ecoinvent v.3.7 in openLCA

Software version: openLCA 1.10.3
Report version: 1
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GreenDeLTa

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1 ecoinvent v.3.7 – What's new?

The latest version of ecoinvent[1] database, version 3.7, released on September 17th, 2020, features more than 900 new datasets, among them 100 new products, and 1000 updated datasets. Few of the major updates and additions are listed below:[2]

1.1 New and updated datasets

- **Building and construction materials:** ecoinvent 3.7 introduces an updated version of glass wool mat datasets.
- **Electricity**: ecoinvent 3.7 comes with new data on biogas production and supply chains for Switzerland. Moreover, attributional electricity market mixes have been updated for all countries.
- **Fertilisers:** The market and market mixes for fertilisers have been restructured and updated, now reflecting the separate provision of organic and mineral fertilisers for nutrient supply.
- **Metals:** LCI data has been updated for copper, nickel, iron and steel, and scarce metals such as cobalt, rare earths, tungsten, and beryllium. Also, aluminium data was revised for North America.
- **Paper and Pulp:** Packaging-related material was updated with the help of industry associations´ data.
- **Waste treatment and recycling:** The Waste Treatment and Recycling sector has been enhanced with new data on recycling activities of packaging materials, namely a range of new regional data for Europe and Switzerland on the recycling of beverage cans and paperboard.
- **Wood:** most of the datasets related to forestry activities and wood processing in the Forestry and Wood sector are updated. Further, new wood-based products have been added, such as cross-laminated timber, structural timber, three and five layered board, and tubular particleboard.

1.2 Database-wide changes

- Some of the processes and products have been renamed in version 3.7 of the database in order to better reflect the dataset. For instance, process - 'biogas, burned in micro gas turbine 100kWe' from ecoinvent v3.6 is renamed as 'biomethane, low pressure burned in

[1] Wernet, G., Bauer, C., Steubing, B. et al. Int J Life Cycle Assess (2016) 21: 1218. https://doi.org/10.1007/s11367-016-1087-8

[2] Quoted from https://www.ecoinvent.org/files/change_report_v3_7_20200918_.pdf (accessed 05.10.2020)

micro gas turbine 100kWe' in ecoinvent v3.7. A list of the changes can be found in the report of changes from the ecoinvent website.

- The prices of several products have been adjusted, sometimes only minorly. For the attributional models, this will affect the results if economic allocation is applied.
- Technology level to modern updated for nine processes in the consequential system model.

1.3 Get ecoinvent 3.7 for openLCA

ecoinvent 3.7 is available for download for openLCA exclusively on https://nexus.openlca.org. Please note that versions of ecoinvent 3.7 obtained elsewhere will not be compatible with openLCA. In addition, users with an ecoinvent 3.7 license will also receive access to older versions of ecoinvent. All the different data packs can be used as independent databases in openLCA or combined together, if necessary[3]. However, special attention should be paid to integration of older versions of ecoinvent databases (3.5 and older) with ecoinvent version 3.7 database owing to the changes in the waste modelling approach in openLCA.

Life Cycle Impact Assessment (LCIA) methods package by ecoinvent are available via openLCA Nexus, too. With this package it is possible to reproduce the LCIA results provided by the ecoinvent Association. However, the use of the openLCA LCIA method package with about 40 LCIA methods is also possible.

2 Unique and interesting properties and features of the ecoinvent database

Several aspects are worth being noted about the ecoinvent database. They have been provided also with previous versions of the database. These include:

- three different "system models" which reflect different allocation, cut-off and substitution rules, and rules for modelling end-of-life and recycling
- every process dataset is available as unit process and as system process (with very few exceptions) in each of the three system models;
- a separate documentation, as a short pdf report, is available for each data set
- a correspondence file is provided with changes from previous version to the current version of ecoinvent databases

[3] It is recommended to always import the data pack of smaller size into the bigger one to reduce the time of the import (e.g. unit process data files into LCI data files).

- costs are provided for all products, with exception of waste flows and products from recycling

For more information about the content and methodology of the ecoinvent v.3.7 database, please check the ecoinvent website, and the report of changes for ecoinvent 3.7 from the ecoinvent website. For current limitations or issues in version 3.7, you can visit the Known Data issues on the ecoinvent website.

3 ecoinvent v.3.7 in openLCA

Ecoinvent v.3.7 is implemented for openLCA 1.10. As in previous ecoinvent 3 versions, six data packs generated by the ecoinvent Centre from the undefined ecoinvent database are provided containing the three different system models, all as unit and aggregated (system[4]) processes:

- APOS, allocation at the point of substitution: *"The APOS system model follows the attributional approach in which burdens are attributed proportionally to specific processes."*
- Cut-Off, allocation cut-off by classification: *"The underlying philosophy is that a producer is fully responsible for the disposal of its wastes, and that he does not receive any credit for the provision of any recyclable materials."*
- Consequential: *"The consequential system model uses different basic assumptions to assess the consequences of a change in an existing system."*

System models in ecoinvent version 3 are explained in detail on the ecoinvent website.

3.1 ecoinvent 3.7 regionalised

In the non-regionalised versions of ecoinvent, elementary flows in the inventory of a process are generic and not assigned to a specific location (Figure 1). In the regionalised versions of ecoinvent, some elementary flows in the inventory of a process are region-specific as indicated by codes[5] for the names of countries, dependent territories, and special areas of geographical interest.

[4] Named "LCI" in the data files

[5] https://en.wikipedia.org/wiki/ISO_3166-1

P Inputs/Outputs: titanium zinc plate production, without pre-weathering | titanium zinc plate, without pre-weathering

Inputs

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided was...	Provi
aluminium casting facility	4100:Construction of buildi...	1.01000E-10	Item(s)		lognormal: ...		P al
aluminium, cast alloy	242:Manufacture of basic p...	5.08800E-5	kg		lognormal: ...		P m
aluminium, wrought alloy	242:Manufacture of basic p...	0.00112	kg		lognormal: ...		P m
casting, brass	243:Casting of metals/2432...	2.11000	kg		lognormal: ...		P m
copper	072:Mining of non-ferrous ...	0.00127	kg		lognormal: ...		P m
electricity, medium voltage	351:Electric power generati...	0.65833	kWh		lognormal: ...		P m
heat, district or industrial, natural gas	351:Electric power generati...	1.60000	MJ		lognormal: ...		P m
lubricating oil	192:Manufacture of refined...	0.00400	kg		lognormal: ...		P m
rolling mill	282:Manufacture of special...	1.42860E-9	Item(s)		lognormal: ...		P ro

Outputs

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided pr
Chromium, ion	Emission to water/unspecif...	1.50860E-7	kg		lognormal: ...	
COD, Chemical Oxygen Demand	Emission to water/unspecif...	7.90000E-5	kg		lognormal: ...	
Copper, ion	Emission to water/unspecif...	1.72860E-6	kg		lognormal: ...	
DOC, Dissolved Organic Carbon	Emission to water/unspecif...	2.05510E-5	kg		lognormal: ...	
dust, unalloyed electric arc furnace steel	382:Waste treatment and d...	0.00044	kg		lognormal: ...	
Lead	Emission to water/unspecif...	1.57140E-7	kg		lognormal: ...	
Mercury	Emission to water/unspecif...	1.57140E-9	kg		lognormal: ...	
Nickel, ion	Emission to water/unspecif...	4.71430E-7	kg		lognormal: ...	
NMVOC, non-methane volatile organic comp...	Emission to air/unspecified	4.50000E-5	kg		lognormal: ...	
sludge from steel rolling	382:Waste treatment and d...	0.01633	kg		lognormal: ...	
Tin, ion	Emission to water/unspecif...	1.57140E-7	kg		lognormal: ...	
titanium zinc plate, without pre-weathering	**242:Manufacture of basic...**	**1.00000**	**kg**	**1.76000 EUR**	**none**	
TOC, Total Organic Carbon	Emission to water/unspecif...	2.05510E-5	kg		lognormal: ...	
Water	Emission to air/unspecified	0.00090	m3		lognormal: ...	
Water	Emission to water/unspecif...	0.00510	m3		lognormal: ...	
Zinc	Emission to air/unspecified	0.00032	kg		lognormal: ...	
Zinc, ion	Emission to water/unspecif...	3.92860E-6	kg		lognormal: ...	

Figure 1: ecoinvent v3.7 unit process; cut-off system model

P Inputs/Outputs: titanium zinc plate production, without pre-weathering | titanium zinc plate, without pre-weatheri

Inputs

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided was...	Pr
aluminium casting facility	4100:Construction of buildi...	1.01000E-10	Item(s)		lognormal: ...		P
aluminium, cast alloy	242:Manufacture of basic p...	5.08800E-5	kg		lognormal: ...		P
aluminium, wrought alloy	242:Manufacture of basic p...	0.00112	kg		lognormal: ...		P
casting, brass	243:Casting of metals/2432...	2.11000	kg		lognormal: ...		P
copper	072:Mining of non-ferrous ...	0.00127	kg		lognormal: ...		P
electricity, medium voltage	351:Electric power generati...	0.65833	kWh		lognormal: ...		P
heat, district or industrial, natural gas	351:Electric power generati...	1.60000	MJ		lognormal: ...		P
lubricating oil	192:Manufacture of refined...	0.00400	kg		lognormal: ...		P
rolling mill	282:Manufacture of special...	1.42860E-9	Item(s)		lognormal: ...		P

Outputs

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoid
Chromium, ion	Emission to water/unspecif...	1.50860E-7	kg		lognormal: ...	
COD, Chemical Oxygen Demand, DE	Emission to water/unspecif...	7.90000E-5	kg		lognormal: ...	
Copper, ion	Emission to water/unspecif...	1.72860E-6	kg		lognormal: ...	
DOC, Dissolved Organic Carbon	Emission to water/unspecif...	2.05510E-5	kg		lognormal: ...	
dust, unalloyed electric arc furnace steel	382:Waste treatment and d...	0.00044	kg		lognormal: ...	
Lead	Emission to water/unspecif...	1.57140E-7	kg		lognormal: ...	
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NMVOC, non-methane volatile organic compo...	Emission to air/unspecified	4.50000E-5	kg		lognormal: ...	
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titanium zinc plate, without pre-weathering	**242:Manufacture of basic...**	**1.00000**	**kg**	**1.76000 EUR**	**none**	
TOC, Total Organic Carbon	Emission to water/unspecif...	2.05510E-5	kg		lognormal: ...	
Water	Emission to air/unspecified	0.00090	m3		lognormal: ...	
Water, DE	Emission to water/unspecif...	0.00510	m3		lognormal: ...	
Zinc	Emission to air/unspecified	0.00032	kg		lognormal: ...	

Figure 2: ecoinvent v3.7 regionalized unit process; cut-off system model

Region specific elementary flows allow usage of region-specific characterisation/impact factors present in the Life Cycle Impact Assessment methods (e.g. water flows assigned to water scarce countries have a different impact factor compared to water flows assigned to countries where water is abundant; Figure **2**).

3.2 Waste modelling for ecoinvent v3.7 in openLCA

For ecoinvent 3.6., we had introduced the possibility to use material flow logic approach for end-of-life modelling. The wastes (e.g. waste paperboard) in the datasets in ecoinvent now appear as waste flows → as can be seen in Figure 3. A waste flow that is output of a process p1 and input of a waste treatment process p2 can simply be modelled as such: as output of p1, and as input into p2 (!).

The earlier versions of ecoinvent contain waste as product flows with negative amounts and appearing in the opposite exchanges (Figure 4), which required users to follow this "double negative" modelling (negative amounts and switched input and output side for waste "producing" and waste treating process) even for their own processes. This is a common, counter-intuitive topic in LCA trainings, and a source for mistakes when only one side of the process links are set negative. This new, more intuitive waste flow modelling is available directly in the openLCA version of ecoinvent 3.7, for all system models.

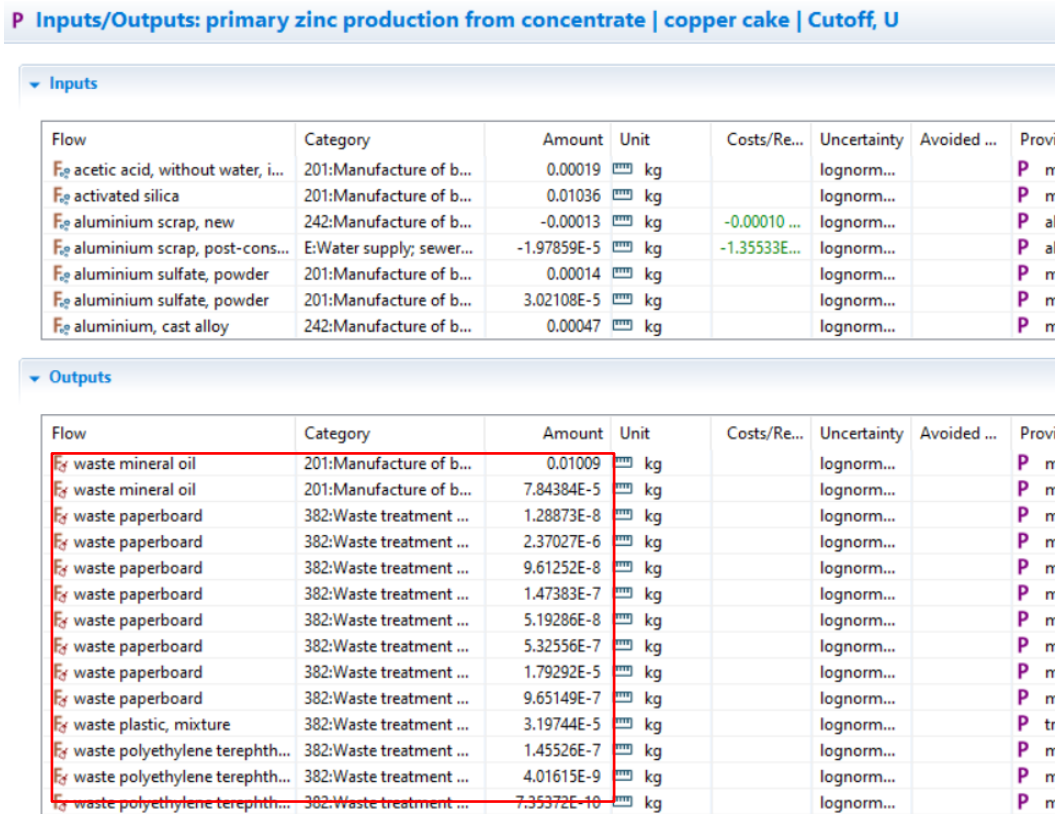


Figure 3: ecoinvent v3.6 database with wastes in material flow logic

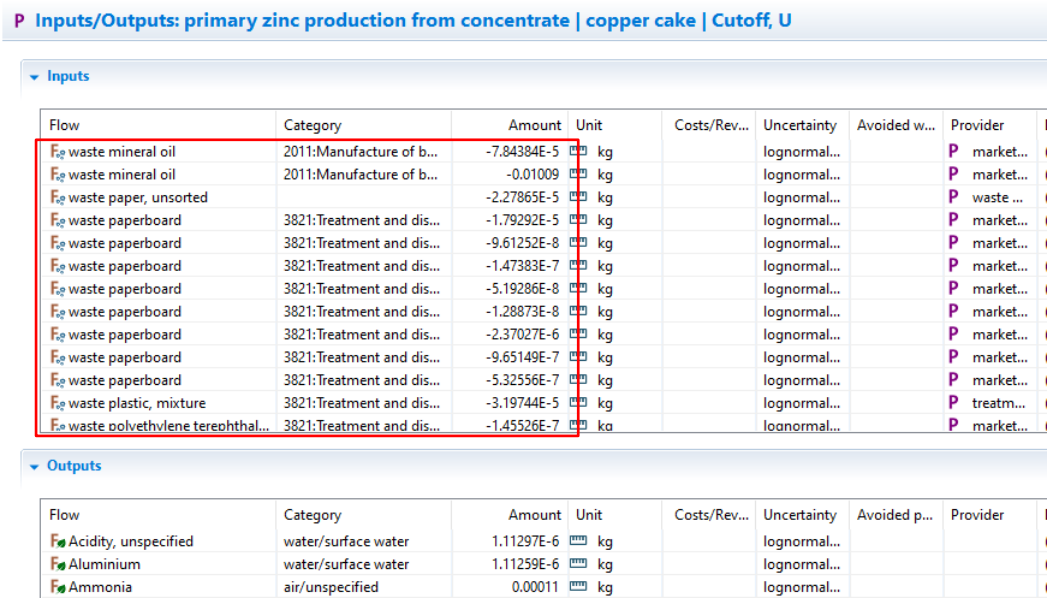


Figure 4: ecoinvent v3.5 database with wastes in the opposite direction approach

When migrating a version 3.5 (or older, from 3.3) versions of ecoinvent to 3.7, or product systems and own models that follow the old "double negative" waste flow logic, the modelling needs to be changed. To do so, **use openLCA version 1.10.2** or higher. Open the database with the old "double negative" waste flow logic, open the python developer window in openLCA and enter therein the script below:

```
from org.openlca.io.ecospold2.input import WasteFlows
WasteFlows.map(db)
```

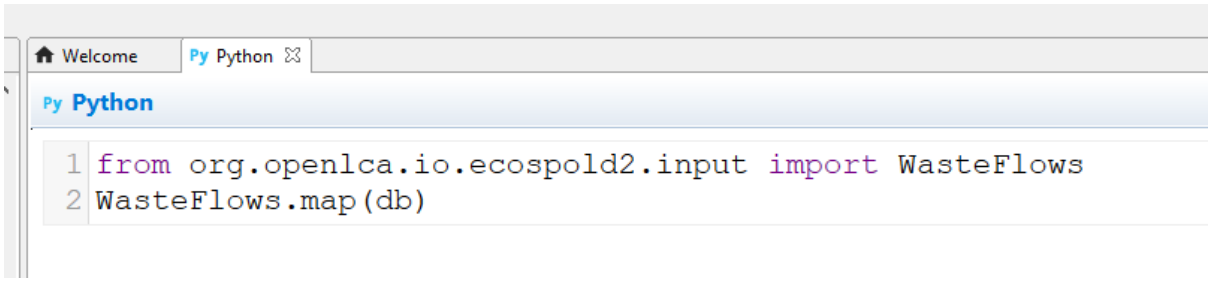


Figure 5: To open python developer window, go to Tools --> Developer tools --> Python

Then execute the script ,  wait for it to finish, then export the elements you want to export, in JSON-LD, and import these in the ecoinvent 3.7. database, of the same, or fitting, system model.

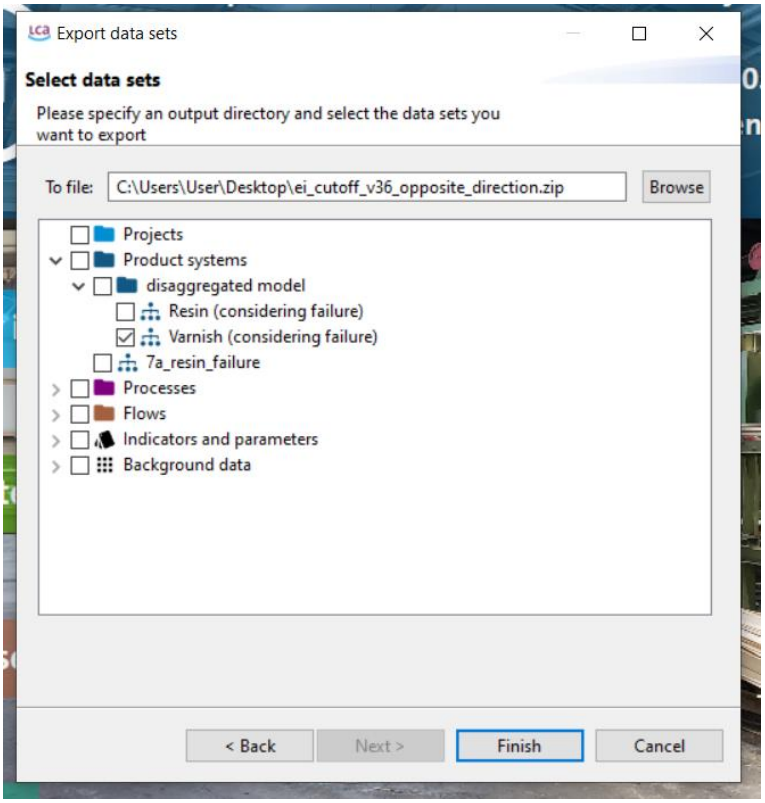


Figure 6: Export window in openLCA

Please be aware that the structure of ecoinvent 3.5 and 3.7 is quite different, due to the new processes added e.g., so it is often advised to start the own model new in ecoinvent 3.7.

Similarly, to reverse to the double negative waste flow modelling, open the database with the new waste flow logic, open the python developer window in openLCA and enter therein the script below:

```
from org.openlca.io.ecospold2.input import WasteFlows
WasteFlows.unmap(db)
```

Figure 7: Run the script to reverse the waste flow logic to 'double negative' waste flow

When importing the product system into a previous version of ecoinvent database, open the ecoinvent database into which you want to import the exported JSON-LD data by double-

clicking on it. Right-click onto the database and select *Import*. Select the *Linked Data (JSON-LD)* import wizard and click *Next* (Figure **8**). Choose the directory where the JSON-LD .zip file which you would like to import is saved and select it in the right column. Click on *Next* to open the import settings and select *Never update a data set that already exists* (Figure **9**).

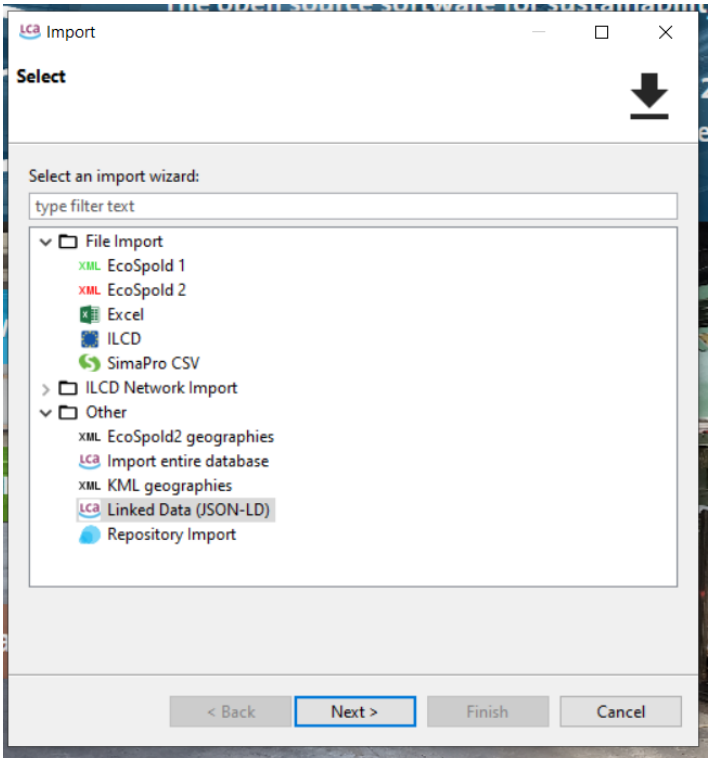


Figure 8: Right-click onto an open database in openLCA to open an import wizard

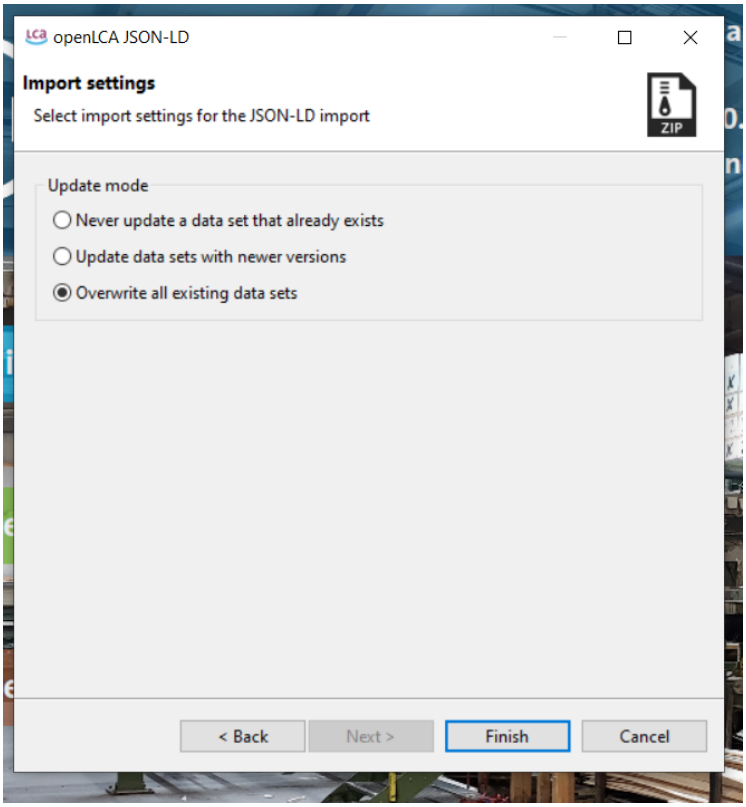


Figure 9: Select Never update a data set that already exists in the import settings

3.3 Addition and extension of price data

As in the previous ecoinvent 3.6 version, the price information for all the intermediate exchanges provided by ecoinvent 3.7 database were extended during the implementation in openLCA so that all exchanges of products with price data had the correspondent cost/revenue specified. As in previous versions of ecoinvent, the prices are provided per product, and do not differ across different processes or also across different countries. This implies that the prices are the same for unit and system processes, and thus, for system processes, do not reflect life cycle costs but "merely" prices.

openLCA includes an advanced **Life Cycle Costing** feature which, allows you to calculate the net added value and the life cycle costs of ecoinvent product systems, using e.g., the price data of products included in ecoinvent v.3.7. For further details on how to perform such calculations, please check the manual "Life Cycle Costing in openLCA" available in the openLCA website.

3.4 Compatibility and quality assurance

ecoinvent 3.7 for openLCA has been thoroughly tested and found to be 100% compatible to the official ecoinvent results without any constraints. The inventory and impact assessment results calculated for product systems using unit process datasets in openLCA were compared to the

LCI and LCIA results published by the ecoinvent Association. The LCI results obtained in openLCA were found to be almost equal to the ecoinvent system processes.

3.5 Memory requirements

With an increased ecoinvent database size, the new product systems in openLCA typically have about almost 15,000 processes and more than 350,000 connections. This can be seen when enabling the "statistics" sheet for product systems (Figure **10Error! Reference source not found.**). When working with ecoinvent 3.7 in openLCA, it is recommended to increase the maximum permitted memory usage of openLCA. This enables smoother and faster calculation of product systems for ecoinvent databases. Visit https://ask.openLCA.org for instructions[6].

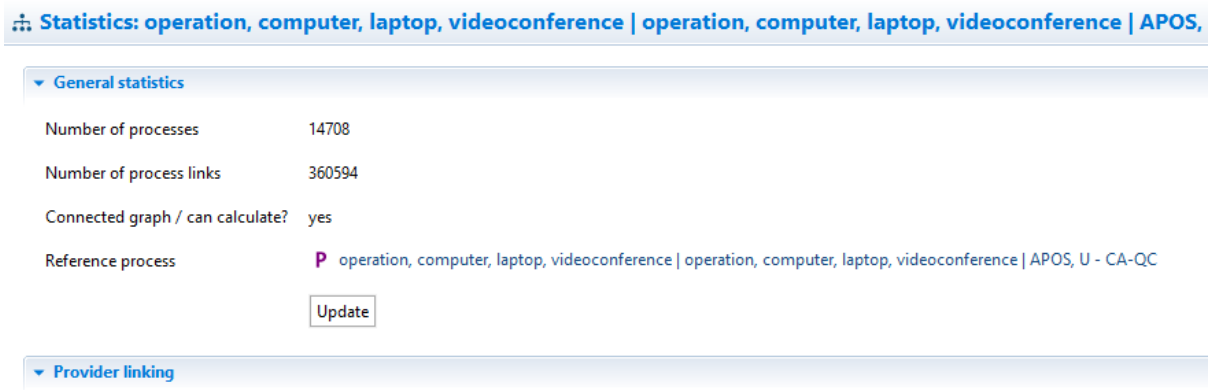


Figure 10. Statistics for the product system created for operation, computer, laptop, videoconference in ecoinvent_apos_v3.7

openLCA is able to handle these systems efficiently, which means an acceptable calculation time, and also memory requirements; however, to calculate a full model, **8GB of RAM** should be available. It is recommended to increase the maximum memory usage of openLCA, which can be done in File→ Settings→ Configuration → Maximum memory usage in MB (Figure **11**).

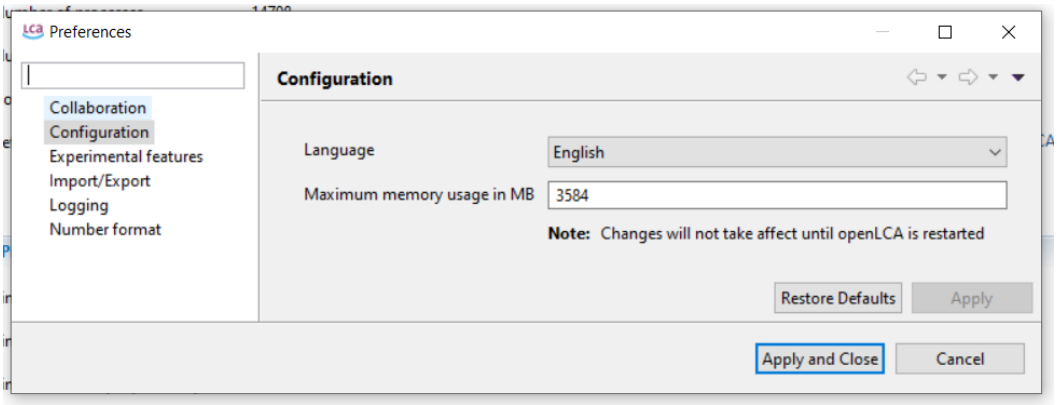


Figure 11: Allocating more memory to openLCA

[6] https://ask.openlca.org/594/how-to-assign-more-memory-to-openlca?show=594

If this is not possible, openLCA allows to specify a **cut-off when creating the product system**, which both reduces the number of processes and the number of connections (and also the result, of course, but for smaller cut-offs the impact should not be dramatic. You can control the impact by checking the system process result.

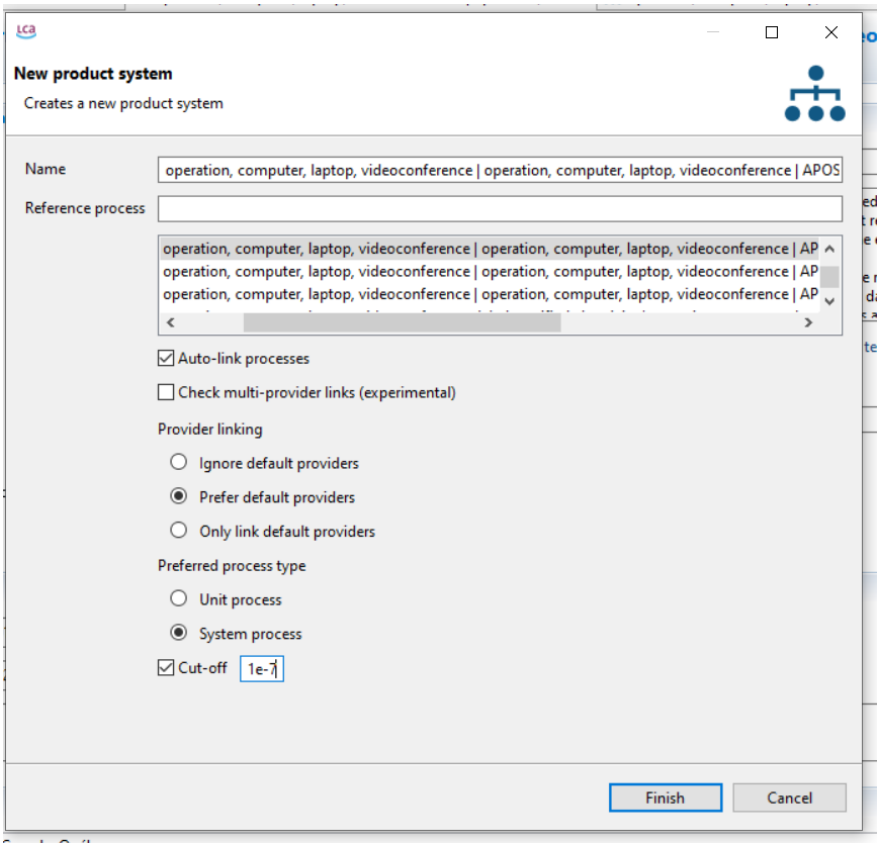


Figure 12. Setting cut-off while creating a product system

3.6 Calculation Libraries

openLCA version 1.10.2 (and higher) now can use faster calculation libraries available via GitHub, that uses much less memory and has a much faster execution time, for the quick calculation. Users should download the one of the zip files within the red box in Figure **13** below, for their operating system, unzip the file, and simply paste it in the openLCA installation folder. The library is ready for use.

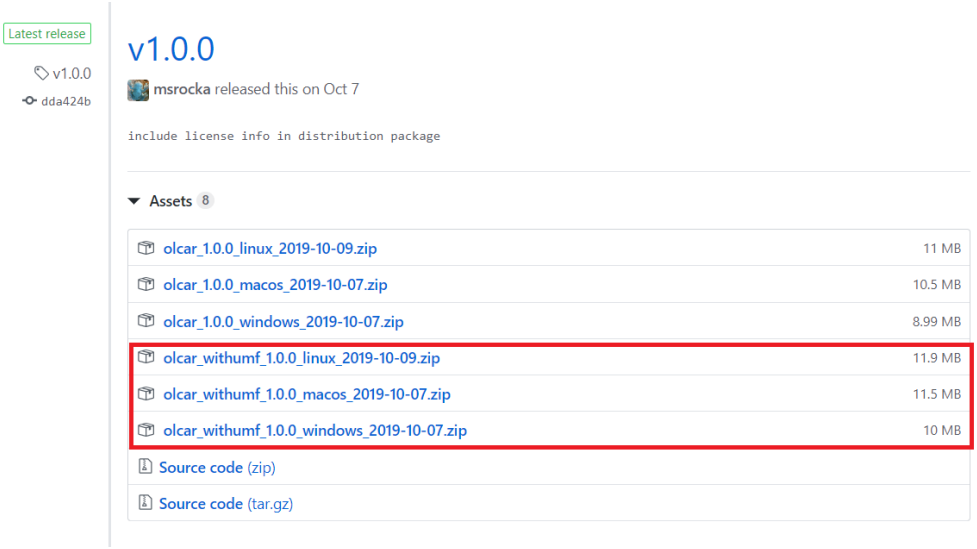


Figure 13: Zip files for importing calculation libraries in openLCA

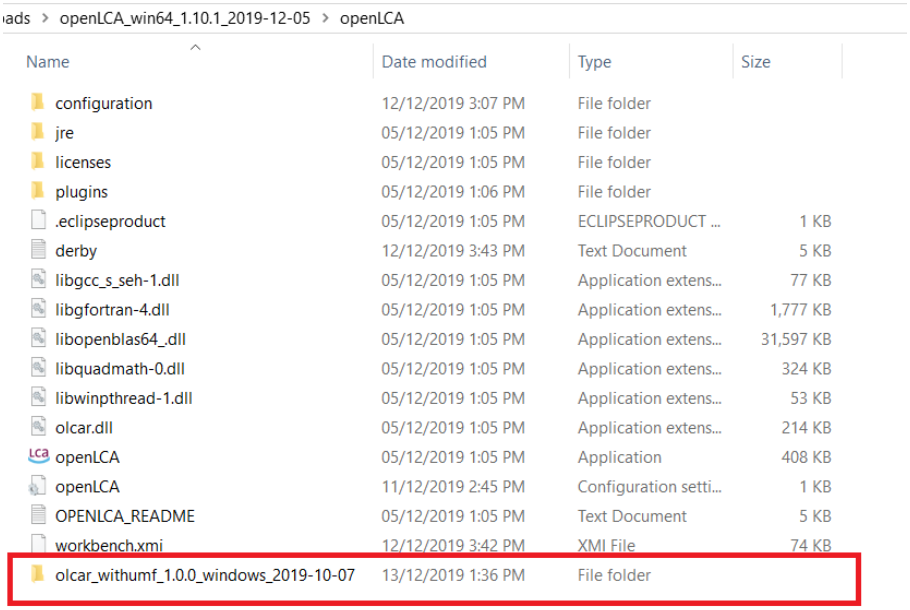


Figure 14: Copy the unzipped folder in the openLCA installation folder; highlighted in red

4 Migration of processes from ecoinvent 3.6 to ecoinvent 3.7

To enable users to import their product systems in the newest version of ecoinvent without having to manually select all providers again, the UUIDs from ecoinvent 3.6 processes were synchronised with ecoinvent 3.7, this way it is possible to update models by just importing the foreground system from ecoinvent 3.7 into the new database. This is mainly done for the datasets that are the same; although the product name or the process name may have changed from version 3.6 to 3.7 (for e.g., 'iron ore beneficiation to 65% Fe | iron ore, beneficiated, 65% Fe | Cutoff, U' to 'iron ore beneficiation | iron ore concentrate | Cutoff, U' has the same UUID: 415a78e1-91ca-3759-ac98-4a1c0204d9d1)

The list of renamed processes and intermediate exchanges can be also found in the document published by ecoinvent titled [Documentation of changes implemented in the ecoinvent database v3.7](#).

The Figure 15 below shows one example process “Test_process” created in ecoinvent 3.6 and imported in ecoinvent 3.7 without losing the providers.

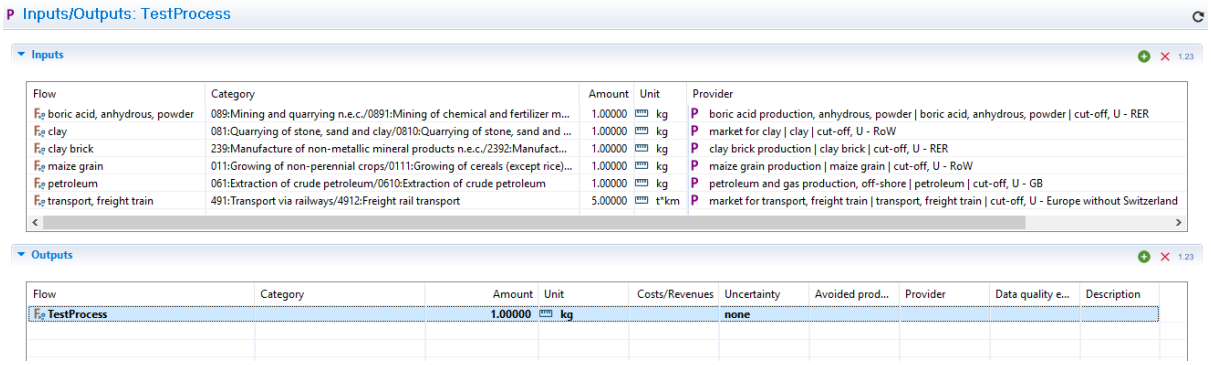


Figure 15: Test process created in ecoinvent 3.6 cutoff unit process and exported in JSON-LD format.

Important: This is only possible between the same type of system models, for instance between 3.6 and 3.7 cut-off or between 3.6 and 3.7 APOS databases.

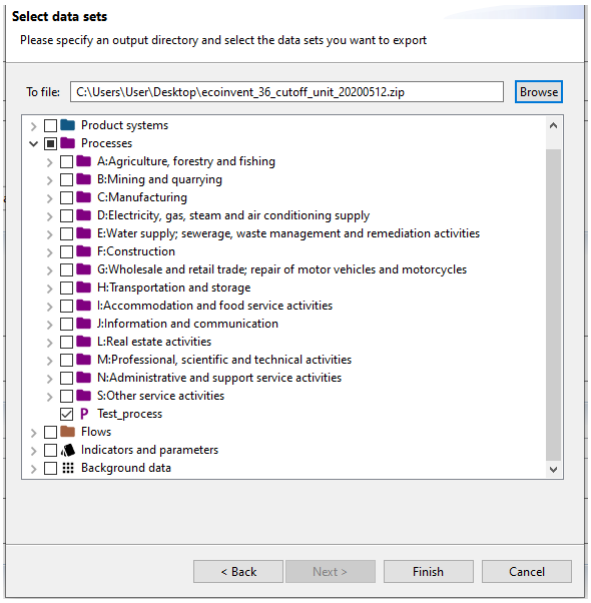


Figure 16: „Test_process “export from ecoinvent 3.6 database in JSON-LD format.

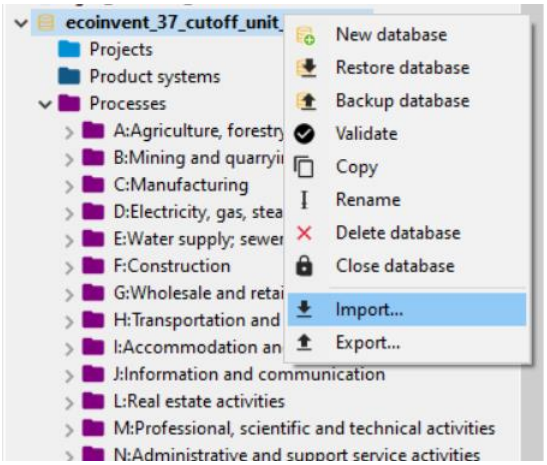
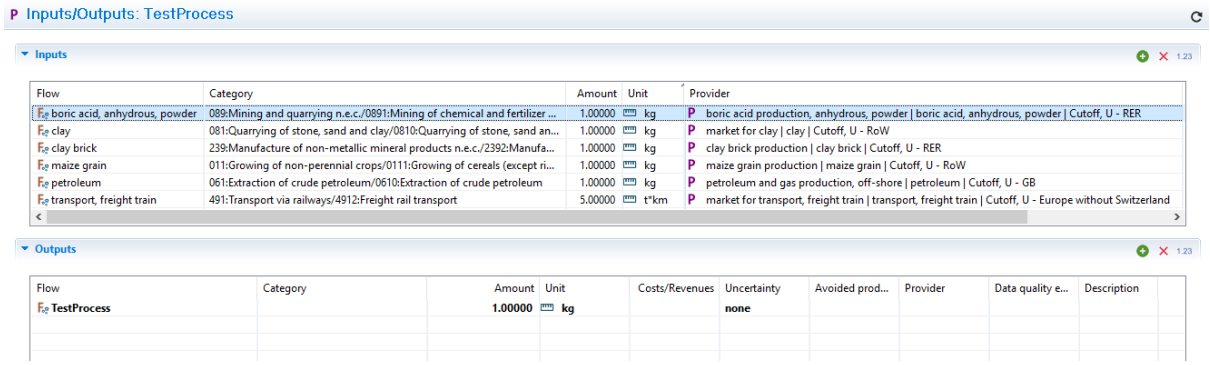


Figure 17: Importing of „Test_process“ into ecoinvent 3.7 cut-off unit process database.

Once the process is imported it can be opened in the process editor and the providers assigned in 3.6 will still be assigned but with 3.7 processes like in Figure **18** as long as it does not fall in the special case highlighted above.

Figure 18: „Test_process“ imported into ecoinvent 3.7 cut-off unit process database.



5 Support

GreenDelta GmbH, developer of openLCA, offers openLCA users prioritised and guaranteed professional openLCA support via the GreenDelta helpdesk: https://www.openlca.org/service-contracts/. Public (*User2User*) support for openLCA is available via https://ask.openlca.org/.

In case you have other questions not addressed by this report, need further clarifications on any of the points commented, or have comments about the ecoinvent v.3.7 database in openLCA, please contact us.