

# FAIR Principles for LCA data

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GreenDelta GmbH

**GreenDELTA**



**siTOlUb**

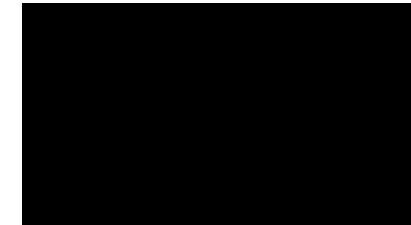


Funded by  
the European Union

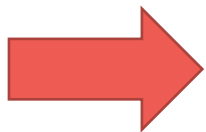
## FAIR: Why I am here

- Our software, openLCA, started as data converter
- Developed by us since 2006
- Completely Open Source (Mozilla Public License)
- We have our own data format (JSON-LD)
- We develop tools and integrate databases

GreenDelta

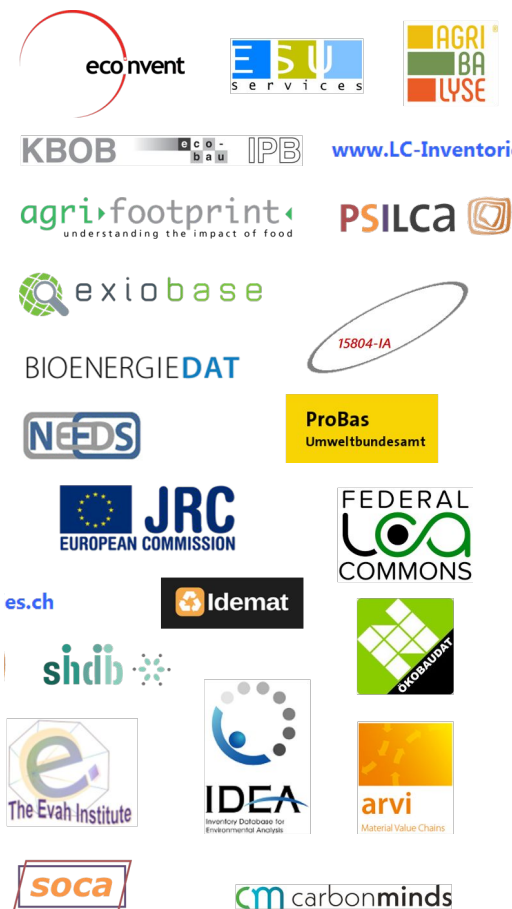


<https://github.com/GreenDelta>

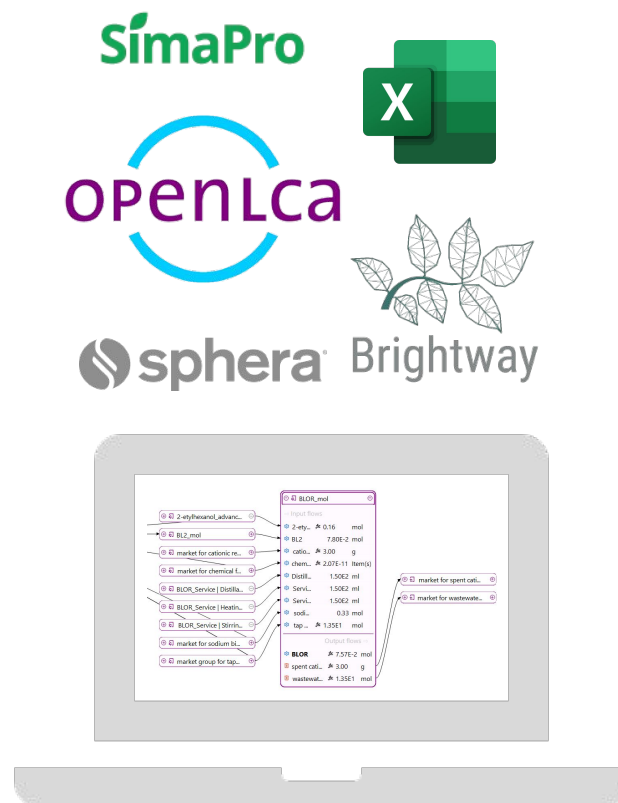


At the forefront of data development for LCA

## How to LCA: Databases, software and data formats



databases



software

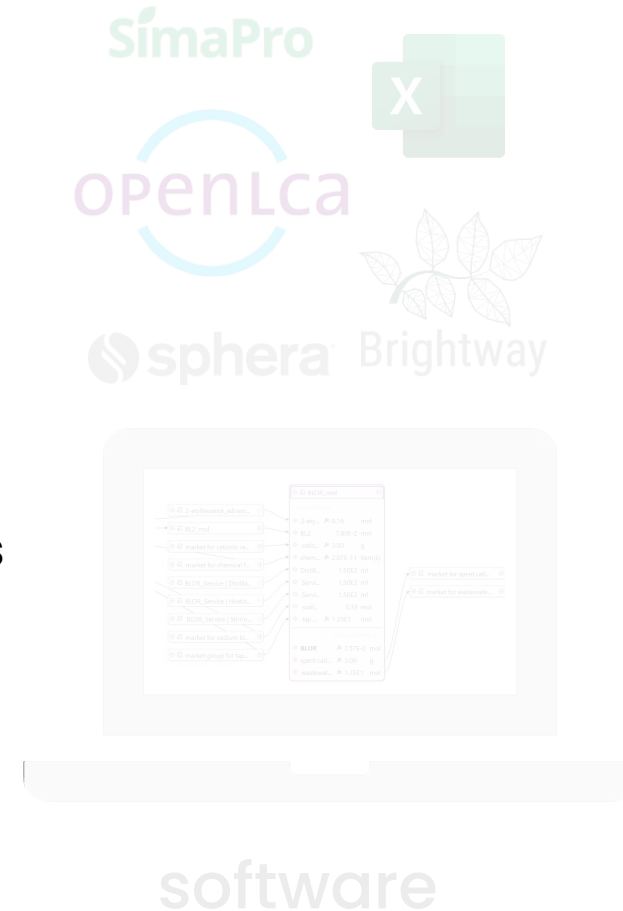


data formats

## How to LCA: Databases and software

### LCA software:

- They differ in business models
  - Software is purchaseable, databases for free
  - Software is free, database purchaseable
- Very often not open-source
- Very often outdated, barely maintained
- Some connect data with UUIDs some with names



## How to LCA: Databases and software



## databases

- Databases can cover general or specific products or processes
  - Unit vs. System process databases
  - General databases (ecoinvent, EF)
  - Specific (CarbonMinds, AgriBalyse)
  - Regional context (EF, LCA Commons, HiQLCD, ProBas, Ökobaudat)
- Check their assumptions! And mix LCI datasets or databases only with care (different assumptions)
- Finally: Good data is never for free!

## How to LCA: Databases and software

ecoinvent



EF 4.0 DB

Unit processes:

Process A

Process C

Process B

Process D

Process E

Process F

Process G

System (LCI) processes:

Process A

Process A

Process B

Process C

Process D

Process E

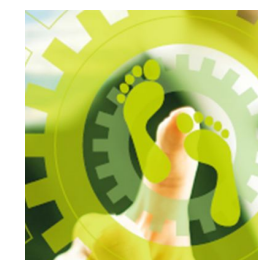
Process F

Process G

carbonminds

PLASTICS  
EUROPE  
Enabling a sustainable future

GaBi  
Database Content



EF 3.1 DB

## How to LCA: Databases, software and data formats

Scheme	Used By	Data format	Notes
ILCD	EF, LCDN, soda4LCA Nodes, GLAD, Sphera/Gabi	XML	Contains process, flow, unit data in schema-compliant XML files
ILCD+EPD	EPDs (from InData)	XML	Adaptation of ILCD for EPDs with mandatory fields and rules for interoperability
EcoSpold v1	ecoinvent2, UVEK, still in use for new data sets	XML	Older format; still widely used in research and legacy datasets
EcoSpold v2	Ecoinvent3, brightway	XML	Modular and improved (parameters, unique IDs, etc.); reflects ecoinvent's specific needs
olca scheme	openLCA, Nexus	JSON + Linked Data (JSON-LD)	implements ILCD and ISO 14048 concepts; supports linking, formulas, parameters, product system etc.
SimaPro CSV	SimaPro	CSV	Tabular import/export format for processes, flows, and results; used for interoperability and data exchange



### Data formats

# FAIR

## FAIR principles



**F**indable



**A**ccessible



**I**nteroperable



**R**eusable

Ghose A. Int. J. Life. Cycle Assess. 2024; 29, 733–744



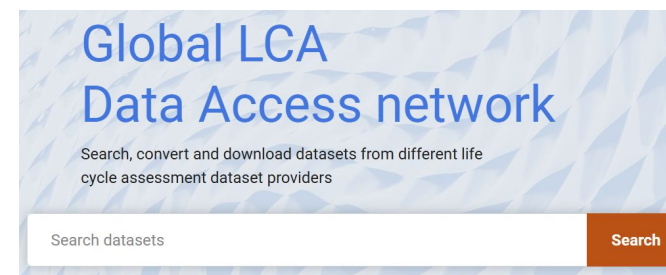
## Findable LCA data

You can find data:

- Search engines for datasets in databases:
  - GLAD search engine
  - openLCA Nexus
- Individual datasets (exchange):
  - Scientific publication (PDFs, .xls)
  - European Platform on LCA (JRC)
  - Zenodo
  - Or not (proprietary data, aggregation)

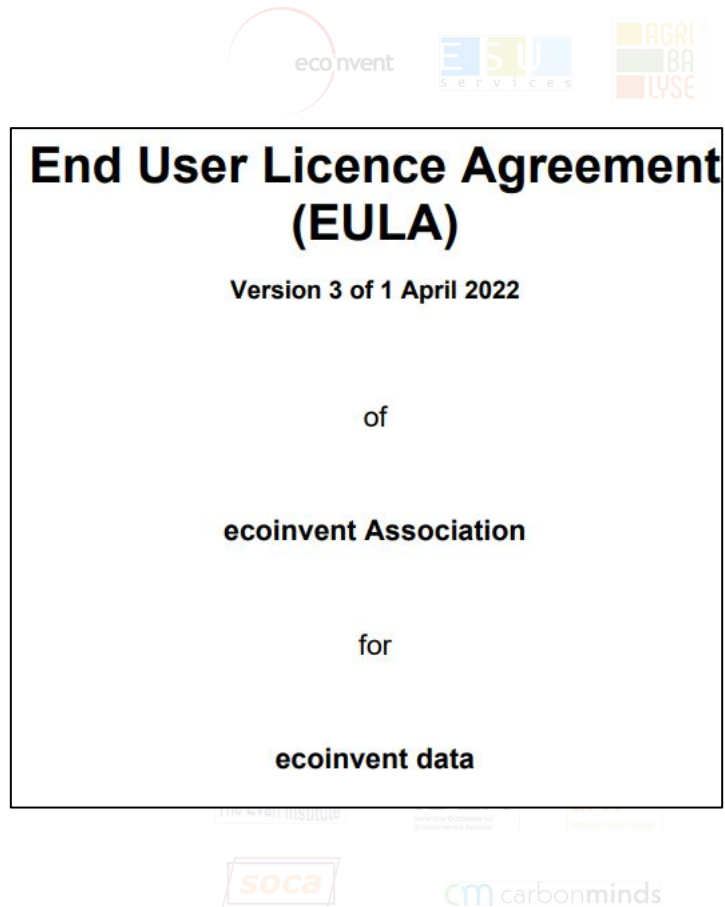


There is no overarching search engine (like SciFinder etc.)



**F**indable

## Accessible LCA data



databases

Every database comes with an EULA

- LCA databases (ecoinvent, Gabi) prohibit sharing any raw data
- LCA databases also limit to publish the amount of calculated data:
  - Not allowed to share own calc. inventories that have been calculation with the background data
  - sharing models and data that contain parts of these difficult
  - Limited by purpose (EF 3.1 DB only for PEF!)



Accessible

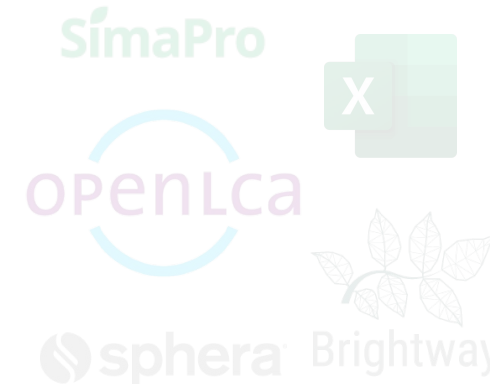
## How to LCA: Databases and software

### LCA software:

- Each software works in a different fashion
  - Fully aggregated data
  - Fixed modelling stages
  - Operational freedom
- Some softwares work with UUIDs, some with names
  - Versioning is optional in most softwares



Interoperable



Version 03.02.003 Last change 2024-11-23 13:47:45 UUID 117339b3-5791-3b05-986f-ad34d5479b55

software

# LCA has still room for improvement – data see also ISO14048



Interoperable

- ▼ EcoSpold
  - XML Impact methods
  - XML Processes
- ▼ Excel
  - One Click LCA - Excel template
  - Processes
- ▼ ILCD
  - ILCD Network Export
  - ILCD Zip-File
- ▼ SimaPro CSV
  - LCIA methods to SimaPro CSV
  - Processes to SimaPro CSV
- ▼ openLCA
  - LCA JSON-LD

Scheme	Used By	Data format	Notes
ILCD	EF, LCDN, soda4LCA Nodes, GLAD, Sphera/Gabi	XML	Contains process, flow, unit data in schema-compliant XML files
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# ILCD vs. JSON



Interoperable

```
<exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="206" olca:unitId="20aad24-a391-41cf-b340-3e4529f44bde"
  <referenceToFlowDataSet type="flow data set" refObjectId="39d1390a-ded6-41cb-a536-d47510bf2fbc" version="03.11.000" uri="../../flows
    <common:shortDescription xml:lang="en">Chlorine</common:shortDescription>
  </referenceToFlowDataSet>
  <exchangeDirection>Output</exchangeDirection>
  <meanAmount>3.6036488798256047E-7</meanAmount>
  <resultingAmount>3.6036488798256047E-7</resultingAmount>
</exchange>
<exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="1765" olca:unitId="e9773595-284e-46dd-9671-5fc9ff406833"
  <referenceToFlowDataSet type="flow data set" refObjectId="af99ce19-4a31-4c6f-b050-491e2b6f1ad1" version="03.11.000" uri="../../flows
    <common:shortDescription xml:lang="en">Cerium-141</common:shortDescription>
  </referenceToFlowDataSet>
  <exchangeDirection>Output</exchangeDirection>
  <meanAmount>6.225705230533937E-9</meanAmount>
  <resultingAmount>6.225705230533937E-9</resultingAmount>
</exchange>
<exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="112" olca:unitId="20aad24-a391-41cf-b340-3e4529f44bde"
  <referenceToFlowDataSet type="flow data set" refObjectId="5e883a00-04e6-4d96-8dce-12d7117c6635" version="03.11.000" uri="../../flows
    <common:shortDescription xml:lang="en">Benzene</common:shortDescription>
  </referenceToFlowDataSet>
  <exchangeDirection>Output</exchangeDirection>
  <meanAmount>9.60592760122648E-7</meanAmount>
  <resultingAmount>9.60592760122648E-7</resultingAmount>
</exchange>
<exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="324" olca:unitId="20aad24-a391-41cf-b340-3e4529f44bde"
  <referenceToFlowDataSet type="flow data set" refObjectId="98ef28f1-cfd5-44a0-ac34-01acf2db84a0" version="03.11.000" uri="../../flows
    <common:shortDescription xml:lang="en">Ethyl benzene</common:shortDescription>
  </referenceToFlowDataSet>
  <exchangeDirection>Output</exchangeDirection>
  <meanAmount>1.8281628459056205E-11</meanAmount>
  <resultingAmount>1.8281628459056205E-11</resultingAmount>
</exchange>
<exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="2487" olca:unitId="20aad24-a391-41cf-b340-3e4529f44bde"
  <referenceToFlowDataSet type="flow data set" refObjectId="45d6f26b-596b-5182-8c08-d6d975ff4efe" version="03.11.000" uri="../../flows
    <common:shortDescription xml:lang="en">Bromine</common:shortDescription>
  </referenceToFlowDataSet>
  <exchangeDirection>Input</exchangeDirection>
  <meanAmount>1.4149521238984541E-8</meanAmount>
  <resultingAmount>1.4149521238984541E-8</resultingAmount>
</exchange>
<exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="1434" olca:unitId="20aad24-a391-41cf-b340-3e4529f44bde"
  <referenceToFlowDataSet type="flow data set" refObjectId="3f616604-f614-586c-9665-f365b08ca734" version="03.11.000" uri="../../flows
    <common:shortDescription xml:lang="en">Quinmerac</common:shortDescription>
```

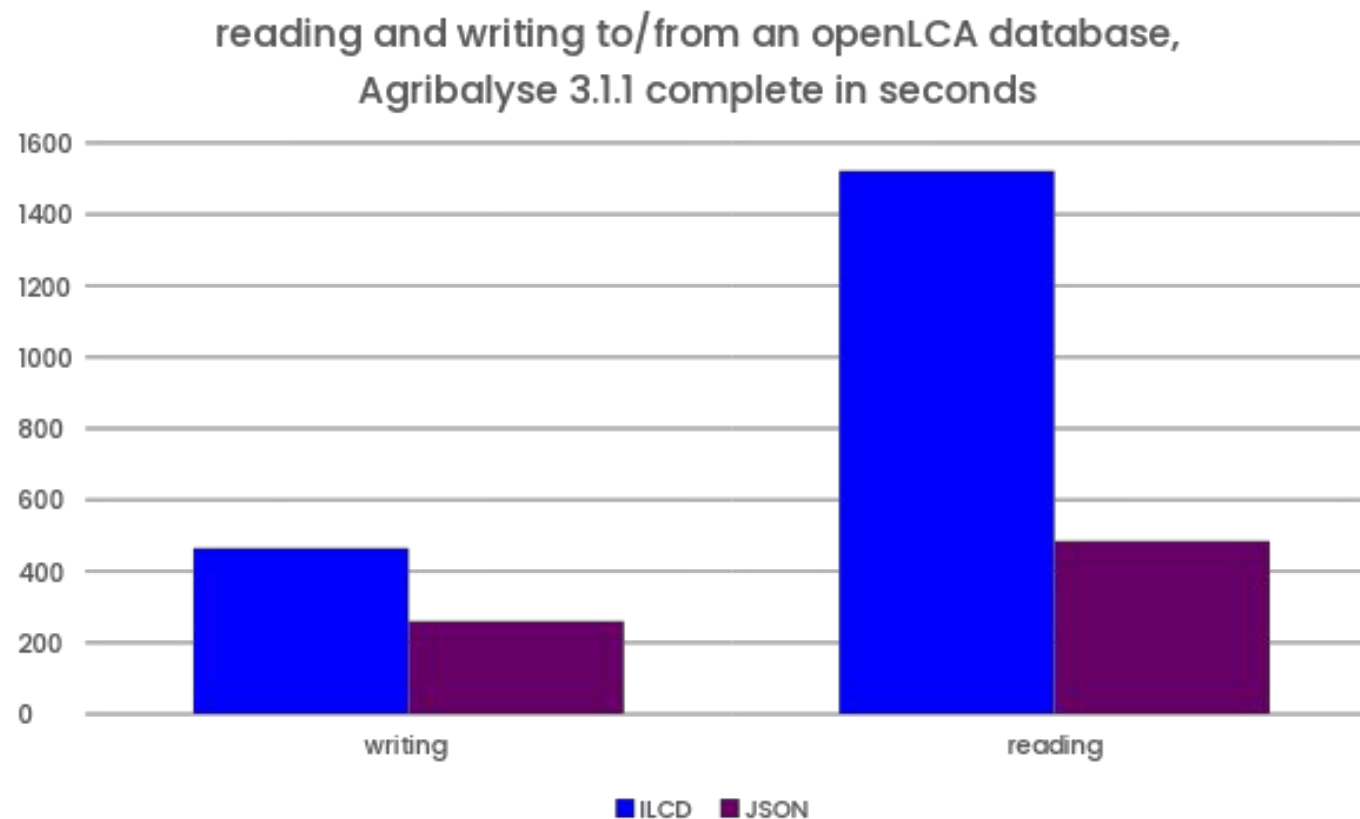
```
exchanges:
  0:
    @type: "Exchange"
    isAvoidedProduct: false
    isInput: false
    amount: 1.0 JS:1
    description: ""
    costValue: 0.7589999999999999
    currency: { "@type": "Currency", "@id": "a20e36f3-bf5d-4e53-82f8-f6991df9a554", name: "Euro 2005", ... }
    internalId: 1
    flow: { "@type": "Flow", "@id": "06eb6d76-0ac1-5ba6-aa9b-6b0228e0dd96", name: "base oil", ... }
    unit: { "@type": "Unit", "@id": "20aad24-a391-41cf-b340-3e4529f44bde", name: "kg" }
    flowProperty: { "@type": "FlowProperty", "@id": "93a60a56-a3c8-11da-a746-0800200b9a66", name: "Mass", ... }
    isQuantitativeReference: true
  1:
    @type: "Exchange"
    isAvoidedProduct: false
    isInput: false
    amount: 2.969483125329865E-7 JS: 2.969483125329865E-7
    internalId: 84
    flow: { "@type": "Flow", "@id": "77927dac-dea3-429d-a434-d5a71d92c4f7", name: "Antimony ion", ... }
    unit: { "@type": "Unit", "@id": "20aad24-a391-41cf-b340-3e4529f44bde", name: "kg" }
    flowProperty: { "@type": "FlowProperty", "@id": "93a60a56-a3c8-11da-a746-0800200b9a66", name: "Mass", ... }
```

System  
proccess:

2.0 MB

1.4 MB

## ILCD vs. JSON

Interoperable

## Reusability



Reusable

- Reusability of datasets depends on clear and correct licensing
  - such as Creative Commons for general outputs
  - but also commercial licenses for exploitation of outputs
- However, reusability is also linked to documentation/data format
  - ILCD format is the closest thing to useable exchange format
  - Lack of traceability and clarity for modelling
  - Use of System processes
  - Lack of documentation
- But data quality is often tracked



# Reusability



Reusable

- Data quality systems can be used on flow or process level

**Criteria**

	1	2	3	4	5	<b>Score</b>
Reliability						
Completeness						
Time						
Geography						
Technology						

**Qualitative descriptors**

For documenting data quality but also to quantify uncertainty.

**Technology**

Description

**Data quality**

Process schema ecoinvent Data Quality System X

Data quality entry (1; 2; 2; 2; 1)

Flow schema ecoinvent Data Quality System X

Social schema - none - X

General information Inputs/Outputs Documentation Parameters A



# Reusability



Reusable

## The calculated data can be used for LCIA results/impact analysis

### computer production, laptop | computer, laptop | Cutoff, U - GLO

#### Impact analysis - EF v3.1

Sub-group by ☐ Flows ☒ Processes | Don't show < 1 %

Name	Category	Impact assessment result	R	C	T	G	F
>  Acidification	ecoinvent 3.11 LCIA Categories/EF v3.1	1.18577 mol H+-Eq	3	3	5	3	3
>  Climate change	ecoinvent 3.11 LCIA Categories/EF v3.1	169.60826 kg CO2-Eq	3	3	5	4	2
>  Climate change: biogenic	ecoinvent 3.11 LCIA Categories/EF v3.1	0.31541 kg CO2-Eq	4	2	5	3	2
>  Climate change: fossil	ecoinvent 3.11 LCIA Categories/EF v3.1	168.98266 kg CO2-Eq	3	3	5	4	2
>  Climate change: land use and land use c	ecoinvent 3.11 LCIA Categories/EF v3.1	0.31020 kg CO2-Eq	5	3	5	3	3
>  Ecotoxicity: freshwater	ecoinvent 3.11 LCIA Categories/EF v3.1	2753.24409 CTUe	1	1	3	2	1
>  Ecotoxicity: freshwater, inorganics	ecoinvent 3.11 LCIA Categories/EF v3.1	2698.73092 CTUe	1	1	3	2	1
>  Ecotoxicity: freshwater, organics	ecoinvent 3.11 LCIA Categories/EF v3.1	54.51316 CTUe	2	3	4	3	2

Final words



Findable

Global LCA  
Data Access network

Search, convert and download datasets from different life cycle assessment dataset providers

Search

openLCA Nexus

Your source for LCA and sustainability data.

Search

Overall providing ~ 300,000 data sets.  
e.g. for Switzerland: 86210 data sets found.



## Final words



Findable



Accessible



Interoperable



Reusable

Sharing LCA data is still not trivial:

- We are limited by licenses of the databases
- Sharing aggregated LCIs (foreground+background) is not allowed
- Sharing disaggregated LCIs is often not allowed by the partners



Please publish unit processes  
of your research projects

# Thanks

Dr. Jonas Hoffmann, LCA Consultant and Researcher  
GreenDelta GmbH **GreenDELTA**



# You want to share your research data? ILCD-only

European Platform on LCA | EPLCA

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Suche Prozesse

Willkommen!

Environmentally conscious Research & Development (R&D) is strongly encouraged by Publicly Funded Research Programmes. The European Union's Research and Innovation funding programme for 2007-2013 (FP7) and Horizon 2020 (2014-onwards) calls explicitly require addressing environmental aspects from a life cycle perspective within the innovative products development process. Life Cycle Assessment (LCA) is often used as a mean to ensure such environmentally conscious Research & Development.

In many specific EU research calls, LCA is proposed as a tool to support decisions and the International Reference Life Cycle Data System (ILCD) handbook and ISO 14040 family are suggested to be used as guidance. Such life cycle approach is expected to be continued in future calls, also considering that in the Horizon 2020 - Work Programme 2014-2015 "Nanotechnologies, Advanced Materials and Production", the life cycle perspective to assess the environmental performances of the solutions is explicitly required in several calls. For example, some recent calls on Circular Economy (e.g. CIRC-01-2016-2017) require "A life cycle thinking and assessment, in line with the recommendations and reference data from the European Platform on Life Cycle Assessment when applicable, should be applied", in particular "Data should be disseminated through nodes in the Life Cycle Data Network and studies through the Resource Directory".

Why is it important to publish on the Life Cycle Data Network datasets on innovative products and manufacturing processes relevant for the EU Funded Research Projects?

- The Life Cycle Data Network is a concrete step to increase the availability and interoperability of reliable data (thanks to LCDN Entry-Level quality requirements);
- Promoting and facilitating data publication and sharing can sensibly increase the number of data providers;
- The tools available through the EPLCA (LCDN, ELCD and Resource Directory) could facilitate the results dissemination and LCI data sharing.

Pilot Case study

HarWin

FP7 HarWin (Harvesting solar energy with multifunctional glass-polymer windows) Project specifically addressed for the development of "Smart Windows" (FP7-2012-NMP-ENV-ENERGY-ICT-EeB, Cooperation call "Energy-efficient Buildings 2012"; 1st September 2012 - 31st August 2015).

One of the major outputs of the HarWin project was one quality-assured LCI dataset on glassflakes production as a result of the final environmental evaluation of HarWin window components. The project aimed at developing laminated glass containing glass-polymer composite interlayers, that are mechanically reinforced materials which enable weight reduction, high visible light transmission, thermal and sound barrier enhanced properties. The integration of datasets into existing LCA database wants to represent a mean to disseminate the results of the Project and also to make available useful data for the scientific and industrial community to further develop highly performing sustainable products.

## Developer Common (ILCD – PEF/OEF)

This page provides tools and information for the creation of both ILCD entry level and PEF/OEF data, and for data sharing through the LCDN.


## Common tools:

NODE INSTALLATION: Soda4LCA - IT infrastructure including the documentation for creating a Node for data sharing and for registration of data in the data network.	Node (Soda4LCA)
VALIDATION TOOL: automatic tool for format and nomenclature validation, remember to download the validation profile according to the compliance that has to be tested (for Environmental Footprint, the profile is also embedded in the package under "other" folder)	ILCD format validation (Soda4LCA)
LOOK@LCI: it allows the analysis of data sets under the International reference Life Cycle Data System (ILCD), directly from the data files (.xml), without the need of mapping the EF/ILCD nomenclature to a software-specific nomenclature	Look@LCI Software
Look@eILCD (LED): designed to work with the eILCD format, directly from the data files (.xml). The eILCD format was developed to allow working with disaggregated datasets (e.g. partly aggregated datasets at level-1) and also more complex EF models. The software allows to perform several checks and it aggregates the model (.xml contained in the lifecyclemodel folder) into an aggregated EF-compliant dataset. (users' guide included)	Look@eILCD(LED) Software

<https://eplca.jrc.ec.europa.eu/EUFRP/>

<https://eplca.jrc.ec.europa.eu/LCDN/developer.html>

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