Life Cycle Assessment Using OpenLCA

Software Exercise Session: Create a life cycle model (Part II)

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Case study: cotton fabrics production

Cotton *fiber* production → Cotton *yarn* production → Cotton *fabrics* production

Cotton Fiber Production

Inputs/Outputs: cotton fiber production

Inputs

1.23

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided w	Provider	Data quali	Descripti
cottonseed; at harve...	Agriculture, forest...	0.02000	kg		none				
CUTOFF irrigate; gra...	Water supply; sew...	22.20000	m3		none				
CUTOFF nitrogenous...	Manufacturing/ISI...	0.45700	kg		none				
CUTOFF pesticide, 1...	Manufacturing/ISI...	0.01600	kg		none				
diesel	Energy carriers an...	47.70000	MJ		none				
electricity mix	Energy carriers an...	12.10000	MJ		none		Elec...		
Hard coal, at consum...	Energy carriers an...	0.52000	kg		none				
LPG - liquefied petrol...	Energy carriers an...	1.38300	MJ		none				
Natural gas, at consu...	Energy carriers an...	0.35000	kg		none				

Outputs

1.23

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided pr	Provider	Data quali	Descripti
Carbon dioxide, from...	Emission to air/lo...	4.26500	kg		none				
Carbon monoxide, fr...	Emission to air/lo...	0.01610	kg		none				
cotton fiber	[case study] cot...	1.00000	kg		none				
Hydrocarbons, unspe...	Emission to air/lo...	0.00500	kg		none				
Methane, from soil or...	Emission to air/lo...	0.00760	kg		none				
Nitrogen oxides	Emission to air/lo...	0.02270	kg		none				
Sulfur dioxide	Emission to air/lo...	0.00400	kg		none				

Cotton

Yarn

Product

Inputs/Outputs: cotton yarn production

Inputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided w	Provider	Data quali	Descripti
cotton fiber	[case study] cotto...	1.10000	kg		none				
electricity mix	Energy carriers an...	3.32000	kWh		none		Elec...		

Outputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided pı	Provider	Data quali	Descripti
cotton yarn	**[case study] cot...**	**1.00000**	**kg**		**none**				

Cotton

Fabrics

Producti

Inputs/Outputs: cotton fabrics production

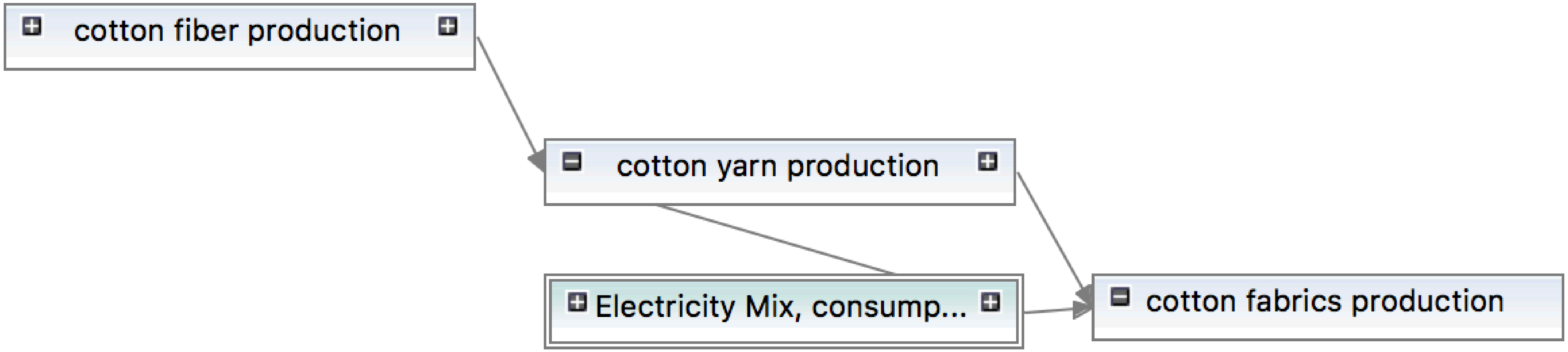
Inputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided w	Provider	Data quali	Descripti
cotton yarn	[case study] cotto...	1.08000	kg		none				
electricity mix	Energy carriers an...	1.68000	kWh		none		Elec...		

Outputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided pr	Provider	Data quali	Descripti
cotton fabrics	**[case study] cot...**	**1.00000**	**kg**		**none**				

Cotton fabrics production system



Part II: 50/50 polyester-cotton fabrics production

- Goal: to compare the environmental impacts between **100% cotton** and **50/50 polyester-cotton** terry towels
- Functional unit?

A proper FU for comparative LCAs

Fiber production → *Yarn* production → *Fabrics* production → Use phase

Function

- Cleaning: absorbing water with 1 towel

Unit

- # of service

Magnitude

- 1000

Lvl. of quality

- Absorbing x kg water per service

- Washing
- Replacement

Please use the handout to complete the life cycle model

- For each process:
  - Create intermediate/final product flows as *quantitative reference*
  - Search for proper flows for input/output
  - Select a proper *provider* for a flow, if applicable
- Create a product system

Polyester fiber production

P Inputs/Outputs: polyester fiber production

Inputs

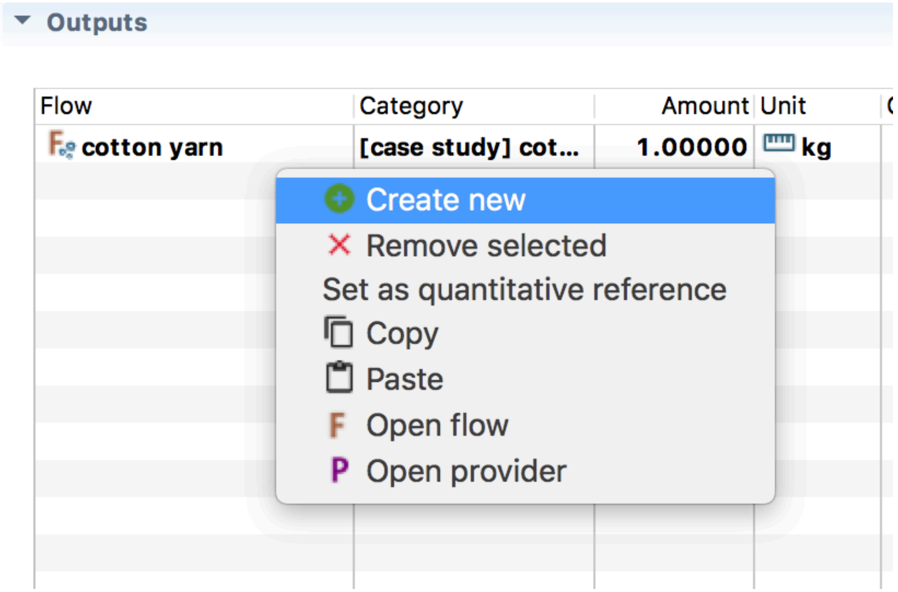
Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided w	Provider	Data quali	Descripti
diesel	Energy carriers an...	82.20000	MJ		none				
drinking water	Materials producti...	17.20000	kg		none				
electricity mix	Energy carriers an...	15.20000	MJ		none		P Elec...		
Hard coal, at consum...	Energy carriers an...	0.37000	kg		none				
Hard coal, at consum...	Energy carriers an...	0.14000	kg		none				
Natural gas, at consu...	Energy carriers an...	0.36000	kg		none				
Natural gas, at consu...	Energy carriers an...	0.29000	kg		none				

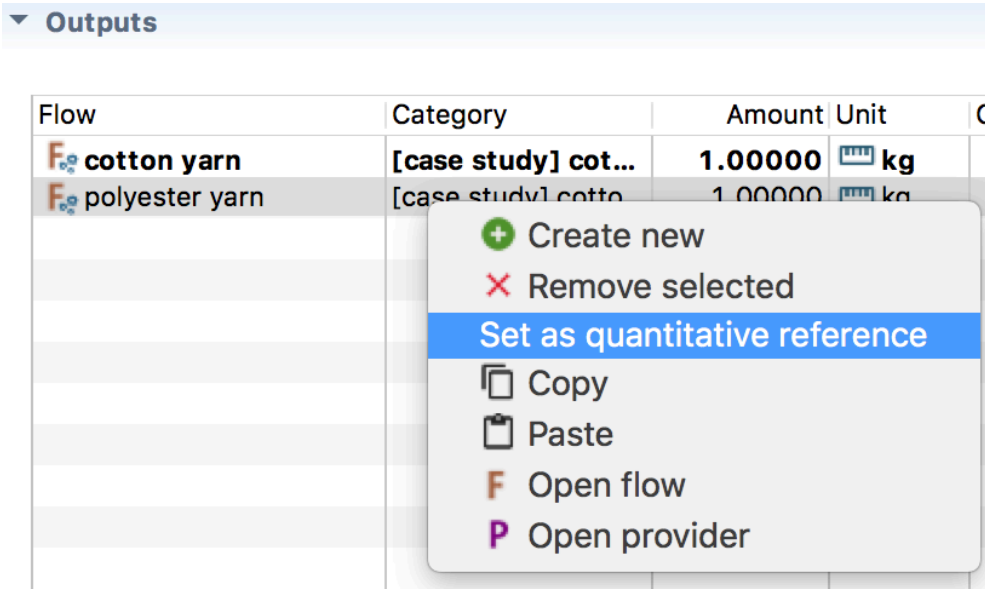
Outputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided pr	Provider	Data quali	Descripti
Carbon dioxide, fossil	Emission to air/lo...	2.31000	kg		none				
Carbon monoxide, fossil	Emission to air/lo...	0.01820	kg		none				
Hydrocarbons, unspe...	Emission to air/lo...	0.03950	kg		none				
Methane, fossil	Emission to air/lo...	0.00010	kg		none				
Nitrogen oxides	Emission to air/lo...	0.01940	kg		none				
polyester fiber	**[case study] cot...**	**1.00000**	**kg**		**none**				
Sulfur dioxide	Emission to air/lo...	0.00020	kg		none				

Polyester yarn and fabrics productions

- Duplicate the existing **cotton yarn production** and **cotton fabrics production** processes
- Swap *quantitative references* with polyester-relevant product flows





Don’t forget to change the input!

Polyester yarn and fabrics productions

Inputs/Outputs: polyester yarn production

Inputs

Flow	Category	Amount	Unit
electricity mix	Energy carriers an...	3.32000	kWh
polyester fiber	[case study] cotto...	1.10000	kg

Outputs

Flow	Category	Amount	Unit
polyester yarn	**[case study] cot...**	**1.00000**	**kg**

Inputs/Outputs: polyester fabrics production

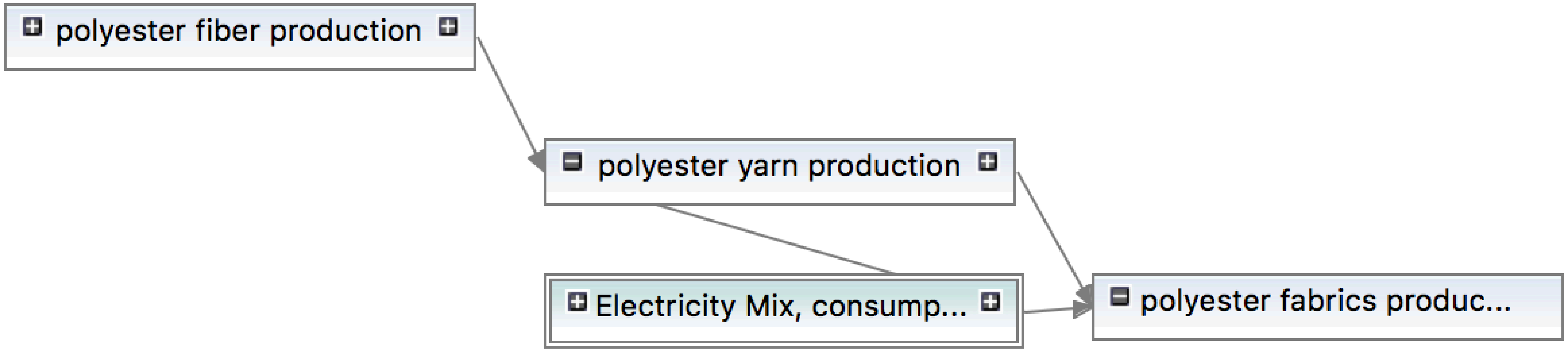
Inputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided w	Provider	Data quali	Descripti
electricity mix	Energy carriers an...	1.68000	kWh		none		Elec...		
polyester yarn	[case study] cotto...	1.08000	kg		none				

Outputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided pı	Provider	Data quali	Descripti
polyester fabrics	**[case study] cot...**	**1.00000**	**kg**		**none**				

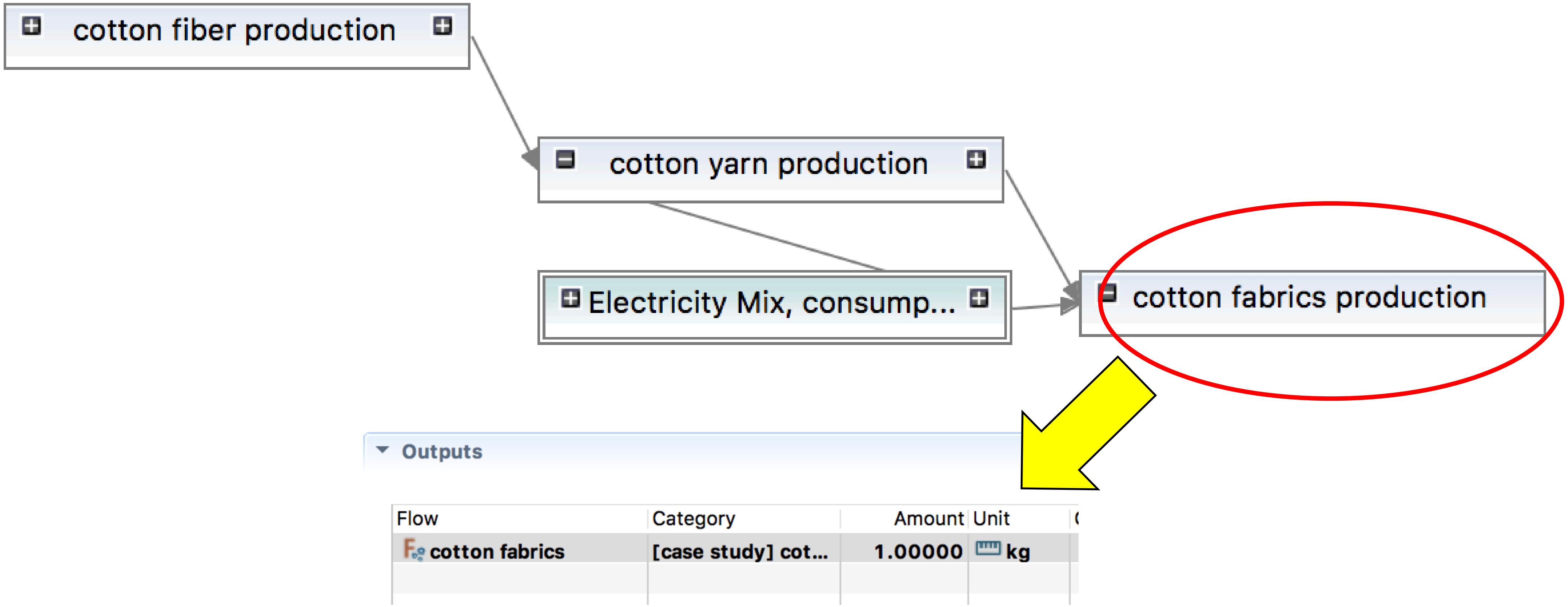
Polyester fabrics production system



Don't forget to save individual Processes before making a Product system!!!

Implement FU in OpenLCA

- As “quantitative reference”



Implement FU for terry towels

Function

- Cleaning: absorbing water with 1 towel

Unit

- # of service

Magnitude

- 1000

Lvl. of quality

- Absorbing x kg water per service

Outputs

Flow	Category	Amount	Unit
terry towel_100% c...	[case study] cot...	1.00000	Ite...

Adjust reference flows

- What could be different for **100% CO** and **50/50 CO-PES** terry towels to fulfill the same function?
  - Area/weight of the towels (to absorb x kg dirty water)
  - Energy to dry (water retained after washing)
  - Textile durability (loss of material that leads to *potential* replacement after 100 washing cycles)

Terry towel use

- Fabrics-to-towel production is omitted for simplicity

P Inputs/Outputs: terry towel_50/50 polyester–cotton_use for cleanning

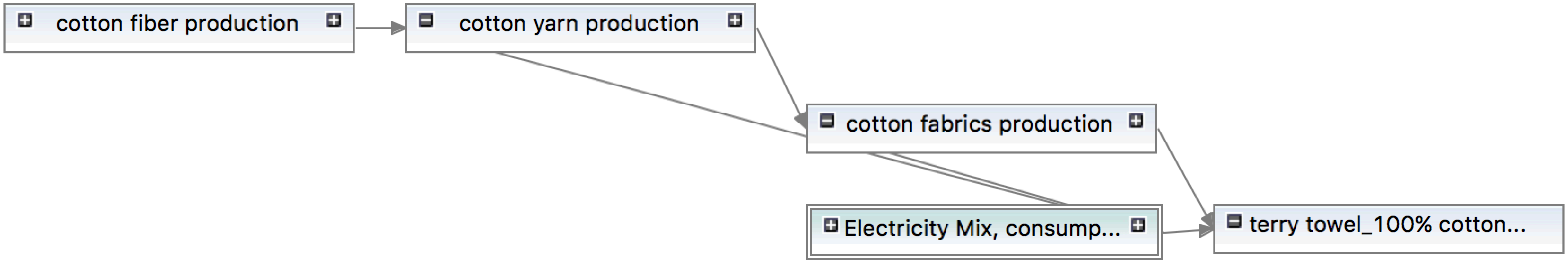
Inputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided w	Provider	Data quali	Descripti
cotton fabrics	[case study] cotto...	0.05000	kg		none				
electricity mix	Energy carriers an...	0.12000	MJ		none		P Elec...		
polyester fabrics	[case study] cotto...	0.05000	kg		none				

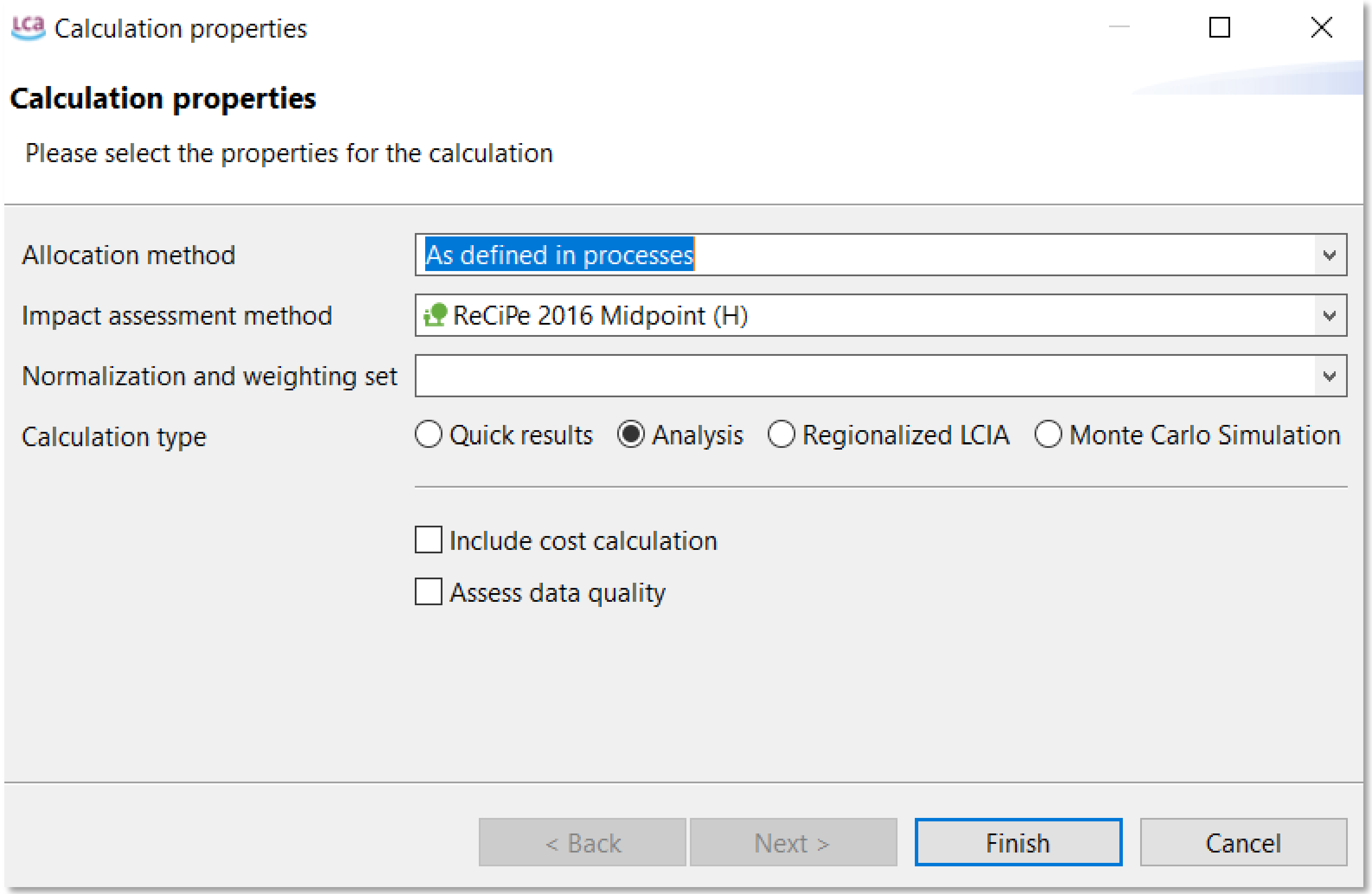
Outputs

Flow	Category	Amount	Unit	Costs/Rev	Uncertaint	Avoided pı	Provider	Data quali	Descripti
terry towel_50/50...	**[case study] cot...**	**1.00000**	**Ite...**		**none**				

Product system for terry towels made from 100% cotton fabrics



Perform impact assessment



Perform impact assessment

50/50 polyester-cotton terry towel production and use

Flow: Mercury - Emission to air/unspecified

Impact category: Global warming - ReCiPe 2016 Midpoint (H)

Contribution	Process	Amount	Unit
100.00%	terry towel_50/50 polyester-co...	2.86844	kg C...
54.45%	polyester fabrics production	1.56187	kg C...
47.62%	polyester yarn production	1.36595	kg C...
06.83%	Electricity Mix, consumption m...	0.19592	kg C...
42.84%	cotton fabrics production	1.22882	kg C...
36.01%	cotton yarn production	1.03290	kg C...
06.83%	Electricity Mix, consumption m...	0.19592	kg C...
02.71%	Electricity Mix, consumption m...	0.07775	kg C...

Discussion

- Create a “project” to compare the life cycle impacts of two towels
    - Is there any tradeoff in impact categories?
    - Compare the “water consumption” category between the two products, is the result reasonable?

Discussion

- Is “drinking water” a good choice for industrial water during polyester fiber production?
  - What are other choices available, why choose/not choose one of them?

Discussion

- Take a look again at input/output table of “terry towel use” process: a lot of ***hard-coding*** here for input values, how can we ***use parameters to “automate”*** the input of some values?

Additional information

- A quick start guide to openLCA (UBC wiki)
- LCA discussion email list (an open, constructive and safe platform where people can freely exchange ideas, look for collaborations and post job ADs)
- Life cycle assessment: Quantitative Approaches for Decisions that Matter (free LCA textbook and presentations compiled by researchers from Carnegie Mellon University)
- LCA training kit from Life Cycle Initiative