

# GreenDELTA

## Quality Assurance of openLCA LCIA methods Comparison with SimaPro 8

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### Changelog

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## 1 Introduction

A comprehensive pack of Life Cycle Impact Assessment (LCIA) methods is now available in the openLCA website ([www.openlca.org](http://www.openlca.org)). The methods are intended to be used with openLCA reference data, which is contained in all the databases provided in the Nexus website (<https://nexus.openlca.org/>). The methodologies included in the pack are:

- CML 2001 (baseline and non-baseline impact categories)
- Eco-Indicator 99 (egalitarian, hierarchist and individualist perspectives)
- Ecological Scarcity 2006
- EDIP 2003
- ILCD 2011 (endpoint and midpoint categories)
- ReCiPe 8 (endpoint and midpoint categories for egalitarian, hierarchist and individualist perspectives).
- TRACI 2.1.
- US EPA default LCIA methods
- USEtox

A quality assessment has been conducted for the methods by comparing the LCIA results calculated in openLCA 1.3.4 with those obtained from different sources. In this document, results from the “ILCD 2011, midpoint” are presented, as this method is a compilation of the recommended impact categories from different methodologies by the Institute for Environment and Sustainability in the European Commission Joint Research Centre (JRC) [1].

## 2 openLCA vs. SimaPro 8

A selection of Ecoinvent 2.2. unit processes were used for the assessment, as shown in table 1.

Database: <b>Ecoinvent 2.2</b>		
<b>Unit Process</b>	<b>Location</b>	<b>Functional Unit (referred to reference product)</b>
Electricity, at wind power plant 600kW	Switzerland (CH)	1 MJ
Electricity, hard coal, at power plant	France (FR)	1 MJ
Electricity, production mix photovoltaic, at plant	Switzerland (CH)	1 MJ
LCD flat screen, 17 inches, at plant	Global (GLO)	1 item
Sheep for slaughtering, live weight, at farm	US	1 kg
Kraft paper, bleached, at plant	Europe (RER)	1 kg

Table 1. Processes used in the quality assessment

LCIA results were calculated using openLCA 1.3.4 and SimaPro 8 [2]. The “openLCA LCIA methods 1.2” and “SimaPro 7.3.3. methods update” [3] packs were used respectively for the analysis.

### 2.1 ILCD 2011, midpoint

Comparison of results was conducted calculating the ratio openLCA:GaBi for each impact category and process. Results are shown in figure 1.

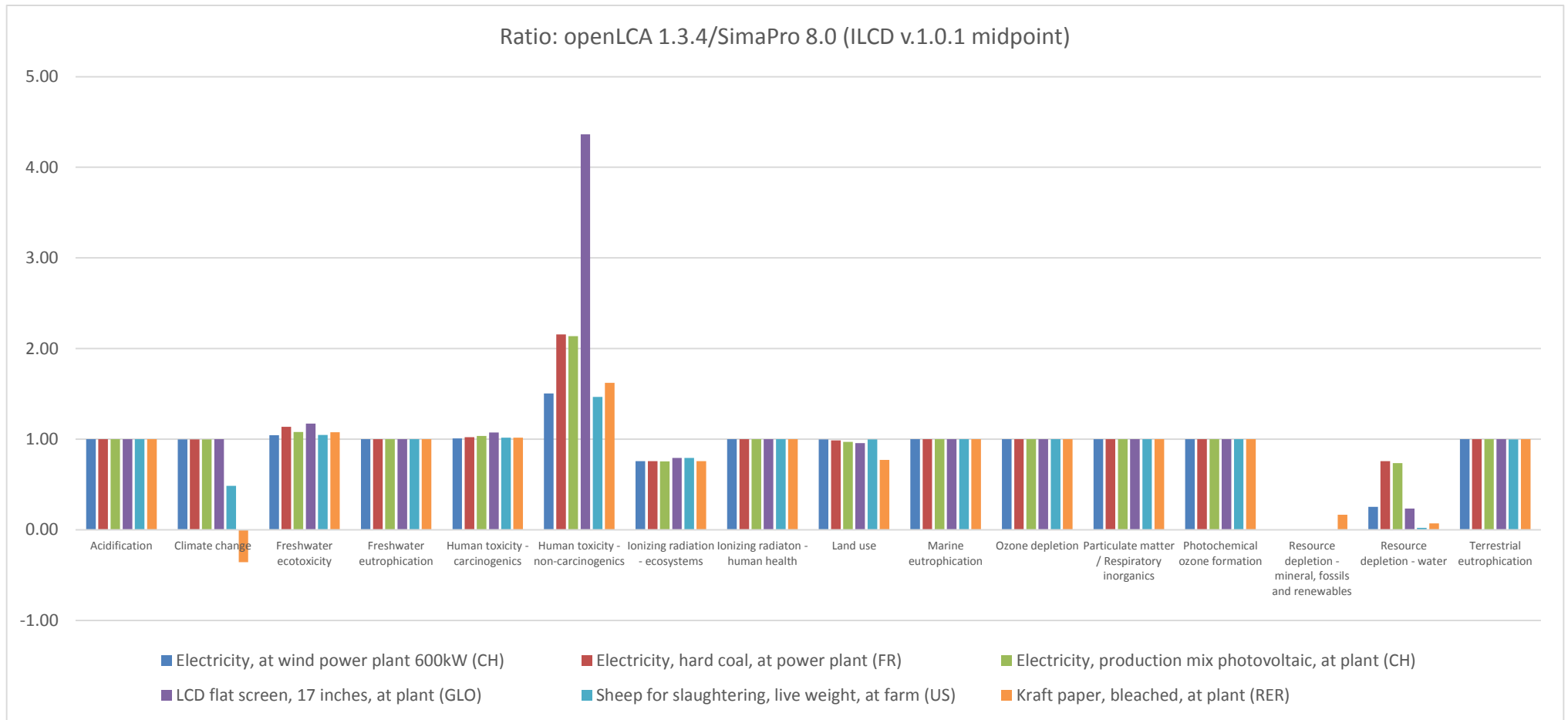


Figure 1. Ratio openLCA: SimaPro LCIA results for the different impact categories in the method “ILCD 2011, midpoint” for the processes in Table 1

As it can be observed, impact categories acidification, freshwater, marine and terrestrial eutrophication, human toxicity – carcinogenics, ionizing radiation – human health, ozone depletion, particulate matter/respiratory inorganics and photochemical ozone formation have equal results using both packs of methods (i.e. ratio=1). For the rest of impact categories, a detailed analysis of the results in order to identify the divergences was performed:

### **Climate change**

The results for this impact category differ only for the processes “Sheep for slaughtering, live weight, at farm” and “Kraft paper, bleached, at plant”. The source of the differences is the characterization factor (CF) of the elementary flow “Carbon dioxide, in air” from the category resource-in air. Whereas openLCA has a CF of -1, SimaPro has a value of 0. As ILCD original data [3] contains the same characterization factor as in openLCA, in order to take into account the reduction of climate change potential that consuming carbon dioxide from air may have.

### **Freshwater ecotoxicity and Human toxicity – non-carcinogenics**

The source of the differences in both impact categories is the same: Arsenic 5+ elementary flow. In ecoinvent 2.2., as well as in openLCA, this flow is stated as “Arsenic, ion”, with CAS number 17428-41-0. In SimaPro, two different elementary flows exist: the one in ecoinvent and “Arsenic V”, with CAS number 61805-96-7, which is the flow taking the CF from ILCD. The flow in the original data of ILCD has also this last CAS number, although a comment is added in the spreadsheet were doubts about the correct correspondence of name and CAS are stated. Several sources [4],[5],[6] were checked in order to clarify which CAS number was correct and if the ion from ecoinvent was other than  $As^{5+}$ . The conclusion is that 17428-41-0 corresponds to  $As^{5+}$  and 61805-96-7 to 1,3-Dimethylthiourea. Thus, the characterization factor from Arsenic 5+ included in ILCD should be applied to the Ecoinvent flow, which is currently only done in openLCA.

### **Ionizing radiation – ecosystems**

In SimaPro there is a characterization factor for the elementary flow “Cesium-137” for the water compartment. This CF is applied to all the water sub-compartments, including ocean, in SimaPro. However, in the original data from ILCD, the characterization factor exists for this flow only for the sub-compartment freshwater. openLCA considers that this factor can be applied to the sub-compartments river, lake, fossil, ground water and surface water, but not to ocean. Thus, divergences in the results are obtained.

### **Land use**

Although the results for this impact category are quite similar for most of the processes, a slight difference is observed in “Kraft paper, bleached, at plant”. This is due to a characterization factor for “Transformation, to traffic area, road embankment”, which exists only in SimaPro and is not included in openLCA. ILCD has a factor for “Transformation, to traffic area, rail/road embankment”, which is the one contained in the openLCA pack. SimaPro, on the contrary, gives the same value to the flows “Transformation, to traffic area, road embankment” and “Transformation, to traffic area, rail embankment”.

## Resource depletion – mineral, fossils and renewables

Various differences in the characterization factor list exist for this impact category. However, the main cause for the important divergences in the results are the differences in process data sets between both tools. Whereas openLCA keeps the original data sets from Ecoinvent, SimaPro made modifications in some processes (e.g. "Resource correction, PbZn, indium, positive (GLO)", "Zinc concentrate, at beneficiation (GLO)", "Tantalum, powder, capacitor-grade, at regional storage (GLO)", "Resource correction, PbZn, cadmium positive (GLO)", etc.). This were mainly changing elementary flows containing a mixture of metals to the pure metal (e.g. "Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn, Ag, In, in ground" to "Cadmium") (Fig 2 and 3).

Known outputs to technosphere. Products and co-products							
Name	Amount	Unit	Quantity	Allocation %	Waste type	Category	Comment
Zinc concentrate, at beneficiation/GLO U	1	kg	Mass	100 %	not defined	Metals\Non ferro	Global

Known outputs to technosphere. Avoided products						
Name	Amount	Unit	Distribution	SD^2 or 2*SDMin	Max	Comment
Inputs						

Known inputs from nature (resources)							
Name	Sub-compartment	Amount	Unit	Distribution	SD^2 or 2*SDMin	Max	Comment
Water, river	in water	0,0029163	m3	Lognormal	1,5276		(2,2,2,1,4,4,12)
Water, well, in ground	in water	0,010443	m3	Lognormal	1,5276		(2,2,2,1,4,4,12)
Cadmium	in ground	0,020785	kg	Lognormal	1,582		(4,2,2,1,4,4,12)
Indium	in ground	0,00034641	kg	Lognormal	1,582		(4,2,2,1,4,4,12)
Zinc	in ground	0,62353	kg	Lognormal	1,582		(4,2,2,1,4,4,12)

Figure 2. Extract from ecoinvent 2.2. "Zinc concentrate, at beneficiation/GLO U" process (SimaPro 8.0.0 Multiuser)

### Process: zinc concentrate, at beneficiation (ec2\_nexus\_georg)

Allocation method:

Inputs

Flow	Category	Flow property	Unit	Resulting amount	Uncertainty
diesel, burned in building machine	construction processes / machinery	Energy	MJ	0.5859	Logarith...
conveyor belt, at plant	construction processes / machinery	Length	m	1.6788E-7	Logarith...
electricity, hard coal, at power plant	hard coal / power plants	Energy	kWh	0.049355	Logarith...
non-ferrous metal mine, underground	metals / extraction	Number of i...	Item(s)	2.491E-10	Logarith...
electricity, natural gas, at power plant	natural gas / power plants	Energy	kWh	0.14806	Logarith...
Indium, 0.005% in sulfide, In 0.003%, Pb, Zn, Ag, Cd, in ground	resource / in ground	Mass	kg	3.4641E-4	Logarith...
Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn, Ag, In, in ground	resource / in ground	Mass	kg	0.020785	Logarith...
Zinc, 9.0% in sulfide, Zn 5.3%, Pb, Ag, Cd, In, in ground	resource / in ground	Mass	kg	0.62353	Logarith...
Water, well, in ground	resource / in water	Volume	m3	0.010443	Logarith...
Water, river	resource / in water	Volume	m3	0.0029163	Logarith...
transport, lorry > 16t, fleet average	transport systems / road	Goods trans...	t*km	0.26038	Logarith...
disposal, sulfidic tailings, off-site	waste management / residual material landfill	Mass	kg	4.882616015344...	Logarith...

Figure 3. Extract from ecoinvent 2.2. "Zinc concentrate, at beneficiation (GLO)" unit process (openLCA 1.3.4.)

ILCD contains characterization factors for the pure metals, but not for the mixtures used in Ecoinvent. Therefore, the results obtained in openLCA are much lower than in SimaPro. For other methodologies, such as CML or ReCiPe, the characterization factors for this kind of flows from the ecoinvent compilation of methods (also available in [www.openlca.org](http://www.openlca.org)) were added to the openLCA LCIA methods pack. However, the ecoinvent pack does not include the ILCD method.

Apart from this, the characterization factor for "Uranium" in compartment resource is not included in openLCA because ILCD only contains CF for this flow in the resource depletion endpoint category.

## **Resource depletion – water**

Although characterization factors for “ground water”, “river water” and “lake water” are only included in ILCD, SimaPro also applied the same factors to flows “Water, unspecified natural origin” and “Water, well, in ground”. openLCA pack does not contain factors for these flows.

## **3 Conclusions**

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openLCA LCIA methods intend to keep, as accurately as possible, the original data from the methodologies considered. Thus, slight differences might exist between different tools for some impact categories. However, the great majority of the impact categories obtain the same result in SimaPro and openLCA.

## **4 References**

- [1] [http://eplca.jrc.ec.europa.eu/?page\\_id=86](http://eplca.jrc.ec.europa.eu/?page_id=86)
- [2] <http://www.pre-sustainability.com/simapro8>
- [3] <http://www.pre-sustainability.com/simapro-7.3.3-methods-update>
- [4] <http://chem.sis.nlm.nih.gov/chemidplus/>
- [5] <http://www.chemindustry.com/apps/chemicals>
- [6] <https://www.chemexper.com>

## **5 Contact**

If you have any questions or comments, please let us know.

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