Environmental Footprint secondary data for openLCA

Product Environmental Footprints

Secondary data in openLCA

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Title image: Grigory Potemkin (https://en.wikipedia.org/wiki/File:Grigorij_Potiomkin.jpeg; accessed 07.01.2019)

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Abbreviations

EULA - *End User License Agreement*
LCA - *Life Cycle Assessment*
LCIA - *Life Cycle Impact Assessment*
OEFSRs - *Organisation Environmental Footprint Sector Rules*
PEFs - *Product Environmental Footprints*
PEFCRs- *Product Environmental Footprint Category Rules*

Introduction to Product Environmental Footprints (PEFs) initiative

The Product Environmental Footprints (PEFs) initiative originates from the European Commission's Single Market for Green Products initiative which proposed to *look into the feasibility of an initiative on the Ecological Footprint of Products to address the issue of the environmental impact of products, including carbon emissions [and] explore possibilities for establishing a common European methodology to assess and label them*[1].

Upon the publication of the Single Market for Green Products Initiative, the European Commission was invited by the European Council to *develop a common methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products*[2].

PEF results from a three-year multi-stakeholder testing period labelled the Environmental Footprint (EF) pilot phase which lasted from 2013 to 2016 (European Commission, 2018a). The methodology developed for PEF already began in 2011 with an analysis of existing methods. The investigated methods (i.e., BP X30, Ecological Footprint, GHG protocol, ILCD, ISO 14040-44, ISO 14025, PAS 2050, WRI/WBCSD) were incorporated into a draft methodological guide for the calculation of environmental footprint of products and organisations as well as into training programs. Following the testing phase accompanied by public stakeholder consultations on policy options, a final methodological guide was released in April 2013 [3].

With finalisation of the pilots, however, it was found that they were not consistent, in terms of modelling approach, background data used, reference data used, and even use of specific features in specific LCA software, resulting from the fact that they were created somewhat independently, by different LCA consultants and experts and groups, with different LCA softwares. Further, the models could not really be shared across different LCA software systems. To address these and some other aspects, the PEF remodelling project has been launched by the European Commission, and has been awarded to a rather large consortium, consisting of all major LCA software providers, and many consultants involved in the EF pilots. This project started in 2017, was planned for 6 months roughly, and still has not finished.

1.1 Results and deliverables of the Environmental Footprint

So, while the entire footprint initiative takes somewhat longer than expected, and while some doubts prevail regarding the consistency and overall quality of results and at the same time EF declares datasets as representative, compliant, and consistent, which inspired us to the picture at the front page, some results and deliverables are of course available meanwhile. These include:

- Final *Product Environmental Footprint Category Rules* (PEFCRs) and *Organisation Environmental Footprint*

[1] http://ec.europa.eu/environment/eussd/smgp/policy_footprint.htm (accessed 07.01.2019)
[2] http://ec.europa.eu/environment/eussd/smgp/policy_footprint.htm (accessed 07.01.2019)
[3] Manfredi, S., Allacker, K., Pelletier, N., Chomkhamsri, K., and de Souza, D. M. (2012). Product environmental footprint (PEF) guide. http://ec.europa.eu/environment/eussd/pdf/footprint/PEF%20methodology%20final%20draft.pdf (accessed 08.01.2019)

Sector Rules (OEFSRs): Guidelines for calculating the Environmental Footprint of products and organisations; developed in compliance with version 6.3 of the PEFCRs Guidance and the OEFSRs Guidance. In particular, 21 PEFCRs (four pilots have been discontinued) and 2 OEFs [4].

- **Secondary data** to be used when implementing PEFCRs and OEFSRs (see section 2.1 *PEF Secondary data for openLCA (PEF LCA datasets)* on p.3). The datasets are organised in nodes (provided by different providers, see Table 2.1). Full consistency among the datasets provided by the different nodes is not guaranteed, e.g. due to the timing of the datasets' development. datasets about transport and energy have been developed first, but with overlap to other data areas, and thus datasets could in most cases not be exchanged and shared between background dataset developers. Datasets so far are available as fully aggregated processes only, with some very few exceptions.
- E-learning packages
- Reports on the Environmental Footprint pilot phase
- Technical reports (about e.g. normalisation method and weighting approach)

Learn more about the deliverables of the Environmental Footprint pilot phase via http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm (accessed 07.01.2019)

[4] http://ec.europa.eu/environment/eussd/smgp/ef_pilots.htm (accessed 08.01.2019)

Product Environmental Footprints in openLCA

2.1 PEF Secondary data for openLCA (PEF LCA datasets)

PEF datasets for life cycle modelling can be downloaded for openLCA via nexus.openlca.org/databases. It is possile to search through the PEF datasets via https://nexus.openlca.org/search. The following process categories and subcategories are part of the PEF datasets:

- **Agricultural products**
- **End-of-life treatment:** Energy recycling, Land-filling, Material recycling, Waste water treatment
- **Energy carriers and technologies:** Crude oil based fuels, Electricity, Hard coal based fuels, Heat and steam, Renewable fuels
- **Materials production:** Agricultural production means, Food and renewable raw materials, Glass and ceramics, Inorganic chemicals, Metals and semimetals, Organic chemicals, Other chemicals, Other materials, Other mineral materials, Paper and cardboard, Plastics, Water, Wood
- **Systems:** Construction, Electrics and electronics, Packaging, Unspecific parts
- **Transport services:** Air, Rail, Road, Water

At GreenDelta, we integrated the various datasets from the nodes into one database which we will call "PEF database" in the following. The PEF database contains datasets from the Life Cycle Data Network nodes listed in table 2.1[1]. Users of the PEF database from nexus.openLCA.org agree to the EULA of the respective data providers (see section 2.6 on p.9).

Table 2.1: Data types, data providers and their respective nodes in the Life Cycle Data Network for the PEF database (as of July 2019).

Data type	Data provider	Node
EF representative products	European commission	http://eplca.jrc.ec.europa.eu/EF-node/
Energy and transport	Thinkstep	http://lcdn.thinkstep.com/Node/
Packaging	Thinkstep	http://lcdn.thinkstep.com/Node/
Agrofood	Quantis	https://lcdn.quantis-software.com/PEF/
Metals	Thinkstep	http://lcdn.thinkstep.com/Node/
Chemicals for Paint	CEPE ecoinvent	http://lcdn-cepe.org
Others	Quantis	https://lcdn.quantis-software.com/PEF/

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[1]Source: http://eplca.jrc.ec.europa.eu/LCDN/contactListEF.xhtml (accessed 08.01.2019)

Table 2.1 (continued from previous page)

Data type	Data provider	Node
Chemicals	Ecoinvent	http://ecoinvent.lca-data.com/
End of Life	Thinkstep	http://lcdn.thinkstep.com/Node/
Feed	Fefac	http://lcdn.blonkconsultants.nl/Node/
Incineration	Thinkstep	http://lcdn.thinkstep.com/Node/
Plastics	Thinkstep	http://lcdn.thinkstep.com/Node/
Textiles	Cycleco	https://node.cycleco.eu/node/
Electronics	Thinkstep	http://lcdn.thinkstep.com/Node/
Cooling and freezing transport	Thinkstep	http://lcdn.thinkstep.com/Node/
Glass recycling	RDC	http://soda.rdc.yp5.be/login.xhtml?stock=FEVE_EF_com

As previously said, full consistency among the different nodes cannot be guaranteed due to overlapping timing of the datasets development, which evidently "bleeds through" the PEF database.

2.2 *Environmental Footprint* LCIA method for openLCA

The PEF *Environmental Footprint (Mid-point indicator)* LCIA method is included in the PEF database available on nexus.openLCA.org. It includes the impact categories listed in table 2.2. The impact assessment method has been used by the remodelling consortium for the PEF remodelling project. The final LCIA method is yet to be approved[2] (the PEF database for openLCA will then be updated). Please note that no other LCIA method from nexus.openLCA.org is compatible with the PEF datasets.

Table 2.2: Impact categories of the PEF *Environmental Footprint (Mid-point indicator)* LCIA method.

Impact category	Description	Unit
Abiotic resource depletion - fossil fuels	ADP for energy carriers, based on van Oers et al. 2002 as implemented in CML, v. 4.8 (2016).	MJ
Abiotic resource depletion - mineral and metals	ADP for mineral and metal resources, based on van Oers et al. 2002 as implemented in CML, v. 4.8 (2016).	kg Sb eq.
Acidification	European country-dependent.	mol H+ eq.
Aquatic eco-toxicity	USEtox™ consensus model (multimedia model). No spatial differentiation beyond continent and world compartments. Specific groups of chemicals requires further works (cf. details in other sections).	CTUe

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[2]Version 2; source: http://eplca.jrc.ec.europa.eu/permalink/TR_SupportingCF_FINAL.pdf

Table 2.2 (continued from previous page)

Impact category	Description	Unit
Aquatic Eutrophication - fresh water	European validity. Averaged characterization factors from country dependent characterization factors.	kg P eq.
Aquatic Eutrophication - marine	European validity. Averaged characterization factors from country dependent characterization factors.	kg N eq.
Cancer human health effects	USEtox consensus model (multimedia model). No spatial differentiation beyond continent and world compartments. Specific groups of chemicals requires further works (cf. details in other sections).	CTUh
Climate change	Baseline model of the IPCC + some factors Calculated from JRC.	kg CO2 eq.
Climate change - biogenic	Baseline model of the IPCC + some factors Calculated from JRC.	kg CO2 eq.
Climate change - fossil	Baseline model of the IPCC + some factors Calculated from JRC.	kg CO2 eq.
Climate change - land use	Baseline model of the IPCC + some factors Calculated from JRC.	kg CO2 eq.
Ionizing radiation	Valid on global and European scale.	kBq U-235 eq.
Land use	CFs set was re-Calculated by JRC starting from LANCAÂ® v 2.2 as baseline model. Out of 5 original indicator only 4 have been included in the aggregation (physico-chemical filtration was excluded due to the high correlation with the mechanical filtration).	pt
Non-cancer human health effects	USEtox consensus model (multimedia model). No spatial differentiation beyond continent and world compartments. Specific groups of chemicals requires further works (cf. details in other sections).	CTUh
Ozone depletion	Based on 1999 WMO assessment (World Meteorological Organization 1999).	kg CFC-11 eq.
Photochemical ozone creation	Only for Europe. Includes spatial differentiation.	kg NMVOC eq.
Respiratory inorganics	The indicator is calculated applying the average slope between the Emission Response Function (ERF) working point and the theoretical minimum-risk level.	death
Terrestrial Eutrophication	European country-dependent.	mol N eq.
Water scarcity	AWARE 100 (based on; UNEP, 2016).	m3 water eq. of deprived water

2.3 Advice for using PEF datasets in openLCA (building a product system)

The background processes included in the PEF database are labelled as *system processes*, also in the original ILCD format. Nevertheless, they also include *product and waste flows*, e.g. waste, recycled materials or energy recovered from waste[3].

This has consequences for openLCA users. When building a product system in openLCA with datasets from the PEF database, users should deselect the **Auto-link processes** box in the the product system creation settings, and connect the processes manually instead, to prevent openLCA from connecting these system-process product flows to other processes.

Considering, for instance, the process *Forging of steel parts, single route, at plant, forging, 1 kg forged part*, without auto-link the user obtains the model graph shown in Fig. 2.1. It is one single, aggregated process.

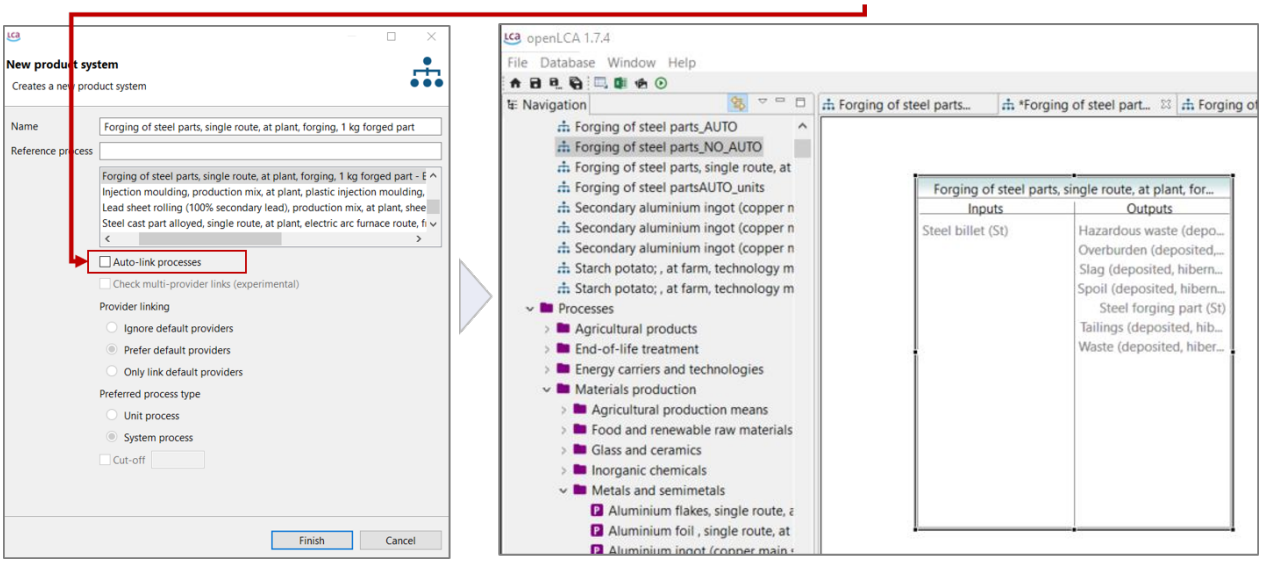

Figure 2.1: Model graph of the product system obtained without auto-link.

Of course, you can link different flows included in the product system to the respective provider by right-clicking on the box in the model graph and selecting *Search providers for* (or *Search recipients for*) as shown in Fig. 2.2 (selecting both *Add* and *Connect*).

[3]Difference between unit and system processes: https://ask.openlca.org/53/difference-between-system-process-and-unit-process?show=601a601 (accessed 09.01.2019)

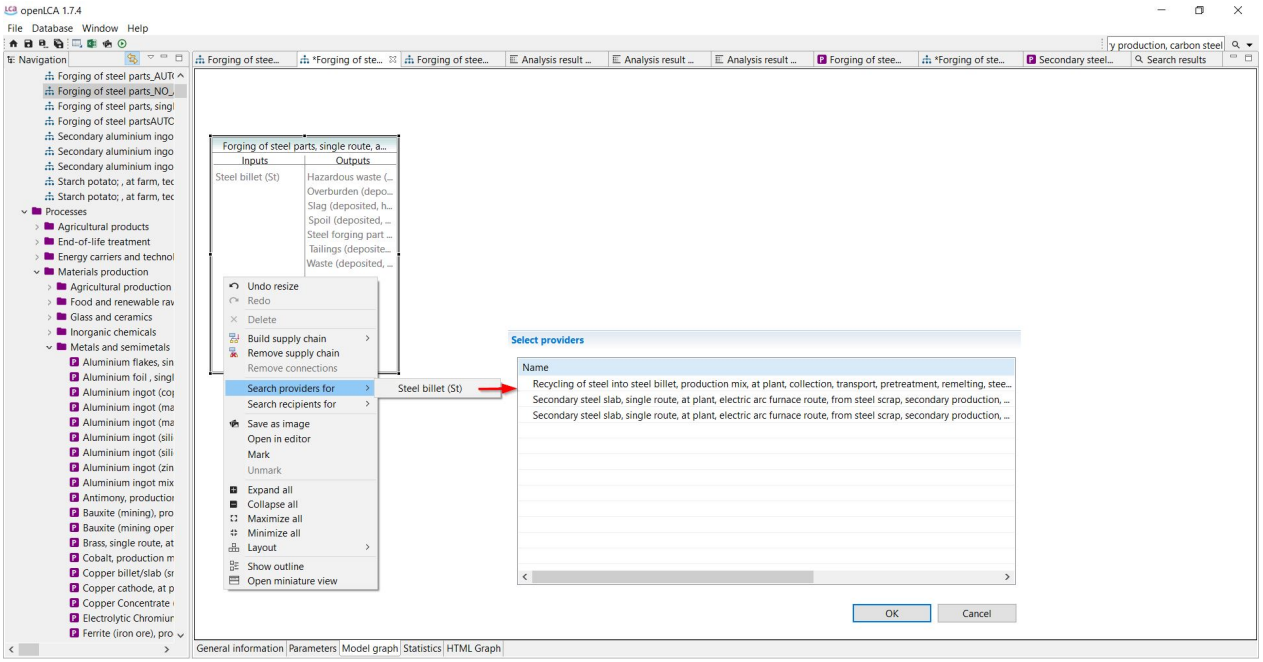

Figure 2.2: Manual linking within a product system.

2.4 Exporting and sharing EF datasets: how to address regionalized flows?

The EF datasets are partly regionalized via the location element in exchanges of processes and characterization factors of LCIA method: the same flow can occur multiple times in exchanges of processes or in characterization factors of an LCIA method, with different locations (see 2.3 upper box). openLCA supports locations so far only for flows, not for exchanges (and many other LCA software packages do neither, as the regionalized exchanges were introduced in the EF datasets quite recently). As a workaround, the localized exchanges have been turned by us into localized flows, by creating one regionalized flow for each regionalized exchange (see 2.3 bottom box).

```
<exchange dataSetInternalID="1">
  <referenceToFlowDataSet
    type="flow data set"
    refObjectId="e3abf13f-3bb9-4e52-b72b-9bd276625c55"
    version="01.00.000"
    uri="../flows/e3abf13f-3bb9-4e52-b72b-9bd276625c55">
    <common:shortDescription xml:lang="en">1,1,1,2-Tetrachloroethane</common:shortDescription>
  </referenceToFlowDataSet>
        <location>PL</location>
  <exchangeDirection>Output</exchangeDirection>
  <meanAmount>1.0</meanAmount>
  <resultingAmount>1.0</resultingAmount>
</exchange>
```

Location in exchanges

```
<factor>
  <referenceToFlowDataSet
    refObjectId="03b56eb6-cc68-4251-9317-06878cb27dff"
    type="flow data set"
    uri="../flows/03b56eb6-cc68-4251-9317-06878cb27dff.xml"
    version="03.00.000">
    <common:shortDescription xml:lang="en">from arable, irrigated,</common:shortDescription>
  </referenceToFlowDataSet>
  <location>AD</location>
  <exchangeDirection>Input</exchangeDirection>
  <meanValue>-128</meanValue>
</factor>
```

Location in flows

Figure 2.3: Define localization in datasets: exchanges vs flows.

In order to recreate the original ILCD regionalized exchanges, e.g. for sharing data for import into other LCA software, or for comparing results with the Look@LCI tool of the European Commission (https://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml), we published a tool called 'peflocus'. Peflocus can be downloaded from our GitHub page (https://github.com/msrocka/peflocus) together with the flow mapping file, a csv file needed by peflocus. In short, peflocus replaces the regionalized flows with the regionalized exchanges, and thus recreates the original data regarding the regionalized exchanges.
To use peflocus, follow these steps:

1. create a folder including the peflocus executable file (i.e., .exe), the flow mapping file (i.e., *flow_mapping.csv*) and a folder including the dataset you want to modify (e.g., *wordir*); the dataset should be in the ILCD format (in a zipped folder);

2. open the command window from the created folder and type the following command lines:

   - if you have to importing EF data (e.g., provided by the EC):
     peflocus **map** -wordir zips -mapfile flow_mapping.csv
   - if you exported EF data from openLCA (e.g., before appling Look@LCI or sending data to the EC):
     peflocus **unmap** -wordir zips -mapfile flow_mapping.csv

3. press enter and, once finished, you will find a new version of your dataset in the *wordir* named 'peflocus...(same name of the input dataset)'.

2.5 Current status of the EF datasets and future updates

The European Commission has asked all nodes to include the following statement, which seems appropriate also for the entire PEF database.

"Within the Environmental Footprint dataset, the results for water use might be overestimated and shall therefore be interpreted with caution. This problem has nothing to do with the impact assessment method or the implementability of EF methods, but occurred during the technical development of some datasets. All results remain valid and usable. The Environmental Footprint datasets will be updated in 2019 (which will automatically adjust the regionalized water flows)."

At present, we do not have further information as to which datasets are affected, and while "results for water might be overestimated" and "all results remain valid" maybe does not sound fully consistent, and even seems to recall Christian Morgenstern[4], this warning is a reminder that the datasets are not final yet. Also, the datasets developed in the PEF pilot products are still under revision, as well as the created pilot models. Once these are also available from the commission, we will seek to make them also available for openLCA.

2.6 End User License Agreement

The PEF datasets are from different data providers. Users of PEF datasets for openLCA agree with the respective EULA of the data providers. The EULA are available via nodes of the data providers (see table 2.1 on p.3), and also on Nexus for the PEF database. **The EF database is free of charge only for users that are conducting PEF or OEF studies exclusively under the approved product groups and sectors, which have been approved during the EF pilot phase and as defined in the PEFCRs and OEFSRs listed, and in accordance with the terms and conditions of the EULAs of all data providers exclusively until 31st December 2021 (permitted use).**

If you are interested in other uses, this is also possible, please contact us then, thank you.

[4] "Weil, so schließt er messerscharf, nicht sein kann, was nicht sein darf"; Christian Morgenstern, Die unmögliche Tatsache, 1909, first published 1932.

Support

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

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