURO 4 [km]; transport, passenger car, medium size, natural gas, EURO 5 [km]; transport, passenger car, medium size, petrol, EURO 3 [km]; transport, passenger car, medium size, petrol, EURO 4 [km]; transport, passenger car, medium size, petrol, EURO 5 [km]; transport, passenger car, small size, diesel, EURO 3 [km]; transport, passenger car, small size, diesel, EURO 4 [km]; transport, passenger car, small size, diesel, EURO 5 [km]; transport, passenger car, small size, natural gas, EURO 3 [km]; transport, passenger car, small size, natural gas, EURO 4 [km]; transport, passenger car, small size, natural gas, EURO 5 [km]; transport, passenger car, small size, petrol, EURO 3 [km]; transport, passenger car, small size, petrol, EURO 4 [km]; transport, passenger car, small size, petrol, EURO 5 [km]; transport, passenger coach [person*km]; transport, passenger train [person*km]; transport, passenger, aircraft, unspecified [person*km]; transport, passenger, bicycle [person*km]; transport, passenger, electric bicycle [person*km]; transport, passenger, electric bicycle, label-certified electricity [person*km]; transport, passenger, electric scooter [km]; transport, passenger, motor scooter [person*km]; transport, pipeline, offshore, petroleum [metric ton*km]; transport, pipeline, onshore, petroleum [metric ton*km]; transport, regular bus [person*km]; transport, tractor and trailer, agricultural [metric ton*km]; transport, tram [person*km]; transport, trolleybus [person*km]; trawler maintenance, steel [kg]; trawler, steel [kg]; tree seedling, for planting [unit]; trellis system, wooden poles, soft wood, tar impregnated [ha]; trichloroborane [kg]; triethyl amine [kg]; trifluoroacetic acid [kg]; trifluoromethane [kg]; trimethyl borate [kg]; triphenyl phosphate [kg]; tris(2,4-ditert-butylphenyl) phosphite [kg]; trisodium phosphate [kg]; tube insulation factory [unit]; ultrafiltration module [unit]; ultraviolet lamp [unit]; uranium conversion facility [unit]; uranium enrichment diffusion facility [unit]; uranium mill [unit]; uranium, enriched 3.0%, per separative work unit [unit]; uranium, enriched 3.8%, per separative work unit [unit]; uranium, enriched 3.9%, per separative work unit [unit]; uranium, enriched 4.0%, per separative work unit [unit]; uranium, enriched 4.2%, per separative work unit [unit]; uranium, in yellowcake [kg]; vanilla seedling, for planting [unit]; vegetable oil esterification facility [unit]; vegetable oil refinery [unit]; ventilation components factory [unit]; ventilation control and wiring, central unit [unit]; ventilation control and wiring, decentralized unit [unit]; ventilation duct, connection piece, steel, 100x50 mm [unit]; ventilation duct, elbow 90°, steel, 100x50 mm [unit]; ventilation duct, steel, 100x50 mm [m]; ventilation of dwellings, central, 1 x 720 m3/h [m2*year]; ventilation of dwellings, decentralized, 6 x 120 m3/h [m2*year]; ventilation system, central, 1 x 720 m3/h, polyethylene ducts, with earth tube heat exchanger [unit]; ventilation system, central, 1 x 720 m3/h, steel ducts, with earth tube heat exchanger [unit]; ventilation system, decentralized, 6 x 120 m3/h, polyethylene ducts [unit]; ventilation system, decentralized, 6 x 120 m3/h, polyethylene ducts, with earth tube heat exchanger [unit]; ventilation system, decentralized, 6 x 120 m3/h, steel ducts [unit]; ventilation system, decentralized, 6 x 120 m3/h, steel ducts, with earth tube heat exchanger [unit]; wafer factory [unit]; wafer, fabricated, for integrated circuit [m2]; waste collection lorry, 21 metric ton [unit]; waste paperboard, unsorted [kg]; wastewater treatment facility, capacity 1.1E10l/year [unit]; wastewater treatment facility, capacity 1.6E8l/year [unit]; wastewater treatment facility, capacity 1E9l/year [unit]; wastewater treatment facility, capacity 4.7E10l/year [unit]; wastewater treatment facility, capacity 5E9l/year [unit]; water works, capacity 1.1E10l/year [unit]; water works, capacity 6.23E10l/year [unit]; water, deionised [kg]; welding, arc, aluminium [m]; welding, arc, steel [m]; welding, gas, steel [m]; wheat grain, feed [kg]; wheat grain, feed, Swiss integrated production [kg]; wheat grain, feed, organic [kg]; wheat seed, Swiss integrated production, for sowing [kg]; wheat seed, for sowing [kg]; wheat seed, organic, for sowing [kg]; white spirit [kg]; wind turbine network connection, 750kW, onshore [unit]; wind turbine, 2.3MW, onshore [unit]; wind turbine, 750kW, onshore [unit]; window frame, poly vinyl chloride, U=1.6 W/m2K [m2]; wire drawing, steel [kg]; wood chipping, chipper, mobile, diesel, at forest road [hour]; wood chipping, forwarder with terrain chipper, in forest [hour]; wood chipping, industrial residual wood, stationary electric chipper [kg]; wood chips and particles, willow

[kg]; wood cladding, softwood [m2]; wood pellet factory [unit]; wood preservation facility, dipping/immersion tank [unit]; wood preservation facility, flow coating equipment [unit]; wood preservation facility, hot/cold dipping tank [unit]; wood preservation facility, oscillating pressure method [unit]; wood preservation facility, vacuum pressure method [unit]; wood preservation, dipping/immersion method, organic solvent-based, indoor use, dry [kg]; wood preservation, dipping/immersion method, organic solvent-based, indoor use, occasionally wet [kg]; wood preservation, dipping/immersion method, organic solvent-based, outdoor use, no ground contact [kg]; wood preservation, dipping/immersion method, water-based, indoor use, dry [kg]; wood preservation, dipping/immersion method, water-based, indoor use, occasionally wet [kg]; wood preservation, dipping/immersion method, water-based, outdoor use, no ground contact [kg]; wood preservation, hot/cold dipping, creosote, outdoor use, ground contact [kg]; wood preservation, oscillating pressure method, inorganic salt, containing Cr, outdoor use, ground contact [kg]; wood preservation, oscillating pressure method, organic salt, Cr-free, outdoor use, ground contact [kg]; wood preservation, pressure vessel, creosote, outdoor use, ground contact [kg]; wood preservation, spray tunnel/deluging, organic solvent-based, indoor use, dry [kg]; wood preservation, spray tunnel/deluging, organic solvent-based, indoor use, occasionally wet [kg]; wood preservation, spray tunnel/deluging, organic solvent-based, outdoor use, no ground contact [kg]; wood preservation, spray tunnel/deluging, water-based, indoor use, dry [kg]; wood preservation, spray tunnel/deluging, water-based, indoor use, occasionally wet [kg]; wood preservation, spray tunnel/deluging, water-based, outdoor use, no ground contact [kg]; wood preservation, vaccum pressure method, inorganic salt, containing Cr, outdoor use, ground contact [kg]; wood preservation, vacuum pressure method, organic salts, Cr-free, outdoor use, ground contact [kg]; wood preservative, creosote [kg]; wood preservative, inorganic salt, containing Cr [kg]; wood preservative, organic salt, Cr-free [kg]; wood preservative, organic, indoor use, dry [kg]; wood preservative, organic, indoor use, occasionally wet [kg]; wood preservative, organic, outdoor use, no ground contact [kg]; wood preservative, water-based, indoor use, dry [kg]; wood preservative, water-based, indoor use, occasionally wet [kg]; wood preservative, water-based, outdoor use, no ground contact [kg]; wood wool boards, cement bonded [m3]; zeolite, slurry, without water, in 50% solution state [kg]; zinc coat, coils [m2]; zinc coat, pieces [m2]; zinc coat, pieces, adjustment per micro-m [m2]; cow milk [kg]; molybdenum [kg]; printed paper, offset [kg]; oil boiler, 100kW [unit]; oil boiler, 10kW [unit]; formaldehyde [kg]; zinc [kg]; nickel, 99.5% [kg]; solar collector system, Cu flat plate collector, one-family house, combined system [unit]; solar collector system, Cu flat plate collector, one-family house, hot water [unit]; aluminium in car shredder residue [kg]; biowaste [kg]; copper in car shredder residue [kg]; digester sludge [kg]; lead in car shredder residue [kg]; municipal solid waste [kg]; raw sewage sludge [kg]; residue from mechanical treatment, IT accessory [kg]; residue from mechanical treatment, cathode ray tube display [kg]; residue from mechanical treatment, desktop computer [kg]; residue from mechanical treatment, industrial device [kg]; residue from mechanical treatment, laptop computer [kg]; residue from mechanical treatment, laser printer [kg]; residue from mechanical treatment, liquid crystal display [kg]; residue from shredder fraction from manual dismantling [kg]; scrap tin sheet [kg]; slaughterhouse waste [kg]; spent anion exchange resin from potable water production [kg]; spent cation exchange resin from potable water production [kg]; steel in car shredder residue [kg]; used liquid crystal display module [kg]; used purse seiner, wood [kg]; used toner module, laser printer, black/white [kg]; used toner module, laser printer, colour [kg]; waste bitumen sheet [kg]; waste building wood, chrome preserved [kg]; waste cement-fibre slab, dismantled [kg]; waste emulsion paint [kg]; waste expanded polystyrene [kg]; waste graphical paper [kg]; waste newspaper [kg]; waste packaging paper [kg]; waste paint [kg]; waste paperboard [kg]; waste plastic, consumer electronics [kg]; waste plastic, industrial electronics [kg]; waste plastic, mixture [kg]; waste polyethylene terephthalate [kg]; waste polyethylene [kg]; waste polypropylene [kg]; waste polystyrene [kg]; waste polyurethane [kg]; waste polyvinylchloride [kg]; waste polyvinylfluoride [kg]; waste rubber, unspecified [kg]; waste sealing sheet, polyethylene [kg]; waste sealing sheet, polyvinylchloride [kg]; waste textile, soiled [kg]; waste vapour barrier, flame-retarded [kg]; waste wire plastic [kg]; waste wood pole, chrome preserved [kg]; waste wood, untreated [kg]; zinc in car shredder residue [kg]; landed tuna, frozen, EPO [kg].

Annex 2: activities with changes in concrete

airport construction, 1990-2000 [GLO]; airport construction, 1990-2000 [RER]; aluminium casting facility construction, 2002-2002 [GLO]; aluminium casting facility construction, 2002-2002 [RER]; aluminium electrolysis facility construction, 2002-2002 [GLO]; aluminium electrolysis facility construction, 2002-2002 [RER]; aluminium hydroxide factory construction, 2002-2002 [GLO]; aluminium hydroxide factory construction, 2002-2002 [RER]; aluminium melting furnace production, 2002-2002 [GLO]; aluminium melting furnace production, 2002-2002 [RER]; anode factory construction, 2002-2002 [GLO]; anode factory construction, 2002-2002 [RER]; anode refinery construction, 2000-2005 [GLO; SE]; bentonite quarry construction, 1997-2000 [GLO]; bentonite quarry construction, 1997-2000 [DE]; blast furnace production, 2002-2002 [GLO]; blast furnace production, 2002-2002 [RER]; blast oxygen furnace converter production, 2002-2002 [GLO]; blast oxygen furnace converter production, 2002-2002 [RER]; blister-copper conversion facility construction, 2000-2005 [GLO; SE]; building construction, hall, steel construction, 2000-2001 [GLO]; building construction, hall, wood construction, 2000-2001 [GLO]; canal construction, 1993-1994 [GLO]; canal construction, 1993-1994 [RER]; chemical factory construction, 2000-2000 [GLO; RER]; chimney production, 1993-1993 [GLO]; chipper production, stationary, electric, 1996-1996 [RER]; chipper production, stationary, electric, 1996-1996 [GLO]; composting facility construction, open, 1999-1999 [GLO]; construction work, heat and power co-generation unit, 160kW electrical, 1987-2000 [GLO; RER]; conveyor belt production, 2000-2001 [GLO; RER]; electric arc furnace converter construction, 2002-2002 [GLO]; electric arc furnace converter construction, 2002-2002 [RER]; electronic component factory construction, 2005-2005 [GLO]; ethanol fermentation plant construction, 1997-2004 [GLO]; greenhouse construction, glass walls and roof, metal tubes, 2005-2012 [FR; GLO]; greenhouse construction, glass walls and roof, plastic tubes, 2005-2012 [FR; GLO]; greenhouse construction, plastic walls and roof, metal tubes, 2005-2012 [FR; GLO]; greenhouse construction, plastic walls and roof, plastic tubes, 2005-2012 [FR; GLO]; heat and power co-generation unit construction, 1MWel, 2015-2015 [GLO]; heat and power co-generation unit construction, 1MWel, 6.4 MWth, 2016-2016 [GLO]; heat and power co-generation unit construction, organic Rankine cycle, 3MW electrical, 2008-2008 [GLO]; inert material landfill construction, 1995-1995 [GLO]; infrastructure construction, for regional distribution of oil product, 1991-1992 [GLO; RER]; liquid storage tank production, chemicals, organics, 1996-1999 [GLO]; methanol factory construction, 2000-2002 [GLO]; offshore platform production, petroleum, 1990-2000 [GLO]; packaging glass factory construction, 2000-2000 [GLO; RER]; packaging glass sorting facility construction, 1994-2000 [GLO; RER]; paper machine production, 2000-2000 [GLO; RER]; phosphoric acid factory construction, fertiliser grade, 1986-1999 [GLO; US]; pipeline construction, natural gas, long distance, high capacity, offshore, 2001-2001 [GLO]; pipeline construction, petroleum, offshore, 1981-2001 [GLO]; planing mill production, 2002-2002 [RER]; planing mill production, 2002-2002 [GLO]; plastic tunnel construction, 2005-2012 [FR; GLO]; port facilities construction, 1990-1992 [GLO]; port facilities construction, 1990-1992 [RER]; precious metal refinery construction, 2000-2005 [GLO; SE]; railway track construction, 1990-2000 [GLO]; railway track construction, for high-speed train, 2000-2000 [GLO]; railway track construction, for high-speed train, 2000-2000 [DE]; residential sewer grid construction, 0.087 km, 1996-1996 [GLO]; residual material landfill construction, 1995-1995 [GLO]; road construction, 1990-2000 [GLO]; sanitary landfill facility construction, 1995-1995 [GLO]; sawmill construction, 2002-2002 [Europe without Switzerland]; sawmill construction, 2002-2002 [GLO]; scrap preparation facility construction, 2002-2002 [GLO]; scrap preparation facility construction, 2002-2002 [RER]; sewer grid construction, 1.1E10l/year, 242 km, 1996-1996 [GLO]; sewer grid construction, 1.6E8l/year, 6 km, 1996-1996 [GLO]; sewer grid construction, 1E9l/year, 30 km, 1996-1996 [GLO]; sewer grid construction, 4.7E10l/year, 583 km, 1996-1996 [GLO]; sewer grid construction, 5E9l/year, 110 km, 1996-1996 [GLO]; slag landfill construction, 1995-1995 [GLO]; sugar refinery construction, 2004-2008 [GLO]; technical wood drying facility construction, 2002-2002 [GLO; RER]; tram track construction, 1990-2000 [GLO]; treatment of waste glass, sanitary landfill, 2010-2017 [GLO]; treatment of waste packaging paper, sanitary landfill, 2010-2017 [GLO]; treatment of waste plastic, consumer electronics, sanitary landfill, wet infiltration class (500mm), 2006-2012 [GLO]; vegetable oil refinery construction, 2004-2008 [GLO]; waste preparation facility construction, 2000-2014 [GLO]; wastewater treatment facility construction, capacity 1.1E10l/year, 1996-2000 [GLO]; wastewater treatment facility construction, capacity 1.6E8l/year, 1996-2000 [GLO]; wastewater treatment facility construction, capacity 1E9l/year, 1996-2000 [GLO]; wastewater treatment facility construction, capacity 4.7E10l/year, 1996-2000 [GLO]; wastewater treatment facility construction, capacity 5E9l/year, 1996-2000 [GLO]; wood preservation facility construction, dipping/immersion tank, 2012-2012 [GLO]; wood preservation facility construction, hot/cold dipping tank, 2012-2012 [GLO]; wood

preservation facility construction, oscillating pressure vessel, 2012-2012 [GLO]; wood preservation facility construction, vacuum pressure vessel, 2012-2012 [GLO]; wooden board factory construction, cement bonded boards, 2002-2002 [RER]; wooden board factory construction, cement bonded boards, 2002-2002 [GLO]; wooden board factory construction, organic bonded boards, 2002-2002 [RER]; wooden board factory construction, organic bonded boards, 2002-2002 [GLO]; zinc mine operation, 2012-2017 [GLO].

Annex 3: activities with changes in transport

electricity production, hard coal, 1980-2015 [CL; KR; MY]; evaporation of natural gas, 2001-2001 [RER]; gold refinery operation, 2017-2017 [ZA]; hard coal, import from AU, 2015-2016 [CN; Europe, without Russia and Turkey; ID; RLA]; hard coal, import from AU, 2015-2016 [RNA; ZA]; hard coal, import from Australia, 2010-2020 [IN]; hard coal, import from ID, 2015-2016 [CN]; hard coal, import from ID, 2015-2016 [Europe, without Russia and Turkey; RLA; RNA]; hard coal, import from Indonesia, 2010-2020 [IN]; hard coal, import from RLA, 2015-2016 [CN; Europe, without Russia and Turkey; RNA]; hard coal, import from RLA, 2015-2016 [IN]; hard coal, import from RNA, 2015-2016 [CN; Europe, without Russia and Turkey; ID; IN; RLA; ZA]; hard coal, import from RU, 2015-2016 [CN; Europe, without Russia and Turkey; IN]; hard coal, import from ZA, 2014-2014 [IN]; hard coal, import from ZA, 2014-2015 [Europe, without Russia and Turkey]; market for 1,1-difluoroethane, HFC-152a, 2011-2011 [GLO]; market for 1,1-dimethylcyclopentane, 2012-2012 [GLO]; market for 1-butanol, 2011-2011 [GLO]; market for 1-pentanol, 2011-2011 [GLO]; market for 1-propanol, 2011-2011 [GLO]; market for 2,3-dimethylbutan, 2012-2012 [GLO]; market for 2,4-di-tert-butylphenol, 2015-2020 [GLO]; market for 2,4-dichlorophenol, 2010-2010 [GLO]; market for 2,4-dichlorotoluene, 2010-2010 [GLO]; market for 2,5-dimethylhexane-2,5-dihydroperoxide, 2015-2020 [GLO]; market for 2,6-di-tert-butylphenol, 2015-2020 [GLO]; market for 2-butanol, 2011-2011 [GLO]; market for 2-cyclopentone, 2010-2010 [GLO]; market for 2-methyl-1-butanol, 2011-2011 [GLO]; market for 2-methyl-2-butanol, 2011-2011 [GLO]; market for 2-methylpentane, 2012-2012 [GLO]; market for 2-nitroaniline, 2010-2010 [GLO]; market for 2-pyridinol, 2010-2010 [GLO]; market for 3-methyl-1-butanol, 2011-2011 [GLO]; market for 3-methyl-1-butyl acetate, 2011-2011 [GLO]; market for 4-methyl-2-pentanone, 2011-2011 [GLO]; market for 4-tert-butylbenzaldehyde, 2010-2010 [GLO]; market for 4-tert-butyltoluene, 2010-2010 [GLO]; market for DTPA, diethylenetriaminepentaacetic acid, 2011-2011 [GLO]; market for EDTA, ethylenediaminetetraacetic acid, 2011-2011 [GLO]; market for EUR-flat pallet, 2011-2011 [GLO]; market for MOX fuel element, for light water reactor, 2011-2011 [GLO]; market for N,N-dimethylformamide, 2011-2011 [GLO]; market for N-methyl-2-pyrrolidone, 2011-2011 [GLO]; market for [sulfonyl]urea-compound, 2011-2011 [GLO]; market for [thio]carbamate-compound, 2011-2011 [GLO]; market for acetaldehyde, 2011-2011 [GLO]; market for acetamide-anillide-compound, unspecified, 2011-2011 [GLO]; market for acetanilide, 2012-2012 [GLO]; market for acetic acid, without water, in 98% solution state, 2011-2011 [GLO]; market for acetic anhydride, 2011-2011 [GLO]; market for acetoacetic acid, 2012-2012 [GLO]; market for acetone cyanohydrin, 2011-2011 [GLO]; market for acetone, liquid, 2011-2011 [GLO]; market for acetonitrile, 2011-2011 [GLO]; market for acetyl chloride, 2012-2012 [GLO]; market for aclonifen, 2011-2011 [GLO]; market for acrolein, 2012-2012 [GLO]; market for acrylic acid, 2011-2011 [GLO]; market for acrylic binder, without water, in 34% solution state, 2011-2011 [GLO]; market for acrylic dispersion, without water, in 65% solution state, 2011-2011 [GLO]; market for acrylic filler, 2011-2011 [GLO]; market for acrylic varnish, without water, in 87.5% solution state, 2011-2011 [GLO]; market for acrylonitrile, 2011-2011 [GLO]; market for acrylonitrile-butadiene-styrene copolymer, 2011-2011 [GLO]; market for activated bentonite, 2011-2011 [GLO]; market for activated carbon, granular, 2005-2015 [GLO]; market for activated silica, 2012-2012 [GLO]; market for adhesive mortar, 2011-2011 [GLO]; market for adhesive, for metal, 2011-2011 [GLO]; market for adipic acid, 2011-2011 [GLO]; market for air distribution terminal panel, steel, 120 m3/h, 2011-2011 [GLO]; market for air filter, central unit, 600 m3/h, 2011-2011 [GLO]; market for air filter, decentralized unit, 180-250 m3/h, 2011-2011 [GLO]; market for air filter, decentralized unit, 250 m3/h, 2011-2011 [GLO]; market for air filter, in exhaust air valve, 2011-2011 [GLO]; market for alkyd paint, white, without solvent, in 60% solution state, 2011-2011 [GLO]; market for alkyd paint, white, without water, in 60% solution state, 2011-2011 [GLO]; market for alkyd resin, long oil, without solvent, in 70% white spirit solution state, 2011-2011 [GLO]; market for alkyl sulphate (C12-14), 2015-2020 [GLO]; market for alkylbenzene sulfonate, linear, petrochemical, 2011-2011 [GLO]; market for alkylbenzene, linear, 2011-2011 [GLO]; market for alkylketene dimer sizing agent, for paper production, 2011-2011 [GLO]; market for allyl chloride, 2011-2011 [GLO]; market for alpha-naphthol, 2012-2012 [GLO]; market for alpha-picoline, 2012-2012 [GLO]; market for aluminium alloy, AlLi, 2013-2013 [GLO]; market for aluminium alloy, AlMg3, 2011-2011 [GLO]; market for aluminium alloy, metal matrix composite, 2013-2013 [GLO]; market for aluminium chloride, 2015-2020 [GLO]; market for aluminium fluoride, 2011-2011 [GLO]; market for aluminium hydroxide, 2011-2011 [GLO]; market for aluminium in car shredder residue, 2011-2011 [GLO]; market for aluminium scrap, new, 2011-2011 [GLO]; market for aluminium scrap, post-consumer, 2011-2011 [GLO]; market for aluminium sulfate, powder, 2011-2011 [GLO]; market for aluminium sulfate, without water, in 4.33% aluminium solution state, 2013-2013 [GLO]; market for aluminium, cast alloy, 2011-2011 [GLO]; market for aluminium, primary,

cast alloy slab from continuous casting, 2012-2012 [GLO]; market for aluminium, primary, ingot, 2010-2010 [IAI Area, EU27 & EFTA]; market for aluminium, wrought alloy, 2011-2011 [GLO]; market for amine oxide, 2015-2020 [GLO]; market for aminopyridine, 2010-2010 [GLO]; market for ammonia, liquid, 2011-2011 [GLO]; market for ammonium bicarbonate, 2011-2011 [GLO]; market for ammonium carbonate, 2011-2011 [GLO]; market for ammonium chloride, 2011-2011 [GLO]; market for ammonium nitrate, as N, 2011-2011 [GLO]; market for ammonium nitrite, 2010-2010 [GLO]; market for ammonium sulfate, as N, 2011-2011 [GLO]; market for ammonium thiocyanate, 2011-2011 [GLO]; market for anhydrite, 2011-2011 [GLO]; market for anhydrite floor, 2011-2011 [GLO]; market for anhydrite, burned, 2011-2011 [GLO]; market for aniline, 2011-2011 [GLO]; market for anionic resin, 2011-2011 [GLO]; market for anthranilic acid, 2010-2010 [GLO]; market for anthraquinone, 2011-2011 [GLO]; market for antifouling paint emissions, 2010-2010 [GLO]; market for antimony, 2011-2011 [GLO]; market for arsine, 2011-2011 [GLO]; market for asbestos, crysotile type, 2011-2011 [GLO]; market for ascorbic acid, 2015-2020 [GLO]; market for atrazine, 2011-2011 [GLO]; market for azodicarbonamide, 2015-2020 [GLO]; market for barite, 2011-2011 [GLO]; market for barium carbonate, 2015-2020 [GLO]; market for barium hydroxide, 2015-2020 [GLO]; market for barium oxide, 2015-2020 [GLO]; market for barium sulfide, 2015-2020 [GLO]; market for barley grain, 2011-2011 [GLO]; market for barley grain, feed, 1996-1999 [GLO]; market for barley grain, feed, organic, 2011-2011 [GLO]; market for barley grain, organic, 2011-2011 [GLO]; market for basalt, 2011-2011 [GLO]; market for battery, Li-ion, rechargeable, prismatic, 2011-2011 [GLO]; market for battery, NaCl, 2012-2012 [GLO]; market for battery, NiMH, rechargeable, prismatic, 2011-2011 [GLO]; market for bauxite, 2011-2011 [GLO]; market for bentonite, 2011-2011 [GLO]; market for benzal chloride, 2011-2011 [GLO]; market for benzaldehyde, 2011-2011 [GLO]; market for benzaldehyde-2-sulfonic acid, 2015-2020 [GLO]; market for benzene, 2011-2011 [GLO]; market for benzimidazole-compound, 2011-2011 [GLO]; market for benzo[thia]diazole-compound, 2011-2011 [GLO]; market for benzoic acid, 2010-2010 [GLO]; market for benzoic-compound, 2011-2011 [GLO]; market for benzyl alcohol, 2011-2011 [GLO]; market for benzyl chloride, 2011-2011 [GLO]; market for bipyridylium-compound, 2011-2011 [GLO]; market for bisphenol A epoxy based vinyl ester resin, 2013-2019 [GLO]; market for bisphenol A, powder, 2011-2011 [GLO]; market for blower and heat exchange unit, Avent E 97, 2011-2011 [GLO]; market for blower and heat exchange unit, GE 250 RH, 2011-2011 [GLO]; market for blower and heat exchange unit, KWL 250, 2011-2011 [GLO]; market for blower and heat exchange unit, KWLC 1200, 2011-2011 [GLO]; market for blower and heat exchange unit, Storkair G 90, 2011-2011 [GLO]; market for blower and heat exchange unit, Twl-700, 2011-2011 [GLO]; market for blower and heat exchange unit, central, 600-1200 m3/h, 2011-2011 [GLO]; market for blower and heat exchange unit, decentralized, 180-250 m3/h, 2011-2011 [GLO]; market for borax, anhydrous, powder, 2011-2011 [GLO]; market for boric acid, anhydrous, powder, 2011-2011 [GLO]; market for boric oxide, 2011-2011 [GLO]; market for boron carbide, 2011-2011 [GLO]; market for brass, 2011-2011 [GLO]; market for brazing solder, cadmium free, 2011-2011 [GLO]; market for bromopropane, 2010-2010 [GLO]; market for bronze, 2011-2011 [GLO]; market for bundle, energy wood, measured as dry mass, 2010-2012 [GLO]; market for butane, 2008-2008 [GLO]; market for butane-1,4-diol, 2011-2011 [GLO]; market for butter, from cow milk, 2007-2014 [GLO]; market for butyl acetate, 2011-2011 [GLO]; market for butyl acrylate, 2011-2011 [GLO]; market for butyldiglycol acetate, 2015-2020 [GLO]; market for butyrolactone, 2011-2011 [GLO]; market for cable yarder with sled winch, 2012-2012 [GLO]; market for cable, data cable in infrastructure, 2011-2011 [GLO]; market for cable, network cable, category 5, without plugs, 2011-2011 [GLO]; market for cable, printer cable, without plugs, 2011-2011 [GLO]; market for cable, three-conductor cable, 2011-2011 [GLO]; market for cable, unspecified, 2005-2012 [GLO]; market for cadmium, 2011-2011 [GLO]; market for cadmium chloride, semiconductor-grade, 2011-2011 [GLO]; market for cadmium sulfide, semiconductor-grade, 2011-2011 [GLO]; market for cadmium telluride, semiconductor-grade, 2011-2011 [GLO]; market for cadmium, semiconductor-grade, 2011-2011 [GLO]; market for calcium borates, 2011-2011 [GLO]; market for calcium carbide, technical grade, 2011-2011 [GLO]; market for calcium carbonate, precipitated, 2015-2020 [GLO]; market for calcium chloride, 2012-2012 [GLO]; market for calcium nitrate, 1998-1998 [GLO]; market for captan, 2011-2011 [GLO]; market for carbon black, 2011-2011 [GLO]; market for carbon disulfide, 2011-2011 [GLO]; market for carboxymethyl cellulose, powder, 2011-2011 [GLO]; market for carrot seed, Swiss integrated production, at farm, 2000-2012 [GLO]; market for cast iron, 2011-2011 [GLO]; market for cationic resin, 2011-2011 [GLO]; market for cattle for slaughtering, live weight, 2017-2017 [GLO]; market for cellulose fibre, inclusive blowing in, 2011-2011 [GLO]; market for cerium concentrate, 60% cerium oxide, 2011-2011 [GLO]; market for charcoal, 2011-2011 [GLO]; market for chassis, internet access equipment, 2011-2011 [GLO]; market for cheese, from cow milk, fresh, unripened, 2007-2014 [GLO]; market for chloroacetic acid, 2011-2011 [GLO]; market for chloroacetyl chloride, 2010-2010 [GLO]; market for chloromethyl methyl ether, 2011-2011 [GLO]; market for

chloronitrobenzene, 2010-2010 [GLO]; market for chloropropionic acid, 2010-2010 [GLO]; market for chlorothalonil, 2011-2011 [GLO]; market for chlorotoluron, 2011-2011 [GLO]; market for chromium, 2011-2011 [GLO]; market for chromium oxide, flakes, 2011-2011 [GLO]; market for chromium steel pipe, 2012-2012 [GLO]; market for citric acid, 2010-2011 [GLO]; market for cladding, crossbar-pole, aluminium, 2011-2011 [GLO]; market for cleft timber, measured as dry mass, 2010-2012 [GLO]; market for coating powder, 2011-2011 [GLO]; market for cobalt, 2011-2011 [GLO]; market for cocamide diethanolamine, 2015-2020 [GLO]; market for coconut, dehusked, 2010-2012 [GLO]; market for coke, 2011-2011 [GLO]; market for computer, desktop, without screen, 2011-2011 [GLO]; market for computer, laptop, 2011-2011 [GLO]; market for conveyor belt, 2011-2011 [GLO]; market for copper, 2011-2011 [GLO]; market for copper cake, 2012-2012 [GLO]; market for copper carbonate, 2011-2011 [GLO]; market for copper in car shredder residue, 2011-2011 [GLO]; market for copper oxide, 2011-2011 [GLO]; market for copper scrap, sorted, pressed, 2011-2011 [GLO]; market for copper sulfate, 2006-2012 [GLO]; market for core board, 2011-2011 [GLO]; market for cork slab, 2011-2011 [GLO]; market for cottonseed, 2015-2018 [GLO]; market for cottonseed oil, refined, 2015-2018 [GLO]; market for cover plaster, mineral, 2011-2011 [GLO]; market for cover plaster, organic, 2011-2011 [GLO]; market for cow milk, 2009-2011 [GLO]; market for cryolite, 2011-2011 [GLO]; market for cumene, 2011-2011 [GLO]; market for cyanoacetic acid, 2010-2010 [GLO]; market for cyanogen chloride, 2010-2010 [GLO]; market for cyanuric chloride, 2005-2010 [GLO]; market for cyclic N-compound, 2011-2011 [GLO]; market for cyclohexane, 2011-2011 [GLO]; market for cyclohexanol, 2011-2011 [GLO]; market for cyclohexanone, 2011-2011 [GLO]; market for de-icer, 2012-2012 [GLO]; market for decabromodiphenyl ether, 2015-2020 [GLO]; market for decommissioned chemical production facilities, 2011-2011 [GLO]; market for decommissioned pipeline, natural gas, 2011-2011 [GLO]; market for decommissioned road, 2011-2011 [GLO]; market for decommissioned tram track, 2011-2011 [GLO]; market for deinking emulsion, in paper production, 2011-2011 [GLO]; market for diazine-compound, 2011-2011 [GLO]; market for diazole-compound, 2011-2011 [GLO]; market for dicyclopentadiene based unsaturated polyester resin, 2013-2019 [GLO]; market for diesel, 2011-2011 [GLO]; market for diesel, low-sulfur, 2011-2011 [GLO]; market for diethanolamine, 2011-2011 [GLO]; market for diethylene glycol, 2011-2011 [GLO]; market for dimethenamide, 2011-2011 [GLO]; market for dimethyl carbonate, 2015-2020 [GLO]; market for dimethyl ether, 2011-2011 [GLO]; market for dimethyl hexanediol, 2015-2020 [GLO]; market for dimethyl malonate, 2010-2010 [GLO]; market for dimethyl sulfide, 2010-2010 [GLO]; market for dimethyl sulfoxide, 2011-2011 [GLO]; market for dimethylacetamide, 2011-2011 [GLO]; market for dimethylamine, 2011-2011 [GLO]; market for dimethylamine borane, 2011-2011 [GLO]; market for dimethylaminopropylamine, 2015-2020 [GLO]; market for dinitroaniline-compound, 2011-2011 [GLO]; market for dioxane, 2011-2011 [GLO]; market for dipropyl amine, 2010-2010 [GLO]; market for dipropylene glycol monomethyl ether, 2011-2011 [GLO]; market for display, cathode ray tube, 17 inches, 2011-2011 [GLO]; market for display, liquid crystal, 17 inches, 2011-2011 [GLO]; market for dithiocarbamate-compound, 2011-2011 [GLO]; market for dodecanol, 2015-2020 [GLO]; market for dolomite, 2011-2011 [GLO]; market for door, inner, glass-wood, 2011-2011 [GLO]; market for door, inner, wood, 2011-2011 [GLO]; market for door, outer, wood-aluminium, 2011-2011 [GLO]; market for door, outer, wood-glass, 2011-2011 [GLO]; market for earth tube heat exchanger, polyethylene, DN 200, 2011-2011 [GLO]; market for electric motor, vehicle, 2011-2011 [GLO]; market for electrolyte, KOH, LiOH additive, 2011-2011 [GLO]; market for electronics scrap, 2011-2011 [GLO]; market for electronics scrap from control units, 2011-2011 [GLO]; market for electrostatic paint, 2013-2013 [GLO]; market for energy wood harvester, 2012-2012 [GLO]; market for enriched uranium, 4.2%, 2011-2011 [GLO]; market for enzymes, 2015-2020 [GLO]; market for epichlorohydrin, 2011-2011 [GLO]; market for epoxy resin insulator, Al2O3, 2011-2011 [GLO]; market for epoxy resin insulator, SiO2, 2011-2011 [GLO]; market for epoxy resin, liquid, 2011-2011 [GLO]; market for esterquat, 2011-2011 [GLO]; market for esters of versatic acid, 2011-2011 [GLO]; market for ethane, 2008-2008 [GLO]; market for ethanol, without water, in 99.7% solution state, from ethylene, 2011-2011 [GLO]; market for ethanol, without water, in 99.7% solution state, from fermentation, at service station, 2011-2011 [GLO]; market for ethoxylated alcohol (AE11), 2011-2011 [GLO]; market for ethoxylated alcohol (AE3), 2011-2011 [GLO]; market for ethoxylated alcohol (AE7), 2011-2011 [GLO]; market for ethoxylated alcohol (AE>20), 2015-2020 [GLO]; market for ethyl acetate, 2011-2011 [GLO]; market for ethyl benzene, 2011-2011 [GLO]; market for ethyl tert-butyl ether, 2011-2011 [GLO]; market for ethylamine, 2012-2012 [GLO]; market for ethylene carbonate, 2011-2011 [GLO]; market for ethylene glycol, 2011-2011 [GLO]; market for ethylene glycol diethyl ether, 2011-2011 [GLO]; market for ethylene glycol dimethyl ether, 2011-2011 [GLO]; market for ethylene glycol monoethyl ether, 2011-2011 [GLO]; market for ethylene vinyl acetate copolymer, 2011-2011 [GLO]; market for ethylenediamine, 2011-2011 [GLO]; market for ethylvinylacetate, foil, 2011-2011 [GLO]; market for exhaust air outlet, steel/aluminium,

85x365 mm, 2011-2011 [GLO]; market for exhaust air roof hood, steel, DN 400, 2011-2011 [GLO]; market for exhaust air valve, in-wall housing, plastic/steel, DN 125, 2011-2011 [GLO]; market for explosive, tovex, 2011-2011 [GLO]; market for fatty acid, 2011-2011 [GLO]; market for fatty alcohol, 2011-2011 [GLO]; market for fatty alcohol sulfate, 2011-2011 [GLO]; market for fava bean, organic, 2011-2011 [GLO]; market for feldspar, 2011-2011 [GLO]; market for ferrite, 2011-2011 [GLO]; market for ferronickel, 25% Ni, 2011-2011 [GLO]; market for ferrosilicon, 2008-2012 [GLO]; market for fibre, cotton, 2011-2011 [GLO]; market for fibreboard, hard, 2011-2011 [GLO]; market for fibreboard, soft, 2011-2011 [GLO]; market for fibreboard, soft, latex bonded, 2011-2011 [GLO]; market for fibreboard, soft, without adhesives, 2011-2011 [GLO]; market for fish oil, 2016-2016 [GLO]; market for fishmeal, 63-65% protein, 2017-2017 [GLO]; market for fishmeal, 65-67% protein, 2017-2017 [GLO]; market for flat glass, coated, 2011-2011 [GLO]; market for fleece, polyethylene, 2011-2011 [GLO]; market for flexible duct, aluminium/PET, DN of 125, 2011-2011 [GLO]; market for floating collar cage, 2017-2017 [GLO]; market for floating hexagonal metal cage, 2017-2017 [GLO]; market for fluorescent whitening agent, DAS1, triazinylaminostilben type, 2011-2011 [GLO]; market for fluorescent whitening agent, distyrylbiphenyl type, 2011-2011 [GLO]; market for fluorspar, 97% purity, 2011-2011 [GLO]; market for flux, for wave soldering, 2011-2011 [GLO]; market for foaming agent, 2012-2012 [GLO]; market for folding boxboard/chipboard, 2011-2011 [GLO]; market for folpet, 2011-2011 [GLO]; market for formaldehyde, 2011-2011 [GLO]; market for formic acid, 2011-2011 [GLO]; market for forwarder, 2012-2012 [GLO]; market for fosetyl-Al, 2011-2011 [GLO]; market for fraction 1 from naphtha separation, 2012-2012 [GLO]; market for fraction 7 from naphtha separation, 2012-2012 [GLO]; market for fraction 8 from naphtha separation, 2012-2012 [GLO]; market for frit, for cathode ray tube display, 2011-2011 [GLO]; market for frit, for ceramic tile, 2012-2012 [GLO]; market for funnel glass, for cathode ray tube display, 2011-2011 [GLO]; market for furnace, logs, 6kW, 2012-2012 [GLO]; market for gallium, in Bayer liquor from aluminium production, 2011-2011 [GLO]; market for gallium, semiconductor-grade, 2011-2011 [GLO]; market for glass cullet, from fluorescent lamps treatment, 1995-1995 [GLO]; market for glass cullet, from used cathode ray tube panels, 1995-1995 [GLO]; market for glass cullet, lead containing, from used cathode ray tube, 1995-1995 [GLO]; market for glass cullet, mixed glass from used cathode ray tube, 1995-1995 [GLO]; market for glass fibre, 2011-2011 [GLO]; market for glass fibre reinforced plastic, polyamide, injection moulded, 2011-2011 [GLO]; market for glass fibre reinforced plastic, polyester resin, hand lay-up, 2011-2011 [GLO]; market for glass from used cathode ray tube, 2011-2011 [GLO]; market for glass tube, borosilicate, 2011-2011 [GLO]; market for glass, for liquid crystal display, 2011-2011 [GLO]; market for glazing, double, U<1.1 W/m2K, 2011-2011 [GLO]; market for glazing, double, U<1.1 W/m2K, laminated safety glass, 2011-2011 [GLO]; market for glazing, triple, U<0.5 W/m2K, 2011-2011 [GLO]; market for glucose, 2015-2020 [GLO]; market for glued laminated timber, for indoor use, 2011-2011 [GLO]; market for glued laminated timber, for outdoor use, 2011-2011 [GLO]; market for glycerine, 2011-2011 [GLO]; market for glycine, 2012-2012 [GLO]; market for glyoxal, 2012-2012 [GLO]; market for glyphosate, 2011-2011 [GLO]; market for gold, 2011-2011 [GLO]; market for gold-silver, ingot, 2012-2012 [GLO]; market for graphite, 2011-2011 [GLO]; market for graphite, battery grade, 2011-2011 [GLO]; market for gravel, crushed, 2011-2011 [GLO]; market for gravel, round, 2011-2011 [GLO]; market for gypsum fibreboard, 2011-2011 [GLO]; market for gypsum plasterboard, 2011-2011 [GLO]; market for gypsum, mineral, 2011-2011 [GLO]; market for hard chromium coat, electroplating, steel substrate, 0.14 mm thickness, 2014-2014 [GLO]; market for hard coal, 2011-2011 [GLO]; market for hard coal briquettes, 2011-2011 [GLO]; market for hard coal, run-of-mine, 2010-2020 [GLO]; market for hay, 2010-2012 [GLO]; market for hazardous waste, for incineration, 2011-2011 [Europe without Switzerland; GLO]; market for hazardous waste, for underground deposit, 2011-2011 [GLO]; market for heat pump, diffusion absorption, 4kW, future, 2011-2011 [GLO]; market for heavy fuel oil, 1989-2000 [Europe without Switzerland]; market for heavy fuel oil, 2011-2011 [GLO]; market for heavy water, 2000-2000 [GLO]; market for helium, 2011-2011 [GLO]; market for heptane, 2011-2011 [GLO]; market for hexafluoroethane, 2011-2011 [GLO]; market for hexamethyldisilazane, 2011-2011 [GLO]; market for hexane, 2011-2011 [GLO]; market for horticultural fleece, 2009-2012 [GLO]; market for hydrazine sulfate, 2015-2020 [GLO]; market for hydrochloric acid, without water, in 30% solution state, 2011-2011 [GLO]; market for hydrogen peroxide, without water, in 50% solution state, 2011-2011 [GLO]; market for hydrogen sulfide, 2011-2011 [GLO]; market for hydroquinone, 2012-2012 [GLO]; market for hydroxylamine, 2012-2012 [GLO]; market for ilmenite, 54% titanium dioxide, 2000-2015 [GLO]; market for imidazole, 2012-2012 [GLO]; market for indium, 2011-2011 [GLO]; market for indium tin oxide powder, nanoscale, for sputtering target, 2011-2011 [GLO]; market for industrial machine, heavy, unspecified, 2011-2011 [GLO]; market for inert filler, 2012-2012 [GLO]; market for insulation spiral-seam duct, rockwool, DN 400, 30 mm, 2011-2011 [GLO]; market for intral, 2011-2011 [GLO]; market for iodine, 2010-2010 [GLO]; market for iron (III) chloride, without water, in 40% solution state, 2011-2011 [GLO]; market for iron ore,

beneficiated, 65% Fe, 2011-2011 [GLO]; market for iron scrap, sorted, pressed, 2011-2011 [GLO]; market for iron sulfate, 2011-2011 [GLO]; market for iron(II) chloride, 2013-2013 [GLO]; market for iron(III) chloride, without water, in 14% iron solution state, 2013-2013 [GLO]; market for iron(III) chloride, without water, in a 12% iron solution state, 2013-2013 [GLO]; market for iron(III) sulfate, without water, in 12.5% iron solution state, 2013-2013 [GLO]; market for iron-nickel-chromium alloy, 2011-2011 [GLO]; market for isobutanol, 2011-2011 [GLO]; market for isobutyl acetate, 2011-2011 [GLO]; market for isohexane, 2011-2011 [GLO]; market for isophthalic acid based unsaturated polyester resin, 2013-2019 [GLO]; market for isopropanol, 2011-2011 [GLO]; market for isopropyl acetate, 2011-2011 [GLO]; market for isopropylamine, 2012-2012 [GLO]; market for isoproturon, 2011-2011 [GLO]; market for jatropha seed, 2005-2014 [GLO]; market for joist, engineered wood, 2011-2011 [GLO]; market for kaolin, 2011-2011 [GLO]; market for kerosene, 1989-2000 [Europe without Switzerland]; market for kerosene, 2011-2011 [GLO]; market for keyboard, 2011-2011 [GLO]; market for kraft paper, bleached, 2011-2011 [GLO]; market for kraft paper, unbleached, 2011-2011 [GLO]; market for lactic acid, 2012-2012 [GLO]; market for laminated timber element, transversally prestressed, for outdoor use, 2011-2011 [GLO]; market for lanthanum oxide, 2011-2011 [GLO]; market for latex, 2011-2011 [GLO]; market for layered sodium silicate, SKS-6, powder, 2011-2011 [GLO]; market for lead, 2011-2011 [GLO]; market for lead in car shredder residue, 2011-2011 [GLO]; market for light fuel oil, 1989-2000 [Europe without Switzerland]; market for light fuel oil, 2011-2011 [GLO]; market for light mortar, 2011-2011 [GLO]; market for lignite briquettes, 2011-2011 [GLO]; market for lime mortar, 2011-2011 [GLO]; market for lime, hydrated, loose weight, 2011-2011 [GLO]; market for lime, hydrated, packed, 2011-2011 [GLO]; market for lime, packed, 2011-2011 [GLO]; market for linseed, 2003-2012 [GLO]; market for linseed seed, at farm, 1996-2012 [GLO]; market for liquefied petroleum gas, 1980-2010 [GLO]; market for liquid packaging board container, 2011-2011 [GLO]; market for lithium, 2011-2011 [GLO]; market for lithium carbonate, 2011-2011 [GLO]; market for lithium chloride, 2011-2011 [GLO]; market for lithium fluoride, 2011-2011 [GLO]; market for lithium hexafluorophosphate, 2011-2011 [GLO]; market for lithium hydroxide, 2011-2011 [GLO]; market for lubricating oil, 2011-2011 [GLO]; market for magnesium, 2011-2011 [GLO]; market for magnesium oxide, 2011-2011 [GLO]; market for magnesium sulfate, 2011-2011 [GLO]; market for magnesium-alloy, AZ91, 2011-2011 [GLO]; market for magnesium-alloy, AZ91, diecast, 2011-2011 [GLO]; market for magnetite, 2011-2011 [GLO]; market for maize grain, 2011-2011 [GLO]; market for maize grain, feed, 1996-1999 [GLO]; market for maize grain, feed, organic, 2011-2011 [GLO]; market for maize grain, organic, 2011-2011 [GLO]; market for maize seed, at farm, 2012-2012 [GLO]; market for maize seed, organic, at farm, 2011-2011 [GLO]; market for maize silage, 2010-2012 [GLO]; market for maize starch, 2011-2011 [GLO]; market for maleic anhydride, 2011-2011 [GLO]; market for maleic unsaturated polyester resin, 2013-2019 [GLO]; market for malusil, 2011-2011 [GLO]; market for mancozeb, 2011-2011 [GLO]; market for manganese, 2011-2011 [GLO]; market for manganese concentrate, 2011-2011 [GLO]; market for manganese dioxide, 2012-2012 [GLO]; market for manganese sulfate, 2012-2012 [GLO]; market for manganese(III) oxide, 2011-2011 [GLO]; market for marine electric motor, 2017-2017 [GLO]; market for marine engine, 2017-2017 [GLO]; market for meat and bone meal, 2012-2012 [GLO]; market for mecoprop, 2011-2011 [GLO]; market for medium density fibreboard, 2011-2011 [GLO]; market for melamine, 2011-2011 [GLO]; market for melamine formaldehyde resin, 2011-2011 [GLO]; market for mercury, 2011-2011 [GLO]; market for meta-phenylene diamine, 2002-2002 [GLO]; market for metal working machine, unspecified, 2011-2011 [GLO]; market for metaldehyde, 2011-2011 [GLO]; market for metalliferous hydroxide sludge, 2018-2018 [GLO]; market for metallization paste, back side, 2011-2011 [GLO]; market for metallization paste, back side, aluminium, 2011-2011 [GLO]; market for metallization paste, front side, 2011-2011 [GLO]; market for metamitron, 2011-2011 [GLO]; market for methacrylic acid, 2012-2012 [GLO]; market for methane sulfonic acid, 2012-2012 [GLO]; market for methanol, 2011-2011 [GLO]; market for methanol, from biomass, 2011-2011 [GLO]; market for methyl acetate, 2011-2011 [GLO]; market for methyl acrylate, 2011-2011 [GLO]; market for methyl ethyl ketone, 2011-2011 [GLO]; market for methyl formate, 2011-2011 [GLO]; market for methyl iodide, 2012-2012 [GLO]; market for methyl tert-butyl ether, 2011-2011 [GLO]; market for methyl-3-methoxypropionate, 2011-2011 [GLO]; market for methylamine, 2011-2011 [GLO]; market for methylchloride, 2011-2011 [GLO]; market for methylcyclohexane, 2011-2011 [GLO]; market for methylcyclopentane, 2012-2012 [GLO]; market for methylene diphenyl diisocyanate, 2011-2011 [GLO]; market for metolachlor, 2011-2011 [GLO]; market for mischmetal, 2011-2011 [GLO]; market for mobile cable yarder, trailer-mounted, 2012-2012 [GLO]; market for mobile cable yarder, truck-mounted, incl. processor, 2012-2012 [GLO]; market for molybdenite, 1994-2003 [GLO]; market for molybdenum, 2011-2011 [GLO]; market for molybdenum trioxide, 2008-2008 [GLO]; market for monochlorobenzene, 2011-2011 [GLO]; market for monochloropentafluoroethane, 2011-2011 [GLO]; market for monoethanolamine, 2011-2011 [GLO]; market for n-

olefins, 2011-2011 [GLO]; market for naphtha, 2011-2011 [GLO]; market for naphthalene sulfonic acid, 2012-2012 [GLO]; market for napropamide, 2011-2011 [GLO]; market for natural gas, liquefied, 2011-2011 [GLO]; market for neodymium oxide, 2011-2011 [GLO]; market for nickel ore, beneficiated, 16%, 2010-2010 [GLO]; market for nickel sulfate, 2006-2012 [GLO]; market for nickel, 99.5%, 2011-2011 [GLO]; market for nitrile-compound, 2011-2011 [GLO]; market for nitro-compound, 2011-2011 [GLO]; market for nitrobenzene, 2011-2011 [GLO]; market for nitrogen fertiliser, as N, 2011-2011 [GLO]; market for nitrous oxide, 2010-2010 [GLO]; market for non-ionic surfactant, 2015-2020 [GLO]; market for nuclear fuel element, for boiling water reactor, UO2 4.0% & MOX, 2011-2011 [GLO]; market for nuclear fuel element, for pressure water reactor, UO2 3.8% & MOX, 2011-2011 [GLO]; market for nuclear fuel element, for pressure water reactor, UO2 3.9% & MOX, 2011-2011 [GLO]; market for nuclear fuel element, for pressure water reactor, UO2 4.0% & MOX, 2011-2011 [GLO]; market for nuclear fuel element, for pressure water reactor, UO2 4.2% & MOX, 2011-2011 [GLO]; market for nuclear fuel element, for pressure water reactor, UO2 4.2% centrifuge & MOX, 2011-2011 [GLO]; market for nylon 6, 2011-2011 [GLO]; market for nylon 6, glass-filled, 2011-2011 [GLO]; market for nylon 6-6, 2011-2011 [GLO]; market for nylon 6-6, glass-filled, 2011-2011 [GLO]; market for o-aminophenol, 2010-2010 [GLO]; market for o-chlorobenzaldehyde, 2010-2010 [GLO]; market for o-chlorotoluene, 2010-2010 [GLO]; market for o-cresol, 2010-2010 [GLO]; market for o-dichlorobenzene, 2011-2011 [GLO]; market for o-nitrophenol, 2010-2010 [GLO]; market for oat grain, 2010-2012 [GLO]; market for oat grain, feed, 1996-1999 [GLO]; market for oat seed, Swiss integrated production, at farm, 1996-2012 [GLO]; market for octabenzone, 2015-2020 [GLO]; market for optical brighteners, for paper production, 2011-2011 [GLO]; market for orbencarb, 2011-2011 [GLO]; market for organophosphorus-compound, unspecified, 2011-2011 [GLO]; market for oriented strand board, 2011-2011 [GLO]; market for ortho-phenylene diamine, 2012-2012 [GLO]; market for orthophthalic acid based unsaturated polyester resin, 2013-2019 [GLO]; market for outside air intake, stainless steel, DN 370, 2011-2011 [GLO]; market for p-chlorophenol, 2010-2010 [GLO]; market for p-dichlorobenzene, 2011-2011 [GLO]; market for p-nitrophenol, 2012-2012 [GLO]; market for p-nitrotoluene, 2012-2012 [GLO]; market for packaging film, low density polyethylene, 2011-2011 [GLO]; market for packaging glass, brown, 2011-2011 [GLO]; market for packaging glass, green, 2011-2011 [GLO]; market for packaging glass, white, 2011-2011 [GLO]; market for packaging, for fertilisers or pesticides, 2009-2015 [GLO]; market for palladium, 2011-2011 [GLO]; market for palm date, 2012-2012 [GLO]; market for palm date, conditioned and dried, 2012-2012 [GLO]; market for palm date, conditioned and dried, organic, 2012-2012 [GLO]; market for palm date, organic, 2012-2012 [GLO]; market for palm oil, refined, 2012-2012 [GLO]; market for panel glass, for cathode ray tube display, 2011-2011 [GLO]; market for paper, melamine impregnated, 2012-2012 [GLO]; market for paper, newsprint, 2011-2011 [GLO]; market for paper, woodcontaining, lightweight coated, 2011-2011 [GLO]; market for paper, woodcontaining, supercalendered, 2011-2011 [GLO]; market for paper, woodfree, coated, 2011-2011 [GLO]; market for paper, woodfree, uncoated, 2011-2011 [GLO]; market for para-phenylene diamine, 2012-2012 [GLO]; market for paraffin, 2011-2011 [GLO]; market for particle board, cement bonded, 2011-2011 [GLO]; market for particle board, for indoor use, 2011-2011 [GLO]; market for particle board, for outdoor use, 2011-2011 [GLO]; market for particleboard, uncoated, 2012-2012 [GLO]; market for peanut, 2009-2012 [GLO]; market for peanut seed, at farm, 1996-2012 [GLO]; market for pendimethalin, 2011-2011 [GLO]; market for pentaerythritol, 2011-2011 [GLO]; market for pentane, 2011-2011 [GLO]; market for perfluoropentane, 2012-2012 [GLO]; market for perlite, 2011-2011 [GLO]; market for pesticide, unspecified, 2011-2011 [GLO]; market for petrol, 15% ETBE additive by volume, with ethanol from biomass, 2011-2011 [GLO]; market for petrol, 4% ETBE additive by volume, with ethanol from biomass, 2011-2011 [GLO]; market for petrol, 5% ethanol by volume from biomass, 2011-2011 [GLO]; market for petrol, 85% ethanol by volume from biomass, 2011-2011 [GLO]; market for petrol, low-sulfur, 2011-2011 [GLO]; market for petrol, two-stroke blend, 2011-2011 [GLO]; market for petrol, unleaded, 2011-2011 [GLO]; market for petroleum, 2011-2011 [GLO]; market for petroleum coke, 2011-2011 [GLO]; market for phenol, 2011-2011 [GLO]; market for phenolic resin, 2011-2011 [GLO]; market for phenoxy-compound, 2011-2011 [GLO]; market for phenyl acetic acid, 2010-2010 [GLO]; market for phenyl isocyanate, 2010-2010 [GLO]; market for phosphate fertiliser, as P2O5, 2011-2011 [GLO]; market for phosphate rock, as P2O5, beneficiated, dry, 2011-2011 [GLO]; market for phosphate rock, as P2O5, beneficiated, wet, 2011-2011 [GLO]; market for phosphoric acid, fertiliser grade, without water, in 70% solution state, 1998-1999 [GLO]; market for phosphoric acid, industrial grade, without water, in 85% solution state, 2011-2011 [GLO]; market for phosphorous chloride, 2011-2011 [GLO]; market for phosphorus oxychloride, 2015-2020 [GLO]; market for phosphorus pentachloride, 2011-2011 [GLO]; market for phosphorus, white, liquid, 2011-2011 [GLO]; market for phosphoryl chloride, 2011-2011 [GLO]; market for phthalic anhydride, 2011-2011 [GLO]; market for phthalimide, 2010-2010 [GLO]; market for phthalimide-compound, 2011-

2011 [GLO]; market for pig iron, 2011-2011 [GLO]; market for piperidine, 2010-2010 [GLO]; market for pitch despergents, in paper production, 2011-2011 [GLO]; market for plasticiser, for concrete, based on sulfonated melamine formaldehyde, 2014-2014 [GLO]; market for platinum, 2019-2019 [GLO]; market for plywood, for indoor use, 2011-2011 [GLO]; market for plywood, for outdoor use, 2011-2011 [GLO]; market for pointing device, optical mouse, with cable, 2011-2011 [GLO]; market for polishing powder, 2012-2012 [GLO]; market for polyacrylamide, 2012-2012 [GLO]; market for polyaluminium chloride, 2015-2020 [GLO]; market for polybutadiene, 2011-2011 [GLO]; market for polycarbonate, 2011-2011 [GLO]; market for polycarboxylates, 40% active substance, 2011-2011 [GLO]; market for polydimethylsiloxane, 2015-2020 [GLO]; market for polyester resin, unsaturated, 2011-2011 [GLO]; market for polyester-complexed starch biopolymer, 2011-2011 [GLO]; market for polyethylene terephthalate, granulate, amorphous, 2011-2011 [GLO]; market for polyethylene terephthalate, granulate, bottle grade, 2011-2011 [GLO]; market for polyethylene, high density, granulate, 2011-2011 [GLO]; market for polyethylene, linear low density, granulate, 2011-2011 [GLO]; market for polyethylene, low density, granulate, 2011-2011 [GLO]; market for polylactide, granulate, 2011-2011 [GLO]; market for polymethyl methacrylate, beads, 2011-2011 [GLO]; market for polymethyl methacrylate, sheet, 2011-2011 [GLO]; market for polyol, 2011-2011 [GLO]; market for polyphenylene sulfide, 2011-2011 [GLO]; market for polypropylene, granulate, 2011-2011 [GLO]; market for polystyrene foam slab, 2011-2011 [GLO]; market for polystyrene foam slab for perimeter insulation, 2009-2011 [GLO]; market for polystyrene foam slab with graphite, 6% recycled, 2009-2011 [GLO]; market for polystyrene foam slab, 10% recycled, 2009-2011 [GLO]; market for polystyrene scrap, post-consumer, 2011-2011 [GLO]; market for polystyrene, expandable, 2011-2011 [GLO]; market for polystyrene, extruded, 2011-2011 [GLO]; market for polystyrene, general purpose, 2011-2011 [GLO]; market for polystyrene, high impact, 2011-2011 [GLO]; market for polysulfide, sealing compound, 2011-2011 [GLO]; market for polysulfone, 2012-2012 [GLO]; market for polyurethane, flexible foam, 2011-2011 [GLO]; market for polyurethane, rigid foam, 2011-2011 [GLO]; market for polyvinylchloride, bulk polymerised, 2011-2011 [GLO]; market for polyvinylchloride, emulsion polymerised, 2011-2011 [GLO]; market for polyvinylchloride, suspension polymerised, 2011-2011 [GLO]; market for polyvinylfluoride, 2011-2011 [GLO]; market for polyvinylfluoride, film, 2011-2011 [GLO]; market for polyvinylidenchloride, granulate, 2011-2011 [GLO]; market for portachrom, 2011-2011 [GLO]; market for portafer, 2011-2011 [GLO]; market for potassium carbonate, 2011-2011 [GLO]; market for potassium chloride, as K2O, 2011-2011 [GLO]; market for potassium fertiliser, as K2O, 2012-2012 [GLO]; market for potassium hydroxide, 2011-2011 [GLO]; market for potassium nitrate, 2012-2012 [GLO]; market for potassium perchlorate, 2011-2011 [GLO]; market for potassium permanganate, 2011-2011 [GLO]; market for potassium sulfate, as K2O, 2011-2011 [GLO]; market for potato seed, at farm, 1996-2003 [GLO]; market for potato seed, organic, at farm, 2011-2011 [GLO]; market for potato starch, 2011-2011 [GLO]; market for potato, organic, 2011-2011 [GLO]; market for power adapter, for laptop, 2011-2011 [GLO]; market for praseodymium oxide, 2011-2011 [GLO]; market for precious metal for jewellery, 2005-2005 [GLO]; market for printer, laser, black/white, 2011-2011 [GLO]; market for printer, laser, colour, 2011-2011 [GLO]; market for printing ink, offset, without solvent, in 47.5% solution state, 2011-2011 [GLO]; market for printing ink, rotogravure, without solvent, in 55% toluene solution state, 2011-2011 [GLO]; market for propanal, 2011-2011 [GLO]; market for propane, 2005-2005 [GLO]; market for propionic acid, 2012-2012 [GLO]; market for propyl amine, 2012-2012 [GLO]; market for propylene glycol, liquid, 2011-2011 [GLO]; market for prosulfocarb, 2011-2011 [GLO]; market for protein pea, 2011-2011 [GLO]; market for protein pea, organic, 2011-2011 [GLO]; market for pulpwood, hardwood, measured as solid wood under bark, 2011-2011 [GLO]; market for pulpwood, softwood, measured as solid wood under bark, 2011-2011 [GLO]; market for pulverised lignite, 2011-2011 [GLO]; market for pumice, 2011-2011 [GLO]; market for purified terephthalic acid, 2011-2011 [GLO]; market for pyrazole, 2012-2012 [GLO]; market for pyrethroid-compound, 2011-2011 [GLO]; market for pyridazine-compound, 2011-2011 [GLO]; market for pyridine, 2010-2010 [GLO]; market for pyridine-compound, 2011-2011 [GLO]; market for pyrite ash, 2009-2013 [GLO]; market for quicklime, milled, packed, 2011-2011 [GLO]; market for rape seed, 2011-2011 [GLO]; market for rape seed, organic, 2011-2011 [GLO]; market for reinforcing steel, 2011-2011 [GLO]; market for retention aid, for paper production, 2011-2011 [GLO]; market for rhodium, 2011-2011 [GLO]; market for rice, non-basmati, 2001-2006 [GLO]; market for room-connecting overflow element, steel, approx. 40 m3/h, 2011-2011 [GLO]; market for rosin size, for paper production, 2011-2011 [GLO]; market for roundwood, azobe from sustainable forest management, CM, debarked, 2011-2011 [GLO]; market for roundwood, azobe from sustainable forest management, under bark, 2011-2011 [GLO]; market for roundwood, eucalyptus ssp. from sustainable forest management, under bark, 2011-2011 [GLO]; market for roundwood, meranti from sustainable forest management, MY, debarked, 2011-2011 [GLO]; market for roundwood, meranti from sustainable forest

management, under bark, 2011-2011 [GLO]; market for roundwood, paraná pine from sustainable forest management, under bark, 2011-2011 [GLO]; market for rye grain, 2011-2011 [GLO]; market for rye grain, feed, organic, 2011-2011 [GLO]; market for rye grain, organic, 2011-2011 [GLO]; market for samarium europium gadolinium concentrate, 94% rare earth oxide, 2011-2011 [GLO]; market for sand, 2011-2011 [GLO]; market for sand-lime brick, 2011-2011 [GLO]; market for sawlog and veneer log, hardwood, measured as solid wood under bark, 2011-2011 [GLO]; market for sawlog and veneer log, softwood, measured as solid wood under bark, 2011-2011 [GLO]; market for sawnwood, azobe from sustainable forest management, planed, air dried, 2011-2011 [GLO]; market for sawnwood, beam, hardwood, dried (u=10%), planed, 2011-2013 [GLO]; market for sawnwood, beam, hardwood, dried (u=20%), planed, 2011-2013 [GLO]; market for sawnwood, beam, hardwood, raw, dried (u=10%), 2011-2013 [GLO]; market for sawnwood, beam, hardwood, raw, dried (u=20%), 2011-2013 [GLO]; market for sawnwood, beam, softwood, dried (u=10%), planed, 2011-2013 [GLO]; market for sawnwood, beam, softwood, dried (u=20%), planed, 2011-2013 [GLO]; market for sawnwood, beam, softwood, raw, dried (u=10%), 2011-2013 [GLO]; market for sawnwood, beam, softwood, raw, dried (u=20%), 2011-2013 [GLO]; market for sawnwood, board, hardwood, dried (u=10%), planed, 2011-2013 [GLO]; market for sawnwood, board, hardwood, dried (u=20%), planed, 2011-2013 [GLO]; market for sawnwood, board, hardwood, raw, dried (u=10%), 2011-2013 [GLO]; market for sawnwood, board, hardwood, raw, dried (u=20%), 2011-2013 [GLO]; market for sawnwood, board, softwood, dried (u=10%), planed, 2011-2013 [GLO]; market for sawnwood, board, softwood, dried (u=20%), planed, 2011-2013 [GLO]; market for sawnwood, board, softwood, raw, dried (u=10%), 2011-2013 [GLO]; market for sawnwood, board, softwood, raw, dried (u=20%), 2011-2013 [GLO]; market for sawnwood, hardwood, raw, 2011-2013 [GLO]; market for sawnwood, lath, hardwood, dried (u=10%), planed, 2011-2013 [GLO]; market for sawnwood, lath, hardwood, dried (u=20%), planed, 2011-2013 [GLO]; market for sawnwood, lath, hardwood, raw, dried (u=10%), 2011-2013 [GLO]; market for sawnwood, lath, hardwood, raw, dried (u=20%), 2011-2013 [GLO]; market for sawnwood, lath, softwood, dried (u=10%), planed, 2011-2013 [GLO]; market for sawnwood, lath, softwood, dried (u=20%), planed, 2011-2013 [GLO]; market for sawnwood, lath, softwood, raw, dried (u=10%), 2011-2013 [GLO]; market for sawnwood, lath, softwood, raw, dried (u=20%), 2011-2013 [GLO]; market for sawnwood, paraná pine from sustainable forest management, kiln dried, 2011-2011 [GLO]; market for sawnwood, softwood, raw, 2011-2013 [GLO]; market for seal, natural rubber based, 2011-2011 [GLO]; market for sealing tape, aluminium/PE, 50 mm wide, 2011-2011 [GLO]; market for selenium, 2011-2011 [GLO]; market for sewage sludge, dried, 2009-2013 [GLO]; market for shale, 2012-2012 [GLO]; market for silencer, steel, DN 125, 2011-2011 [GLO]; market for silencer, steel, DN 315, 50 mm, 2011-2011 [GLO]; market for silica sand, 2011-2011 [GLO]; market for silicon, electronics grade, 2011-2011 [GLO]; market for silicon, metallurgical grade, 2011-2011 [GLO]; market for silicon, solar grade, 2011-2011 [GLO]; market for silicone product, 2011-2011 [GLO]; market for silver, 2011-2011 [GLO]; market for skidder, 2012-2012 [GLO]; market for soap, 2011-2011 [GLO]; market for soda ash, dense, 2011-2011 [GLO]; market for soda ash, light, crystalline, heptahydrate, 2011-2011 [GLO]; market for sodium, 2010-2010 [GLO]; market for sodium aluminate, powder, 2012-2012 [GLO]; market for sodium amide, 2010-2010 [GLO]; market for sodium arsenide, 2011-2011 [GLO]; market for sodium bicarbonate, 2011-2011 [GLO]; market for sodium borates, 2011-2011 [GLO]; market for sodium chlorate, powder, 2011-2011 [GLO]; market for sodium chloride, powder, 2011-2011 [GLO]; market for sodium chloroacetate, 2015-2020 [GLO]; market for sodium cumenesulphonate, 2015-2020 [GLO]; market for sodium cyanide, 2011-2011 [GLO]; market for sodium dichromate, 2011-2011 [GLO]; market for sodium dithionite, anhydrous, 2011-2011 [GLO]; market for sodium ethoxide, 2010-2010 [GLO]; market for sodium fluoride, 2012-2012 [GLO]; market for sodium formate, 2012-2012 [GLO]; market for sodium hydrogen sulfate, 2015-2020 [GLO]; market for sodium hydrogen sulfite, 2010-2010 [GLO]; market for sodium hydrosulfide, 2010-2010 [GLO]; market for sodium hydroxide, without water, in 50% solution state, 2011-2011 [GLO]; market for sodium metasilicate pentahydrate, 58% active substance, powder, 2011-2011 [GLO]; market for sodium methoxide, 2011-2011 [GLO]; market for sodium nitrate, 2010-2010 [GLO]; market for sodium nitrite, 2010-2010 [GLO]; market for sodium perborate, monohydrate, powder, 2011-2011 [GLO]; market for sodium perborate, tetrahydrate, powder, 2011-2011 [GLO]; market for sodium percarbonate, powder, 2011-2011 [GLO]; market for sodium perchlorate, 2011-2011 [GLO]; market for sodium persulfate, 2011-2011 [GLO]; market for sodium phenolate, 2010-2010 [GLO]; market for sodium phosphate, 2011-2011 [GLO]; market for sodium pyrophosphate, 2012-2012 [GLO]; market for sodium silicate, solid, 2011-2011 [GLO]; market for sodium silicate, spray powder, 80%, 2011-2011 [GLO]; market for sodium silicate, without water, in 37% solution state, 2011-2011 [GLO]; market for sodium silicate, without water, in 48% solution state, 2011-2011 [GLO]; market for sodium sulfate, anhydrite, 2011-2011 [GLO]; market for sodium sulfide, 2013-2013 [GLO]; market for sodium sulfite, 2010-2010

[GLO]; market for sodium tetrafluoroborate, 2011-2011 [GLO]; market for sodium tripolyphosphate, 2011-2011 [GLO]; market for soft solder, Sn97Cu3, 2011-2011 [GLO]; market for soil pH raising agent, as CaCO3, 2015-2015 [GLO]; market for solar collector glass tube, with silver mirror, 2011-2011 [GLO]; market for solar glass, low-iron, 2011-2011 [GLO]; market for solder, bar, Sn63Pb37, for electronics industry, 2011-2011 [GLO]; market for solder, bar, Sn95.5Ag3.9Cu0.6, for electronics industry, 2011-2011 [GLO]; market for solder, paste, Sn63Pb37, for electronics industry, 2011-2011 [GLO]; market for solder, paste, Sn95.5Ag3.9Cu0.6, for electronics industry, 2011-2011 [GLO]; market for solid bleached board, 2011-2011 [GLO]; market for solid unbleached board, 2011-2011 [GLO]; market for solvent for chromatography analysis, 2012-2012 [GLO]; market for soybean, 2011-2011 [GLO]; market for soybean beverage, 2010-2013 [GLO]; market for soybean meal, 2011-2011 [GLO]; market for soybean oil, refined, 2012-2012 [GLO]; market for soybean, feed, 1996-1999 [GLO]; market for soybean, organic, 2011-2011 [GLO]; market for spent activated carbon with mercury, 2011-2011 [GLO]; market for spent activated carbon, granular, 2005-2015 [GLO]; market for spent catalytic converter NOx reduction, 2011-2011 [GLO]; market for spent nuclear fuel, 2011-2011 [GLO]; market for spent oxychlor catalyst for ethylene dichloride production, 2011-2011 [GLO]; market for spiral-seam duct, steel, DN 125, 2011-2011 [GLO]; market for spiral-seam duct, steel, DN 400, 2011-2011 [GLO]; market for stearic acid, 2015-2020 [GLO]; market for steatite, 2011-2012 [GLO]; market for steel in car shredder residue, 2011-2011 [GLO]; market for steel, chromium steel 18/8, 2011-2011 [GLO]; market for steel, low-alloyed, 2011-2011 [GLO]; market for steel, unalloyed, 2011-2011 [GLO]; market for stibnite ore, 70% stibnite, 2011-2011 [GLO]; market for strontium carbonate, 2012-2012 [GLO]; market for strontium sulfate, unprocessed, 2012-2012 [GLO]; market for stucco, 2011-2011 [GLO]; market for styrene, 2011-2011 [GLO]; market for styrene-acrylonitrile copolymer, 2011-2011 [GLO]; market for succinic acid, 2015-2020 [GLO]; market for sugar, from sugar beet, 2011-2011 [GLO]; market for sugar, from sugarcane, 2011-2011 [GLO]; market for sulfamic acid, 2015-2020 [GLO]; market for sulfate pulp, bleached, 2017-2020 [GLO]; market for sulfate pulp, unbleached, 2017-2020 [GLO]; market for sulfite, 2011-2011 [GLO]; market for sulfur, 2011-2011 [GLO]; market for sulfur dichloride, 2010-2010 [GLO]; market for sulfuric acid, 2011-2011 [GLO]; market for sulfuryl chloride, 2012-2012 [GLO]; market for sunflower seed, 2011-2011 [GLO]; market for supply air inlet, steel/SS, DN 75, 2011-2011 [GLO]; market for sweet corn, 2006-2012 [GLO]; market for synthetic rubber, 2011-2011 [GLO]; market for tall oil, crude, 2017-2020 [GLO]; market for tallow, unrefined, 2011-2011 [GLO]; market for tantalum, powder, capacitor-grade, 2011-2011 [GLO]; market for tea, dried, 2009-2012 [GLO]; market for tellurium, semiconductor-grade, 2011-2011 [GLO]; market for terrain chipper on forwarder, 2012-2012 [GLO]; market for tert-butyl amine, 2010-2010 [GLO]; market for tetraethyl orthosilicate, 2013-2013 [GLO]; market for tetrafluoroethane, 2012-2012 [GLO]; market for tetrafluoroethylene film, on glass, 2011-2011 [GLO]; market for tetrahydrofuran, 2011-2011 [GLO]; market for textile, jute, 2011-2011 [GLO]; market for textile, kenaf, 2011-2011 [GLO]; market for textile, knit cotton, 2005-2009 [GLO]; market for textile, woven cotton, 2011-2011 [GLO]; market for thermal plaster, outdoor, 2011-2011 [GLO]; market for three layered laminated board, 2011-2011 [GLO]; market for tilapia feed, 24-28% protein, 2012-2013 [GLO]; market for tin, 2011-2011 [GLO]; market for tin dioxide, 2001-2001 [GLO]; market for tin plated chromium steel sheet, 2 mm, 2011-2011 [GLO]; market for tissue paper, 1998-1998 [GLO]; market for titanium dioxide, 2011-2011 [GLO]; market for titanium zinc plate, without pre-weathering, 2011-2011 [GLO]; market for tofu, 2010-2013 [GLO]; market for toluene, liquid, 2011-2011 [GLO]; market for toner module, laser printer, black/white, 2011-2011 [GLO]; market for toner module, laser printer, colour, 2011-2011 [GLO]; market for toner, black, powder, 2011-2011 [GLO]; market for toner, colour, powder, 2011-2011 [GLO]; market for transformer, high voltage use, 2011-2011 [GLO]; market for transformer, low voltage use, 2011-2011 [GLO]; market for triazine-compound, unspecified, 2011-2011 [GLO]; market for trichloroacetic acid, 2010-2010 [GLO]; market for trichloroborane, 2011-2011 [GLO]; market for trichloroethylene, 2011-2011 [GLO]; market for triethanolamine, 2011-2011 [GLO]; market for triethyl amine, 2010-2010 [GLO]; market for triethylene glycol, 2011-2011 [GLO]; market for trifluoroacetic acid, 2010-2010 [GLO]; market for trifluoromethane, 2011-2011 [GLO]; market for trimesoyl chloride, 2012-2012 [GLO]; market for trimethylamine, 2011-2011 [GLO]; market for triphenyl phosphate, 2015-2020 [GLO]; market for tris(2,4-ditert-butylphenyl) phosphite, 2015-2020 [GLO]; market for trisodium phosphate, 2015-2020 [GLO]; market for trout feed, 42% protein, 2012-2013 [GLO]; market for tube insulation, elastomere, 2011-2011 [GLO]; market for turpentine, 2017-2020 [GLO]; market for uranium, enriched 3.0%, in fuel element for light water reactor, 2011-2011 [GLO]; market for uranium, enriched 3.8%, in fuel element for light water reactor, 2011-2011 [GLO]; market for uranium, enriched 3.9%, in fuel element for light water reactor, 2011-2011 [GLO]; market for uranium, enriched 4%, in fuel element for light water reactor, 2011-2011 [GLO]; market for uranium, enriched 4.2%, in fuel element for light water reactor, 2011-2011 [GLO]; market for uranium, in yellowcake,

2011-2011 [GLO]; market for urea formaldehyde foam slab, hard, 2011-2011 [GLO]; market for urea formaldehyde foam, in situ foaming, 2011-2011 [GLO]; market for urea formaldehyde resin, 2011-2011 [GLO]; market for urea, as N, 2011-2011 [GLO]; market for used Li-ion battery, 2005-2005 [GLO]; market for used Ni-metal hydride battery, 2011-2011 [GLO]; market for used air distribution terminal panel steel, 120 m3/h, 2011-2011 [GLO]; market for used air filter central unit, 600 m3/h, 2011-2011 [GLO]; market for used air filter decentralized unit, 180-250 m3/h, 2011-2011 [GLO]; market for used air filter decentralized unit, 250 m3/h, 2011-2011 [GLO]; market for used air filter in exhaust air valve, 2011-2011 [GLO]; market for used blower and heat exchange unit Avent E 97, 2011-2011 [GLO]; market for used blower and heat exchange unit GE 250 RH, 2011-2011 [GLO]; market for used blower and heat exchange unit KWL 250, 2011-2011 [GLO]; market for used blower and heat exchange unit KWLC 1200, 2011-2011 [GLO]; market for used blower and heat exchange unit Storkair G 90, 2011-2011 [GLO]; market for used blower and heat exchange unit Twl-700, 2011-2011 [GLO]; market for used blower and heat exchange unit central, 600-1200 m3/h, 2011-2011 [GLO]; market for used blower and heat exchange unit decentralized, 180-250 m3/h, 2011-2011 [GLO]; market for used cathode ray tube display, 2011-2011 [GLO]; market for used desktop computer, 2011-2011 [GLO]; market for used diesel-electric generating set, 18.5kW, 2010-2014 [GLO]; market for used door, inner, glass-wood, 2011-2011 [GLO]; market for used door, inner, wood, 2011-2011 [GLO]; market for used door, outer, wood-aluminium, 2011-2011 [GLO]; market for used door, outer, wood-glass, 2011-2011 [GLO]; market for used double glazing, U<1.1W/m2K, 2011-2011 [GLO]; market for used double glazing, U<1.1W/m2K, laminated safety glass, 2011-2011 [GLO]; market for used exhaust air roof hood steel, DN 400, 2011-2011 [GLO]; market for used exhaust air valve in-wall housing, plastic/steel, 2011-2011 [GLO]; market for used flexible duct aluminium/PET, DN of 125, 2011-2011 [GLO]; market for used insulation spiral-seam duct rockwool, DN 400, 2011-2011 [GLO]; market for used intermodal shipping container, 20-foot, 2010-2014 [GLO]; market for used intermodal shipping container, 40-foot, 2010-2014 [GLO]; market for used intermodal shipping container, 40-foot, high-cube, 2010-2014 [GLO]; market for used intermodal shipping container, 45-foot, high-cube, 2010-2014 [GLO]; market for used laptop computer, 2011-2011 [GLO]; market for used liquid crystal display, 2011-2011 [GLO]; market for used liquid crystal display module, 2011-2011 [GLO]; market for used lorry with refrigeration machine, 16 metric ton, 2010-2014 [GLO]; market for used lorry, 16 metric ton, 2011-2011 [GLO]; market for used outside air intake stainless steel, DN 370, 2011-2011 [GLO]; market for used perfluoropentane, 2012-2012 [GLO]; market for used printer, laser, 2011-2011 [GLO]; market for used purse seiner, steel, 2017-2017 [GLO]; market for used purse seiner, wood, 2017-2017 [GLO]; market for used refrigerant R134a, 2010-2014 [GLO]; market for used refrigeration machine, R134a as refrigerant, 2010-2014 [GLO]; market for used refrigeration machine, carbon dioxide, liquid as refrigerant, 2010-2014 [GLO]; market for used room-connecting overflow element steel, approx. 40 m3/h, 2011-2011 [GLO]; market for used sealing tape aluminium/PE, 50 mm wide, 2011-2011 [GLO]; market for used silencer steel, DN 125, 2011-2011 [GLO]; market for used silencer steel, DN 315, 2011-2011 [GLO]; market for used trawler, steel, 2017-2017 [GLO]; market for used triple glazing, U<0.5W/m2K, 2011-2011 [GLO]; market for used tyre, 2012-2012 [GLO]; market for used ventilation control and wiring central unit, 2011-2011 [GLO]; market for used ventilation control and wiring decentralized unit, 2011-2011 [GLO]; market for used window frame, plastic, 2011-2011 [GLO]; market for used window frame, wood, 2011-2011 [GLO]; market for used window frame, wood-metal, 2011-2011 [GLO]; market for vegetable oil, refined, 2012-2012 [GLO]; market for ventilation duct, PE corrugated tube, DN 75, 2011-2011 [GLO]; market for ventilation duct, connection piece, steel, 100x50 mm, 2011-2011 [GLO]; market for ventilation duct, elbow 90°, steel, 100x50 mm, 2011-2011 [GLO]; market for ventilation duct, steel, 100x50 mm, 2011-2011 [GLO]; market for vermiculite, 2011-2011 [GLO]; market for vinyl acetate, 2011-2011 [GLO]; market for waste electric wiring, 2011-2011 [GLO]; market for waste frit from cathode ray tube production, 2011-2011 [GLO]; market for waste packaging glass, unsorted, 2011-2011 [GLO]; market for waste packaging paper, 1994-2000 [GLO]; market for waste paperboard, unsorted, 1994-2002 [GLO]; market for waste polyethylene terephthalate, 2011-2011 [GLO]; market for waste polypropylene, 2011-2011 [GLO]; market for waste polyurethane, 2011-2011 [GLO]; market for waste polyvinylfluoride, 2011-2011 [GLO]; market for waste, from silicon wafer production, 2011-2011 [GLO]; market for wax, lost-wax casting, 2018-2018 [GLO]; market for wheat grain, 2011-2011 [GLO]; market for wheat grain, feed, 1996-1999 [GLO]; market for wheat grain, feed, organic, 2011-2011 [GLO]; market for wheat grain, organic, 2011-2011 [GLO]; market for white spirit, 2011-2011 [GLO]; market for window frame, aluminium, U=1.6 W/m2K, 2011-2011 [GLO]; market for window frame, poly vinyl chloride, U=1.6 W/m2K, 2011-2011 [GLO]; market for window frame, wood, U=1.5 W/m2K, 2011-2011 [GLO]; market for window frame, wood-metal, U=1.6 W/m2K, 2011-2011 [GLO]; market for wood cladding, softwood, 2012-2012 [GLO]; market for wood preservative, creosote, 2011-2011 [GLO]; market for wood preservative, inorganic salt, containing Cr, 2011-

2011 [GLO]; market for wood preservative, organic salt, Cr-free, 2011-2011 [GLO]; market for wood preservative, organic, indoor use, dry, 2012-2012 [GLO]; market for wood preservative, organic, indoor use, occasionally wet, 2012-2012 [GLO]; market for wood preservative, organic, outdoor use, no ground contact, 2012-2012 [GLO]; market for wood preservative, water-based, indoor use, dry, 2012-2012 [GLO]; market for wood preservative, water-based, indoor use, occasionally wet, 2012-2012 [GLO]; market for wood preservative, water-based, outdoor use, no ground contact, 2012-2012 [GLO]; market for wood wool boards, cement bonded, 2011-2011 [GLO]; market for xenon, gaseous, 2011-2011 [GLO]; market for xylene, 2011-2011 [GLO]; market for yarn, jute, 2011-2011 [GLO]; market for yarn, kenaf, 2011-2011 [GLO]; market for yogurt, from cow milk, 2010-2012 [GLO]; market for zeolite, powder, 2011-2011 [GLO]; market for zeolite, slurry, without water, in 50% solution state, 2011-2011 [GLO]; market for zinc, 2011-2011 [GLO]; market for zinc concentrate, 2012-2017 [GLO]; market for zinc in car shredder residue, 2011-2011 [CH; GLO]; market for zinc monosulfate, 2011-2011 [GLO]; market for zinc oxide, 2011-2011 [GLO]; market for zinc sulfide, 2011-2011 [GLO]; market for zircon, 50% zirconium, 2011-2011 [GLO]; market for zirconium oxide, 2011-2011 [GLO]; primary zinc production from concentrate, 2015-2017 [GLO]; smelting and refining of nickel ore, 2010-2010 [GLO]; soybean production, 2009-2012 [AR]; strawberry production, open field, macro tunnel, 2010-2010 [US]; sugar beet production, 2009-2012 [US]; sulfate pulp production, from eucalyptus, bleached, 2017-2020 [RLA]; sulfate pulp production, from hardwood, bleached, 2011-2021 [GLO]; sulfate pulp production, from hardwood, bleached, 2017-2020 [RER]; sulfate pulp production, from softwood, bleached, 2017-2020 [RER]; sweet corn production, 2006-2012 [US]; sweet corn production, 2010-2011 [TH]; tea production, dried, 2009-2012 [CN; KE; LK]; tomato production, fresh grade, open field, 2009-2012 [MX]; tomato production, fresh grade, open field, 2009-2012 [GLO]; transport, freight, sea, container ship with reefer, cooling, 2010-2014 [GLO]; transport, freight, sea, container ship with reefer, freezing, 2010-2014 [GLO]; wheat production, 2009-2012 [AU; Canada without Quebec]; zinc mine operation, 2012-2017 [GLO].

Annex 4: direct activity links to services or infrastructures

Activities for which direct links to services or immobile infrastructure were added

acetone production, from isopropanol, 2015-2020 [RER]; airport construction, 1990-2000 [RER]; aluminium hydroxide production, 2015-2015 [IAI Area, EU27 & EFTA]; aluminium oxide production, 2015-2015 [IAI Area, EU27 & EFTA]; aluminium production, primary, ingot, 2015-2015 [IAI Area, EU27 & EFTA]; anchovy, capture by steel purse seiner and landing whole, fresh, 2010-2020 [PE]; anchovy, capture by wooden purse seiner and landing whole, fresh, 2010-2020 [PE]; anode production, paste, for aluminium electrolysis, 2015-2015 [IAI Area, EU27 & EFTA]; anode production, prebake, for aluminium electrolysis, 2015-2015 [IAI Area, EU27 & EFTA]; biogas, burned in micro gas turbine 100kWe, 2000-2005 [CH]; biogas, burned in solid oxide fuel cell 125kWe, future, 2000-2005 [CH]; biogas, burned in solid oxide fuel cell, with micro gas turbine, 180kWe, future, 2000-2005 [CH]; bitumen seal production, V60, 1994-2000 [CA-QC]; canal construction, 1993-1994 [RER]; chemi-thermomechanical pulp production, 2000-2000 [RER]; coffee green bean production, robusta, 2012-2014 [BR]; concentrated solar power plant construction, solar thermal parabolic trough, 50 MW, 2010-2020 [ZA]; concentrated solar power plant construction, solar tower power plant, 20 MW, 2010-2020 [ZA]; contouring, brass, 1997-2002 [RER]; contouring, bronze, 1997-2002 [RER]; dehydrogenation of butan-1,4-diol, 2000-2007 [RER]; dried roughage store construction, air dried, solar, 1994-2002 [CH]; dried roughage store construction, cold-air dried, conventional, 1994-2002 [CH]; dried roughage store construction, non ventilated, 1994-2002 [CH]; electricity production, nuclear, boiling water reactor, 1990-2015 [FRCC; MRO, US only; NPCC, US only; RFC; SERC; SPP; TRE; WECC, US only]; electricity production, nuclear, pressure water reactor, 1990-2015 [CN-GD; CN-JS; CN-ZJ; FRCC; MRO, US only; NPCC, US only; RFC; SERC; SPP; TRE; WECC, US only]; electricity production, nuclear, pressure water reactor, 2016-2018 [CN-SH]; electricity production, nuclear, pressure water reactor, heavy water moderated, 2010-2015 [CA-QC]; electricity production, solar thermal parabolic trough, 50 MW, 2010-2020 [ZA]; electricity production, solar tower power plant, 20 MW, 2010-2020 [ZA]; electricity production, wind, 1-3MW turbine, onshore, 2005-2015 [CA-QC]; electricity production, wind, 2.3MW turbine, precast concrete tower, onshore, 2010-2015 [CA-QC]; epoxy resin production, liquid, 2015-2020 [RER]; fish canning, large fish, 2012-2013 [EC]; fish canning, small fish, 2011-2012 [PE]; fish curing, small fish, 2010-2012 [PE]; fish freezing, small fish, 2011-2012 [PE]; fishmeal and fish oil production, 63-65% protein, from fish residues, 2010-2020 [PE]; fishmeal and fish oil production, 63-65% protein, from fresh anchovy, 2010-2020 [PE]; fishmeal and fish oil production, 63-65% protein, from fresh anchovy and fish residues, 2010-2020 [PE]; fishmeal and fish oil production, 65-67% protein, 2010-2020 [PE]; garage construction, wood, non-insulated, fire-protected, 2009-2012 [CH]; geothermal power plant construction, 2015-2015 [CH]; gold production, 2001-2006 [AU]; gold production, 2003-2006 [CA; TZ; US]; gold-silver mine operation with refinery, 2000-2006 [PG]; hard coal mine operation and hard coal preparation, 1990-2002 [Europe, without Russia and Turkey]; hay production, organic, intensive, 2005-2005 [CH]; hay production, Swiss integrated production, extensive, 2005-2005 [CH]; hay production, Swiss integrated production, intensive, 2005-2005 [CH]; heat and power co-generation unit construction, 160kW electrical, common components for heat+electricity, 1987-2000 [RER]; heat and power co-generation unit construction, 160kW electrical, components for electricity only, 1987-2000 [RER]; heat and power co-generation unit construction, 160kW electrical, components for heat only, 1987-2000 [RER]; heat and power co-generation unit construction, 1MW electrical, common components for heat+electricity, 1987-2000 [RER]; heat and power co-generation unit construction, 1MW electrical, components for electricity only, 1987-2000 [RER]; heat and power co-generation unit construction, 1MW electrical, components for heat only, 1987-2000 [RER]; heat and power co-generation unit construction, 200kW electrical, common components for heat+electricity, 1987-2000 [RER]; heat and power co-generation unit construction, 200kW electrical, components for electricity only, 1987-2000 [RER]; heat and power co-generation unit construction, 200kW electrical, components for heat only, 1987-2000 [RER]; heat and power co-generation unit construction, 200kW electrical, diesel SCR, common components for heat+electricity, 1987-2000 [RER]; heat and power co-generation unit construction, 200kW electrical, diesel SCR, components for electricity only, 1987-2000 [RER]; heat and power co-generation unit construction, 200kW electrical, diesel SCR, components for heat only, 1987-2000 [RER]; heat and power co-generation unit construction, 500kW electrical, common components for heat+electricity, 1987-2000 [RER]; heat and power co-generation unit construction, 500kW electrical, components

for electricity only, 1987-2000 [RER]; heat and power co-generation unit construction, 500kW electrical, components for heat only, 1987-2000 [RER]; heat and power co-generation unit construction, 50kW electrical, common components for heat+electricity, 1987-2000 [RER]; heat and power co-generation unit construction, 50kW electrical, components for electricity only, 1987-2000 [RER]; heat and power co-generation unit construction, 50kW electrical, components for heat only, 1990-2000 [RER]; heat and power co-generation, oil, 1980-2015 [DK]; hot rolling, steel, 1997-2002 [RER]; housing system construction, cattle, loose, 1994-2002 [CH]; housing system construction, cattle, tied, 1994-2002 [CH]; housing system construction, pig, fully-slatted floor, 1994-2002 [CH]; housing system construction, pig, label-certified, 1994-2002 [CH]; hydrogen fluoride production, 1979-2020 [RER]; inert material landfill construction, 1995-1995 [CH]; liquid manure storage and processing facility construction, 1994-2002 [CH]; market for biowaste, 2000-2002 [CH]; market for diesel, 1989-2000 [CH; Europe without Switzerland]; market for diesel, low-sulfur, 2000-2005 [CH; Europe without Switzerland]; market for electricity, high voltage, 2014-2017 [AT; BA; BE; BG; CA-QC; CH; CZ; DE; ES; FR; GI; GR; HR; HU; IT; LU; ME; MK; NL; PL; PT; RO; RS; SI; SK; XK]; market for electricity, high voltage, for Swiss Federal Railways, 2011-2015 [CH]; market for electricity, high voltage, label-certified, 2011-2015 [CH]; market for electricity, medium voltage, 2014-2017 [CH]; market for ethanol, without water, in 99.7% solution state, from fermentation, at service station, 2000-2005 [CH]; market for heavy fuel oil, 1989-2000 [CH]; market for heavy fuel oil, 1989-2000 [Europe without Switzerland]; market for kerosene, 1989-2000 [CH]; market for kerosene, 1989-2000 [Europe without Switzerland]; market for light fuel oil, 1989-2000 [CH]; market for light fuel oil, 1989-2000 [Europe without Switzerland]; market for liquefied petroleum gas, 1999-2008 [CH]; market for methanol, from biomass, 1995-2006 [CH]; market for municipal solid waste, 2018-2018 [CH]; market for naphtha, 1989-2000 [RER]; market for natural gas, high pressure, 1997-2000 [AT; GB; NL]; market for natural gas, high pressure, 2000-2000 [BE; CH; CZ; DE; DK; ES; FI; GR; HU; IE; PL; SE; SK]; market for natural gas, high pressure, 2000-2001 [FR; IT]; market for natural gas, high pressure, 2012-2012 [NO]; market for natural gas, low pressure, 2000-2000 [CH]; market for petrol, low-sulfur, 1989-2005 [CH; Europe without Switzerland]; market for petrol, unleaded, 1989-2000 [RER]; market for rape oil, crude, 2004-2008 [CH]; market for tap water, 2012-2012 [CH]; market for waste paper, unsorted, 2000-2000 [CH]; methylene diphenyl diisocyanate production, 2015-2020 [RER]; milking parlour construction, 1994-2002 [CH]; mowing, by motor mower, 1991-2002 [CH]; natural gas, burned in micro gas turbine, 100kWe, 2000-2005 [CH]; natural gas, burned in solid oxide fuel cell 125kWe, future, 2000-2005 [CH]; natural gas, burned in solid oxide fuel cell, with micro gas turbine, 180kWe, future, 2000-2005 [CH]; N-methyl-2-pyrrolidone production, 2015-2020 [RER]; operation, computer, desktop, with cathode ray tube display, office use, 2012-2012 [CA-QC]; operation, computer, laptop, 23% active work, 2001-2006 [CA-QC]; orange production, fresh grade, 2015-2015 [ZA]; orange production, processing grade, 2000-2012 [BR]; peat moss production, horticultural use, 2010-2010 [CA-QC]; petroleum and gas production, off-shore, 2000-2000 [NO]; phosphate rock beneficiation, dry, 1986-2001 [MA]; phosphate rock beneficiation, wet, 1986-2001 [US]; phosphoric acid production, dihydrate process, 1986-2001 [US]; pipeline construction, liquid manure, 2009-2009 [CH]; pipeline construction, natural gas, high pressure distribution network, 1990-2000 [Europe without Switzerland]; pipeline construction, natural gas, high pressure distribution network, 2012-2012 [CH]; pipeline construction, natural gas, low pressure distribution network, 2012-2012 [CH]; port facilities construction, 1990-1992 [RER]; railway track construction, 1990-2000 [CH]; railway track construction, for high-speed train, 2000-2000 [DE]; residual material landfill construction, 1995-1995 [CH]; road construction, 1990-2000 [CH]; road construction, company, internal, 1990-2000 [CH]; sanitary landfill facility construction, 1995-1995 [CH]; section bar extrusion, aluminium, 2000-2002 [RER]; shed construction, 1994-2002 [CH]; shed construction, large, wood, non-insulated, fire-unprotected, 2009-2012 [CH]; sheet rolling, aluminium, 2000-2002 [RER]; sheet rolling, chromium steel, 1997-2002 [RER]; sheet rolling, copper, 2000-2002 [RER]; sheet rolling, steel, 1997-2002 [RER]; silver-gold mine operation with refinery, 2002-2006 [CL]; slag landfill construction, 1995-1995 [CH]; steatite quarry operation, 2011-2012 [CA-QC]; sulfate pulp production, from hardwood, bleached, 2017-2020 [RER]; sulfate pulp production, from softwood, bleached, 2017-2020 [RER]; sulfate pulp production, from softwood, unbleached, 2017-2020 [RER]; sulfite pulp production, bleached, 1997-2000 [RER]; thermo-mechanical pulp production, 1993-2000 [RER]; tin plating, pieces, 2001-2005 [RER]; titanium zinc plate production, without pre-weathering, 1997-2002 [DE]; tram track construction, 1990-2000 [CH]; transport, freight train, diesel, with particle filter, 2000-2000 [CH]; transport, freight train, electricity, 2000-2000 [CH]; transport, passenger, electric bicycle, 2005-2009 [CH]; transport, passenger, electric bicycle, label-certified electricity, 2005-2009 [CH]; transport, passenger, motor scooter, 2005-2009 [CH]; treatment of aluminium in car shredder residue, municipal incineration, 1994-2000 [CH]; treatment of aluminium in car shredder residue, municipal incineration with fly ash extraction, 2006-

2012 [CH]; treatment of ash from deinking sludge, residual material landfill, 1994-2000 [CH]; treatment of ash from paper production sludge, residual material landfill, 1994-2000 [CH; Europe without Switzerland]; treatment of average incineration residue, residual material landfill, 1994-2000 [CH]; treatment of basic oxygen furnace waste, residual material landfill, 1994-2000 [CH]; treatment of bilge oil, hazardous waste incineration, 1997-2000 [CH; Europe without Switzerland]; treatment of biowaste, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of coating from waste cathode ray tube display, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of coating from waste cathode ray tube display, municipal waste incineration, 1994-2000 [CH]; treatment of condensate from light oil boiler, capacity 1.1E10l/year, 1994-2000 [CH]; treatment of copper in car shredder residue, municipal incineration, 1994-2000 [CH]; treatment of copper in car shredder residue, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of decarbonising waste, residual material landfill, 1994-2000 [CH]; treatment of decommissioned airport infrastructure, contaminated gravel, 1990-2000 [RER]; treatment of decommissioned pipeline, natural gas, inert material landfill, 1995-1995 [CH]; treatment of decommissioned road, 1985-2000 [RER]; treatment of digester sludge, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of digester sludge, municipal incineration, future, 2010-2020 [CH]; treatment of drilling waste, residual material landfill, 1994-2000 [CH]; treatment of dross from Al electrolysis, residual material landfill, 1994-2000 [CH]; treatment of dust, alloyed electric arc furnace steel, residual material landfill, 1994-2000 [CH]; treatment of dust, unalloyed electric arc furnace steel, residual material landfill, 1994-2000 [CH]; treatment of filter dust from Al electrolysis, residual material landfill, 1994-2000 [CH]; treatment of fly ash and scrubber sludge, hazardous waste incineration, 1997-2000 [CH; Europe without Switzerland]; treatment of green liquor dregs, residual material landfill, 1994-2000 [CH]; treatment of H3PO4 purification residue, residual material landfill, 1994-2000 [CH]; treatment of hard coal ash, municipal incineration, 1994-2000 [CH]; treatment of hard coal ash, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of hard coal ash, residual material landfill, 1994-2000 [AT; BE; CZ; DE; ES; FR; HR; IT; NL; PL; PT; SK]; treatment of hard coal ash, sanitary landfill, 1994-2000 [CH]; treatment of hazardous waste, hazardous waste incineration, 1997-2000 [CH; Europe without Switzerland]; treatment of heat carrier liquid, 40% C3H8O2, capacity 1.1E10l/year, 1994-2000 [CH]; treatment of inert waste, inert material landfill, 1995-1995 [CH]; treatment of inert waste, sanitary landfill, 1994-2000 [CH]; treatment of lead in car shredder residue, municipal incineration, 1994-2000 [CH]; treatment of lead in car shredder residue, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of lignite ash, municipal incineration, 1994-2000 [CH]; treatment of lignite ash, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of lignite ash, sanitary landfill, 1994-2000 [CH]; treatment of limestone residue, inert material landfill, 1995-1995 [CH]; treatment of low level radioactive waste, surface or trench deposit, 2000-2000 [CH]; treatment of municipal solid waste, incineration, 2006-2012 [AT; BE; BG; CH; CZ; DE; DK; ES; FI; FR; GB; HU; IT; LU; NL; NO; PL; PT; SE; SK]; treatment of municipal solid waste, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of municipal solid waste, sanitary landfill, 1994-2000 [CA-QC]; treatment of municipal solid waste, sanitary landfill, 1994-2000 [CH]; treatment of nickel smelter slag, residual material landfill, 1994-2000 [CH]; treatment of pollutant from rail ballast, residual material landfill, 1994-2000 [CH]; treatment of rainwater mineral oil storage, in wastewater treatment plant, capacity 1.1E10l/year, 1994-2000 [CH; Europe without Switzerland]; treatment of raw sewage sludge, municipal incineration, 1994-2000 [CH]; treatment of raw sewage sludge, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of redmud from bauxite digestion, residual material landfill, 1994-2000 [CH]; treatment of refinery sludge, hazardous waste incineration, 1997-2000 [CH; Europe without Switzerland]; treatment of refinery sludge, sanitary landfill, 1994-2000 [CH]; treatment of refinery sludge, sanitary landfill, 1994-2000 [Europe without Switzerland]; treatment of refractory spent pot liner from Al electrolysis, residual material landfill, 1994-2000 [CH]; treatment of residue from cooling tower, sanitary landfill, 1994-2000 [CH]; treatment of residue from mechanical treatment, cathode ray tube display, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, cathode ray tube display, municipal waste incineration, 1994-2000 [CH]; treatment of residue from mechanical treatment, desktop computer, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, desktop computer, municipal waste incineration, 1994-2000 [CH]; treatment of residue from mechanical treatment, industrial device, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, industrial device, municipal waste incineration, 1994-2000 [CH]; treatment of residue from mechanical treatment, IT accessory, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, IT accessory, municipal waste incineration, 1994-2000 [CH]; treatment of residue from mechanical treatment, laptop computer, municipal incineration with fly ash

extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, laptop computer, municipal waste incineration, 1994-2000 [CH]; treatment of residue from mechanical treatment, laser printer, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, laser printer, municipal waste incineration, 1994-2000 [CH]; treatment of residue from mechanical treatment, liquid crystal display, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from mechanical treatment, liquid crystal display, municipal waste incineration, 1994-2000 [CH]; treatment of residue from Na-dichromate production, residual material landfill, 1994-2000 [CH]; treatment of residue from shredder fraction from manual dismantling, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of residue from shredder fraction from manual dismantling, municipal waste incineration, 1994-2000 [CH]; treatment of residue from TiO2 production, chloride process, residual material landfill, 1994-2000 [CH]; treatment of residue from TiO2 production, sulfate process, residual material landfill, 1994-2000 [CH]; treatment of salt tailing from potash mine, residual material landfill, 1994-2000 [CH]; treatment of scrap aluminium, municipal incineration, 1994-2000 [CH]; treatment of scrap aluminium, municipal incineration, 2006-2012 [Europe without Switzerland]; treatment of scrap aluminium, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of scrap copper, municipal incineration, 1994-2000 [CH]; treatment of scrap copper, municipal incineration, 2006-2012 [Europe without Switzerland]; treatment of scrap copper, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of scrap steel, inert material landfill, 1995-1995 [CH]; treatment of scrap steel, municipal incineration, 1994-2000 [CH]; treatment of scrap steel, municipal incineration, 2006-2012 [Europe without Switzerland]; treatment of scrap steel, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of scrap tin sheet, municipal incineration, 1994-2000 [CH]; treatment of scrap tin sheet, municipal incineration with fly ash extraction, 2006-2012 [CH]; treatment of scrap tin sheet, sanitary landfill, 1994-2000 [CH]; treatment of slag from metallurgical grade silicon production, inert material landfill, 1995-1995 [CH]; treatment of slag, unalloyed electric arc furnace steel, residual material landfill, 1994-2000 [CH]

Activities for which direct links to mobile infrastructure were removed

adhesive mortar production, 2000-2004 [CH]; aluminium casting facility construction, 2002-2002 [RER]; aluminium drilling, computer numerical controlled, 2006-2007 [RER]; aluminium drilling, conventional, 2006-2007 [RER]; aluminium electrolysis facility construction, 2002-2002 [RER]; aluminium hydroxide factory construction, 2002-2002 [RER]; aluminium melting furnace production, 2002-2002 [RER]; aluminium milling, average, 2006-2007 [RER]; aluminium milling, dressing, 2006-2007 [RER]; aluminium milling, large parts, 2006-2007 [RER]; aluminium milling, small parts, 2006-2007 [RER]; aluminium oxide factory construction, 2002-2002 [RER]; aluminium turning, average, computer numerical controlled, 2006-2007 [RER]; aluminium turning, average, conventional, 2006-2007 [RER]; aluminium turning, primarily dressing, computer numerical controlled, 2006-2007 [RER]; aluminium turning, primarily dressing, conventional, 2006-2007 [RER]; aluminium turning, primarily roughing, computer numerical controlled, 2006-2007 [RER]; aluminium turning, primarily roughing, conventional, 2006-2007 [RER]; anhydrite floor production, 2000-2004 [CH]; anhydrite production, 1997-2003 [CH]; anhydrite production, burned, 1997-2003 [CH]; anode factory construction, 2002-2002 [RER]; base plaster production, 1995-2001 [CH]; bentonite quarry construction, 1997-2000 [DE]; blast furnace production, 2002-2002 [RER]; blast oxygen furnace converter production, 2002-2002 [RER]; brass drilling, computer numerical controlled, 2006-2007 [RER]; brass drilling, conventional, 2006-2007 [RER]; brass turning, average, computer numerical controlled, 2006-2007 [RER]; brass turning, average, conventional, 2006-2007 [RER]; brass turning, primarily dressing, computer numerical controlled, 2006-2007 [RER]; brass turning, primarily dressing, conventional, 2006-2007 [RER]; brass turning, primarily roughing, computer numerical controlled, 2006-2007 [RER]; brass turning, primarily roughing, conventional, 2006-2007 [RER]; cast iron drilling, computer numerical controlled, 2006-2007 [RER]; cast iron drilling, conventional, 2006-2007 [RER]; cast iron milling, average, 2006-2007 [RER]; cast iron milling, dressing, 2006-2007 [RER]; cast iron milling, large parts, 2006-2007 [RER]; cast iron milling, small parts, 2006-2007 [RER]; cast iron turning, average, computer numerical controlled, 2006-2007 [RER]; cast iron turning, average, conventional, 2006-2007 [RER]; cast iron turning, primarily dressing, computer numerical controlled, 2006-2007 [RER]; cast iron turning, primarily dressing, conventional, 2006-2007 [RER]; cast iron turning, primarily roughing, computer numerical controlled, 2006-2007 [RER]; cast iron turning, primarily roughing, conventional, 2006-2007 [RER]; cement factory construction, 1997-2001 [CH]; cement mortar

production, 1994-2001 [CH]; ceramic factory construction, 2001-2002 [CH]; chromium steel drilling, computer numerical controlled, 2006-2007 [RER]; chromium steel drilling, conventional, 2006-2007 [RER]; chromium steel milling, average, 2006-2007 [RER]; chromium steel milling, dressing, 2006-2007 [RER]; chromium steel milling, large parts, 2006-2007 [RER]; chromium steel milling, small parts, 2006-2007 [RER]; chromium steel turning, average, computer numerical controlled, 2006-2007 [RER]; chromium steel turning, average, conventional, 2006-2007 [RER]; chromium steel turning, primarily dressing, computer numerical controlled, 2006-2007 [RER]; chromium steel turning, primarily dressing, conventional, 2006-2007 [RER]; chromium steel turning, primarily roughing, computer numerical controlled, 2006-2007 [RER]; chromium steel turning, primarily roughing, conventional, 2006-2007 [RER]; clay pit construction, 1992-2002 [CH]; clay plaster production, 1995-2001 [CH]; clinker production, 1998-2003 [Europe without Switzerland]; clinker production, 2009-2013 [CH]; concrete mixing factory construction, 1997-2001 [CH]; copper mine operation, sulfide ore, 1994-2003 [RER]; cover plaster production, mineral, 1995-2001 [CH]; cover plaster production, organic, 1995-2001 [CH]; deep drawing, steel, 10000 kN press, automode, 2006-2007 [RER]; deep drawing, steel, 10000 kN press, single stroke, 2006-2007 [RER]; deep drawing, steel, 3500 kN press, automode, 2006-2007 [RER]; deep drawing, steel, 3500 kN press, single stroke, 2006-2007 [RER]; deep drawing, steel, 38000 kN press, automode, 2006-2007 [RER]; deep drawing, steel, 38000 kN press, single stroke, 2006-2007 [RER]; deep drawing, steel, 650 kN press, automode, 2006-2007 [RER]; deep drawing, steel, 650 kN press, single stroke, 2006-2007 [RER]; dolomite production, 2000-2000 [RER]; electric arc furnace converter construction, 2002-2002 [RER]; explosive production, tovex, 1997-2001 [CH]; explosives factory construction, 2000-2001 [CH]; fibre cement corrugated slab production, 1991-2001 [CH]; fibre cement roof slate production, 1991-2001 [CH]; flat glass factory construction, 2000-2001 [RER]; foam glass factory construction, 2005-2005 [BE]; graphite production, 2000-2000 [RER]; gravel and sand quarry operation, 1997-2001 [CH]; gravel production, crushed, 2013-2013 [CH]; gravel/sand quarry construction, 1997-2001 [CH]; gypsum quarry operation, 1997-2003 [CH]; heat production, biogas, at diffusion absorption heat pump 4kW, future, 2000-2005 [CH]; heat production, mixed logs, at wood heater 6kW, 2000-2014 [CH]; heat production, mixed logs, at wood heater 6kW, state-of-the-art 2014, 2014-2014 [CH]; impact extrusion of aluminium, 1 stroke, 2006-2007 [RER]; impact extrusion of aluminium, 2 strokes, 2006-2007 [RER]; impact extrusion of aluminium, 3 strokes, 2006-2007 [RER]; impact extrusion of aluminium, 4 strokes, 2006-2007 [RER]; impact extrusion of aluminium, 5 strokes, 2006-2007 [RER]; impact extrusion of steel, cold, 1 strokes, 2006-2007 [RER]; impact extrusion of steel, cold, 2 strokes, 2006-2007 [RER]; impact extrusion of steel, cold, 3 strokes, 2006-2007 [RER]; impact extrusion of steel, cold, 4 strokes, 2006-2007 [RER]; impact extrusion of steel, cold, 5 strokes, 2006-2007 [RER]; impact extrusion of steel, hot, 1 strokes, 2006-2007 [RER]; impact extrusion of steel, hot, 2 strokes, 2006-2007 [RER]; impact extrusion of steel, hot, 3 strokes, 2006-2007 [RER]; impact extrusion of steel, hot, 4 strokes, 2006-2007 [RER]; impact extrusion of steel, hot, 5 strokes, 2006-2007 [RER]; impact extrusion of steel, warm, 1 strokes, 2006-2007 [RER]; impact extrusion of steel, warm, 2 strokes, 2006-2007 [RER]; impact extrusion of steel, warm, 3 strokes, 2006-2007 [RER]; impact extrusion of steel, warm, 4 strokes, 2006-2007 [RER]; impact extrusion of steel, warm, 5 strokes, 2006-2007 [RER]; intral production, 2000-2000 [RER]; laser machining, metal, with CO2-laser, 2000W power, 2006-2007 [RER]; laser machining, metal, with CO2-laser, 2700W power, 2006-2007 [RER]; laser machining, metal, with CO2-laser, 3200W power, 2006-2007 [RER]; laser machining, metal, with CO2-laser, 4000W power, 2006-2007 [RER]; laser machining, metal, with CO2-laser, 5000W power, 2006-2007 [RER]; laser machining, metal, with CO2-laser, 6000W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 120W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 200W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 30W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 330W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 40W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 500W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 50W power, 2006-2007 [RER]; laser machining, metal, with YAG-laser, 60W power, 2006-2007 [RER]; light mortar production, 1995-2001 [CH]; lime mortar production, 1995-2001 [CH]; lime production, hydrated, loose weight, 2000-2002 [CH]; lime production, hydraulic, 1997-2001 [CH]; lime production, milled, loose, 2000-2002 [CH; Europe without Switzerland]; limestone production, crushed, for mill, 2000-2002 [CH]; limestone production, crushed, washed, 2000-2002 [CH]; magnesium oxide production, 2000-2000 [RER]; magnesium sulfate production, 2000-2000 [RER]; malusil production, 2000-2000 [RER]; mastic asphalt production, 2000-2004 [CH]; metal working, average for aluminium product manufacturing, 2006-2007 [RER]; metal working, average for chromium steel product manufacturing, 2006-2007 [RER]; metal working, average for copper product manufacturing, 2006-2007 [RER]; metal working, average for metal product manufacturing, 2006-2007 [RER]; metal working, average for steel product manufacturing, 2006-2007 [RER]; mine

construction, gold-silver-zinc-lead-copper, 2004-2006 [SE]; natural stone plate production, grounded, 2000-2004 [CH]; natural stone plate production, polished, 2000-2004 [CH]; nuclear spent fuel conditioning facility construction, 2002-2002 [CH]; nuclear waste storage construction, final repository for high level radioactive waste, 1985-2002 [CH]; nuclear waste storage construction, final repository for low level radioactive waste, 1985-2002 [CH]; packing, cement, 1997-2001 [CH]; packing, clay product, 2000-2002 [CH]; packing, fibre cement product, 2000-2001 [CH]; packing, lime product, 2000-2002 [CH]; photovoltaic cell factory construction, 2000-2005 [DE]; plaster mixing, 2001-2001 [CH]; plastic processing factory construction, 1999-2003 [RER]; polystyrene foam slab for perimeter insulation, 2009-2011 [CH]; polystyrene foam slab production, 10% recycled, 2009-2011 [CH]; polystyrene foam slab with graphite, 6% recycled, 2009-2011 [CH]; portachrom production, 2000-2000 [RER]; portafer production, 2000-2000 [RER]; pumice quarry operation, 2000-2000 [DE]; quicklime production, in pieces, loose, 2000-2002 [CH]; quicklime production, milled, loose, 2000-2002 [CH]; refractory production, basic, packed, 1999-2001 [DE]; refractory production, fireclay, packed, 1999-2001 [DE]; refractory production, high aluminium oxide, packed, 1999-2001 [DE]; rock crushing, 1999-2001 [RER]; sawmill construction, 2012-2013 [CH]; scrap preparation facility construction, 2002-2002 [RER]; spodumene production, 2000-2000 [RER]; steel drilling, computer numerical controlled, 2006-2007 [RER]; steel drilling, conventional, 2006-2007 [RER]; steel milling, average, 2006-2007 [RER]; steel milling, dressing, 2006-2007 [RER]; steel milling, large parts, 2006-2007 [RER]; steel milling, small parts, 2006-2007 [RER]; steel turning, average, computer numerical controlled, 2006-2007 [RER]; steel turning, average, conventional, 2006-2007 [RER]; steel turning, primarily dressing, computer numerical controlled, 2006-2007 [RER]; steel turning, primarily dressing, conventional, 2006-2007 [RER]; steel turning, primarily roughing, computer numerical controlled, 2006-2007 [RER]; steel turning, primarily roughing, conventional, 2006-2007 [RER]; stone wool factory construction, 2000-2002 [CH]; stone wool production, packed, 2000-2007 [CH]; stucco production, 1997-2003 [CH]; thermal plaster production, outdoor, 1995-2001 [CH]; urea formaldehyde foam production, in situ foaming, 1997-2003 [CH]; ventilation components factory construction, 1998-2003 [RER]; wafer factory construction, 2000-2005 [DE]; waste preparation facility construction, 2000-2014 [CH]