Documentation of changes implemented in ecoinvent database 3.0

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1 Introduction

[This draft report summarises the central database changes performed up until the date stated on the front page of this report. It will continuously be updated concurrently with the further planned changes, until the final release of the ecoinvent database version 3. The report also contains an outlook on the work currently planned for implementation before the release of version 3.0. This outlook is either placed in separate sections marked "outlook" or placed in the running text in bold font.]

This report summarises the central changes implemented in the datasets of the ecoinvent database version 3 as compared to version 2.2. The central changes are changes that are performed for all or several datasets as a centralised procedure by the database administration.

Accompanying the report at hand is an Excel file (available on the ecoinvent web-site in the same location as the report at hand) listing all datasets converted from ecoinvent version 2.2, indicating which of the changes reported here are applicable to each individual dataset.

Universally Unique Identifiers (UUIDs) are now applied for all datasets and exchanges (see Chapter 2) in place of the version 2.2 ID numbers. UUIDs are now also applied to all other master data (units, geographies, properties, sources, persons, etc.). For the user, these UUIDs are not visible, but "behind the scene" the use of UUIDs allows the database management to e.g. change names database-wide without having to make this change in each individual dataset. The UUIDs are publicly and freely available, for e.g. software developers who implement converters to other database formats.

Since the changes described in the report at hand have been implemented centrally, the responsibility for these changes and any errors related to these obviously falls on the ecoinvent database management, and not on the individual authors of the datasets. We have nevertheless retained the original authors of the v2.2 datasets as authors of the converted datasets in order to give due credit to their work. From the descriptions in this report, it should be clear what parts of the datasets have been changed centrally and for which the ecoinvent database management is responsible.

A general disclaimer has been added to the General Comment field of all datasets converted from v2.2 to the effect that "This is a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfil the requirements of the ecoinvent data quality guideline for version 3." This disclaimer will only be removed for a specific dataset if an author updates the dataset and finds that the disclaimer is no longer relevant.

In addition to the central changes described in the report at hand, there are changes performed for specific datasets by individual dataset authors. These changes are documented directly in the datasets and can be identified by comparing the new dataset to the original v.2.2. dataset, using the compare function of the free ecoEditor software. **[The compare function will be implemented before the final publication of the ecoinvent database version 3]**

In addition to the changes to individual datasets, the format and structure for the datasets and the database has also been revised. These structural changes are described in the ecoSpold 2 documentation (www.spold.org) and in the ecoinvent report 1 (Weidema et al. 2011), respectively.

2 Names and IDs of datasets and exchanges

2.1 Activity names and product names

In ecoinvent version 1&2, separate names for *activities* (in ecoinvent version 1&2 called *processes*) and *products* was only implemented for datasets with multiple product outputs.

In ecoinvent version 3, most datasets have multiple intermediate outputs, and separate names for activities and intermediate outputs have been implemented throughout the database.

At the same time, all names have been reviewed to ensure consistency with the ecoinvent naming conventions, which were at the same time made more stringent in some aspects (see the Data Quality Guidelines: Weidema et al. 2011).

The documentation file in Excel format accompanying the report at hand (and available on the ecoinvent web-site in the same location as the report at hand) lists the old and the new names (and ID numbers) for all datasets converted from ecoinvent version 2.2.

In version 2.2, some activity datasets were available in duplicates, with both the generic name of the product group and the name of specific products within the product group. The datasets with the more specific product names have been deleted and for datasets that used the specific products, the inputs have been changed to the generic product name, thus reflecting the actual level of unit process modelling. For used IT accessory, this also involved a change in the unit of the exchange. See Table 2.1 for a list of all specific products deleted.

Finally, a few obsolete datasets for activities that no longer exist have been deleted. These are listed in Table 2.2.

Table 2.1. Name of detailed products for which the duplicate datasets have been deleted and the generic product that is now used instead. The factor column lists the conversion factors applied for the unit changes involved.

Name of detailed products deleted	Instead modelled as generic product:	Factor
2,4-D	phenoxy-compound	
alachlor	acetamide-anilide-compound	
carbofuran	[thio]carbamate-compound	
cyanazine	triazine-compound	
dicamba	benzoic-compound	
diuron	[sulfonyl]urea-compound	
linuron	[sulfonyl]urea-compound	
maneb	dithiocarbamate-compound	
MCPA	phenoxy-compound	
parathion	organophosphorus-compound	
propachlor	acetamide-anilide-compound	
used keyboard	used IT accessory	1.25 kg/unit
used pointing device, optical mouse, with cable	used IT accessory	0.12 kg/unit
used power adapter, for laptop	used IT accessory	0.53 kg/unit
used printer, laser, colour	used printer, laser	5.87 kg/unit

Table 2.2. Obsolete datasets deleted.

Obsolete datasets deleted	comment
portland slag sand cement	product falls outside new cement classifications

2.2 Treatment activities / Materials for treatment

In ecoinvent version 2, waste treatment was expressed as service outputs of the treatment activities and service inputs to the activities supplying the waste. All such waste treatment services have been reviewed and their reference products are now expressed as negative outputs of wastes, reflecting that the service activity physically removes the waste. For example, the version 2.2 dataset "disposal, road", which for consistency reasons is now called "treatment of decommissioned road", has as its reference product "-1 m*year decommissioned road".

Some treatment activities in version 2 did not have a service output, but were instead expressed relative to the output of by-products produced from the treated waste. The input of waste was either given as an input or not included in the datasets at all. For these activities, the missing outputs have now been added, either by moving the input of waste to be a negative output or by adding the missing waste, see Chapters 3.1 and 3.2.

For a number of products in the ecoinvent database version 2 that have now been identified as by-products (e.g. straw, sodium hydroxide), the activities that have the by-product as its reference product or as an input for treatment are missing. These activities have been added temporarily as empty dummy datasets with the name "dummy activity for [name of product]". **[Before the publication of the ecoinvent database version 3, these dummy datasets will be replaced by more realistic activity datasets, either with the product as a main product, as a material for treatment or as an output from a constrained market. To avoid temporary problems in the re-linking of the database three datasets for collection of waste ("polystyrene scrap, post-consumer", "waste packaging glass, unsorted", and "waste paper, unsorted") have not yet been adjusted to become markets for waste treatment.]**

2.3 Production and supply mixes and imports

In the ecoinvent database version 1&2, production mixes and supply mixes (a supply mix is a production mix plus any imports) could be used as an input to a market (producing a consumption mix) or to a transforming activity. In the ecoinvent database version 3, production and supply mixes are not used as inputs to any other activities. All intermediate inputs are coming either directly from transforming activities or via markets.

In the ecoinvent database version 3, production and supply mixes can be auto-generated by the database service layer for any desired geographical area **[This feature has not yet been implemented]**.

Currently, production and supply mixes that were available in the database version 2.2 have been converted as any other dataset and are therefore temporarily available as such (unless deleted for other reasons; see Chapters 2.1, 3.3, 6.5, 7.2, 7.3, 11.1, and 11.3). This has been done in order to preserve any non-market information that may be present in these datasets, since some production and supply mixes in version 2.2 contains more than just a sum of the production outputs (and imports) for the geographical area.

[Before the publication of the ecoinvent database version 3, the converted datasets will be manually reviewed and any relevant information will be manually retrieved and placed in other relevant datasets. The converted production and supply mixes will then be deleted, and when relevant re-created by auto-generation as pure production and supply mixes, only containing inputs of the relevant intermediate product. Currently the review process is in progress, which means that some relevant production and supply mixes are temporarily not available in the database.]

Import datasets (of the special activity type "Import") contributes to the supply mixes, but to avoid double-counting they are not used as input to markets (consumption mixes) that already have the imported amounts as part of their inputs. This is to be distinguished from imports that are reported as ordinary transforming activities, which do contribute to the markets (consumption mixes) that geographically contains them. The former is used in national balancing of the supply and use of a product, while the latter is used to model the import from or to partly isolated markets; see also Chapter 7.4 in the report at hand and Chapter 11.5 in the ecoinvent report 1 (Weidema et al. 2011).

The import datasets from the ecoinvent database version 2.2., listed in Table 2.3, have all been classified as import datasets of the special activity type "Import". [**As for the production and supply mixes, they will now be manually reviewed and unless the datasets are retained, any relevant information will be manually retrieved and placed in other relevant datasets.]**

Table 2.3. Import datasets converted from version 2.2 (here listed with their version 3 activity names)

Dataset name
import of natural gas, liquefied
import of roundwood, azobe from sustainable forest management, CM, debarked, 30% water on dry mass basis
import of roundwood, meranti from sustainable forest management, MY, debarked, 70% water on dry mass basis
import of sawnwood, paraná pine from sustainable forest management, kiln dried, 15% water on dry mass basis
import of sulfate pulp, unbleached, from eucalyptus ssp. from sustainable forest management, TH

2.4 Consumption mixes (markets)

Market activities typically mix similar intermediate outputs from different transforming activities. Market activities therefore provide consumption mixes of the intermediate outputs. The term consumption mix is not part of the name of the output, but is a consequence of the activity being a market activity.

In the ecoinvent database version 1&2, market activities existed for some products, but were not named as such and were not identified as a special activity type. In the ecoinvent database version 3,

market datasets are always named "market for [name of product]" and are identified as a special activity type that results in a specific handling during the linking of the datasets in the database; see Chapter 6.2.

In the ecoinvent database version 3, the inputs of the marketed product to market datasets are filled in automatically by the database service layer, based on the output from the activities that produce the product within the geographical area of the market, weighted in proportion to their production volumes. Therefore, the inputs of the marketed products are not manually entered into these datasets, and in market datasets converted from the ecoinvent database version 2.2, such inputs are deleted.

Market datasets converted from the ecoinvent database version 2.2 may furthermore contain some information that rather belongs in transforming activity datasets. The converted market datasets will therefore be manually reviewed before the release of the ecoinvent database version 3, to retrieve such information and place it in the relevant transforming datasets.

2.5 ID numbers of activity datasets

Universally Unique Identifiers (UUIDs) are applied for all datasets in the ecoinvent database version 3, in place of the version 2.2 ID numbers.

The UUIDs for the converted datasets are listed in the Excel file accompanying the report at hand (and available on the ecoinvent web-site in the same location). The file also contains the UUIDs applied for any datasets that are generated by the automatic database update routine when these were not already present: When no global (GLO) market datasets exist for an intermediate output (see Chapter 6.2), when global datasets are generated by extrapolation from a dataset for a non-global geography (see Chapter 6.6), and when Rest-Of-World (ROW) datasets are generated as the difference between a global dataset and the local datasets with the same activity name (see Chapter 6.7).

The Excel file also contain the UUIDs of the activity names (because there can be more datasets for the same activity, individual datasets and activity names have separate UUIDs) of the converted activity datasets as well as the UUIDs applied for any market activity names generated by the automatic database update routine when these were not already present (see Chapter 6.2).

2.6 ID numbers of intermediate exchanges

Universally Unique Identifiers (UUIDs) are applied for all intermediate exchanges in the ecoinvent database version 3. The UUIDs for the product outputs of the converted datasets are listed in the Excel file accompanying the report at hand (and available on the ecoinvent web-site in the same location).

2.7 Names and ID numbers of elementary exchanges (from and to nature)

Universally Unique Identifiers (UUIDs) are applied for all elementary exchanges (exchanges from and to nature) in the ecoinvent database version 3. The UUIDs for the elementary exchanges are listed in a separate Excel file available on the ecoinvent web-site.

A few name changes have been made, see Table 2.4. In addition to what is listed here, land use exchanges starting with "occupation" and "transformation" are affected by the name changes to the land use classes, see Chapter 8.2.

Table 2.4. Name changes for elementary exchanges

Exchange name in version 2.2	Exchange name in version 3
Carbon dioxide, land transformation	Carbon dioxide, from soil and biomass stocks
Carbon dioxide, biogenic	Carbon dioxide, non-fossil

Carbon monoxide, biogenic	Carbon monoxide, non-fossil
Methane, biogenic	Methane, non-fossil
Oils, biogenic	Oils, non-fossil

Note that there are also some name changes to the environmental compartments; see Chapter 8.1.

3 Reference products

In the ecoinvent database version 3, a distinction is introduced between reference products and by-products/wastes. The reference products are those products for which a change in demand will affect the production volume of the activity (also known as the determining products in consequential modelling).

All multi-product activities converted from ecoinvent version 2 have been reviewed and the reference products identified. The identified reference products are indicated in the documentation file in Excel format accompanying the report at hand (available on the ecoinvent web-site in the same location as the report at hand).

3.1 Existing inputs turned into reference products

For the majority of treatment activities in ecoinvent version 2.2, the reference product was already the material received for treatment, corresponding to the service of treating this material. For such activities, the change in version 3 is limited to a possible name change and changing the sign of the reference product, so that the reference product becomes negative, reflecting that the activity physically removes the waste. The example was already given in Chapter 2.2 of the dataset "treatment of decommissioned road" where the reference product is now -1 m*year "decommissioned road" as opposed to the original 1 m*year "disposal, road".

However, in some treatment activities in ecoinvent version 2.2, the product output was not the material received for treatment, but rather the by-products produced from the treated waste. Thus, these datasets miss their reference products (the treated waste). In some cases, the treated waste was given in the dataset as an input, and has therefore now simply been changed to become a negative output. For example, in the activity "treatment of waste glass from unsorted public collection, sorting", where only the by-product "glass cullet" was given as an output, the original input "1.08 kg waste packaging glass, unsorted" has now been turned into the reference product "-1.08 kg waste packaging glass, unsorted". See Table 3.1 for a complete list of all such instances.

In most cases, the name and amount of the new reference product corresponds to the name and amount of the original waste input. In one case ("paper, recycling"), two waste inputs had to be merged to make up the new reference product "waste paper, sorted". In another case, the two datasets ("treatment of copper scrap by electrolytic refining" and "treatment of scrap lead acid battery, remelting"), the new reference products ("copper scrap, sorted, pressed" and "scrap lead acid battery", respectively) replace an existing input that was given as "iron scrap, sorted, pressed", which therefore has been deleted in these two datasets.

Table 3.1. Activity datasets with new reference products that were previously inputs

Activity name	New reference product (previously input)	Amount	Unit
coal gas, burned in power plant	coal gas	-1	MJ
treatment of aluminium scrap, new, by melting, alloying and casting	aluminium scrap, new	-1.01	kg
treatment of aluminium scrap, post-consumer, prepared for melting, by melting, alloying and casting	aluminium scrap, post-consumer, prepared for melting	-1.03	kg
treatment of biogas from biowaste in gas engine	biogas	-0.04399	m3
treatment of biogas from biowaste in ignition gas engine	biogas, from liquid manure	-0.041597	m3
treatment of biogas mix from agricultural co-digestion, in gas engine	biogas, from liquid manure	-0.041597	m3
treatment of biogas, production mix, burned in micro gas turbine 100kWe	methane, 96% by volume, from biogas, low pressure, at user	-1	MJ
treatment of biogas, production mix, burned in polymer electrolyte membrane fuel cell 2kWe, future	methane, 96% by volume, from biogas, low pressure, at user	-1	MJ
treatment of biogas, production mix, burned in solid oxide fuel cell 125kWe, future	methane, 96% by volume, from biogas, low pressure, at user	-1	MJ
treatment of biogas, production mix, burned in solid oxide fuel cell, with micro gas turbine, 180kWe, future	methane, 96% by volume, from biogas, low pressure, at user	-1	MJ
treatment of biogas, purification to methane 96 vol-%	biogas	-1.5	m3
treatment of crust from Parkes process for lead production	crust from Parkes process for lead production	-5.7743	kg
treatment of metal part of electronics scrap, in blister-copper, by electrolytic refining	metal part of electronics scrap, in blister-copper	-60.362	kg
treatment of precious metal from electronics scrap, in anode slime, precious metal extraction	precious metal from electronics scrap, in anode slime	-35.765	kg
treatment of residual hardwood, including bark, 70% water on dry mass basis, air drying to 20%	residual hardwood, including bark, 70% water on dry mass basis	-1.14	m3
treatment of residual softwood, 70% water on dry mass basis, air drying to 20%	residual softwood, 70% water on dry mass basis	-1.1	m3
treatment of tallow to esterquat	tallow, unrefined	-0.6	kg
treatment of waste cooking oil, purified, esterification	used vegetable cooking oil, purified	-1	kg
treatment of waste glass from unsorted public collection, sorting	waste packaging glass, unsorted	-1.08	kg
treatment of waste paper, recycling, no deinking	waste paper, sorted	-1.013	kg
treatment of waste paper, recycling, with deinking	waste paper, sorted	-1.174	kg
treatment of waste paper, unsorted, sorting	waste paper, unsorted	-1.025	kg
treatment of whey by fermentation	whey	-1	kg
treatment of whey, anaerobic digestion	whey	-23	kg
treatment of wood fuel, hardwood, under bark, 80% water on dry mass basis, air drying to 20%	wood fuel, hardwood, under bark, 80% water on dry mass basis	-1.14	m3
treatment of wood fuel, softwood, under bark, 140% water on dry mass basis, air drying to 20%	wood fuel, softwood, under bark, 140% water on dry mass basis	-1.1	m3

3.2 Reference products added

In some treatment activities in ecoinvent version 2.2, only the by-products produced from the treated waste was given in the dataset, not the treated waste itself. The treated waste therefore had to be added as a new reference product. For example, the activity “treatment of biowaste, composting” has the by-product “compost”, while the treated “biowaste” was not available in the version 2.2 dataset, and has now been added as the reference product. See Table 3.2 for a complete list of all reference products added. The calculation of the amount of the new reference product is given in the dataset. When a new calculation had to be made, the documentation for this calculation is added to the comment field of the new reference product exchange.

In one case, not only the treated waste (the reference product) was missing but the entire dataset was missing and only available as two allocated datasets (the version 2.2. datasets “silicon carbide, recycling, at plant” and “triethylene glycol, recycling, at plant”). These two datasets were therefore merged into one: “treatment of spent sawing slurry from Si-wafer cutting” and the missing reference product (-1.5873 kg spent sawing slurry from Si-wafer cutting) added. The output of the new merged activity is 1 kg of silicon carbide and 1 kg triethylene glycol, besides the new reference product.

Table 3.2. Activity datasets with new reference products added.

Activity name	New reference product	Amount	Unit	Comment
blast furnace gas, burned in power plant	blast furnace gas	-1	MJ	
cheese production	whey, for carbon correction (to be deleted)	-1	kg	This is a dummy dataset that only contains an input of CO_2 to correct the carbon balance for whey. It should be replaced by a full dataset on cheese production with cheese as reference product.
treatment of aluminium scrap, post-consumer, by collecting, sorting, cleaning, pressing	aluminium scrap, post-consumer	-1.13	kg	Calculated from the transport distances provided in the original dataset.
treatment of automobile catalyst	spent automobile catalyst	-400	kg	Assumed average recoverable PGM content 0.25% (ecoinvent v2.0 report 10, part V, Fig. 5.16)
treatment of biowaste, composting	biowaste	-1.8519	kg	Equals 1000kg/540kg compost. Dry mass of the compost is 50% of the wet mass, while the biowaste dry mass is 40% of the biowaste wet mass.
treatment of copper scrap by electrolytic refining	copper scrap, sorted, pressed	-1.31	kg	Replaces the v2.2 input 'iron scrap, sorted, pressed'
treatment of electronics scrap, metals recovery in copper smelter	electronics scrap	-2.7244	kg	Equals 5882/2159kg (ecoinvent v2.0 report 10, part V, Fig. 5.9, page 84 and Fig.5.13, page 93)
treatment of iron scrap, collection, sorting, pressing	iron scrap, unsorted	-1	kg	
treatment of liquid manure by anaerobic co-digestion	liquid manure	-11.8395	kg	7.5% dry matter content. Together with the activities 'treatment of biowaste in agricultural co-digestion, with methane recovery' and 'treatment of waste fat and vegetable oil in agricultural co-digestion, with methane recovery' this activity makes up a multi-otput activity with 3 variable reference products. It is an example of a multi-product activity that is manually disaggregated into activities for each of its variable reference products.
treatment of liquid manure by anaerobic digestion	liquid manure	-48.2393	kg	7.5% dry matter content
treatment of liquid manure in agricultural co-digestion, with methane recovery	liquid manure	-48.2393	kg	7.5% dry matter content. Based on the values for the treatment without methane recovery, as that activity does not actually take losses into account.
treatment of poultry manure, drying, pelleting	poultry manure, fresh	-2.2666	kg	Calculated from the transport distances provided in the original dataset.
treatment of scrap lead acid battery, remelting	scrap lead acid battery	-1.5446	kg	Replaces the v2.2 input 'iron scrap, sorted, pressed'
treatment of sewage sludge by anaerobic digestion	sewage sludge	-0.060274	m3	Concentrated, 5.6% dry matter content. Values from the original dataset.
treatment of slaughterhouse waste to tallow	slaughterhouse waste	-6.25	kg	Assuming 40% dry matter and 40% extractable fat in dry matter of slaughterhouse waste. Rest of dry matter is bone, blood and meat, which will be added manually as meal by-product/waste.
treatment of used toner cartridge, black/white, remanufacturing for laser jet, including 50% new toner modules	used toner cartridge, black/white	-2.1368	unit	Relates to 1 kg toner actually printed on paper, when each cartridge of 0.26 kg toner is reused once
treatment of used toner cartridge, colour, remanufacturing for laser jet, including 50% new toner modules	used toner cartridge, colour	-2.1368	unit	ditto
treatment of used vegetable cooking oil, purification	used vegetable cooking oil	-1.0082	kg	Calculated from the transport distances provided in the original dataset.
treatment of waste wood, 40% water on dry mass basis, sorting and chopping	waste wood, 40% water on dry mass basis	-188.6	kg	Value from the comment field of the original dataset
treatment of spent sawing slurry from Si-wafer cutting	spent sawing slurry from Si-wafer cutting	-1.5873	l	Source: ecoinvent v2 report 6_XII, page 24, table 4.8.

3.3 Reference products not available as goods or services

Since reference products in the ecoinvent database version 3 are defined as those products for which a change in demand will affect the production volume of the activity, reference products must be specified as either a good or a service. Furthermore, it is sought to avoid the separate reporting of unit processes when this does not add any useful information in an LCA context. This is the case when one unit processes always supplies all of its products directly to another specific unit process at the same location, so that the product of the first unit process never appears as a marketable product, and cannot be supplied by an external supplier. In such cases, the use of parameterisation is preferred to further subdivision of unit processes. Thus, the necessary degree of detail in unit process descriptions as well as in naming of products depends on whether meaningful markets are identified for the different reference products.

A number of activities in the ecoinvent database version 2.2 did not produce marketable products. For version 3, these activities have either been deleted, merged with the dataset they supply, or the reference product has been redefined. Table 3.3 lists the activities affected, including:

- Datasets which in version 2.2 had reference products referring to a fuel input, all with the term "burned in" in their name, e.g. "hard coal, burned in power plant", being the only supplier to an activity producing heat and/or electricity, are – with a few exceptions; see Table 3.3 – merged with the corresponding heat/electricity producing datasets.
- The datasets producing electricity as "…, average mix with average share of label-certified electricity" were deleted because such a product (where the label-certified electricity is included in the exact proportion by which it is produced) is not available to the consumers as such, but represents a specific mix of different products.

[Further activities to be merged or to have redefined reference products include: 1) Remaining datasets which in version 2.2 had reference products referring to a fuel input, all with the term "burned in" in their name, are to have reference products of heat or work added. 2) Datasets for "energy use and combustion emissions, …" for different vehicles (in version 2.2. named "operation, …"): These datasets are to be merged with the corresponding datasets for "transport, …' for the same vehicles type. At the same time a number of errors will be corrected where other datasets use the output from the "energy use and combustion emissions, …" datasets instead of the output from the transport datasets. 3) "metal working, average ..." (5 datasets) and all other metal working datasets (ISIC 259x), as well as metal working machinery and factory (operation as well as infrastructure): Re-structure to have reference product in units of the service provided rather than in the amount of material treated. For chipless activities, this may be diameter reduction (mm), power used (MJ), or hours worked. For chipping activities, if no better reference product can be found, these activities can at least be defined as treatment activities with -1 kg of (turning, milling, drilling) swarf as reference product and the same amount of material as by-product output for recycling. Many of these processes can be parameterised to increase usability. At the same time a number of errors will be corrected, by adding machinery operation as input to the specific activities, and factory overhead to the machine activity, and infrastructure to each of these. 4) Metal working datasets with outputs of kg of material removed and inputs of the material "lost" by this operation: To avoid double counting, the activities supplied must have an input of an untreated object with the same weight as the treated object, which is not reflecting the real situation. These datasets need to be changed so that the treatment activity has the full input of the material treated and an output of a treated object and the material removed. 5) Compressed air: Consider if the production activity and the market activity should be merged, if the production always supplies all of its products directly to the market activity at the same location, so that the product never appears as a marketable product, and cannot be supplied by an external supplier. In such cases, the use of parameterisation is preferred to further subdivision of unit processes. 6) Inputs to cogen unit (24 datasets): Instead of having each piece of compo-

nent separate, the original inputs shall be integrated into one activity producing the infrastructure. 7) Irrigating, with the unit "ha". The unit is to be changed to m^3.

Table 3.3. Changes made to activity datasets with non-marketable reference products

Activity name	Change made
[fuel, except peat, refinery gas, sour gas, and sweet gas], burned in [boiler, coal mine power plant, combined cycle plant, furnace, gas turbine, industrial furnace, power plant, stove, wood heater] (when supplying a dataset that has no other inputs and produce heat or electricity as reference product)	merged with supplied heat or electricity producing dataset [1)]
electricity, high voltage, average mix with average share of label-certified electricity	Deleted
market for electricity, high voltage, average mix with average share of label-certified electricity	Deleted
market for electricity, low voltage, average mix with average share of label-certified electricity	Deleted
market for electricity, medium voltage, average mix with average share of label-certified electricity	Deleted

1) Except the activity 'natural gas, burned in power plant' for the geographies NORDEL and CENTREL, which is anyway to be deleted and added to Table 7.3, see this.

3.4 Outlook: Datasets with more than one reference product

For some of the datasets from the ecoinvent database version 2.2, more than one of the intermediate outputs were identified as a possible reference product. Some datasets were cases of combined production; while others were cases of joint production (see Chapter 5.3 in Weidema et al. 2011 for a description of the distinction). In some cases, more investigation is required to determine if one of the co-products can be identified as the reference product. Table 3.4 lists the datasets concerned.

For the cases of combined production, the dataset shall be described by parameters and sub-divided as described in Chapter 5.3 of Weidema et al. (2011).

For the cases of joint production, direct activityLinkIds shall be added for the reference products and the conditional exchanges, as described in Chapter 14.4.2 of of Weidema et al. (2011).

A special situation applies for the way fertilisers were modelled in version 2. Here, what is in fact single products (ammonium nitrate phosphate, diammonium phosphate, monoammonium phosphate, potassium nitrate) were artificially modelled as multiple products ("nitrogen fertiliser, as N", "phosphate fertiliser, as P2O5", "potassium fertiliser, as K2O"). For the ecoinvent database version 3, separate markets will be created for the single-element and/or composite fertilisers, from which the agricultural activities can demand their specific requirements. This implies that the chemical names of all upstream fertiliser products can be maintained while introducing a separate activities that mix these chemicals and supply the said markets. At the same time an error will be corrected for ammonium sulfate production, which in version 2 is modelled as a separate production, while it is in fact a by-product in caprolactam production and shall therefore be integrated into this multi-output activity.

Table 3.4. Datasets from version 2.2 for which more than one reference product was identified, divided in cases of combined and joint production

Activity name	**Combined or joint production**
air separation, cryogenic	Argon and oxygen are joint products; nitrogen is variable (i.e. combined)
air separation, xenon krypton purification	Joint
ethanolamine production	Combined
gravel and sand quarry operation*	Combined
petroleum refinery operation	Combined (with bitumen, electricity, sulfur, LPG and refinery gas as by-products)
gypsum quarry operation	Combined
molecular sieve separation of naphtha	Hexane and heptane are joint products but may be treated as having equivalent functionality. Other product outputs are by-products.
hydroformylation of butene	Combined
benzene chlorination	Combined (with hydrochloric acid as by-product)
hydroformylation of propylene	Combined
rare earth oxides production from bastnäsite concentrate	Consider if different deposits can be individually modelled so that each has one reference product. If not, calculate which co-product is reference product and document
sheep production	Combined
modified Solvay process, Hou's process	Joint
gold-silver-zinc-lead-copper mine operation**	Calculate which co-product is reference product and document

* Active author: Daniel Kellenberger
** Active author: Matthias Tuchschmid

4 Units

4.1 Unit changes

Some units applied in the ecoinvent database version 2 have changed their symbol in the version 3 implementation. This does not affect the amounts. The changes are listed in Table 4.1.

Table 4.1 Unit changes from version 2.2 to version 3.

Unit in version 2.2	Unit in version 3	Comment
a m^2*a	year m^2*year	
tkm pkm vkm	metric ton*km person*km km	Used for transport services. The term vkm (vehicle-km) is synonymous to km and no longer applied
LU pig place	unit unit	The explanation of the unit (e.g. LU = animal unit) is now provided in the name of the exchange and if necessary further explained in the comment fields.
kg SWU	kg	The specification “per separative work unit” is now given as part of the name of the exchange.
Nm^3	m^3	Normal cubic metre. For natural gas, biogas, compogas, town gas: Normal cubic metre = cubic metre of gas at 15 °C and 101.325 kPa (ISO 13443). If other standard conditions are used (for other gases), this is to be given either in the product name or in the comment field of the exchange.

4.2 One unit per exchange

The unit is no longer an identifying field, i.e. the same dataset cannot exist with different units for the reference product. Instead, alternative units can be applied as properties of the reference product.

Datasets which were found in the database version 2.2 in duplicate units have been merged to one dataset. Table 4.2 lists the exchanges for which the unit has been changed and the factor used for converting from the old to the new unit.

In several cases the products in version 2.2 were expressed in MJ and in m^3 in different datasets. In some cases, e.g. “waste natural gas, sour”, and “sweet gas, burned in gas turbine”, only one of these datasets contained the emissions and other exchanges, while the other dataset was used simply to convert from the other unit. In such cases, the unit of the former dataset is retained. In other cases, e.g. “refinery gas, burned in furnace”, and “heavy fuel oil, burned in refinery furnace”, both datasets contained the full set of exchanges, and the most useful unit could therefore be chosen.

Some electronics waste products in version 2.2, e.g. “used desktop computer”, were expressed in units of “units” in the collection (market) datasets, while the further disassembly and treatment was reported in kg. For version 3.0, these exchanges were all changed to kg.

Table 4.2. Harmonisation of units of intermediate exchanges.

Product	Unit in v.2.2	Unit in v. 3.0	Factor
waste natural gas, sour	m^3	MJ	37
waste natural gas, sweet	m^3	MJ	36
sour gas, burned in gas turbine	m^3	MJ	37
sweet gas, burned in gas turbine	m^3	MJ	36
natural gas, high pressure	MJ	m^3	1/39
natural gas, low pressure	MJ	m^3	1/39
heavy fuel oil, burned in refinery furnace	kg	MJ	41.2
refinery gas, burned in furnace	kg	MJ	50.3
used desktop computer	unit	kg	11.3
used laptop computer	unit	kg	3.12
used cathode ray tube display	unit	kg	19.9
used liquid crystal display	unit	kg	5.04
used printer, laser	unit	kg	5.87

4.3 Outlook: Unit conversion

The ecoSpold 2 data format applied for the ecoinvent database version 3 allows the expression of amounts via mathematical relations (formula). Data can therefore be entered in the original units and converted to the standard unit by the use of a conversion factor. A specific unit conversion feature is included in the ecoSpold 2 format, which means that it is only necessary to enter the data, the unit and the target unit, without the need to look up and enter the conversion factors. While this feature is a part of the ecoSpold 2 format, the practical implementation into the ecoEditor and ecoinvent database is not ready at this point in time.

5 Classifications and tags

In the ecoinvent database version 3, a new compulsory classification systems for activities is applied based on the ISIC classification (Rev. 4), <http://unstats.un.org /unsd/cr/registry/>, with some additional sub-divisions necessary for ecoinvent.

For datasets transferred from the ecoinvent database version 2.2, the activity classification of version 2 is applied as an additional classification. However, this classification system is no longer maintained by the ecoinvent Centre. The ISIC class of each of the converted datasets is listed in the Excel file accompanying (and available on the ecoinvent web-site in the same location as) the report at hand.

In addition to the compulsory classification systems for activities, CPC <http://unstats.un.org /unsd/cr/registry/> is recommended as a voluntary classification system for products.

In addition to these classification systems, the ecoSpold 2 format and the ecoinvent database version 3 supports the addition of tags to both activities and exchanges. Tags can be seen as an optional, user-defined classification system, to group specific activities or exchanges together. A number of tags have been predefined and are described in Chapter 9.8 of Weidema et al. (2011). **[To allow auto-generation of the production mixes for electricity by source type, all electricity products will be tagged with one of the following tags: biogas power, hard coal power, hydropower, lignite power, industrial gas power, natural gas power, nuclear boiling water reactor power, nuclear pressure water reactor power, oil power, photovoltaic power, wind power (and further tags as required).]**

6 Linking of datasets

6.1 Direct links

In the ecoinvent database version 1&2 datasets were linked via the names of the activities, which were at the same time names of the intermediate products. This automatic correspondence between activities and products is not maintained in version 3, where the activities and intermediate outputs have separate names (see Chapter 2). In version 3, the linking is done primarily via the product name. Market datasets exists for all products, and all product inputs can therefore be linked to a market, which again can be linked to the transforming activities that produce this product. This is done automatically by the database service layer according to different linking algorithms for each system model. Only when an input is not traded via a market, the data provider must manually specify the UUID of the supplying activity as an ActivityLinkId, which will then be used to provide a direct link from the input to the corresponding output of the supplying activity.

During the conversion of the datasets from version 2.2 to version 3, most direct links were deleted in order to allow the re-linking of the unit process datasets according to different linking algorithms for each system model. **[maintained ActivityLinkIds will be listed here. For example, the author (Hans-Jörg Althaus) of the datasets "anodising, aluminium sheet" and "pentaerythritol production in sodium hydroxide solution", which in version 2.2 linked its input of sodium hydroxide directly to the output from the production using diaphragm cells, has been asked to consider if this is intentional and should be maintained as a direct activityLinkId, or whether the input should just be of "sodium hydroxide" (unlinked), which is used by most other using activities.]**

6.2 Generation of new market datasets (consumption mixes)

In the ecoinvent database version 1&2, market datasets (consumption mixes) were only available for some intermediate outputs (see also Chapter 2.4). Due to the importance of the market datasets for the ability to automatically link inputs to outputs of transforming activities, global market datasets were added during the conversion to version 3 for any intermediate output for which such a global market dataset did not already exist. Even when only one transforming activity is supplying a specific intermediate output, a market dataset is generated.

The autogenerated market datasets are initially very rudimentary, only including the output of the reference product. During the linking of the system models, the corresponding inputs are added, based on the production-volume-weighted output of the transforming activities available within the geographical area of the market.

[At a later stage in the development of the ecoinvent database version 3, market datasets will be supplemented by inputs of transport, wholesale and retail activities, as well as primary production factors and product losses during trade and transport; see Weidema et al. (2011) for details.

New default transport data will be provided for the market datasets, replacing the current inputs of transport to the transforming activity datasets. Changes to the datasets 'disposal, building,...' and for wastewater, which is transported in sewers, will be handled by the ecoinvent editor for waste treatment.

For some products that do not store or transport easily, such as heat and waste treatment, it is obvious that a large number of local markets exist, but that it is also meaningless to fill the database with many local, very similar datasets. For such products, a compromise between local relevance and general applicability is sought, in cooperation with the responsible editors.]

6.3 New transforming activities

In the ecoinvent database version 3, market activity datasets have the same product as input and output. Thus, no transformation of the products can occur in a market activity.

In the ecoinvent database version 2.2, some market datasets include transformation, e.g. from high voltage to low voltage electricity, and therefore have outputs that differ from the inputs. New datasets have therefore been added to separately represent this transformation, so that the inputs to the market datasets are now the same as the marketed outputs. For example, "transformation from high voltage to medium voltage" activities have been created for each geographical localisation supporting a medium voltage market. Those activities have "electricity, high voltage" as an input and "electricity, medium voltage" as an output, thus providing the necessary input for the activity "market for electricity, medium voltage". Table 6.1 lists the new transformation datasets that have been added to enable market datasets to have the same product as input and output.

Table 6.1 New transformation datasets providing the missing products required for market datasets.

Activity name	Locations
electricity voltage transformation from high to medium voltage	AT, BA, BE, BG, BR, CH, CN, CS, CZ, DE, DK, ES, FI, FR, GB, GLO, GR, HR, HU, IE, IT, JP, LU, MK, NL, NO, PL, PT, RO, SE, SI, SK
electricity voltage transformation from high to medium voltage, aluminium industry	GLO
electricity voltage transformation from high to medium voltage, label-certified	CH
electricity voltage transformation from medium to low voltage	AT, BA, BE, BG, BR, CH, CN, CS, CZ, DE, DK, ES, FI, FR, GB, GLO, GR, HR, HU, IE, IT, JP, LU, MK, NL, NO, PL, PT, RO, SE, SI, SK
electricity voltage transformation from medium to low voltage, label-certified	CH
natural gas pressure reduction from high to low pressure	CH

The transformation datasets should in principle include the input of capital goods necessary for the transformation and the transformation losses, which should be separated out from the transmission losses in the market datasets currently including these data. This separation has not yet been done, which implies that the new transformation datasets are empty except for the single input and output. The losses in the market datasets, which in the v.2 datasets were included only in the amount of the input, have now been added as separate losses (outputs) and compensating inputs.

6.4 Merging of duplicate intermediate exchanges

In the version 2.2 datasets, the same product could enter as an input to a dataset more than once as long as the supplying activity was different. Due to the removal of the direct ActivityLinkIds during the conversion to version 3, such inputs would now appear with their product name only, and thus be identical. Since duplicate inputs of the same product is not allowed, such duplicate entries were merged during the conversion.

It is still possible to have the same product input from different suppliers, as long as the ActivityLinkId is different.

6.5 Re-linking inputs from production and supply mixes

In the ecoinvent database version 1&2, production and supply mixes were available for some products, and was sometimes used in the further modelling, typically in place of market datasets (consumption mixes). A production mix represents the production-volume-weighted average of the suppliers of a

specific product within a specific geographical area. A supply mix is a production mix with the addition of the import of the specified product to the specified geographical area.

In the ecoinvent database version 3, production and supply mixes are no longer applied in the further modelling, since they can be generated for any geographical area, irrespective of the market boundaries. This implies that those activities that used the production and supply mixes of version 2.2 as inputs, now have been adjusted so that the input instead comes from the corresponding market datasets (consumption mixes). This is obtained by changing the name of the inputs; for example, "gold, production mix", would be replaced by "gold", and "hard coal, supply mix" by "hard coal". Table 6.1 shows a list of inputs which were modified in this straightforward way. Table 6.2 list additional inputs where the modification was more extensive because the inputs to the production or supply mixes were not uniform, i.e. the mixes where in fact mixes of *different* products. For example, "gravel, production mix" is a mix of – and therefore replaced by – "gravel, crushed" and "gravel, round" in a 21:79 ratio, while "log, at forest, production mix" is replaced by "log, hardwood, at forest" and "log, softwood, at forest" in a 28:72 ratio. Table 6.2 lists the names of the replaced inputs. Also one consumption mix "heat, in chemical industry" is included here, since this is in fact also a mix of different products.

Table 6.1. Inputs of production and supply mixes, replaced by inputs of the corresponding products.

Input of	**replace by input of**
aluminium, cast alloy, production mix	aluminium, cast alloy
aluminium, wrought alloy, production mix	aluminium, wrought alloy
biogas, production mix	biogas
biogas, agricultural co-digestion, with methane recovery, production mix	biogas, from liquid manure
chlorine, liquid, production mix	chlorine, gaseous
copper, supply mix	copper
electricity, high voltage, at market, production mix	electricity, high voltage
electricity, high voltage, label-certified, production mix	electricity, high voltage, label-certified
electricity, high voltage, supply mix	electricity, high voltage
electricity, low voltage, production mix	electricity, low voltage
electricity, medium voltage, production mix	electricity, medium voltage
electricity, natural gas, production mix	electricity, high voltage
electricity, wind, production mix	electricity, high voltage, label-certified
fluosilicic acid, without water, in 22% solution state, supply mix	fluosilicic acid, without water, in 22% solution state
naphtha, APME mix	naphtha
gold, production mix	gold
hard coal, supply mix	hard coal
hard coal power plant, production mix	hard coal power plant
hydrogen liquid, production mix	hydrogen, liquid
pesticide, unspecified, supply mix	pesticide, unspecified
[pesticide]-compound, supply mix	[pesticide]-compound
petroleum, long distance transport from [XX], production mix	petroleum
polystyrene, extruded, production mix	polystyrene, extruded
sodium hydroxide, without water, in 50% solution state, production mix	sodium hydroxide, without water, in 50% solution state
synthetic gas, production mix	synthetic gas
transport, freight, aircraft, production mix	transport, freight, aircraft
transport, passenger, aircraft, production mix	transport, passenger, aircraft
uranium ore, as U, production mix	uranium ore, as U
uranium, enriched [YY]%, [...], supply mix	uranium, enriched [YY]%, per separative work unit

In addition to the replacements listed in Tables 6.1 and 6.2, "1 kg methane, 96% by volume, from biogas, at service station, production mix" and the consumption mix "1 kg natural gas, at service station" have been replaced by "45.83 MJ methane, 96% by volume, from biogas, high pressure, at user" and "1.2282 m^3 natural gas, high pressure", respectively, as inputs to the consuming activities, reflecting that these inputs are also used in industrial activities and that the activities of the service station will be separately included as an input to the transport activities.

In addition to the replacements listed in Tables 6.1 and 6.2, a few production mixes that were not used by any other dataset have been deleted: "fungicide, production mix", "herbicide, production mix", "insecticide, production mix", "plant growth regulator, production mix".

Table 6.2. Production and supply mixes (and one consumption mix), which are no longer used as inputs; the inputs being replaced by the previous inputs to these production and supply mixes, thus circumventing the mixes.

Intermediate exchange name
heat, in chemical industry (consumption mix)
biocide, for paper production, production mix
pigment, for paper production, production mix
inductor, production mix
transistor, production mix
diode, production mix
resistor, production mix
gravel, production mix
electricity, industrial gas, production mix
electronic component, production mix
printed wiring board, production mix
printed wiring board, mounted mainboard, desktop computer, production mix
printed wiring board, mounted mainboard, laptop computer, production mix
printed wiring board, for power supply unit, desktop computer, production mix
(treatment of) used battery, production mix
log, at forest, production mix
wood chips and particles from industry, 40% water on dry mass basis, production mix
wood chips and particles at forest, 120% water on dry mass basis, production mix
wood chips and particles, hardwood, 40% water on dry mass basis, production mix
wood chips and particles, softwood, 40% water on dry mass basis, production mix
polyvinylchloride, production mix

[The production mix "electricity, high voltage, at grid, SBB, supply mix" has not yet been added to Table 6.1 since the operation requires also the re-location of transmission losses and infrastructure.]

[For some production mixes it still needs to be considered how they should be treated. For example, "cement, production mix" and "solvent, organic, production mix" could be treated as described above for other production mixes or could be seen as adequately representative of generic markets for unspecified cement and organic solvents, respectively, or, as a third alternative, more specific cement and solvent markets (based on different product properties) may be identified and distinguished in the modelling. Similar considerations are relevant for the supply chain of fatty alcohol sulphate (from coconut oil and petrochemical sources), "methane production, 96% by volume, from biogas, at service station, production mix", "silicon production, photovoltaics, production mix" and "sulfate pulp, average, production mix", which may be adequately representative of markets for the unspecified products, in which case the producing activities

should not have separate product names or should have niche markets with a niche conversion activity. Some production mixes from version 2.2 are not explicit production mixes (where the dataset have inputs from different activities producing the same product) but "hidden" production mixes, representing averages of other, already existing datasets. This is the case for example for several transport datasets (passenger car and lorry fleet averages and freight by rail for Europe and specified shares with particle filters). These datasets can sometimes be useful if they represent generic markets (which may be the case for the specified examples). However, they should then be re-structured as "niche product to generic market" transforming activities having inputs of the specific transport datasets representing the fleet average. For "aluminium, production mix", it still needs to be identified which of the 140 activities that use this activity should use 'aluminium, cast alloy' and which should use 'aluminium, wrought alloy'. Such considerations and re-structuring will be made by the active authors or responsible institutions, e.g. for cement: Daniel Kellenberger; for ethoxylated alcohol chain: Rainer Zah; for methane from biogas: Mireille Faist Emmenegger; for transport: Matthias Tuchschmid and PSI; for aluminium: Hans-Jörg Althaus].

6.6 Global datasets generated by extrapolation

The ecoinvent database version 3 requires a global reference activity dataset to exist for any activity in the database, to avoid artificial introduction of differences between datasets for the same technology, and in order that all specific products in the database are available as inputs to all other datasets in any geographical location.

For each activity, the global reference activity dataset is intended to represent the global average. Ideally, new data should be collected when global data are not available. However, as a temporary solution, while efforts to collect new data are on-going, most global datasets for the converted version 2.2 datasets have currently been generated as production-volume-weighted averages of the existing, non-global version 2.2 datasets, increasing the uncertainty by changing the geographical representativeness score in the pedigree matrix of each exchange, and adding a comment on the averaging in the field 'Extrapolations'.

6.7 Rest-Of-World datasets generated by calculation

When one or more non-global datasets are available for the same activity, a dataset with the geographical location Rest-Of-World (ROW) is calculated as the residual difference between the global dataset and the non-global datasets, when all datasets are scaled to the production volume of their reference product. This calculation is performed automatically each time a new non-global dataset is accepted for inclusion in the ecoinvent database version 3.

6.8 Classification of technology level used for linking datasets

In the system model "Substitution, constrained markets and technologies" recommended for consequential LCA modelling, the inputs to the market datasets are limited to outputs from unconstrained activities. As part of the algorithm to determine if a dataset is unconstrained (see Chapter 14.6.1 of Weidema et al. 2011), the database service layer queries the field "technology level" of the supplying datasets. This is a new field in the ecoSpold 2 format. For ecoinvent version 3, the field is applied with a 5-level classification system: "outdated", "old", "current", "modern" and "new" (see Chapter 5.5 of Weidema et al. 2011 for the definitions of these classes). The class "current" is applied as default, also for all transforming datasets converted from version 2.2**. [Before the release of version 3, some activities may have their technology level changed to 'modern', to indicate that they can and will be able to increase their output with an increase in demand, or 'old' if their supply is being phased out, while technologies that are constrained should retain technology level 'current'. This is mainly relevant when activity datasets are available for different technologies providing the**

same reference product, such as acetic and maleic anhydride productions, chlor-alkali electrolysis, coconut oil and petrochemical sources for the fatty alcohol sulphate supply chain, compressed air production, computer production (CRT/LCD, desktop/laptop), electricity and heat production, extruded polystyrene, grass production, hard coal mine operation, titanium dioxide production, and vehicles in different EURO emission classes. Datasets where the technology level has been changed from the default "current" will be listed here].

7 Geographical information

In the ecoinvent database version 3, information on the geographical location of the datasets is applied in the linking of datasets: An input is automatically linked to the outputs from the local market dataset that supplies the input, i.e. the market that geographically covers the location of the activity that demands the input. And the inputs to the market for this product are automatically linked to the outputs of this product from the transforming activities located within the area of the market.

7.1 Geography IDs, names and coordinates

For the ecoinvent database version 3, all geographical locations are expressed as specified by the ecoSpold format 2, with a UUID, a short name, a long name and in terms of geographical information system coordinates (longitude, latitude) in the Keyhole Markup Language (KML). This allows the database service layer to automatically identify which activities are located within a given area, and thus apply these relationships in the above described linking of the inputs and outputs of the activities. An additional advantage of the use of the geographical information system coordinates is that the location of the activities can be used for automated linking to the spatially differentiated characterisation factors of site-dependent impact assessment methods.

All geographies used in ecoinvent v2 have been defined in KML in the new geographies master file, which is available from the ecoinvent web-site. The previously used short names (e.g. CH for Switzerland, RER for Europe) have been maintained, with a few exceptions listed in Table 7.1, and new longer, more descriptive names (e.g. Switzerland for Switzerland) have been added for ease of use.

Table 7.1. Changes in short names for geographies used in version 2.2

Version 2 short name	Version 2 description	ecoinvent version 3	Related dataset changes
OCE	Oceanic	Deleted	Datasets relocated to GLO (Global)
RAS	Asia and the Pacific	Redefined as Asia	Used for “copper mine operation” and “copper production, primary“, where it is wrongly described as “Europe and Russia”.
RNE	Near East	Deleted	
PAO	Pacific OECD	Deleted	
EEU	Central and Eastern Europe	Deleted	Used for “hard coal mine operation” and “market for hard coal”. These datasets are moved to PL (Poland) where the majority of the production takes place.
MEA	Middle East and North Africa	Deleted	
AFR	Sub-Saharan Africa	Deleted	
CPA	Centrally Planned Asia and China	Deleted	Used for “hard coal mine operation” and “market for hard coal”. These datasets are moved to ID (Indonesia) and new geography “Asia without China”, since separate datasets for India are added and datasets for China exist.
PAS	Other Pacific Asia	Deleted	

New geographies have been added, e.g. the 30 UN regions and sub-regions, and further geographies can be added by the data providers; see Chapter 9.9 of the data quality guidelines (Weidema et al. 2011).

7.2 Non-overlapping geographical areas

In the ecoinvent database version 3, overlapping geographical *areas* for datasets for the same activity are not allowed, except that a global dataset is allowed to co-exist with datasets for smaller areas and that production and supply mixes (see Chapter 6.5) can be established for any area of interest.

In the ecoinvent database version 1&2, transforming and market datasets could exist for areas contained within the area of another dataset for the same activity. This was especially the case of extensive regions like Europe and the electricity generation networks, like UCTE, CENTREL and NORDEL.

To avoid the overlap of areas for different datasets for the same activity, the geography of the containing datasets have been modified to exclude the contained areas. For example, the dataset "esterification of rape oil" existed in version 2.2 for the two geographies Europe (RER) and Switzerland (CH). For version 3, the geography of the European dataset has been changed to "Europe without Switzerland". The same procedure of excluding the smaller areas from the more extensive geography has been applied in cases where more than one datasets was contained within the containing area. For example, "transport, freight train" exists as a dataset for in Austria (AT), Belgium (BE), Switzerland (CH), Germany (DE), France (FR), Italy (IT), and Europe (RER). For version 3, the geography of the European dataset is changed to "Europe without Austria, Belgium, Switzerland, Germany, France, Italy". Table 7.2 lists the affected datasets.

In some cases, when the sum of the contained datasets represents all or nearly all of the dataset for the containing area, the latter was simply deleted. Any smaller areas thereby not covered will then be included in the Rest-Of-World dataset; see Chapter 6.7. This solution was applied to the datasets listed in Table 7.3.

A special case is the activity "dewatering of ethanol from biomass, from 95% to 99.7% solution state" where the converted dataset for Sweden (SE) was in fact identical to the existing dataset for Europe (RER) and was therefore deleted.

Another special case is the activities "copper mine operation", and "copper production, primary" existed for both Asia (RAS) and Indonesia (ID). On inspection, it appeared that the dataset for Indonesia was in fact intended to cover Indonesia and Australia, and the production volume for Australia is dominating the output of these two countries. Therefore, two non-overlapping datasets were achieved by relocating the Indonesian dataset to the more representative location of Australia (AU).

The dataset "rape seed production (obsolete)" (DE) was deleted due to the overlap with the more recent dataset "rape seed production" (DE).

Table 7.2. Changes in the geographical location of datasets. See also Table 7.1.

Dataset name	Version 2.2 location	Version 3.0 location
corrugated board production, […4 datasets]	RER	Europe without Switzerland
dewatering of ethanol from biomass, from 95% to 99.7% solution state	RER	Europe without Switzerland
diesel production, low-sulfur	RER	Europe without Switzerland
electricity production, hydro, run-of-river	RER	Europe without Switzerland
energy use and combustion emissions, light commercial vehicle	RER	Europe without Switzerland
energy use and operation emissions, freight train, electricity	RER	Europe without Switzerland
esterification of rape oil	RER	Europe without Switzerland
floor heating from borehole heat pump	RER	Europe without Switzerland
heat and power co-generation, natural gas, 1MWe lean burn	RER	Europe without Switzerland
heat production, air-water heat pump 10kW	RER	Europe without Switzerland
heat production, borehole heat exchanger, brine-water heat pump 10kW	RER	Europe without Switzerland
heat production, heavy fuel oil, at industrial furnace 1MW	RER	Europe without Switzerland
heat production, light fuel oil, at industrial furnace 1MW	RER	Europe without Switzerland
heavy fuel oil, burned in industrial furnace 1MW, non-modulating	RER	Europe without Switzerland
heavy fuel oil, burned in refinery furnace	RER	Europe without Switzerland
hydropower plant construction, run-of-river	RER	Europe without Switzerland
light fuel oil, burned in industrial furnace 1MW, non-modulating	RER	Europe without Switzerland
market for diesel	RER	Europe without Switzerland
market for diesel, low-sulfur	RER	Europe without Switzerland
market for heavy fuel oil	RER	Europe without Switzerland
market for kerosene	RER	Europe without Switzerland
market for light fuel oil	RER	Europe without Switzerland
market for naphta	RER	Europe without Switzerland
market for operation, computer, desktop, […6 datasets]	RER	Europe without Switzerland
market for petrol, low-sulfur	RER	Europe without Switzerland
market for petrol, two-stroke blend	RER	Europe without Switzerland
market for petrol, unleaded	RER	Europe without Switzerland
market for waste paper, unsorted	RER	Europe without Switzerland
natural gas, burned in cogen 1MWe lean burn	RER	Europe without Switzerland
nuclear fuel element production, for boiling water reactor, UO2 4.0% & MOX	UCTE	UCTE without Germany
operation, computer, desktop, […6 datasets]	RER	Europe without Switzerland
operation, computer, laptop, 23% active work	RER	Europe without Switzerland
operation, computer, laptop, active mode	RER	Europe without Switzerland
operation, computer, laptop, off mode	RER	Europe without Switzerland
operation, computer, laptop, standby/sleep mode	RER	Europe without Switzerland
operation, printer, laser, […4 datasets]	RER	Europe without Switzerland
packaging glass production, […3 datasets]	RER	RER w/o CH+DE
packaging production, corrugated board box, mixed fibre, single wall	RER	Europe without Switzerland
petrol production, low-sulfur	RER	Europe without Switzerland
petroleum refinery operation	RER	Europe without Switzerland
pipeline construction, natural gas, high pressure distribution network	RER	Europe without Switzerland
rape oil mill operation	RER	Europe without Switzerland
refinery gas, burned in furnace	RER	Europe without Switzerland
tap water production and supply	RER	Europe without Switzerland
transport, freight train	RER	RER w/o AT+BE+CH+DE+FR+IT
transport, freight, light commercial vehicle	RER	Europe without Switzerland
transport, pipeline, long distance, natural gas	RER	RER w/o DE+NL+NO
treatment of waste paper, unsorted, sorting	RER	Europe without Switzerland
uranium fuel element production, enriched 4%, for light water reactor	UCTE	UCTE without Germany
wind power plant construction, 800kW, fixed parts	RER	Europe without Switzerland
wind power plant construction, 800kW, moving parts	RER	Europe without Switzerland

Table 7.3. Datasets deleted due to the existence of datasets for more specific locations covering the all or nearly all of the area of the deleted dataset.

Dataset name	**location**
electricity production, at wind power plant 800kW	RER
electricity production, hard coal	NORDEL
electricity production, natural gas	CENTREL
electricity production, natural gas	NORDEL
electricity production, peat	NORDEL
market for electricity, high voltage	US
market for electricity, low voltage	US
market for electricity, medium voltage	US
market for natural gas, high pressure	RER
natural gas, burned in gas turbine, for compressor station	UCTE
natural gas, burned in power plant	UCTE
nuclear power plant construction, boiling water reactor 1000MW	UCTE
nuclear power plant construction, pressure water reactor 1000MW	UCTE

7.3 Market activity datasets deleted

Non-global market activities (consumption mixes) now requires justification. All non-global market datasets converted from version 2.2 have been reviewed by the ecoinvent LCI expert group, and datasets for markets without restrictions on imports and exports, and for which no other justification for a market boundary could be found, have been deleted. **[Justifications still have to be added to retained non-global market datasets]** Table 7.4 lists the market datasets deleted on these grounds. The deletions mainly affect chemicals, metals, and paper, where a separate Swiss or European market could not be justified. All petrol in Switzerland is sold as "petrol, low-sulfur" and "petrol, unleaded" does therefore not have a separate Swiss market. Likewise, the different datasets for "…, methyl ester, …"s from different specified origins have been deleted, since the market does not currently distinguish between different origins. The specific transforming datasets can still be accessed individually for specific study purposes.

Table 7.4. Non-global market datasets deleted due to missing justification for the existence of a market boundary

market for ammonia, liquid	CH
market for calcium chloride	CH
market for ferrochromium, high-carbon, 68% Cr	RER
market for gallium, semiconductor-grade	RER
market for gold	RER
market for hard coal	US
market for krypton, gaseous	CH
market for lead	RER
market for methanol	CH
market for methylchloride	CH
market for naphtha	CH
market for palladium	RER
market for paper, newsprint	CH
market for paper, woodcontaining, lightweight coated	CH
market for paper, wood-containing, supercalendred	CH
market for paper, woodfree, coated	CH
market for paper, woodfree, uncoated	CH
market for platinum	RER
market for rhodium	RER
market for silver	RER
market for tetrachloroethylene	CH
market for xenon, gaseous	CH
market for palm methyl ester, at service station	CH
market for petrol, unleaded	CH
market for photovoltaic laminate, CdTe	RER
market for rape methyl ester, production RER, at service station	CH
market for soybean methyl ester, BR, at service station	CH
market for soybean methyl ester, US, at service station	CH

7.4 Placing transforming activities in the markets they supply

In the ecoinvent database version 3, inputs of the marketed product to market datasets are automatically generated by the database service layer, based on the output from the transforming activities that produce the product within the geographical area of the market, weighted in proportion to their production volumes. Thus, all relevant contributing activities must be located within the same geographical area as the market they contribute to.

This requirement is new relative to the ecoinvent database version 1&2, where all datasets were manually linked and links across market boundaries were unproblematic.

For example, the activity "electricity production, hard coal" localised in Poland (PL) was often used as a proxy to represent the local electricity production from hard coal in other national electricity markets with a similar production technology, e.g. the United Kingdom (GB). To ensure the correct market mix of electricity in GB, a copy of the dataset for Polish electricity production from hard coal was added with GB as geographical location, with the appropriate production volume, and so on for other geographies and technologies. Thereby, the electricity mix calculated with the database version 3 linking algorithm for average suppliers will be identical to the mix in version 2.2. Table 7.5 lists all datasets added to ensure presence of the relevant production activities in all markets.

Likewise, imports must be located within the same geographical area as the market they contribute to.

For example, the import of electricity to Switzerland (CH) from different foreign markets is now modelled by adding separate transforming activities "electricity, high voltage, import from [X]" with the geographical specification CH and with the exchange "electricity, high voltage" linking directly with ActivityLinkId to the consumption mix (= export mix) of the exporting market (X). Table 7.6 lists all datasets added to ensure presence of the relevant imports to all markets.

Although imports are typically linked to the exporting markets, there are some situations where the direct links are made to specific transforming activities. For example, Switzerland imports electricity from Germany as part of the UCTE mix, and that is modelled as described in the previous paragraph; nevertheless, part of the Swiss electricity import in ecoinvent version 2.2 was also modelled as specifically produced in hard coal power plants in Germany. In order to represent that import, a new transforming activity "electricity, hard coal, import from DE", located in Switzerland, has been created, and it has been directly linked to the transforming activity "electricity production, hard coal", located in Germany.

The same type of direct link to a transforming activity has been implemented in the case of foam glass. Foam glass is only produced in Belgium, so the "foam glass factory construction" should have been localised in BE, but the actual "foam glass production" has the location Europe (RER). Foam glass is then exported to Austria and Switzerland, with separate markets for foam glass, due to different amounts of renewable energy certificates applied by the Belgium producer for the products in these two countries. To model that, two new transforming activities "foam glass, import from BE" have been created, with locations Austria and Switzerland respectively. Those activities have direct links to the RER transforming activity "foam glass production", **[which will later be re-located to BE, while moving the current compensation for renewable energy certificates in the market activity to the BE factory (e.g. by modelling the average production and adding a separate 'electricity for CH market' activity directly to the end of this)]**

The new activity datasets are *not* modelled as special import activities, because by definition, special import activities do *not* contribute to the auto-generated consumption mix, but are solely used for national balancing.

Table 7.5. New activities placed within the markets they supply, thereby replacing proxy supplies from other locations.

New activity		Replaced activity (now only used within original location)		Note
Name	**Locations**	**Name**	**Location**	
electricity production, at wind power plant 600kW	CN	electricity production, at wind power plant 600kW	CH	
electricity production, at wind power plant 800kW	AT	electricity production, at wind power plant 800kW, label-certified	CH	a
electricity production, at wind power plant 800kW	BE, BR, DE, DK, ES, FI, FR, GB, GR, IE, IT, JP, LU, NL, NO, PL, PT, SE	electricity production, at wind power plant 800kW	RER	
electricity production, at wind power plant 800kW, label-certified	Europe without Switzerland	electricity production, at wind power plant 800kW	RER	a
electricity production, hard coal	BG, BR, GB, HU, IE, RO	hard coal, burned in power plant	PL	b
electricity production, hard coal	DK, FI, NO, SE	hard coal, burned in power plant	NORDEL	b
electricity production, hard coal	JP	hard coal, burned in power plant	BE	b
electricity production, hard coal	SI	hard coal, burned in power plant	HR	b
electricity production, hard coal, aluminium industry	GLO	hard coal, burned in power plant	PL	b
electricity production, hydro, average without pumped storage	BG	electricity production, hydro, average without pumped storage	SK	
electricity production, hydro, label-certified	CH	electricity production, hydro, average without pumped storage	CH	a
electricity production, hydro, reservoir, aluminium industry	GLO	electricity production, hydro, reservoir, alpine region	RER	a
electricity production, hydro, reservoir, non-alpine region	CN	electricity production, hydro, reservoir, non-alpine region	RER	
electricity production, hydro, run-of-river, aluminium industry	GLO	electricity production, hydro, run-of-river	RER	a
electricity production, lignite	BG, RO	lignite, burned in power plant	PL	b
electricity production, lignite, aluminium industry	GLO	lignite, burned in power plant	DE	b
electricity production, natural gas	BA, BR, GR, HR, IE, PT, SI	natural gas, burned in power plant	UCTE	b
electricity production, natural gas	BG, CN, CS, CZ, HU, PL, RO, SK	natural gas, burned in power plant	CENTREL	b
electricity production, natural gas	DK, FI, NO, SE	natural gas, burned in power plant	NORDEL	b
electricity production, natural gas, aluminium industry	GLO	natural gas, burned in power plant	UCTE	b
electricity production, nuclear	BE, BG, CZ, ES, FI, GB, HR, HU, NL, RO, SE, SI, SK, GLO	electricity, nuclear, production mix	UCTE	
electricity production, nuclear	BR, JP	electricity, nuclear, production mix	CH	
electricity production, nuclear, aluminium industry	GLO	electricity, nuclear, production mix	UCTE	a
electricity production, oil	BG	heavy fuel oil, burned in power plant	SK	b
electricity production, oil	BR	heavy fuel oil, burned in power plant	IT	b
electricity production, oil	CN, PL	heavy fuel oil, burned in power plant	CZ	b
electricity production, oil	JP	heavy fuel oil, burned in power plant	FR	b
electricity production, oil	MK	heavy fuel oil, burned in power plant	HR	b
electricity production, oil	NO	heavy fuel oil, burned in power plant	FI	b
electricity production, oil, aluminium industry	GLO	heavy fuel oil, burned in power plant	IT	b
electricity production, peat	FI, IE	peat, burned in power plant	NORDEL	b
electricity, photovoltaic, production mix, label-certified	CH	electricity, photovoltaic, production mix	CH	a
heat and power co-generation, diesel, 200kWe SCR-NOx reduction	BR	heat and power co-generation, diesel, 200kWe SCR-NOx reduction	CH	
heat and power co-generation, wood chips, 1400kWth Organic Rankine Cycle	AT, BE, CN, CZ, DE, DK, ES, FI, FR, GB, HU, IE, IT, NL, NO, PL, PT, SE, SI, SK	heat and power co-generation, wood chips, 1400kWth Organic Rankine Cycle	CH	
import of natural gas, liquefied, DZ	RER			c
lime production, algae	FR			d
treatment of biogas from biowaste in gas engine	AT, BE, CZ, DE, DK, ES, FI, FR, GR, HU, IE, IT, LU, NL, PL, PT, SE, SI, SK	treatment of biogas from biowaste in gas engine	CH	
treatment of blast furnace gas, in power plant	BG, BR, CZ, FI, GB, GLO, HU, NL, NO, PL, RO, SE, SK	blast furnace gas, burned in power plant	RER	e
treatment of coal gas, in power plant	AT, BG, BR, CZ, FI, GB, GLO, HU, NO, PL, RO, SE, SK	coal gas, burned in power plant	RER	e

a) Name of reference product modified
b) Reference product changed to electricity output
c) This dataset already existed, but was erroneously geographically located in DZ
d) This dataset already existed, but was erroneously geographically located in CH
e) Electricity output added as by-product

Table 7.6. New import activities placed within the markets they supply, thereby replacing direct supplies from other locations.

activityName	location	Product (input and output)	input directly linking to activity in location "X"	location "X"
electricity, hard coal, import from DE	CH	electricity, high voltage	electricity production, hard coal	DE
electricity, high voltage, import from ["X"]	AT	electricity, high voltage	market for electricity, high voltage	CH, CZ, DE, HU, SI
electricity, high voltage, import from ["X"]	BA	electricity, high voltage	market for electricity, high voltage	CS, HR
electricity, high voltage, import from ["X"]	BE	electricity, high voltage	market for electricity, high voltage	FR, LU, NL
electricity, high voltage, import from ["X"]	BG	electricity, high voltage	market for electricity, high voltage	CS, GR, RO
electricity, high voltage, import from ["X"]	CH	electricity, high voltage	market for electricity, high voltage	AT, BA, BE, BG, CH, CS, CZ, DE, ES, FR, GR, HR, HU, IT, LU, MK, NL, PL, PT, RO, SI, SK
electricity, high voltage, import from ["X"]	CS	electricity, high voltage	market for electricity, high voltage	BA, BG, CZ, HR, HU, PL, RO, SK
electricity, high voltage, import from ["X"]	CZ	electricity, high voltage	market for electricity, high voltage	AT, DE, PL, SK
electricity, high voltage, import from ["X"]	DE	electricity, high voltage	market for electricity, high voltage	AT, CH, CZ, DK, FR, NL, SE
electricity, high voltage, import from ["X"]	DK	electricity, high voltage	market for electricity, high voltage	DE, NO, SE
electricity, high voltage, import from ["X"]	ES	electricity, high voltage	market for electricity, high voltage	FR, PT
electricity, high voltage, import from ["X"]	FI	electricity, high voltage	market for electricity, high voltage	CZ, HU, NO, PL, SE, SK
electricity, high voltage, import from ["X"]	FR	electricity, high voltage	market for electricity, high voltage	BE, CH, DE, ES, GB, IT
electricity, high voltage, import from ["X"]	GB	electricity, high voltage	market for electricity, high voltage	FR
electricity, high voltage, import from ["X"]	GR	electricity, high voltage	market for electricity, high voltage	BG, CZ, HU, IT, MK, PL, SK
electricity, high voltage, import from ["X"]	HR	electricity, high voltage	market for electricity, high voltage	BA, CS, HU, SI
electricity, high voltage, import from ["X"]	HU	electricity, high voltage	market for electricity, high voltage	AT, BA, BE, BG, CH, CS, CZ, DE, ES, FR, GR, HR, HU, IT, LU, MK, NL, PL, PT, RO, SI, SK
electricity, high voltage, import from ["X"]	IE	electricity, high voltage	market for electricity, high voltage	GB
electricity, high voltage, import from ["X"]	IT	electricity, high voltage	market for electricity, high voltage	AT, CH, FR, GR, SI
electricity, high voltage, import from ["X"]	LU	electricity, high voltage	market for electricity, high voltage	BE, DE
electricity, high voltage, import from ["X"]	MK	electricity, high voltage	market for electricity, high voltage	CS, GR
electricity, high voltage, import from ["X"]	NL	electricity, high voltage	market for electricity, high voltage	BE, DE
electricity, high voltage, import from ["X"]	NO	electricity, high voltage	market for electricity, high voltage	CZ, DK, FI, HU, PL, SE, SK
electricity, high voltage, import from ["X"]	PL	electricity, high voltage	market for electricity, high voltage	AT, BA, BE, BG, CH, CS, CZ, DE, ES, FR, GR, HR, HU, IT, LU, MK, NL, PL, PT, RO, SE, SI, SK
electricity, high voltage, import from ["X"]	PT	electricity, high voltage	market for electricity, high voltage	ES
electricity, high voltage, import from ["X"]	RO	electricity, high voltage	market for electricity, high voltage	BG, CS, CZ, HU, PL, SK
electricity, high voltage, import from ["X"]	SE	electricity, high voltage	market for electricity, high voltage	DE, DK, FI, NO, PL
electricity, high voltage, import from ["X"]	SI	electricity, high voltage	market for electricity, high voltage	AT, HR, IT
electricity, high voltage, import from ["X"]	SK	electricity, high voltage	market for electricity, high voltage	AT, BA, BE, BG, CH, CS, CZ, DE, ES, FR, GR, HR, HU, IT, LU, MK, NL, PL, PT, RO, SI, SK
electricity, high voltage, label-certified, import from Europe	CH	electricity, high voltage, label-certified	electricity production, at wind power plant 800kW, label-certified	Europe without Switzerland
electricity, hydro, average without pumped storage, import from FR	CH	electricity, high voltage	electricity production, hydro, average without pumped storage	FR
electricity, natural gas, import from DE	CH	electricity, high voltage	electricity production, natural gas	DE
electricity, nuclear, pressure water reactor, import from FR	CH	electricity, high voltage	electricity production, nuclear, pressure water reactor	FR
electricity, oil, import from IT	CH	electricity, high voltage	electricity production, oil	IT
foam glass, import from BE	AT	foam glass	foam glass production	RER
foam glass, import from BE	CH	foam glass	foam glass production	RER
kerosene, import from Europe	CH	kerosene	market for kerosene	Europe without Switzerland
light fuel oil, import from Europe	CH	light fuel oil	market for light fuel oil	Europe without Switzerland

liquefied petroleum gas, import	CH	liquefied petroleum gas	petroleum refinery operation	Europe without Switzerland
petrol, low-sulfur, import from Europe	CH	petrol, low-sulfur	market for petrol, low-sulfur	Europe without Switzerland

8 Exchanges from and to the environment

8.1 Environmental categories / compartments

The term ‘environmental category’ (version 1&2) has been changed to ‘environmental compartment’ (version 3). The compartment ‘Resource’ has been changed to ‘Natural resource’. The sub-compartments ‘Lake’ and ‘River’ have been merged to ‘Surface water’. New compartments have been added for indoor air, direct human uptake, economic and social exchanges.

Duplicate elementary exchanges in the same dataset, as a result of the merger of the sub-compartments ‘Lake’ and ‘River’, have been merged.

8.2 Land use impacts

The land use classes used for reporting land occupation and land transformation have been revised based on a draft version of the Handbook on LCIA of Global Land Use within the framework of the UNEP/SETAC Life Cycle Initiative. At the same time, all descriptions/definitions of the classes have been reviewed and made more precise. New land use classes are mainly for natural areas (non-use), to allow reporting of transformation from more specific nature types. Some additional land use types for agriculture and seabed use have also been added. Some names have been changed for increased precision, consistency and generality. Some land use classes in version 2.2 have been merged into four more aggregated classes (‘forest, extensive’, ‘forest, intensive’, ‘industrial area’ and ‘traffic area, rail/road embankment’), since the previous distinctions were not easily applicable in practice. Table 8.1 provides an overview of the changes. Note that the correspondence to v.2.2 exclusively reflects how these land classes were applied in the ecoinvent database v2.2, and is not reflecting a general correspondence (for example between vine and non-irrigation, and fruit and irrigation). For the revised definitions of the land use classes, please see the data quality guideline (Table 6.1 in Weidema et al. 2011).

Duplicate elementary exchanges in the same dataset, as a result of the merger of the land use classes, have been merged.

[In the ecoinvent database version 2, tropical wood from clear-cut is modelled as co-product of land transformation from forest to agricultural land. This will be revised so that each cause of land transformation is modelled separately, i.e. ‘tropical wood production’ and ‘conversion of forest to agricultural land’ will be modelled as separate activities, each with their own land use impacts.

In the ecoinvent database version 2, land occupation and land transformation was modelled as specific inputs to transforming datasets that require land or directly cause land transformation. For the ecoinvent database version 3, the general global land occupation and land transformation will be included in separate datasets delivering ‘land tenure’ expressed in g NPP-C, which is then an input – via a market for land tenure - to the specific transforming datasets that require land tenure; see Chapter 6.7 in Weidema et al. (2011).

Land tenure, as well as the already recorded specific land occupation and transformation within each general land class provided by a market for land tenure, are generally inputs to infrastructure datasets, except for agricultural and forestry activities where these exchanges are direct inputs to the transforming datasets. In some transport datasets from ecoinvent version 2.2 the land occupation and transformation (and the infrastructure maintenance) are erroneously placed as inputs to the transport rather than to the infrastructure (airports, canals, ports, railways, roads). This error will be corrected by the responsible institution (PSI).

Table 8.1 Correspondence between land use classes in the ecoinvent database version 2.2 and version 3

Land use class (ecoinvent 2)	Land use class (ecoinvent 3)	
unknown	unspecified	Name change
	unspecified, natural (non-use)	New
forest	forest, unspecified	Name change
	forest, primary (non-use)	New
	forest, secondary (non-use)	New
forest, extensive	forest, extensive	
tropical rain forest	forest, extensive	Merged with the above
forest, intensive	forest, intensive	
forest, intensive, normal	forest, intensive	Merged with the above
forest, intensive, clear-cutting	forest, intensive	Merged with the above
forest, intensive, short-cycle	forest, intensive	Merged with the above
	wetland, coastal (non-use)	New
	wetland, inland (non-use)	New
shrub land, sclerophyllous	shrub land, sclerophyllous	
	grassland, natural (non-use)	New
	grassland, natural, for livestock grazing	New
	arable land, unspecified use	New
pasture and meadow	pasture, man made	Name change
pasture and meadow, extensive	pasture, man made, extensive	Name change
pasture and meadow, intensive	pasture, man made, intensive	Name change
arable	annual crop	Name change
arable, non-irrigated, fallow	cropland fallow (non-use)	Name change
arable, non-irrigated	annual crop, non-irrigated	Name change
arable, non-irrigated, diverse-intensive	annual crop, non-irrigated, extensive	Name change
arable, non-irrigated, monotone-intensive	annual crop, non-irrigated, intensive	Name change
	annual crop, irrigated	New
	annual crop, irrigated, extensive	New
	annual crop, irrigated, intensive	New
	annual crop, flooded crop	New
	annual crop, greenhouse	New
	field margin/hedgerow	New
permanent crop	permanent crop	
permanent crop, vine	permanent crop, non-irrigated	Name change
permanent crop, vine, extensive	permanent crop, non-irrigated, extensive	Name change
permanent crop, vine, intensive	permanent crop, non-irrigated, intensive	Name change
permanent crop, fruit	permanent crop, irrigated	Name change
permanent crop, fruit, extensive	permanent crop, irrigated, extensive	Name change
permanent crop, fruit, intensive	permanent crop, irrigated, intensive	Name change
heterogeneous, agricultural	heterogeneous, agricultural	
	urban/industrial fallow (non-use)	New
urban, continuously built	urban, continuously built	
urban, discontinuously built	urban, discontinuously built	
	urban, green area	New
industrial area	industrial area	
industrial area, built up	industrial area	Merged with the above
industrial area, vegetation	industrial area	Merged with the above
mineral extraction site	mineral extraction site	
dump site	dump site	
construction site	construction site	
traffic area, road network	traffic area, road network	
traffic area, rail network	traffic area, rail network	
traffic area, road embankment	traffic area, rail/road embankment	Merged with the below
traffic area, rail embankment	traffic area, rail/road embankment	Merged with the above
	bare area (non-use)	New
	snow and ice (non-use)	New
	inland waterbody, unspecified	New
	river, natural (non-use)	New
	lake, natural (non-use)	New
water courses, artificial	river, artificial	Name change
water bodies, artificial	lake, artificial	Name change
sea and ocean	seabed, unspecified	Name change
	Seabed, natural (non-use)	New
	Seabed, natural (non-use)	New
	Seabed, natural (non-use)	New
industrial area, benthos	Seabed, infrastructure	Name change
dump site, benthos	Seabed, drilling and mining	Name change
	Seabed, sediment displacement	New
	Seabed, bottom fishing	New

To avoid double-counting of land occupation and transformation, the characterisation factors applied in LC impact assessment will be adjusted so that the impact related to each specific land class is only contributing to the *difference* in impact relative to the general land class provided by the corresponding market for land tenure. These general land classes will in turn contribute with the difference in impact relative to the natural reference situation.]

8.3 Sum parameters for carbon compounds (BOD5, COD, DOC, TOC)

In the ecoinvent datasets, all four sum parameters, BOD_5, COD, DOC and TOC, for carbon content in wastewaters are recorded in parallel. Missing data are added using best estimates.

Although required also in the ecoinvent version 2 datasets, the parallel reporting was not consistently implemented. For version 3, all situations where entries were missing have been filled by default:

- If only BOD_5 exist, COD is set to $2*BOD_5$ (rule of thumb applicable to untreated water; the worst-case assumption BOD_5 = COD applied for ecoinvent version 1&2, has been removed as recommendation),
- Missing entries for TOC (gC) are set to COD/2.7 (COD measured in g O_2)
- Missing entries for DOC are set as equal to TOC (i.e. assuming all carbon to be dissolved)
- If TOC exist and DOC is missing, TOC is set as equal to DOC
- If both BOD_5 and COD are missing the reverse of the above is applied.

See also Chapter 5.9.7 in the Data Quality Guideline (Weidema et al. 2011).

8.4 Outlook: Metal resources

For the ecoinvent database version 3, resource inputs of metal shall be reported separately from the residual ore; see Chapter 5.9.3 in Weidema et al. (2011). The current exchanges for metal resources will therefore be adjusted to this new format, but this has not yet been implemented.

8.5 Renewable energy

Since it is theoretically impossible to define a consistent boundary between the natural system supplying renewable energy and the human activities that convert this energy, and thereby to calculate consistent energy efficiencies for renewable energy inputs, the resource inputs of renewable energy will no longer be recorded. Instead, the energy content will be provided for the reference products from the resource extracting activities. Since system-wide energy balances are not required, the inclusion of waste heat emissions has also been abandoned. **[The impact assessment methods for Cumulative Energy Demand will be adjusted accordingly].**

9 Production volumes added

For ecoinvent version 3, all intermediate outputs of transforming activities have information on their annual production volume relating to the geographical area of the dataset and the unit of the product. For the datasets converted from version 2.2 and generated during conversion, the production volumes are added centrally, preferably using year 2005 data.

The sources and calculations for the production volumes are documented for each intermediate output in each dataset.

For some products from ecoinvent v2.2, the production volume in year 2005 is zero. If such an input is requested by a converted dataset, this leads to a missing input. In such cases, the missing input has been replaced by the most appropriate alternative input. These re-named inputs are listed in Table 9.1. **[Additionally a number of inputs with zero production volume will be replaced manually: "aircraft, freight (obsolete)", "azobe from sustainable forestry management, CO2-removal and land use", "ethanol, 99.7% in H2O, from biomass, at service station", "meranti, CO2-removal and land use", "monochloropentafluoroethane", "paraná pine, CO2-removal and land use", "roundwood, azobe from sustainable forest management, CM, debarked, 30% water on dry mass basis", "roundwood, azobe from sustainable forest management, under bark, 30% water on dry mass basis", "roundwood, paraná pine from sustainable forest management, under bark, 50% water on dry mass basis", "sewage, unpolluted, from residence", "wind power plant, 150kW, fixed parts", "wind power plant, 150kW, moving parts", "wind power plant, 2MW, offshore, fixed parts", "wind power plant, 2MW, offshore, moving parts", "wind power plant, 30kW, fixed parts", "wind power plant, 30kW, moving parts".]**

Table 9.1. Product inputs replaced due to zero production volume of previous input

Input of	replaced by input of
sawdust, softwood, 70% water on dry mass basis	residual softwood, 70% water on dry mass basis
wood chips and particles, softwood, 70% water on dry mass basis	residual softwood, 70% water on dry mass basis
transport, freight, lorry >32 metric ton, EURO4	transport, freight, lorry >32 metric ton, EURO3
transport, freight, lorry 16-32 metric ton, EURO4	transport, freight, lorry 16-32 metric ton, EURO3

The production volumes are applied by the linking routines of the database, to calculate the proportions of the inputs to the market datasets. The production volumes are therefore especially important when there is more than one activity that produces the same intermediate output. **[Therefore, priority has been given to provide production volumes for products that are currently outputs from more than one activity dataset. For some waste treatment datasets, we have temporarily applied proportions only. For some products that are currently the output of one activity only, a dummy value of 1 for non-global and 4 for global datasets have been applied. These dummy values will be replaced as soon as a second dataset with the same output is added to the database and latest before the release of version 3 of the ecoinvent database.]**

10 Uncertainty information

10.1 Uncertainty format changes

The ecoinvent database version 3 uses a new format (ecoSpold 2) for reporting uncertainty. It is now possible to report the basic uncertainty separately from the total uncertainty (= the basic uncertainty + the additional uncertainty from data quality indicator scores in the pedigree matrix). Each data quality score now has a separate numerical field, which allows automatic calculation of the additional uncertainty. And finally more distributions are now supported (beta, gamma, binomial) and the parameters of the lognormal distribution has been re-defined to be closer to the format used with original data.

10.2 Basic uncertainty recalculated

In the format ecoSpold 1 used for the ecoinvent database version 1&2, there was only one numerical field for reporting the uncertainty, and this was therefore used for the total uncertainty for use in further calculations. The data quality indicator scores were reported in the comment field.

For ecoinvent version 3, the data quality indicator scores were extracted from the comment fields of version 2.2 and placed in the new numerical fields. As it is now possible to distinguish the basic uncertainty from the total uncertainty, the basic uncertainty of each exchange amount was back-calculated using the original formula applied to calculate total uncertainty from basic uncertainty and the additional uncertainty from the data quality indicator scores. In some cases this resulted in a negative value for the basic uncertainty, indicating an error in the original (manual) calculation. In these cases, the basic uncertainty field has been left blank.

11 Allocation

11.1 Deleted joint production datasets with specific allocations

In the ecoinvent database version 3, allocation for joint production is performed automatically by the database service layer for those system models that apply allocation. Allocated datasets are not manually entered in the database. The allocation factors from version 2.2 have been retained in the converted datasets, but cannot be manually changed, since there are currently no system models that apply manual allocation factors, although the option for this is still available.

11.2 Outlook: Property for true value allocation

Allocation factors for true value allocation are set by the database service layer based on the property "true value relation". Unless this property is specifically provided in the original, manually edited dataset, the database service layer sets its value equal to the price of the intermediate exchange.

The "true value relation" is manually added in the following situations:

- When there is a very high annual variation in the relative average prices of the joint products, the "true value relation" property may be set to the same ratio as the ratio of the average prices for the last three years.
- When the joint products have a shared functional property that should determine their relative value if not affected by market imperfections or distorting regulation, the "true value relation" property may be set to the same ratio as the amounts of this property.

For the converted datasets from version 2.2, the true value allocation is only added for one specific situation, namely the joint production of heat and electricity, where the ratio of exergy of the products, i.e. the ability of the products to perform work, is used as "true value relation". Thus, when both electricity and useful heat are products of the same activity, the "true value relation" results in the same allocation factors for the two products as if the property "exergy" had been used, while the sum of the "true value" of the two products equal the sum of the revenue from these two products, so that allocation based on the price can still be made for any other joint product.

For simple identification of activities for which "true value relation" properties are provided in the original dataset, the ecoinvent database automatically adds a tag "with true value" to these activities.

The addition of exergy as "true value relation" property to the heat and electricity producing datasets and the addition of the tag "with true value" has not been implemented at this point in time.

11.3 Allocation corrections

In the ecoinvent database version 2, allocation corrections for carbon were added manually as separate datasets and allocation corrections for metal resources were added manually as separate exchanges.

In the ecoinvent database version 3, allocation corrections for carbon are automatically calculated by the database service layer and therefore the manually entered datasets of version 2.2 have been deleted. **[in order to be able to test that the converted database version 3 can reproduce the results of version 2.2, these datasets have temporarily been retained]**

[In the ecoinvent database version 3, manual allocation corrections for metal resources will not be retained. A procedure for systematically eliminating the manually entered allocation corrections is being investigated by the responsible author, Hans-Jörg Althaus.] Currently there are no allocation methods in ecoinvent that require allocation corrections for metal resources.

12 Review of centrally implemented changes

[All centrally implemented changes reported in the previous chapters will be reviewed by the active authors and/or editors. The review will be done for all changes in one review procedure, and therefore awaits the last centrally implemented changes. Thus, the reported changes have not yet been reviewed.]

13 Access to datasets

13.1 Public access and terms of use

With the ecoinvent database version 3, access to all unit process datasets becomes public, however still under usage restrictions:

> "I agree that my access to the ecoinvent database is subject to the general End User Licence Agreement <www.ecoinvent.org/database/terms-of-use/> for the ecoinvent datasets, which particularly implies that the datasets are not to be collected, copied or used in any combination of data into aggregated, calculated results, unless I specifically obtain a separate license for such use."

[The access is currently only provided via the search function in the ecoEditor software, but access via the web-site is planned for the release of version 3.]

The database that can be accessed via the ecoEditor software is the working version of the database, i.e. including all datasets that have been accepted after review since the last published version. Thus, the content can be different from the content of the previous or coming public release versions accessible via the ecoinvent web-page. This ensures that data providers always work on the latest versions of all dataset files.

13.2 Sponsored datasets

In addition to the access to the unit process data, access to the accumulated system datasets (LCI results) is free for a limited number of sponsored datasets. The sponsored datasets are free of copyright, but are subject to the normal rules for citation (see Chapter 15.5 of Weidema et al. 2011).

The sponsored datasets in the ecoinvent database version 3 are labelled with the following sentence in the general comment field: "The kind contribution of [sponsor name] has made it possible to make this dataset freely available to the public. The sponsors have no influence on the content and/or validation procedure for the sponsored datasets."

14 Outlook: Further planned changes before release of version 3

14.1 New or updated datasets

On each editor's page **[web-feature to be supplied],** a list is provided of datasets solicited within that editorial area or for which data collection is in progress. The lists include identified errors that are in process for correction. Data providers are urged to announce on these pages if they are intending to submit datasets, to enable coordination with other data providers within the same area.

Projects that are currently sponsored by or via the ecoinvent Centre include a complete global update of all electricity mixes, global aluminium production (incl. new electricity mixes specific to the aluminium industry) and pulp and paper production.

For the new global reference datasets created by extrapolation (see Chapter 6.6), we urge data providers to consider submitting datasets that better reflect the global average technology for the activity. When working on other updating tasks, we urge data providers to always consider performing the updating in the global reference dataset.

Provided that the global dataset is of adequate quality, we urge data providers to consider if any geographically located datasets could better be expressed as child datasets relative to the global reference dataset (see Chapter 4.2 of Weidema et al. 2011).

We urge data providers to express some or all amounts of exchanges by variables, using the new option for mathematical relations between amounts of exchanges, exchange properties and/or dataset-internal parameters. This can lead to a reduction in the number of datasets submitted, because one dataset with variables replaces several other datasets. This may also be applicable when revising some of the existing datasets from the ecoinvent version 2.2.

When manually updating datasets from version 2.2, we urge data suppliers to review the current content of the fields for "Included activities" (start and end of an activity), adding information according to the good practice described in the Chapter 5.9.1 of Weidema et al. (2011), and removing redundant information, for example information on which raw materials, infrastructure or transport is included or which emissions are included, both types of information already being provided in the information on the exchanges.

14.2 Documentation from the ecoinvent version 2 reports

The content of the reports from version 2 is to be re-located partly to the datasets, partly to the editors' web-pages, which has the same structure as the ISIC activity classification. The original report authors will be duly acknowledged on the web-pages. This re-location of the report contents is being performed by the ecoinvent Centre.

For the ecoinvent version 2.2 datasets, a cut-off approach was practiced for by-products for recycling, sometimes reported only in the background reports. Such reported by-products/wastes may be added as intermediate outputs during the transfer of the documentation. An example of this is "vermiculite mine operation" where phosphate rock shall be added as by-product/waste (in this case by the active author Daniel Kellenberger).

14.3 Single-enterprise data

Single-enterprise datasets from version 2.2 will be tagged and possibly given a more specific geographical location. Company or brand names will be removed, unless the company is willing to provide the dataset as a branded dataset (see Chapter 11.3 of Weidema et al. 2011).

14.4 Mass, water and carbon content to be added as properties

Wet mass, dry mass, water mass, and water and carbon content (the latter divided in fossil and non-fossil) will be added as properties to all exchanges as a central updating task.

14.5 Mass, water and carbon balances

With the addition of wet mass, dry mass, water mass, and water and carbon as properties to all exchanges, it becomes possible to perform balances for mass, water and carbon per dataset. A feature to facilitate this will be added to the ecoEditor software.

The balancing will result in recommendations to correct any imbalances by adjusting the inputs or outputs.

For activities involving oxidation, the datasets from version 2.2 will not show a mass balance due to the missing input of oxygen from the air.

It is especially important to check the carbon balance of wood production, palm fruit production, soybean production and other important land using activities.

For some datasets, such as the datasets “electricity production, hydro, pumped storage”, the elementary exchange (resource) "Carbon, organic, in soil or biomass stocks" needs to be added to complete the carbon balance for these activities. Also for the datasets “electricity, hydropower, at reservoir power plant” it will be considered to add this resource input and the corresponding emission “Carbon dioxide, from soil and biomass stocks” (the emission is available in the dataset for Brazil, and it is unclear if the difference is intended). These adjustments will be performed by the editor for electricity.

14.6 Price as a property

Prices will be added as a property to all intermediate outputs, with priority for those that arise from activities with more than one product output.

References

Weidema et al. 2011 Weidema B P, Bauer C, Hischier R, Mutel C, Nemecek T, Vadenbo C O, Wernet G. (2011). Overview and methodology. Data quality guideline for the ecoinvent database version 3. Ecoinvent Report 1. St. Gallen: The ecoinvent Centre.