Cotton Fabrics Case Study
(Part II)

Learning objective

To learn how to define a proper functional unit and to adjust reference flows for comparative LCA studies

Overview

- *Adapted from: Eija M.Kalliala and Pertti Nousiainen (1999) "Life Cycle Assessment Environmental Profile Of Cotton And Polyester-Cotton Fabrics"*
- Goal: to compare the environmental impacts of terry towels made of cotton and polyester-cotton fabrics
- Database: ELCD, USDA crop database 1.1
- System boundary: "cradle-to-gate"

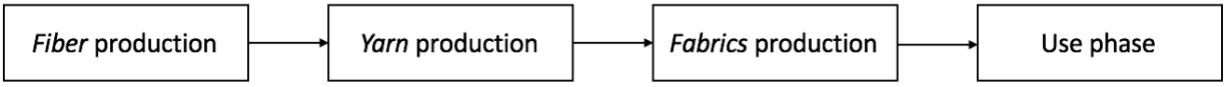

Figure 1. Life cycle stages included in this study

- Functional unit: 1000 uses of terry towel (0.25 m^2) for cleaning (absorbing x kg dirty water per cleaning)
- Allocation method: none
- Geographic location: mixed
- Impact assessment method: ReCiPe 2016 Midpoint (H)
- Limitations:
  - Transportation of intermediate products are not modeled
  - Infrastructure (e.g., machinery) is not modeled
  - Geographic relevance of the data is not strictly preserved
  - Manufacturing of towels from fabrics is not modeled
  - Technologies and corresponding life cycle inventory data for yarn production and fabrics production of polyester fabrics are assumed to be the same as those of cotton fabrics, for simplicity.

Polyester fiber production

- Input/output for polyester fiber production

	Unit/output	Value	Flow in ELCD/USDA database
Input			
Electricity	MJ	15.2	"electricity mix" (2nd to the last: 230 V processes; then in "Provider" choose the one with "CH")
Fossil fuel	MJ	82.2	"diesel" (choose the unit of "MJ-net calorific value")
Natural gas	kg	0.36	"Natural gas, at consumer EU-27"
Natural gas, feedstock for polyester production	kg	0.29	
Coal	kg	0.14	"Hard coal, at consumer EU-27"
Coal, feedstock for polyester production	kg	0.37	
Water	kg	17.2	"drinking water" (1st one on the list)
Output			
Polyester fiber	kg	1	Intermediate product flow created by the user
Emissions to air			
CO_2	kg	2.31	"Carbon dioxide, fossil" (under "low population density" subfolder)
CH_4	kg	0.0001	"Methane, fossil" (under "low population density" subfolder)
SO_2	kg	0.0002	"Sulfur dioxide" (under "low population density" subfolder)
NO_x	kg	0.0194	"Nitrogen oxides" (under "low population density" subfolder)
CH	kg	0.0395	"Hydrocarbons, unspecified" (under "low population density" subfolder)
CO	kg	0.0182	"Carbon monoxide, fossil" (under "low population density" subfolder)

Polyester yarn production

Technologies and corresponding life cycle inventory data are assumed to be the same as those for cotton yarn production.

Polyester fabrics production

Technologies and corresponding life cycle inventory data are assumed to be the same as those for cotton fabrics production.

Product system (100% polyester fabrics)

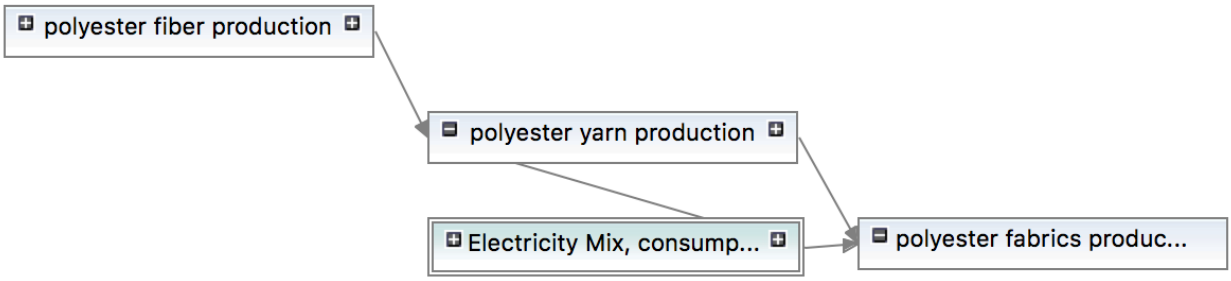

Figure 2. Product system diagram of the polyester fabrics production

Terry towel use

- Mass of fabrics for one towel (0.25 m^2) is assumed to be the same for both materials: 100 g (based on 400 g/m^2 from *Eija M.Kalliala and Pertti Nousiainen (1999)*). So, without considering durability:
  - 100% cotton terry towel: 0.1 kg of cotton fabrics
  - 50/50 polyester-cotton terry towel: 0.05 kg polyester fabrics, 0.05 kg cotton fabrics
- Energy consumption for washing towels is assumed to be the same for two types of towels and is hence omitted
- Energy consumption for drying the 100% cotton towel and 50/50 polyester-cotton towel.
  - Energy consumption for evaporating 1kg of water from 20°C under 1 atm is 2.6 MJ/kg water
  - Remaining water in 100% cotton towel after washing is 65% its dry weight (i.e., 65 g water) while for 50/50 polyester-cotton towel, the value is 47% (i.e., 47 g water)
  - Therefore, the energy needed (without considering dryer efficiency) for drying one washed towel made of 100% cotton is 0.17 MJ. The value is 0.12 MJ for 50/50 polyester-cotton towel.

- Input/output for terry towel use

	Unit/ output	**Value_*100% cotton***	**Value_*50/50 polyester-cotton***	**Flow in ELCD/USDA database**
Input				

Cotton fabrics input	kg	0.1	0.05	Intermediate product flow created by the user
Polyester fabrics input	kg		0.05	
Electricity for drying washed towel	MJ	0.17	0.12	"electricity mix" (2nd to the last: 230 V processes; then in "Provider" choose the one with "CH")
Output				
Cleaning using one terry towel	# of item	1	1	Intermediate product flow created by the user

Product system *with use phase*

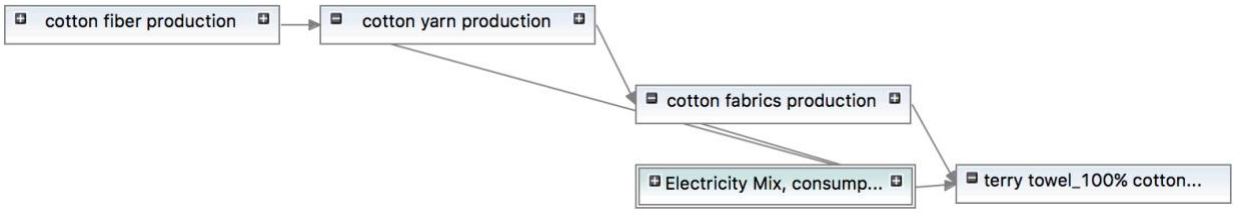

Figure 3(a). Product system diagram of the 100% cotton terry towel production and use

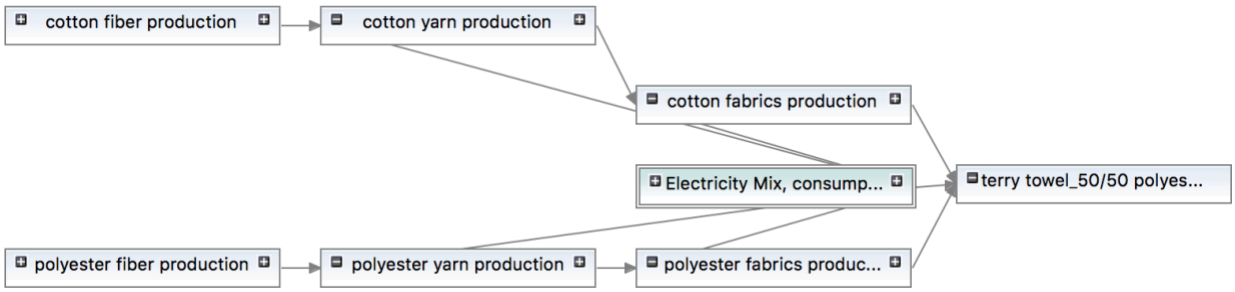

Figure 3(b). Product system diagram of the 50/50 polyester-cotton terry towel production and use

Discussion

- [*Results interpretation*] Create a "project" to compare the life cycle impacts of two towels (hint: save the report (as html file) and review the results outside OpenLCA)
  - Is there any tradeoff in impact categories?
  - Compare the "water consumption" category between the two products, is the result reasonable?

- [*Modeling choices*] 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?
- [*Modeling choices*] 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?