THE UNIVERSITY OF BRITISH COLUMBIA

ENGR 544, Life Cycle Assessment and Management

School of Engineering, Faculty of Applied Science

The University of British Columbia (Okanagan)

PET Water Bottles Case Study

HDPE lid (high density polyethylene)

PP label (polypropylene)

PET bottle (polyethylene terephthalate)

Plastic component production

Plastic granulate production

Bottle filling

Market

To Quantify Potential Environmental Impact

- **Climate change**
- **Acidification**
- **Resource depletion**
- **Human toxicity**

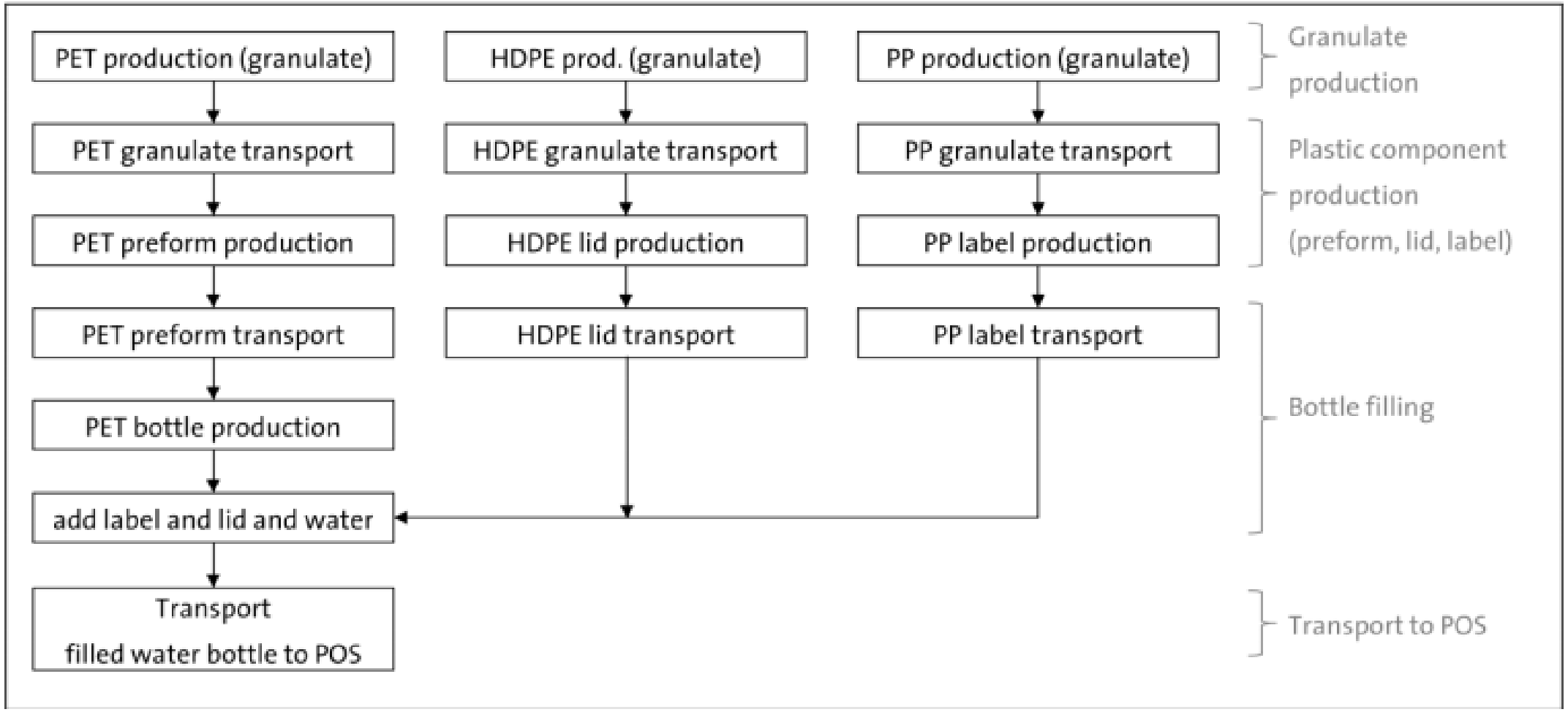
Scope Definition

The functional unit for this study was set as 1,000 units of one-liter drinking water bottles made of

- **Polyethylene terephthalate (PET)**
- **High density polyethylene (HDPE) lids**
- **Polypropylene (PP) labels**
- **Water**

The Agribalyse v3.0.1 allocation default database was used for all data.

OpenLCA 1.4 case study, Manufacturing Process



Source from https://www.openlca.org/wp-content/uploads/2015/11/1412_GreenDelta_LSA-Case-study_Comparison-of-PET-bottles.pdf

PET = polyethylene terephthalate, PP = polypropylene, HDPE = high density polyethylene, POS = point of sale

OpenLCA 1.4 case study

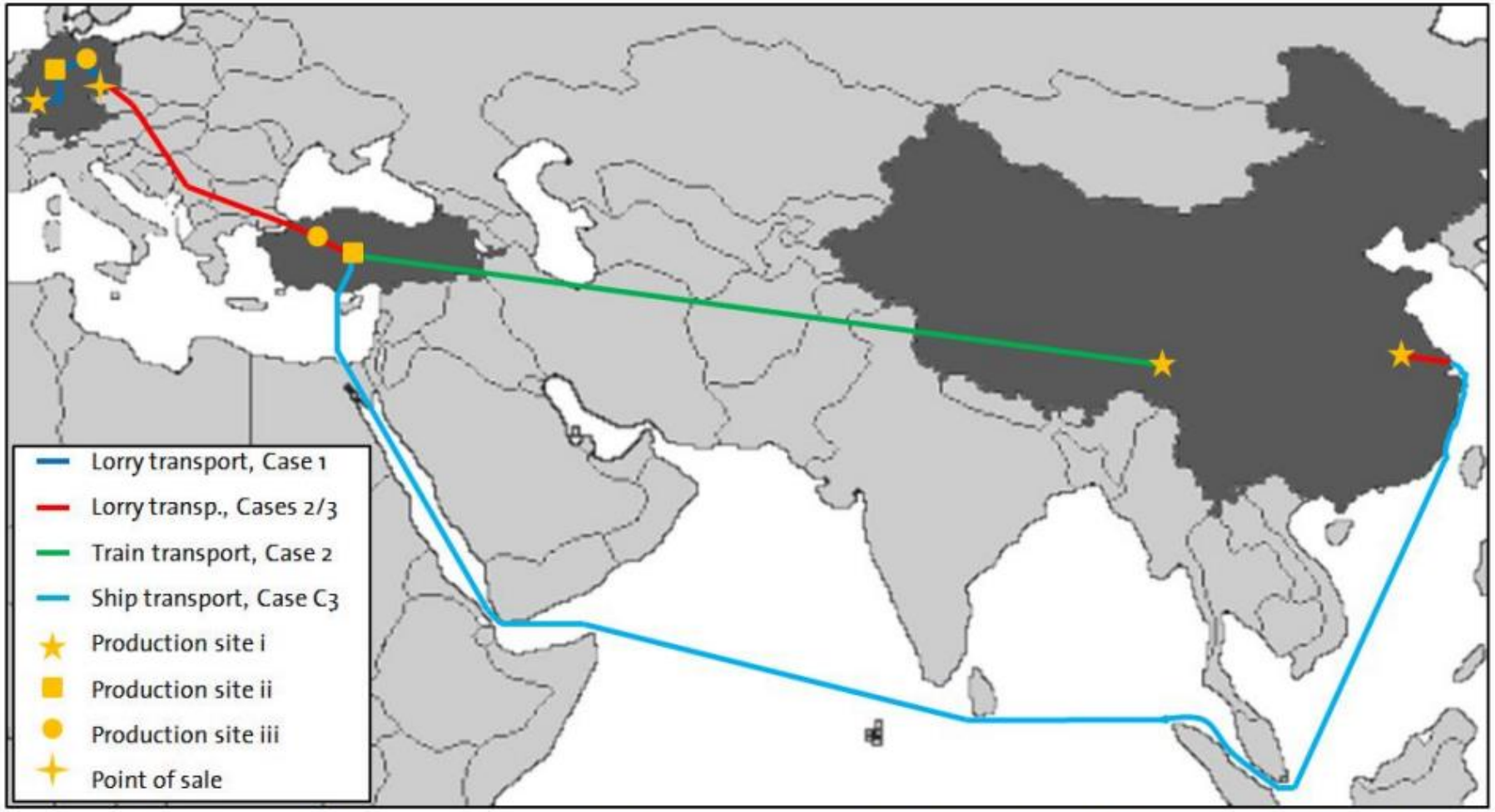


Figure 1: Illustration of transport routes for Cases 1, 2 and 3. Not to scale with distances listed in Table 1. Production site i refers to granulate production, site ii refers to preform/lid/label manufacture, and site iii refers to the site where the preforms are made to bottles, lids and labels are attached and the bottle is filled with water.

Source from https://www.openlca.org/wp-content/uploads/2015/11/1412_GreenDelta_LSA-Case-study_Comparison-of-PET-bottles.pdf

OpenLCA 1.4 case study

Table 1: Transport distances and weight of goods grouped according to which process they take place in (RER: Europe; CN: China; TR: RoW: Rest of World, GLO: Global)

Transport	Process	Weight	Case 1	Case 2	Case 3
A	Plastic component production	0.065 kg	200km lorry RER	5,000km train CN	300km lorry RoW 13,887km ship GLO
B	Bottle filling	0.065 kg	200km lorry RER	200km lorry RER	200km lorry RER
C	Transport to POS	1.065 kg	50km lorry RER	2,600km lorry RER	2,600km lorry RER

- The first case (Case 1) will represent 1,000 one-liter water bottles (non-carbonated) produced and consumed in Germany.
- For Case 2, the first stage of production (plastic granulate production) takes place in China and the components are then transported on a train to Turkey for further processing.
- Case 3 will differ in that the transport between China and Turkey is carried out primarily by **ship**.

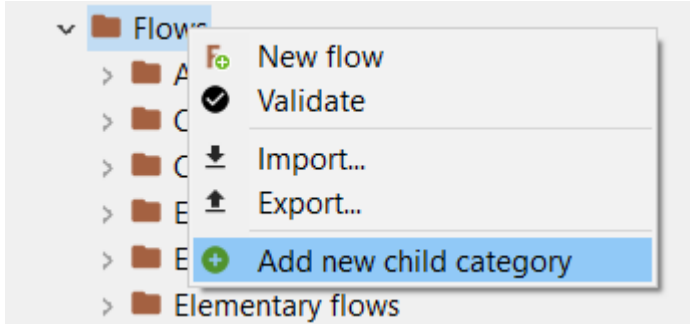
Source from https://www.openlca.org/wp-content/uploads/2015/11/1412_GreenDelta_LSA-Case-study_Comparison-of-PET-bottles.pdf

Modeling in OpenLCA

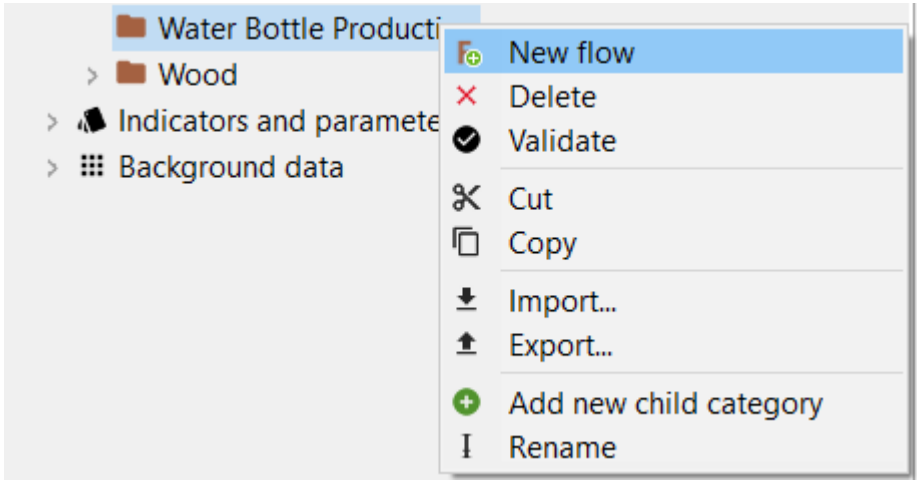
First, we import the Agribalyse v3.0.1 database.

❑ Flows:

- Right click on **Flows** and add new child category and name it **“Water Bottle Production”.**

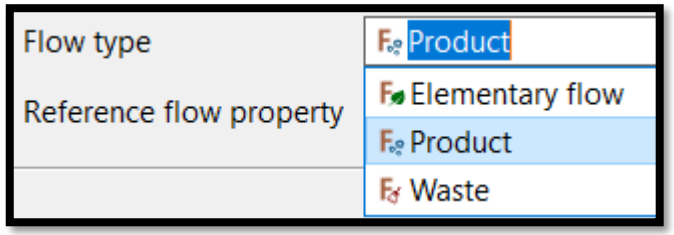


- Right click on **Water Bottle Production** and create new flow and name it **“Water Bottle”.**

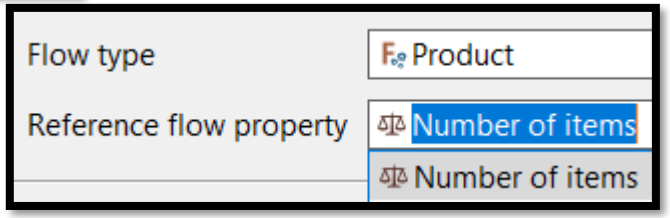


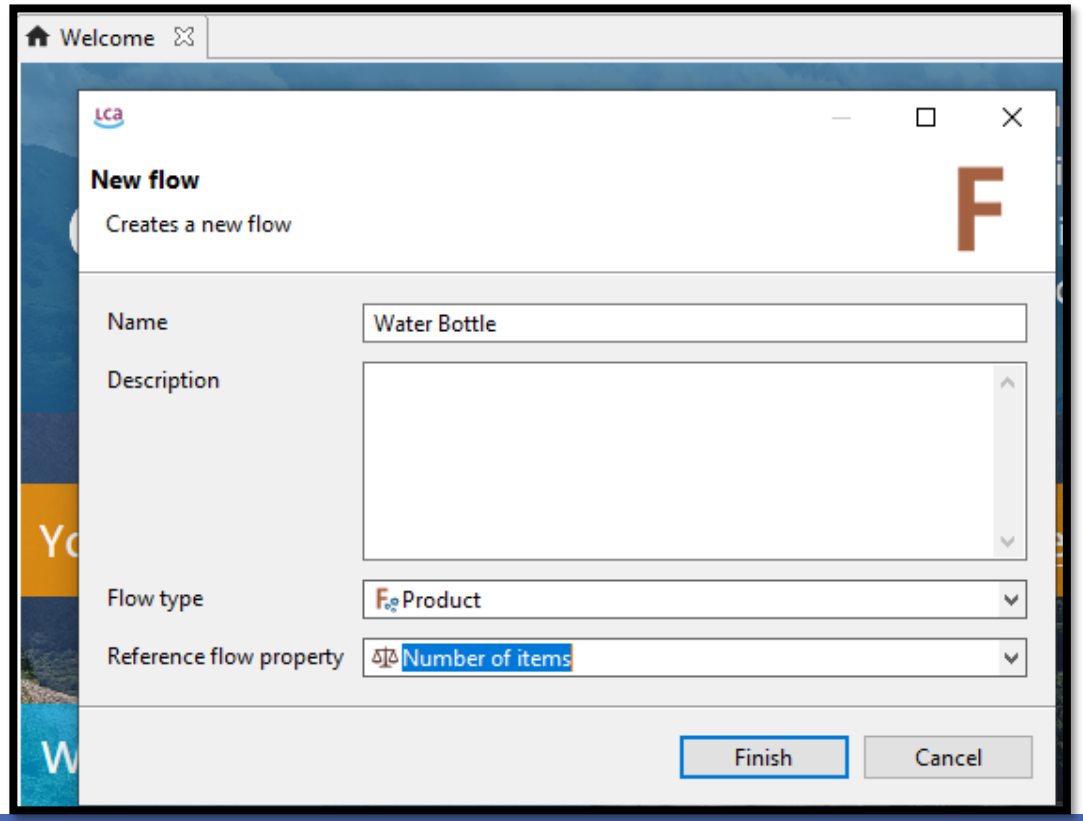
Create New Flow

- Select **Product** for flow type



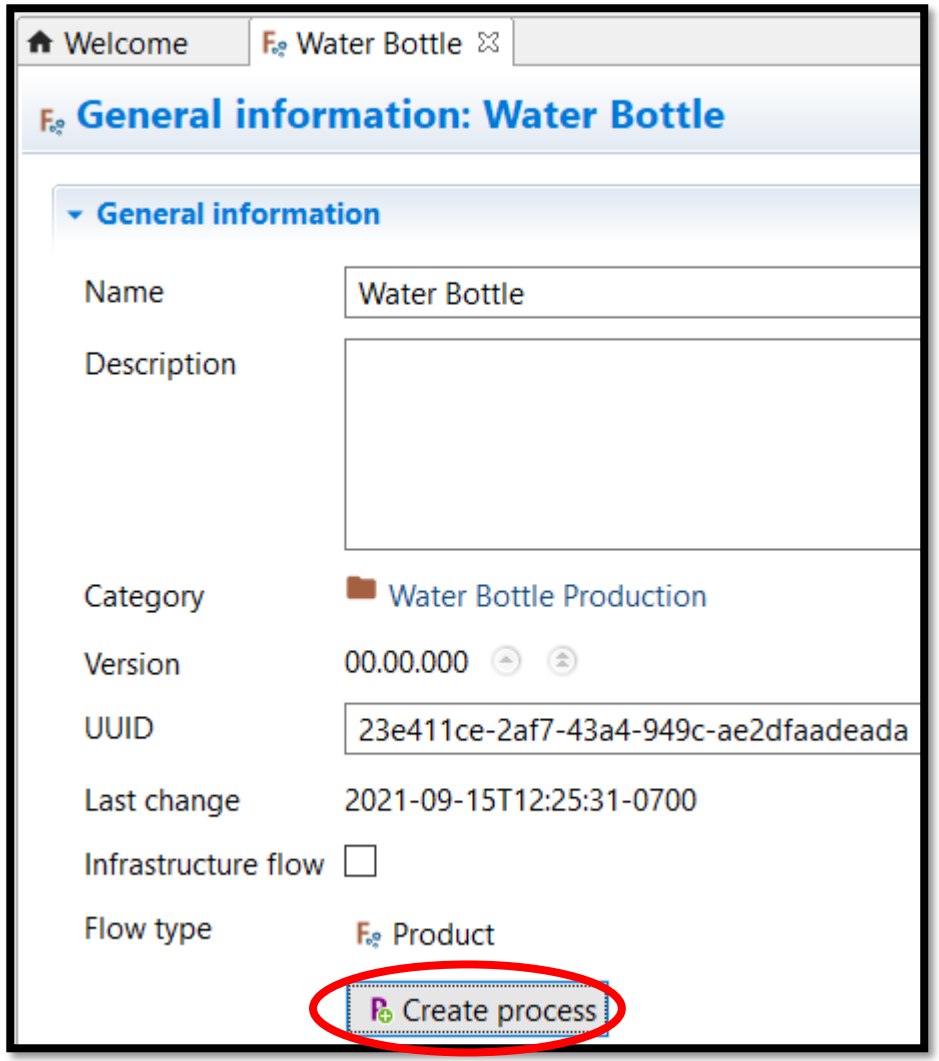
- Select **Number of items** for reference flow property

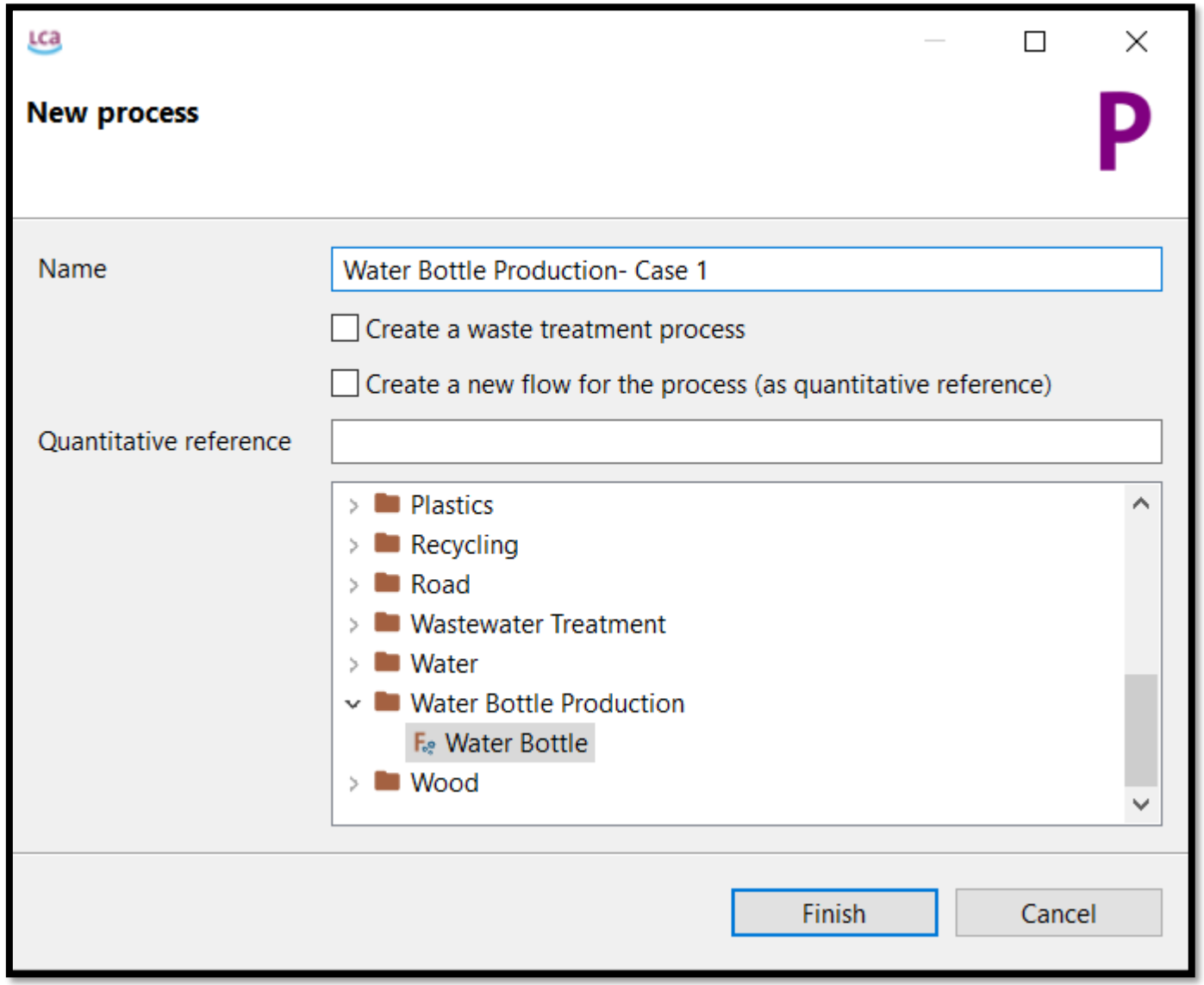




Create New Process

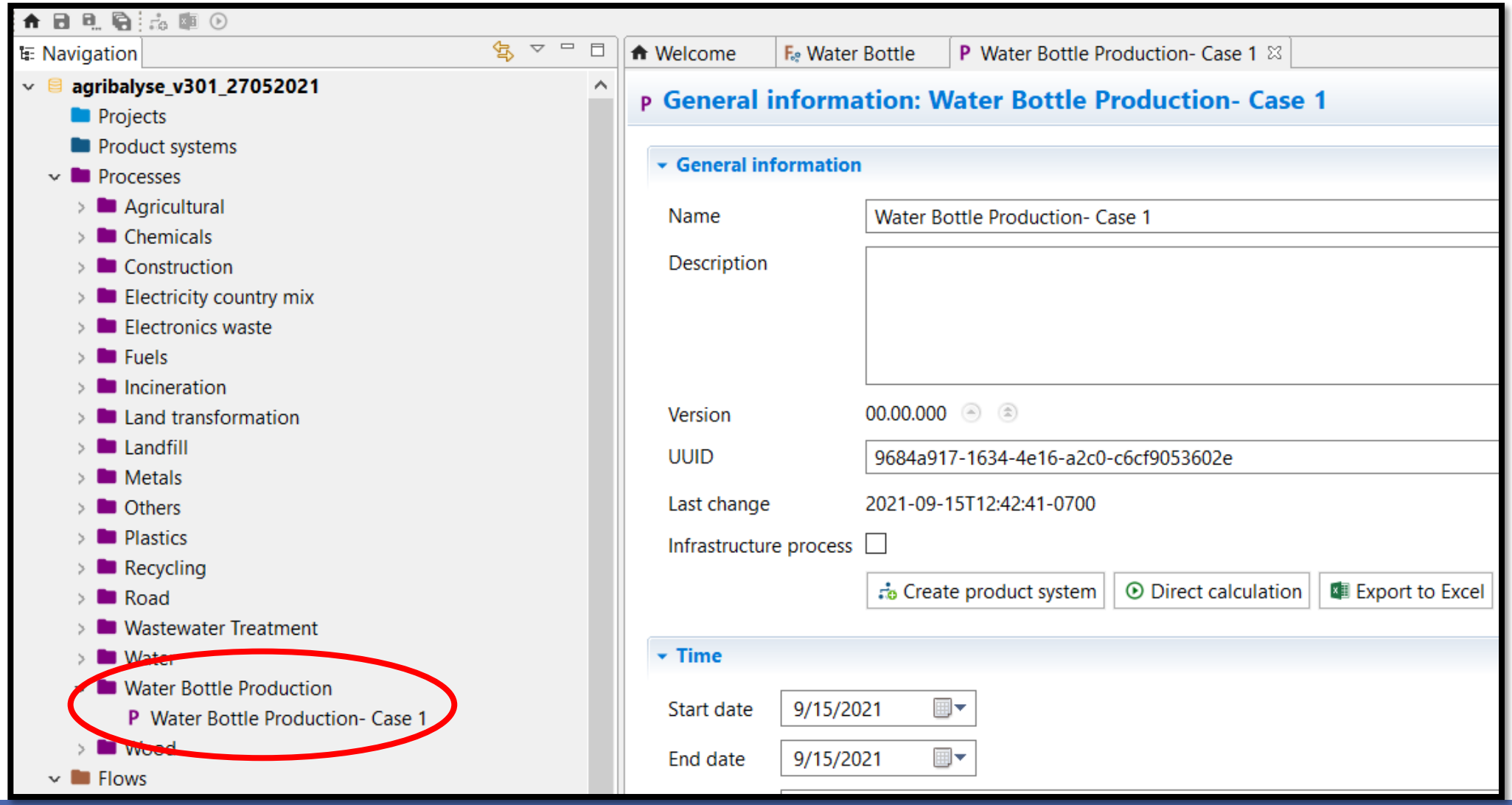
- Click on **Create process** and name it Water Bottle Production-Case 1.



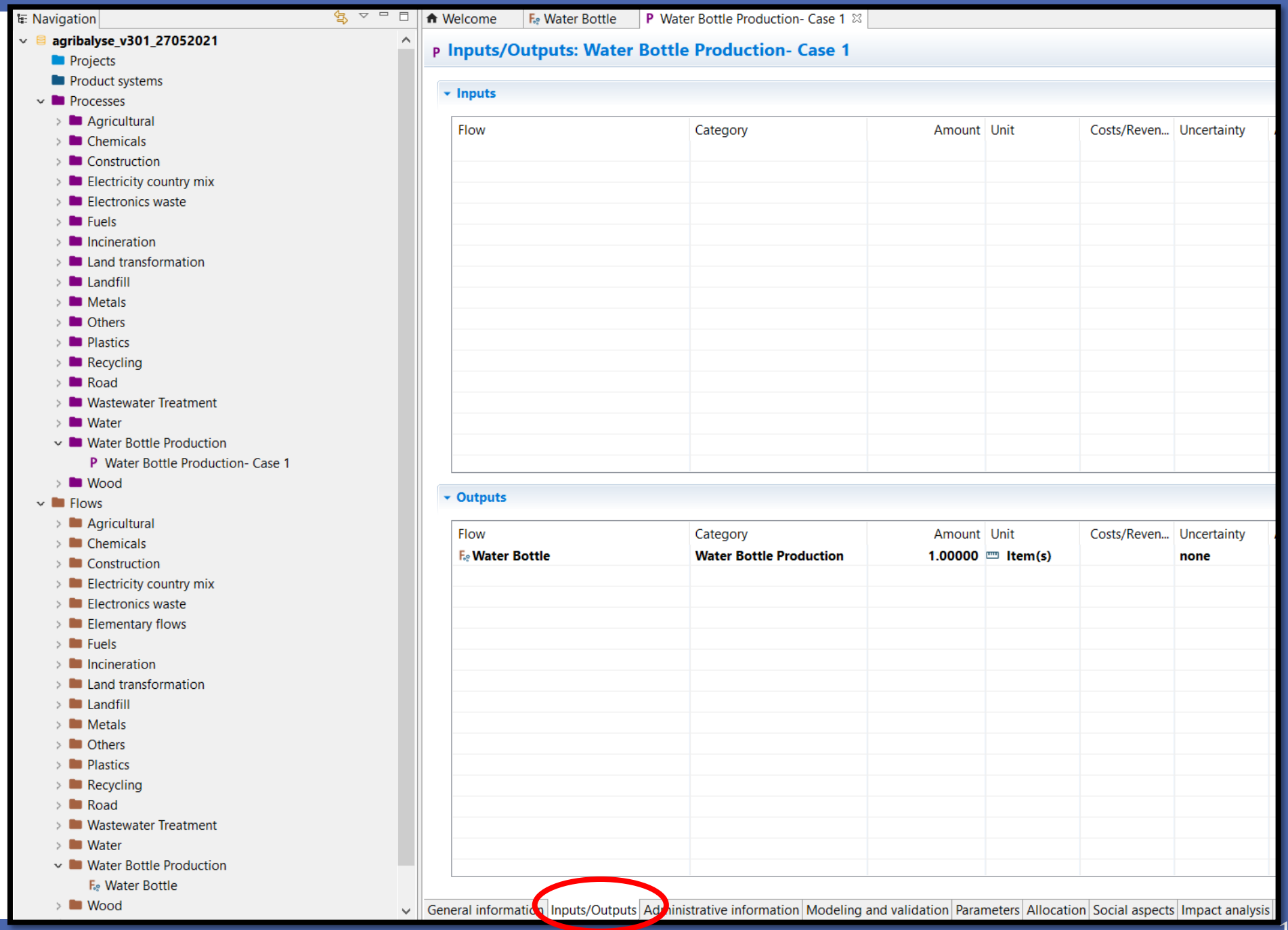


Create New Process

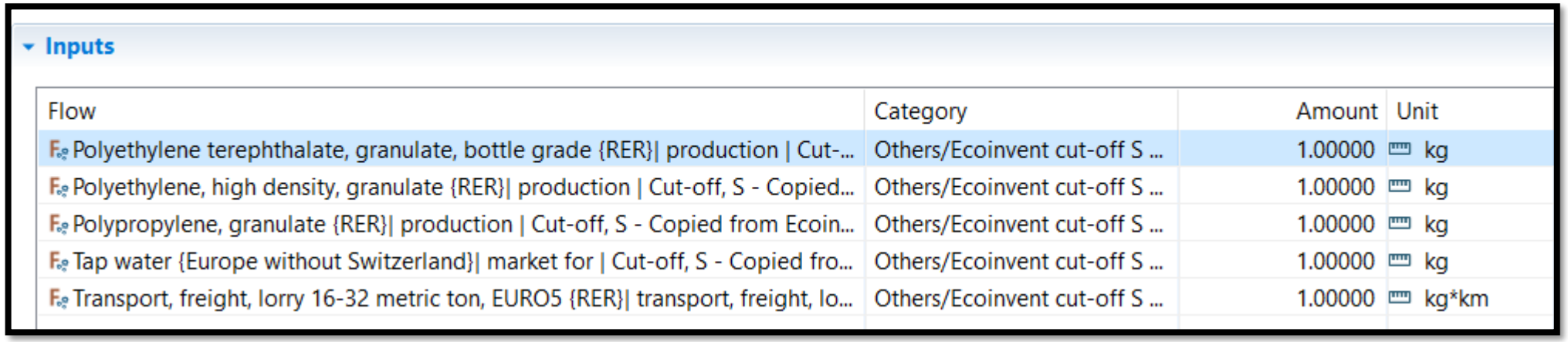
- Process:
  - Right click on **Processes** and add new child category and name it **“Water Bottle Production”.**



Click on **Input/Outputs** to enter the following data.



Step 1: On **Inputs/outputs** tab

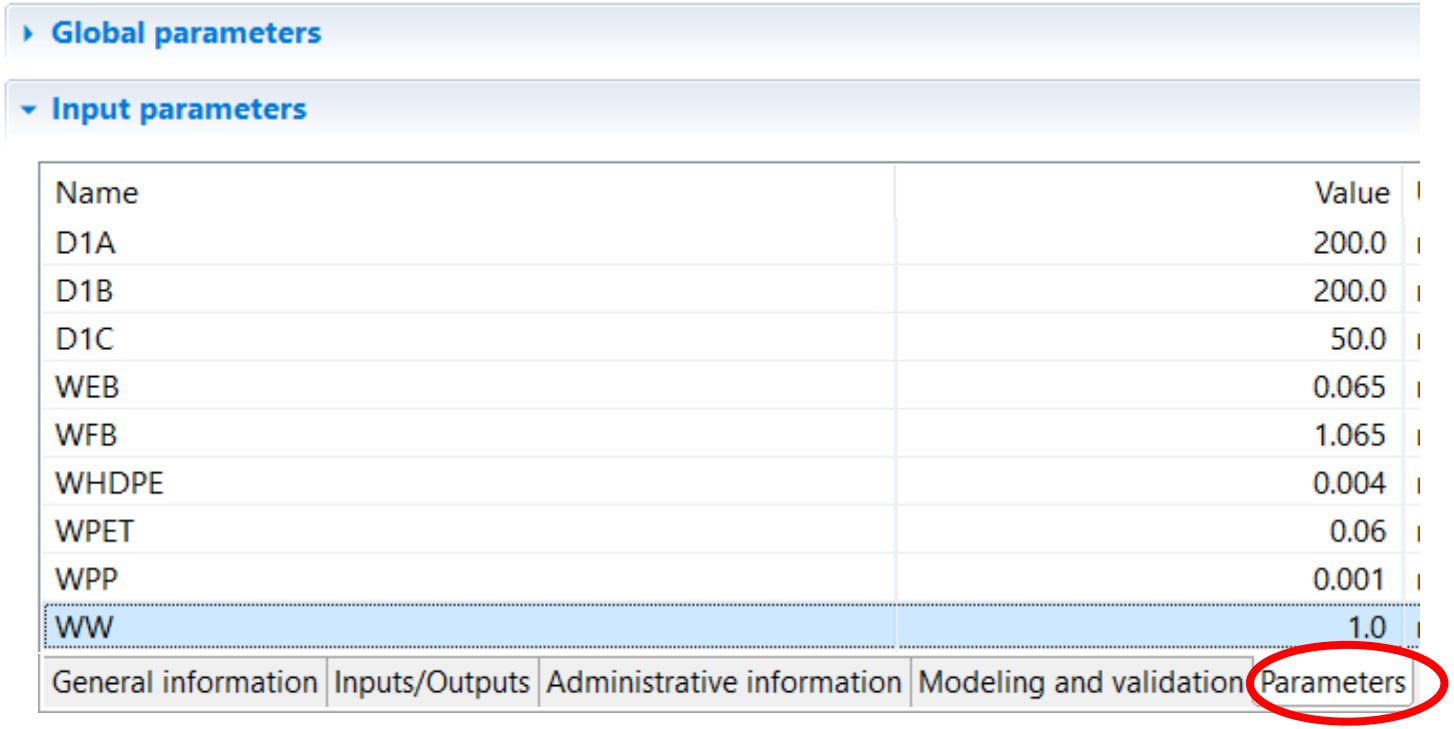


Inputs

Flow	Category	Amount	Unit
Polyethylene terephthalate, granulate, bottle grade {RER}| production | Cut-...	Others/Ecoinvent cut-off S ...	1.00000	kg
Polyethylene, high density, granulate {RER}| production | Cut-off, S - Copied...	Others/Ecoinvent cut-off S ...	1.00000	kg
Polypropylene, granulate {RER}| production | Cut-off, S - Copied from Ecoin...	Others/Ecoinvent cut-off S ...	1.00000	kg
Tap water {Europe without Switzerland}| market for | Cut-off, S - Copied fro...	Others/Ecoinvent cut-off S ...	1.00000	kg
Transport, freight, lorry 16-32 metric ton, EURO5 {RER}| transport, freight, lo...	Others/Ecoinvent cut-off S ...	1.00000	kg*km

Step 2: On **Parameters** tab

D1A = transport distance A for case 1;
D1B = transport distance B for case 1;
D1C = transport distance C for case 1;
WEB = weight empty bottle;
WFB = weight full bottle;
WHDPE = weight HDPE;
WPET = weight PET;
WPP = weight PP; and
WW = weight water.

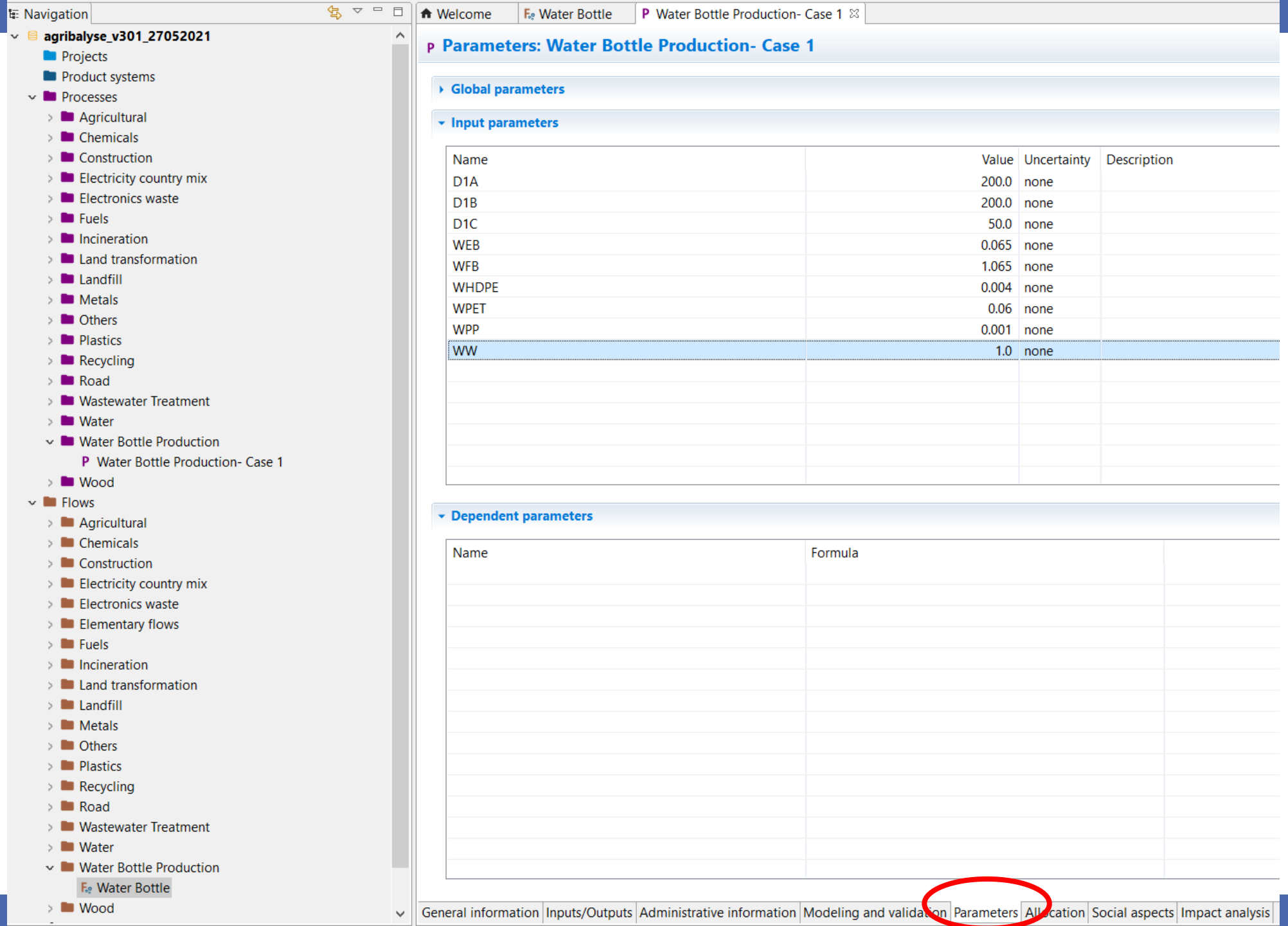


Global parameters

Input parameters

Name	Value
D1A	200.0
D1B	200.0
D1C	50.0
WEB	0.065
WFB	1.065
WHDPE	0.004
WPET	0.06
WPP	0.001
WW	1.0

General information | Inputs/Outputs | Administrative information | Modeling and validation | Parameters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Projects
Product systems
Processes
Agricultural
Chemicals
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Electricity country mix
Electronics waste
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Incineration
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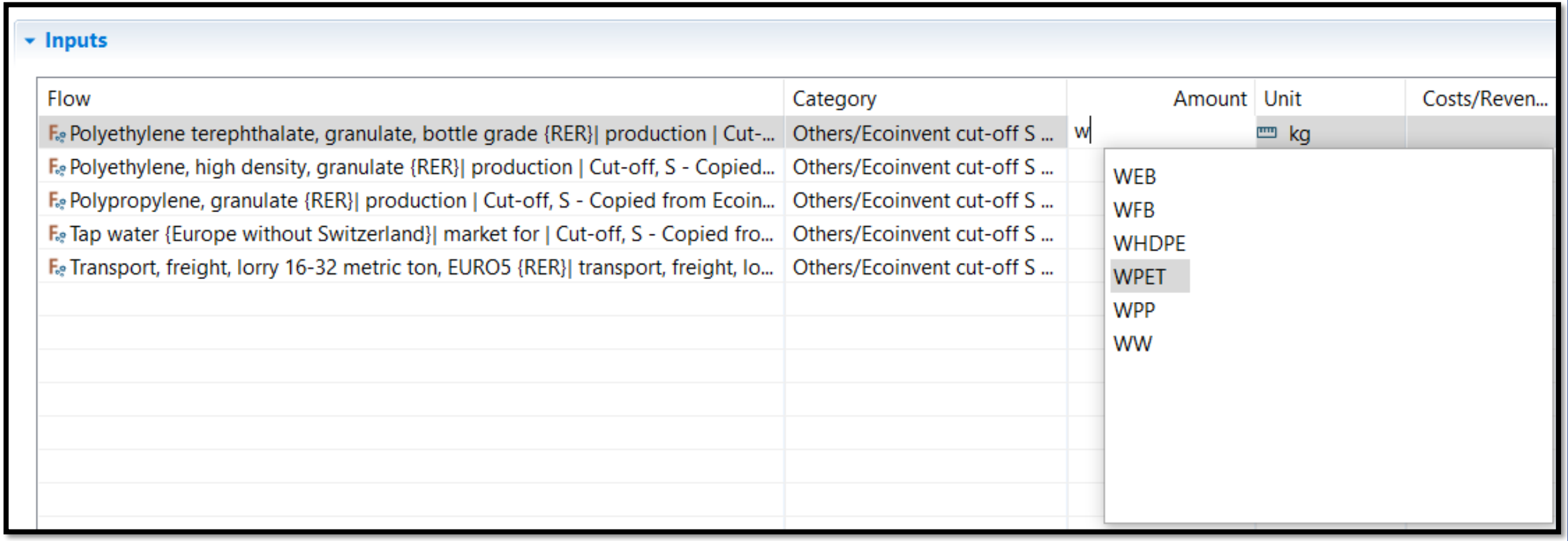
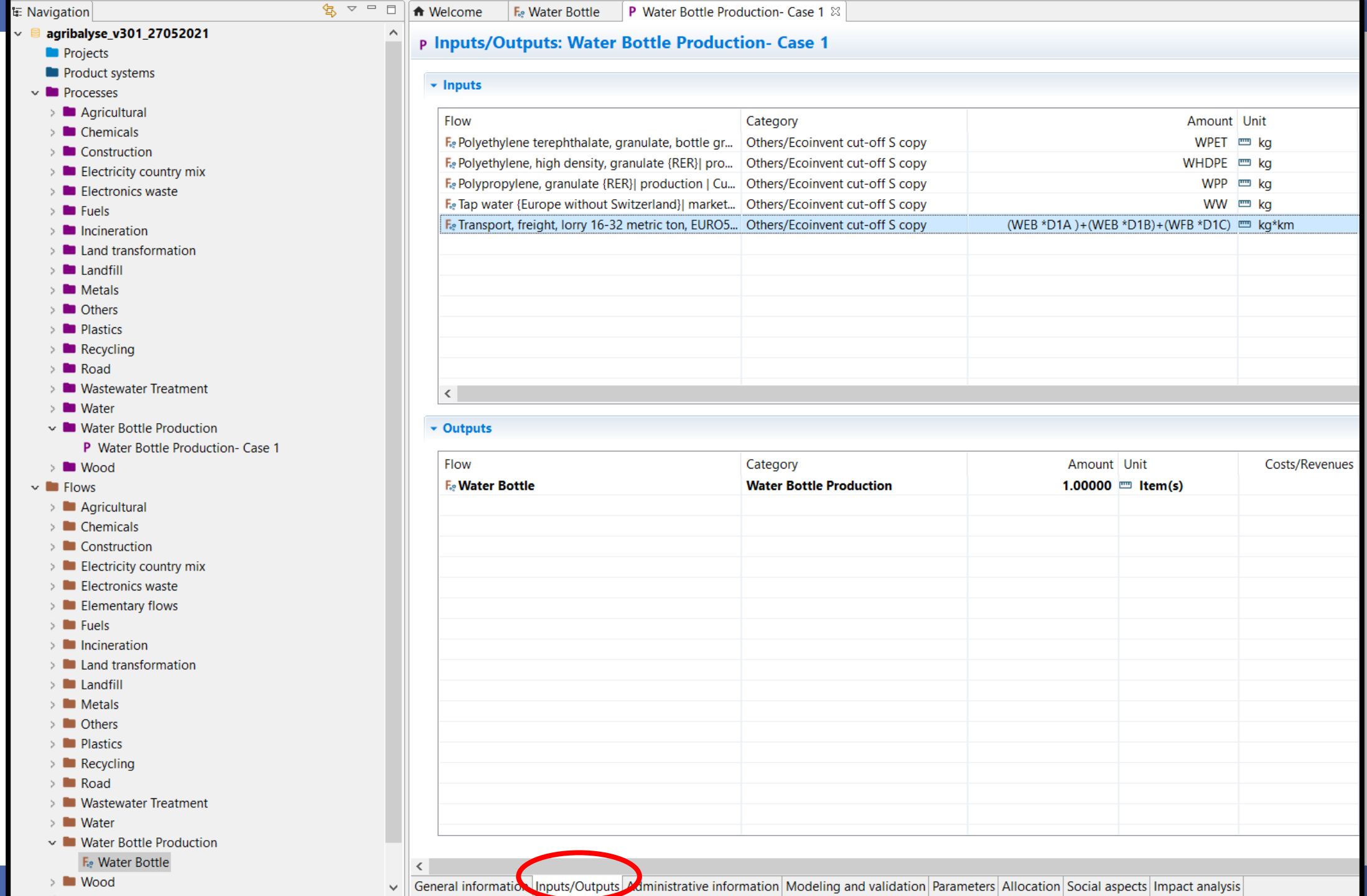
Water Bottle Production
Water Bottle
Wood
Welcome
Water Bottle
Water Bottle Production- Case 1
Parameters: Water Bottle Production- Case 1
Global parameters
Input parameters
Name
Value
Uncertainty
Description
D1A 200.0 none
D1B 200.0 none
D1C 50.0 none
WEB 0.065 none
WFB 1.065 none
WHDPE 0.004 none
WPET 0.06 none
WPP 0.001 none
WW 1.0 none
Dependent parameters
Name
Formula
General information
Inputs/Outputs
Administrative information
Modeling and validation
Parameters
Allocation
Social aspects
Impact analysis

Step 3: On **Inputs/outputs** tab




Navigation
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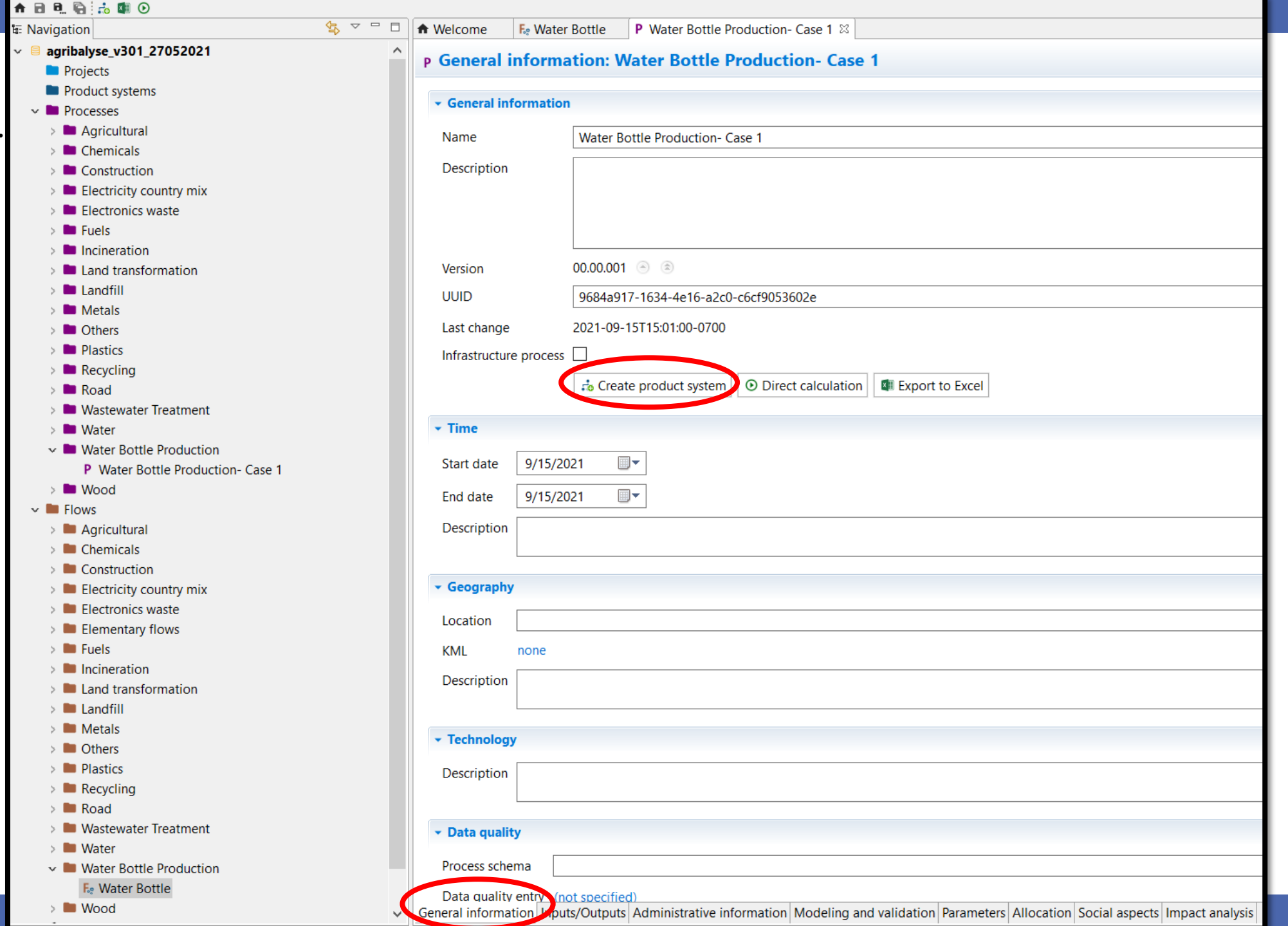
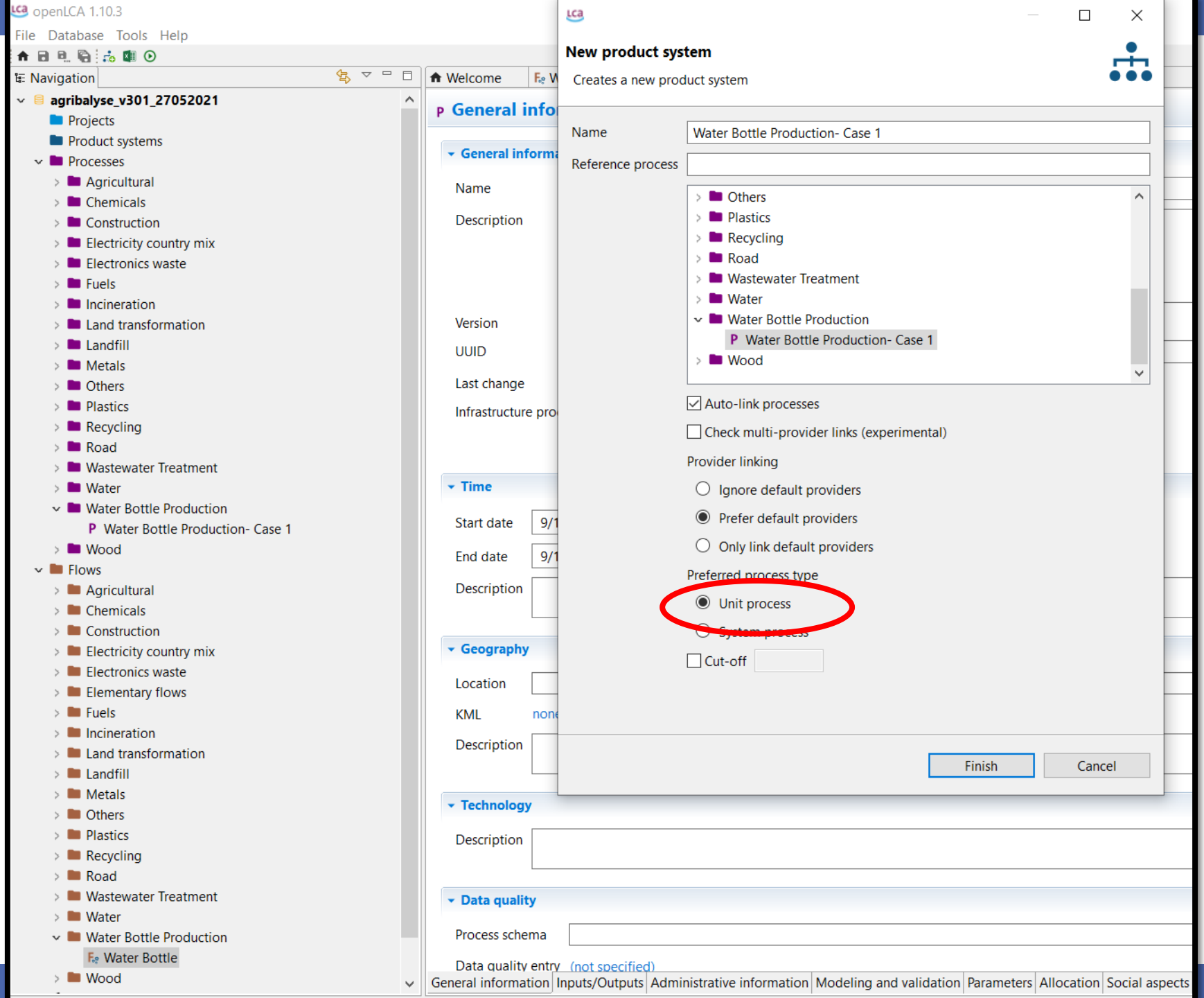
Water Bottle
Wood
Welcome
Water Bottle
Water Bottle Production- Case 1
Inputs/Outputs: Water Bottle Production- Case 1
Inputs
Flow
Category
Amount
Unit
Polyethylene terephthalate, granulate, bottle gr...
Others/Ecoinvent cut-off S copy
WPET
kg
Polyethylene, high density, granulate {RER}| pro...
Others/Ecoinvent cut-off S copy
WHDPE
kg
Polypropylene, granulate {RER}| production | Cu...
Others/Ecoinvent cut-off S copy
WPP
kg
Tap water {Europe without Switzerland}| market...
Others/Ecoinvent cut-off S copy
WW
kg
Transport, freight, lorry 16-32 metric ton, EURO5...
Others/Ecoinvent cut-off S copy
(WEB *D1A)+(WEB *D1B)+(WFB *D1C)
kg*km
Outputs
Flow
Category
Amount
Unit
Costs/Revenues
Water Bottle
Water Bottle Production
1.00000
Item(s)
General information
Inputs/Outputs
Administrative information
Modeling and validation
Parameters
Allocation
Social aspects
Impact analysis

Click on **General information** tab to create **product system**.




openLCA 1.10.3
File Database Tools Help
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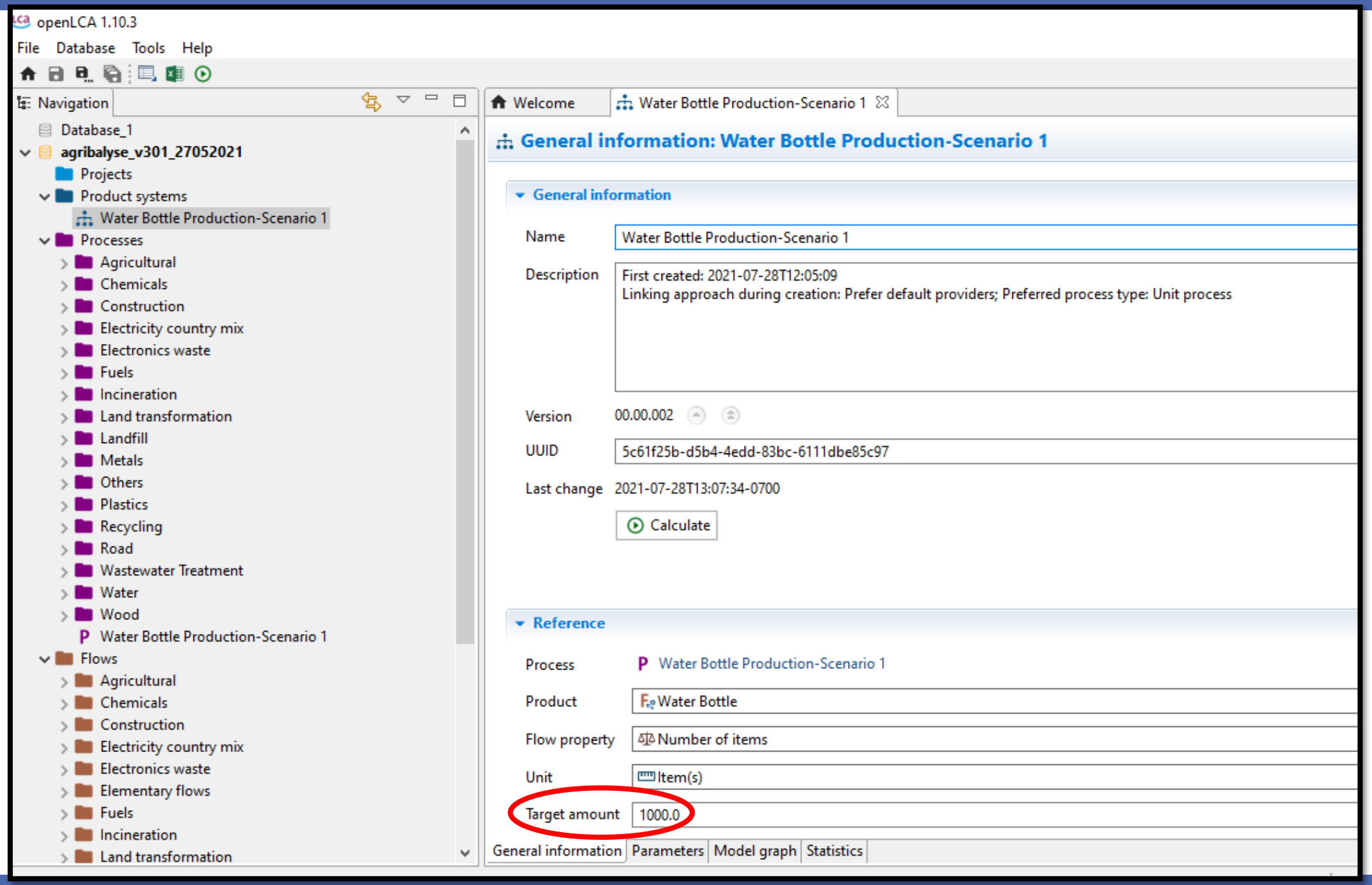
Water Bottle
Wood
Welcome
General info
General informa
Name
Description
Version
UUID
Last change
Infrastructure pro
Time
Start date
End date
Description
Geography
Location
KML
Description
Technology
Description
Data quality
Process schema
Data quality entry (not specified)
General information
Inputs/Outputs
Administrative information
Modeling and validation
Parameters
Allocation
Social aspects
New product system
Creates a new product system
Name
Water Bottle Production- Case 1
Reference process
Others
Plastics
Recycling
Road
Wastewater Treatment
Water
Water Bottle Production
Water Bottle Production- Case 1
Wood
Auto-link processes
Check multi-provider links (experimental)
Provider linking
Ignore default providers
Prefer default providers
Only link default providers
Preferred process type
Unit process
Cut-off
Finish
Cancel


openLCA 1.10.3
File Database Tools Help
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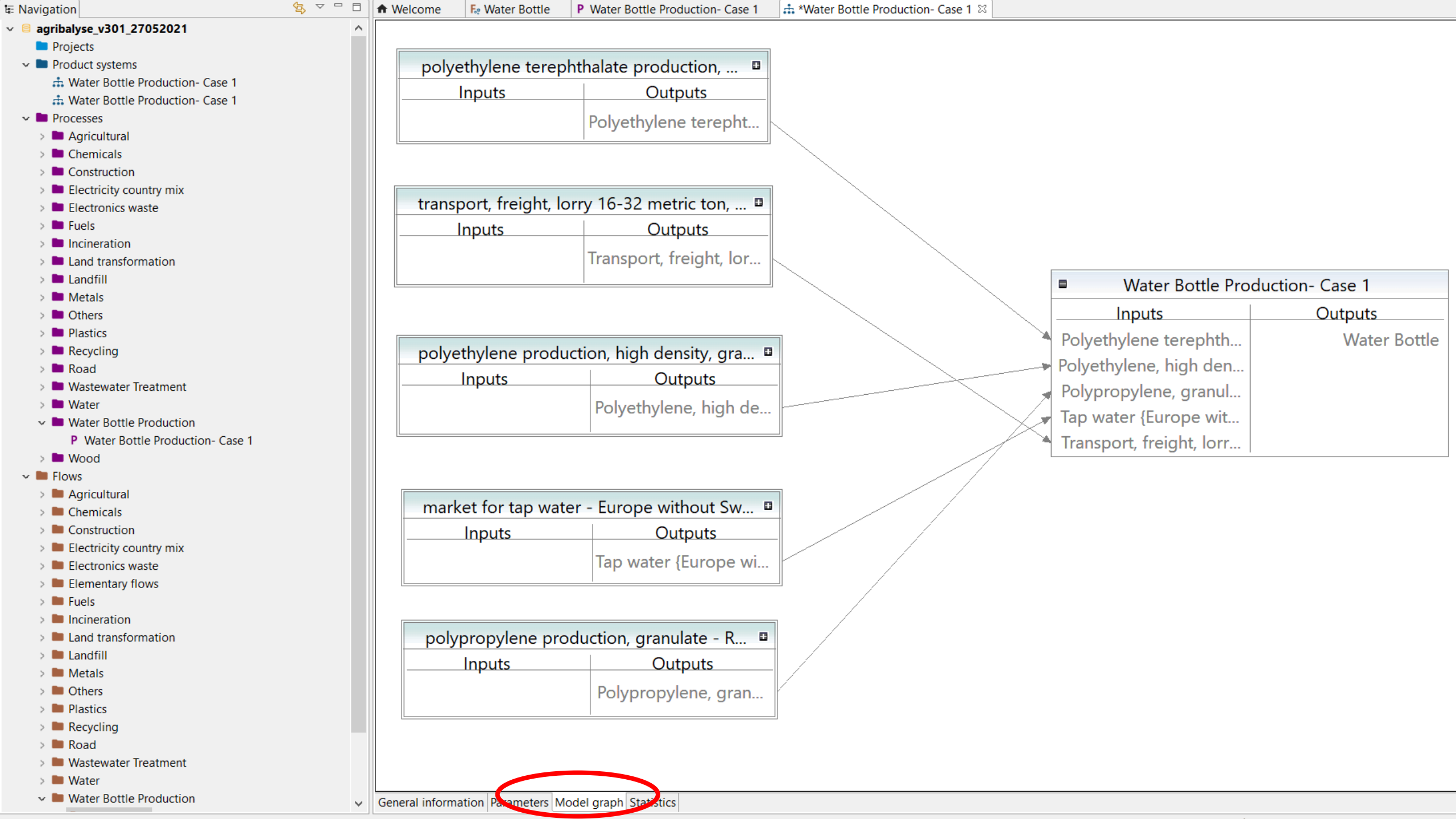
Welcome
Water Bottle Production-Scenario 1
General information: Water Bottle Production-Scenario 1
General information
Name
Water Bottle Production-Scenario 1
Description
First created: 2021-07-28T12:05:09
Linking approach during creation: Prefer default providers; Preferred process type: Unit process
Version
00.00.002
UUID
5c61f25b-d5b4-4edd-83bc-6111dbe85c97
Last change
2021-07-28T13:07:34-0700
Calculate
Reference
Process
Water Bottle Production-Scenario 1
Product
Water Bottle
Flow property
Number of items
Unit
Item(s)
Target amount
1000.0
General information
Parameters
Model graph
Statistics


Navigation
agribalyse_v301_27052021
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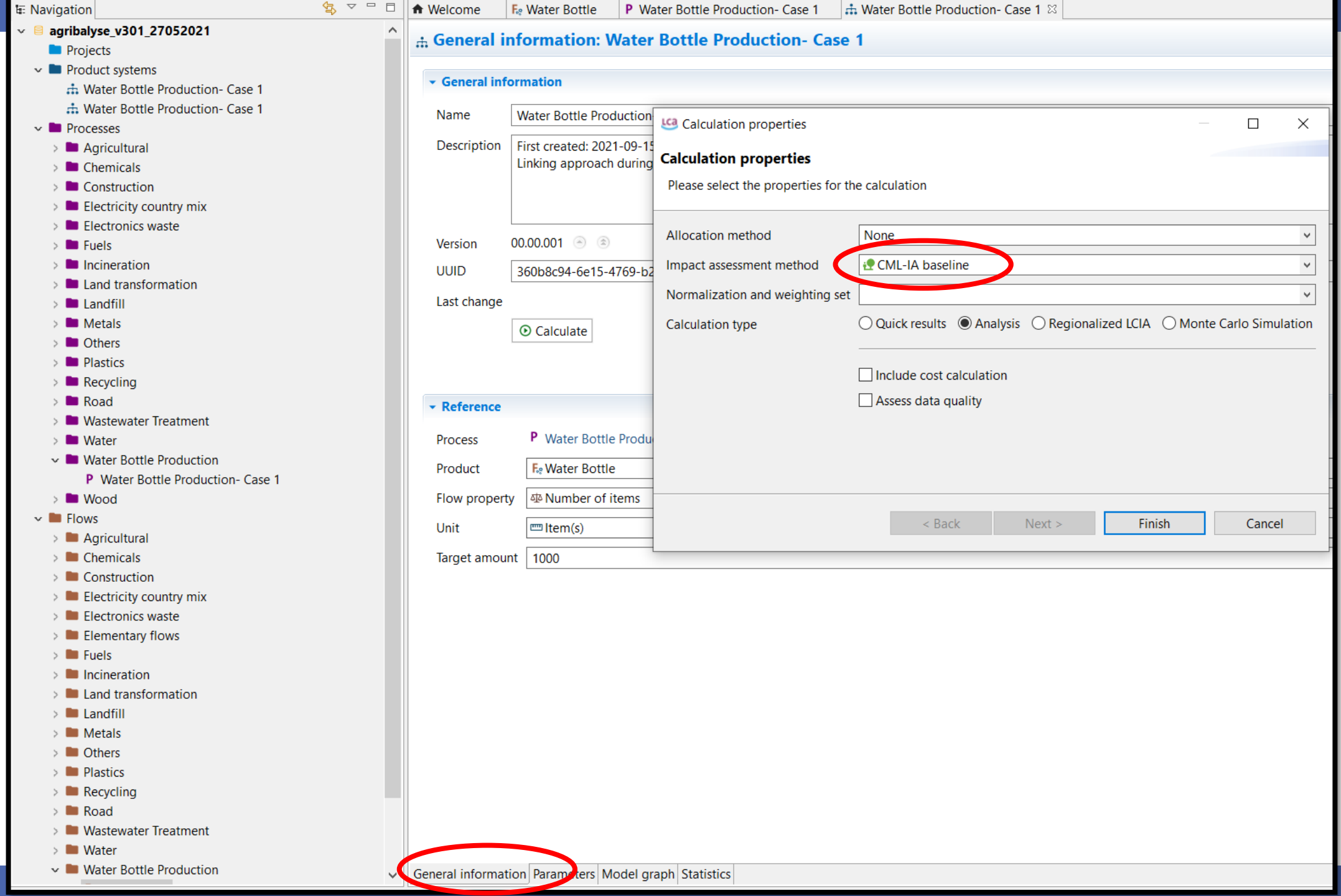
Welcome
Water Bottle
Water Bottle Production- Case 1
*Water Bottle Production- Case 1
polyethylene terephthalate production, ...
Inputs
Outputs
Polyethylene terepht...
transport, freight, lorry 16-32 metric ton, ...
Inputs
Outputs
Transport, freight, lor...
polyethylene production, high density, gra...
Inputs
Outputs
Polyethylene, high de...
market for tap water - Europe without Sw...
Inputs
Outputs
Tap water {Europe wi...
polypropylene production, granulate - R...
Inputs
Outputs
Polypropylene, gran...
Water Bottle Production- Case 1
Inputs
Outputs
Polyethylene terephth...
Polyethylene, high den...
Polypropylene, granul...
Tap water {Europe wit...
Transport, freight, lorr...
Water Bottle
General information
Parameters
Model graph
Statistics


Navigation
agribalyse_v301_27052021
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Water Bottle Production
Welcome
Water Bottle
Water Bottle Production- Case 1
Water Bottle Production- Case 1
General information: Water Bottle Production- Case 1
General information
Name
Water Bottle Production
Description
First created: 2021-09-15
Linking approach during
Version
00.00.001
UUID
360b8c94-6e15-4769-b2
Last change
Calculate
Reference
Process
Water Bottle Produ
Product
Water Bottle
Flow property
Number of items
Unit
Item(s)
Target amount
1000
Calculation properties
Calculation properties
Please select the properties for the calculation
Allocation method
None
Impact assessment method
CML-IA baseline
Normalization and weighting set
Calculation type
Quick results
Analysis
Regionalized LCIA
Monte Carlo Simulation
Include cost calculation
Assess data quality
< Back
Next >
Finish
Cancel
General information
Parameters
Model graph
Statistics

Class Practice 10

- Upload your results in terms of "**Global Warming**" and "**Human Toxicity**" on Canvas.

Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. I. (2018). Life cycle assessment (Vol. 2018). Springer International Publishing.