openLCA Tutorial

Basic Modelling with Parameters

Software Version:	1.10
Manual Version:	1.2 (March 2020)

GreenDeLTa

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1 Introduction

This text focuses on basic modelling with parameters using the 1.10 version of openLCA and includes using global and local parameters on different levels, such as process and project levels. If you feel that some steps are missing (instructions are not clear enough), please first read the 'openLCA 1.10 - Basic Modelling' documentation which is available on the openLCA website.

Please note that the example given is not a comprehensive LCA case study with realistic data. The example given is for instructional purposes only and is not meant to be accurate.

The example given is based on the product system modelled in the tutorial "openLCA 1.10 - Basic Modelling" using the ELCD database 3.2 and the LCIA method package openLCA LCIA methods v2.0.4, both of which are available free of charge on the Nexus web repository (https://nexus.openlca.org/databases). The solved version of this database is linked in the 'openLCA 1.10 - Basic Modelling' tutorial.

2 Goal and Scope

In this tutorial, the product system PET Bottle Production modelled in the previous tutorial 'openLCA 1.10 - Basic Modelling' (available in the openLCA website) will be extended to a 'PET Bottle Life Cycle' product system. The environmental impacts of different transport types and distances are modelled with parameters in openLCA.

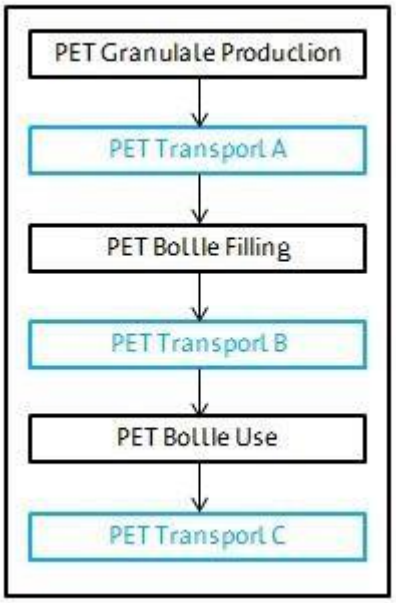

Figure 1: Product system *PET Bottle Life Cycle*

It was assumed that the lorry transports are carried out with the process *Lorry transport, Euro 0, 1, 2, 3, 4 mix, 22 t total weight, 17,3t max payload - RER* in case 1 and 2 and the rail transports are conducted with *Rail transport, technology mix, diesel driven, cargo - RER process* (ELCD database 3.2). Furthermore, it was assumed that the empty water bottle after usage is transported to landfill as final disposal.

Table 1: Transport types and distances for each case

Process	Case 1	Case 2
PET Transport A	500 km lorry	500 km lorry
PET Transport B	300 km lorry	300 km rail
PET Transport C	50 km lorry	50 km lorry

3 Parameters

Parameters can be used instead of concrete values for inputs and outputs in openLCA. It is possible to define parameters as simple values, formulas, or complex functions.
Parameters are available on different levels:

- Process
- Product system
- Project
- LCIA method
- Database

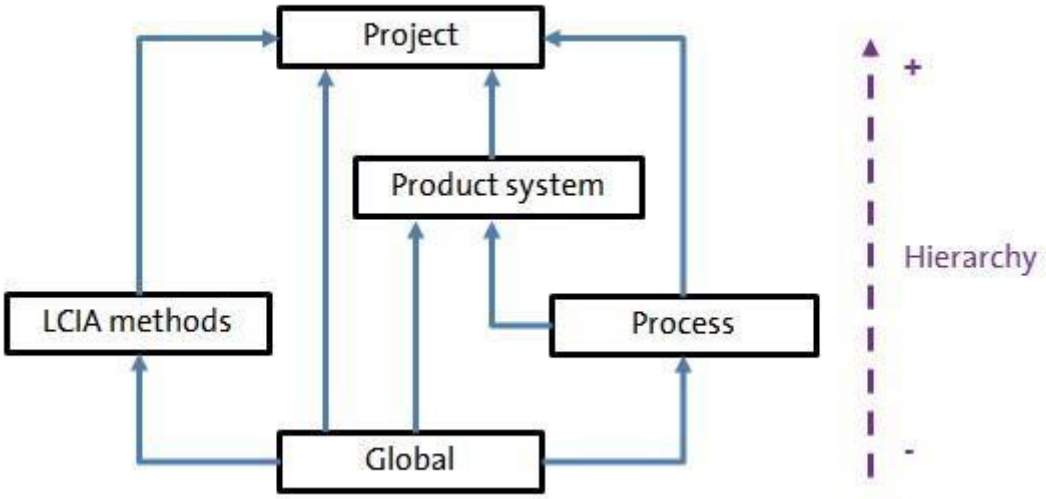

Figure 2: Hierarchy of parameter levels

Note! Parameters modelled on higher levels (e.g. project level), will overwrite parameters created on lower levels (e.g. process level).

4 Modelling with parameters

4.1 Create global parameters

To create a new global parameter, double click the database elements Indicators and parameters, right-click next to *Global parameters* and select New Parameter. Enter the parameter names and amounts according to table 2.

The global parameters created are now available on all levels within the active database (e.g. process, product system, etc.)

Table 2: Inputs for creating global parameters (Case 1)

Process	Parameter Name	Amount
PET Transport A	TA	500
PET Transport B	TB	300
PET Transport C	TC	50

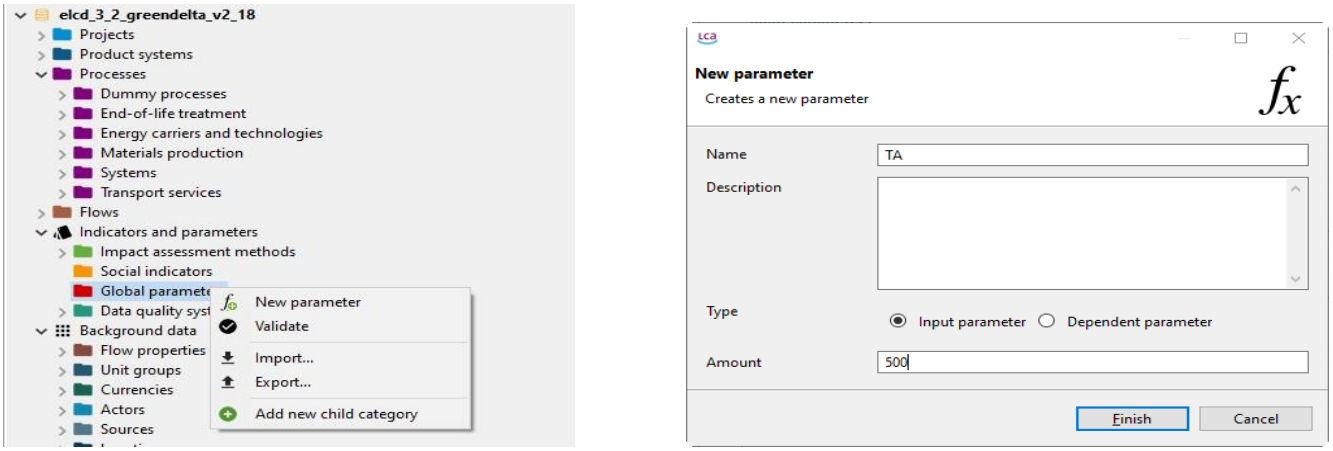

Figure 3: Create a new global parameter

4.2 Create a product system

The processes *PET Granulate Production*, *PET Transport A*, and *PET Bottle Filling* were already modelled in the product system *PET Bottle Production* of the 'openLCA 1.10 - Basic Modelling' documentation.

Create the flow *PET Bottle, filled, transported* with the flow type *product flow* and the reference property *Number of items*. Create the flow *PET Bottle, empty* with the flow type *product flow* and the reference property *Mass*. Create the flow *PET Bottle, empty, transported* with the flow type *product flow* and the reference property *Number of Items*.

4.3 Create parameters on the process level

Then, create the process *PET Transport B* with the quantitative reference flow *PET Bottle, filled, transported.*

In the *Input parameter* section of the parameter tab of the process created, you can add the parameters on the process level according to table 3. In the Input/Outputs tab, you can enter the input flows and according to table 4. Add the input flow *Transport in t*km* twice and select the *provider Lorry transport, Euro 0, 1, 2, 3, 4 mix, 22 t total weight, 17,3t max payload - RER* for case 1 and *Rail transport, technology mix, diesel driven, cargo - RER* for case 2. The parameter Rail is set to zero, so the input flow connected to the rail transport process is switch off and will not be considered for the process in case 1.

The process modelled with the transport types as parameters on the process level allows for switching on and off the transport types depending on the case considered. Modelling the process *PET Transport B* with parameters this way, it can be used for both cases, instead of creating a process for each case.

Table 3: Inputs for creating parameters on the process level for case 1

Process	Parameter Name	Value	Description
PET Transport B	Lorry	1	0 if not used, 1 if used
PET Transport B	Rail	0	0 if not used, 1 if used

Table 4: Inputs for creating the product system *PET Bottle Life Cycle*

Process	Quantitative reference	Input Flows	Amount	Comment
PET Transport B	PET Bottle, filled, transported	PET Bottle, filled	1.065 kg	
		Transport in t*km	1.065 kg * TB * Lorry	Case 1
		Transport in t*km	1.065 kg * TB * Rail	Case 2
PET Bottle Use	PET Bottle, empty	PET Bottle, filled, transported	1 item	
PET Transport C	PET Bottle, empty, transported	PET Bottle, empty	0.065 kg	

		Transport in t*km	0.065kg * TC	
		Landfill of plastic waste	-0.065 kg	

Create the processes *PET Bottle Use* and *PET Transport C* with the respective the input flows and quantitative references as output flows, adjust the amount, and select the provider according to table 4. The process *PET Transport C* reflects the transportation of the empty water bottle after usage to the final disposal. Currently, waste modelling in openLCA (using the ELCD database) is modelled in 'reverse direction': waste is not modelled as an output flow of the process generating the waste, but as an input flow with a negative sign.

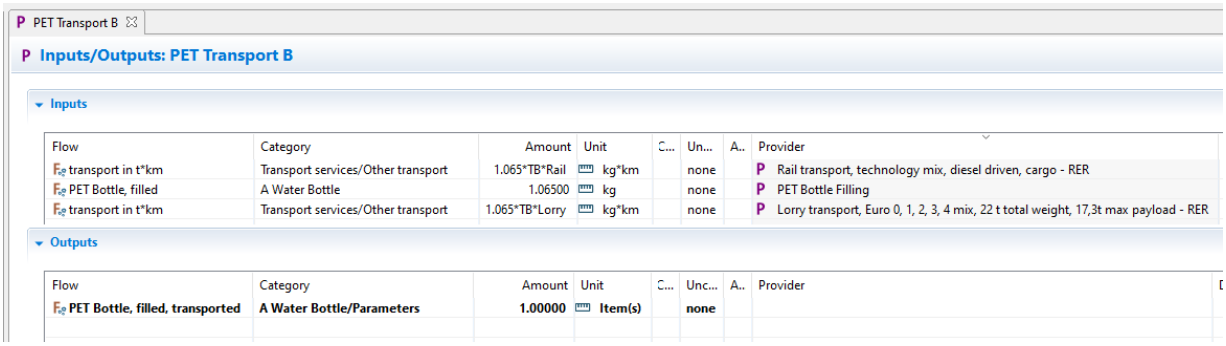

Figure 4: Input/Output tab of the process *PET Transport B*

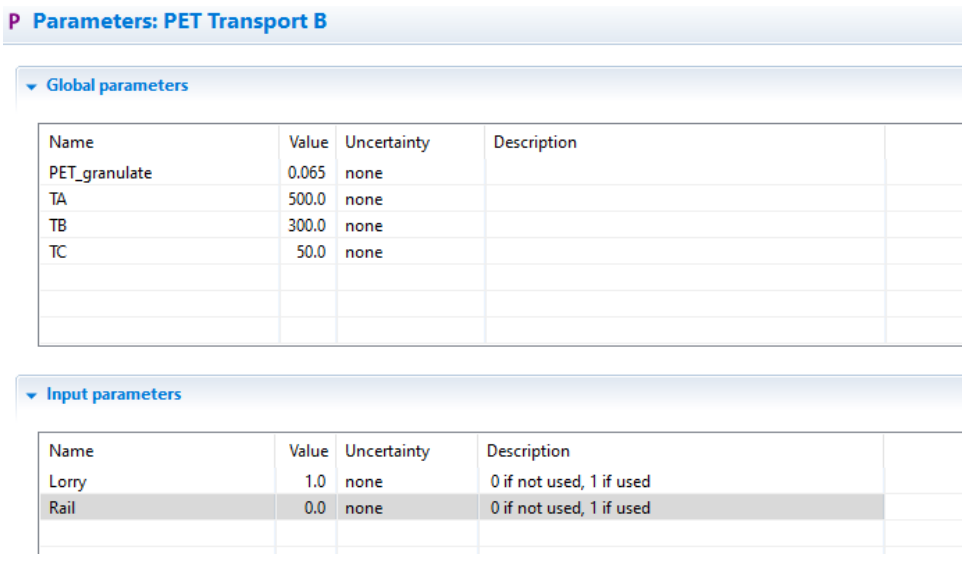

Figure 5: Parameters tab of the process *PET Transport B*

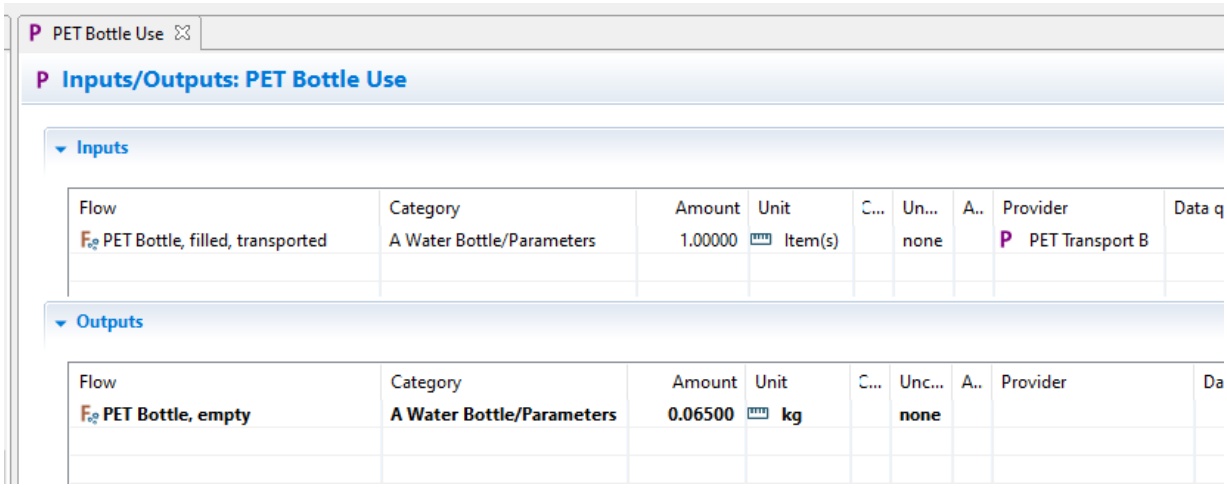

Figure 6: Input/Output tab of the process *PET Bottle Use*

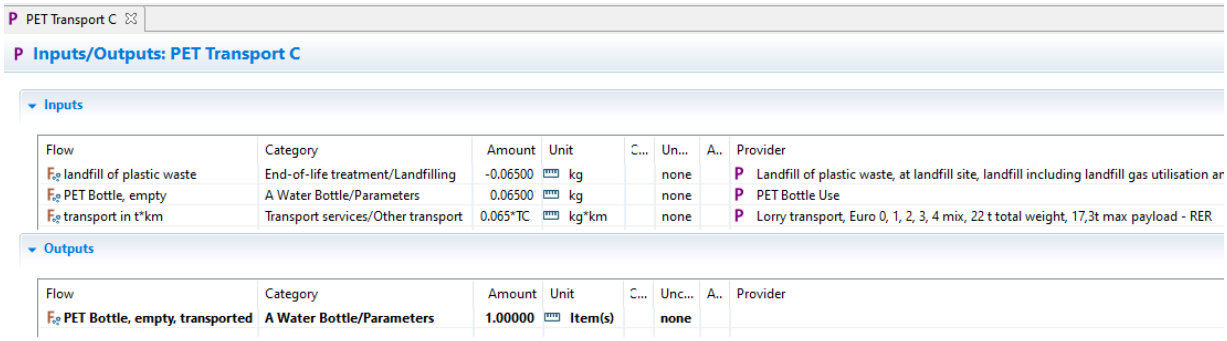

Figure 7: Input/Output tab of the process *PET Transport C* for case 1

After having modelled the processes, you can create the product system *PET Bottle Life Cycle* with the reference process *PET Transport C* by selecting *Auto-link processes* and *Only link default providers*. The product system created should look like figure 8.

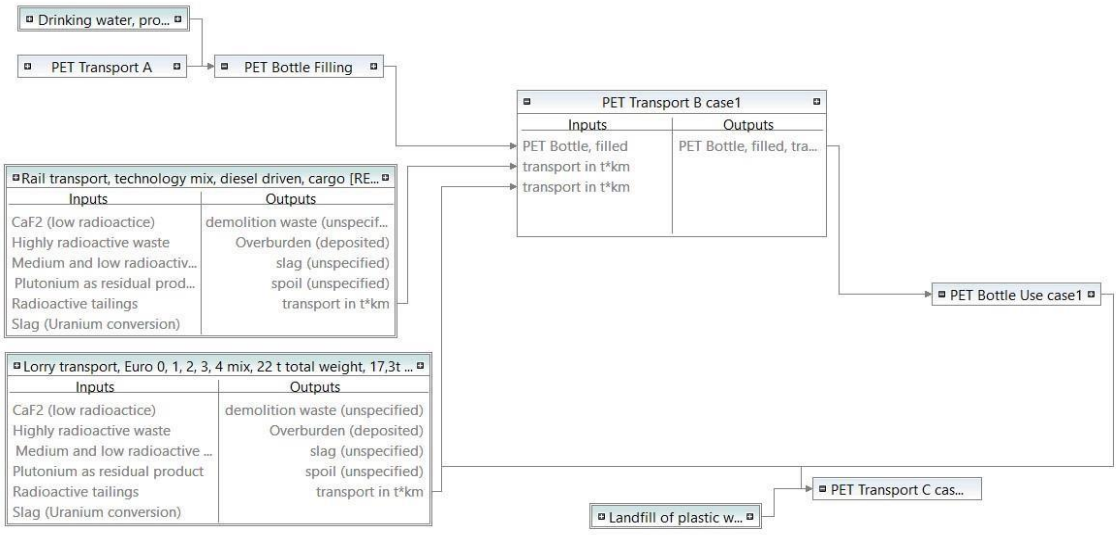

Figure 8: Model graph of the product system *PET Bottle Life Cycle*

4.4 Using parameters on the project level

Create the project *Water Bottle Life Cycle - Case 1 vs Case 2*, select the LCIA method *ILCD 2011 Midpoint+* and the following the impact categories:

- Acidification
- Climate change
- Ozone depletion

In the Compared product systems section of project setup, add the product system *PET Bottle Life Cycle* and name it *Case 1*. Then, add the product system *PET Bottle Life Cycle* again and name it *Case 2*.
In the Parameters section of the project setup, add the process parameters, *Lorry* and *Rail*. Then, change the amount for the parameter *Lorry* in case 2 to the amount of zero and the amount for the parameter Rail in Case 2 to the amount of 1. By changing the amounts of the process parameters on a higher hierarchy level, such as the project level, the parameters on the lower level (process level) will be overwritten. Since the global parameters defined for the transport distances are available on LCIA methods level and have the same amount in both cases, they do not need to be added in the parameter section.

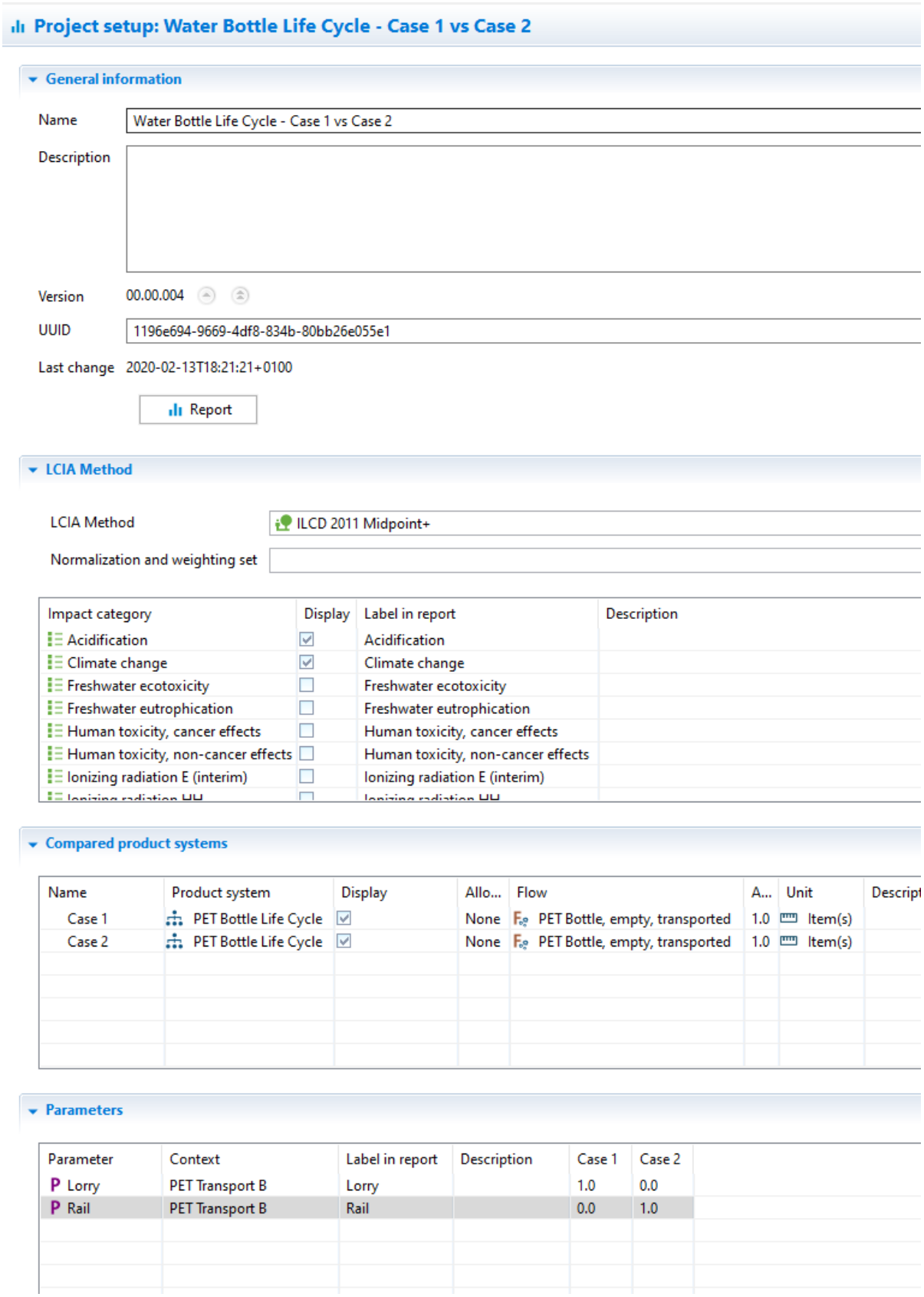

Figure 9: Project setup for comparison of the product system in case 1 and 2

LCIA Results

This table shows the LCIA results of the project variants. Each selected LCIA category is displayed in the rows and the project variants in the columns. The unit is the unit of the LCIA category as defined in the LCIA method.

Indicator	Case 1	Case 2	Unit
Acidification	1.33467e-3	1.29857e-3	molc H+ eq
Climate change	2.34249e-1	2.22002e-1	kg CO2 eq
Ozone depletion	2.47154e-10	2.20733e-10	kg CFC-11 eq

Relative Results

The following chart shows the relative indicator results of the respective project variants. For each indicator, the maximum result is set to 100% and the results of the other variants are displayed in relation to this result.

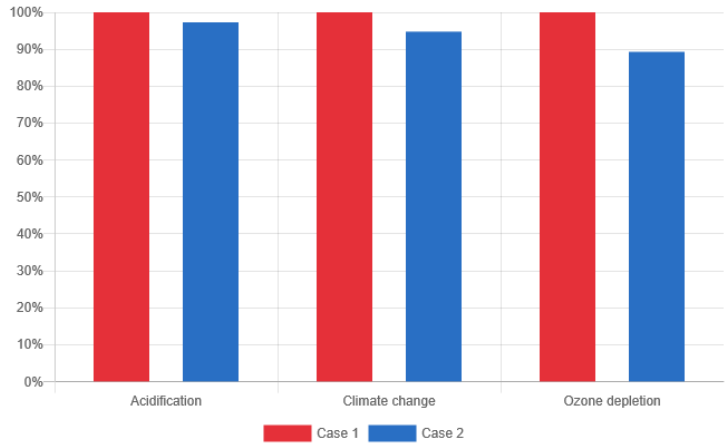

Figure 10: Environmental impact results for the product system in case 1 and 2

Now duplicate the project by using copy and paste and rename it *Water Bottle Life Cycle - Variant 1 vs Variant 2*. Select the same LCIA method and impact categories as described above. Rename the product system options *Transport_normal* as option 1 and *Transport_long* as option 2.

Clear the parameters section and then add the global parameters *TA*, *TB*, and *TC*. Adjust the amounts of the parameters for the variant *Transport_long* according to table 5.

Table 5: Inputs for creating parameters on the project level

Process	**Case 1**	**Transport_normal**	**Transport_long**
PET Transport A	500 km lorry	500	2000
PET Transport B	300 km lorry	300	1200
PET Transport C	50 km lorry	50	200

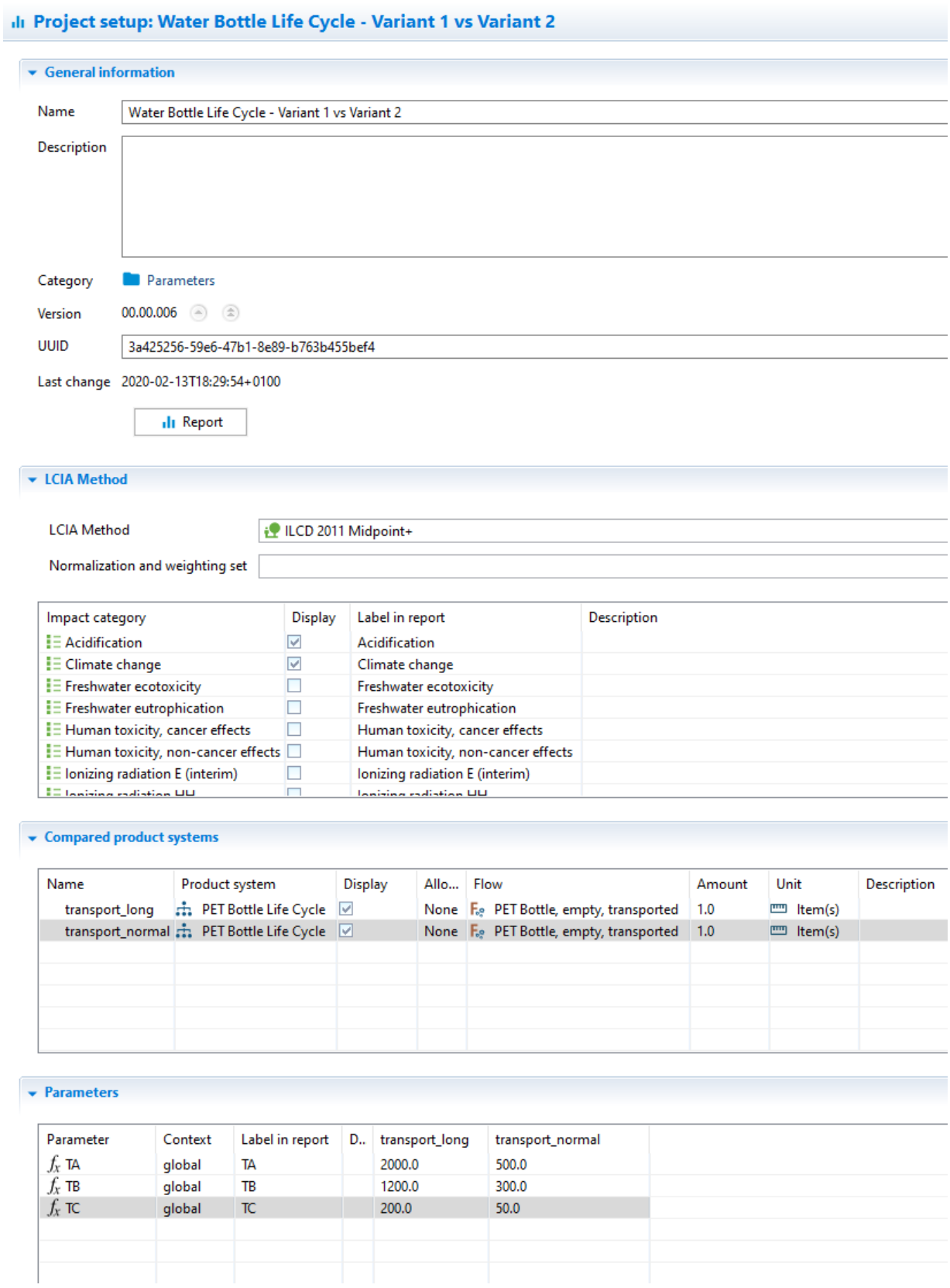

Figure 11: Project setup for comparison of variant 1 and 2

LCIA Results

This table shows the LCIA results of the project variants. Each selected LCIA category is displayed in the rows and the project variants in the columns. The unit is the unit of the LCIA category as defined in the LCIA method.

Indicator	transport_long	transport_normal	Unit
Acidification	1.76510e-3	1.33467e-3	molc H+ eq
Climate change	2.97893e-1	2.34249e-1	kg CO2 eq
Ozone depletion	3.76032e-10	2.47154e-10	kg CFC-11 eq

Relative Results

The following chart shows the relative indicator results of the respective project variants. For each indicator, the maximum result is set to 100% and the results of the other variants are displayed in relation to this result.

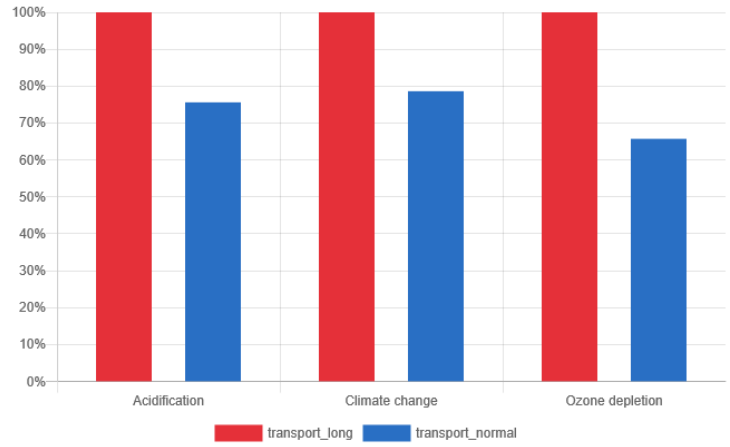

Figure 12: Environmental impact results of variant 1 and 2

5 Feedback & Contact

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

GreenDelta GmbH

Kaiserdamm 13
14057 Berlin, Germany
www.greendelta.com

Tel. +49 30 62 924–319
Fax +49 30 48 496–991
gd@greendelta.com

@GreenDeltaGmbH
GreenDelta GmbH
GreenDelta

@openLCA
openLCA software
openLCA
ask.openLCA.org

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sustainability consulting + software