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OpenLCA practical exercises

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2021

Presenter's Bio

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Aim/Objectives

This module will introduce you to the LCA modelling basics using OpenLCA software. You will be able to create models, work with the selected databases, understand about LCA methods and undertake different types of LCA studies.

Other objectives:

- Work with different allocation methods
- Create sensitivity analysis scenarios

Learning outcomes

- Apply the bio economy principles by the use of quantitative approaches, models and tools
- Manage the organization of quantitative assessments by the use life cycle thinking approaches.

Keywords

- E-LCA: Environmental Life Cycle Assessment
- ISO: International Standard Organization
- LCA tool: A program that simplifies modelling of products
- Characterization factor: factor which is applied to convert an assigned life cycle inventory analysis result to the common unit of the category indicator

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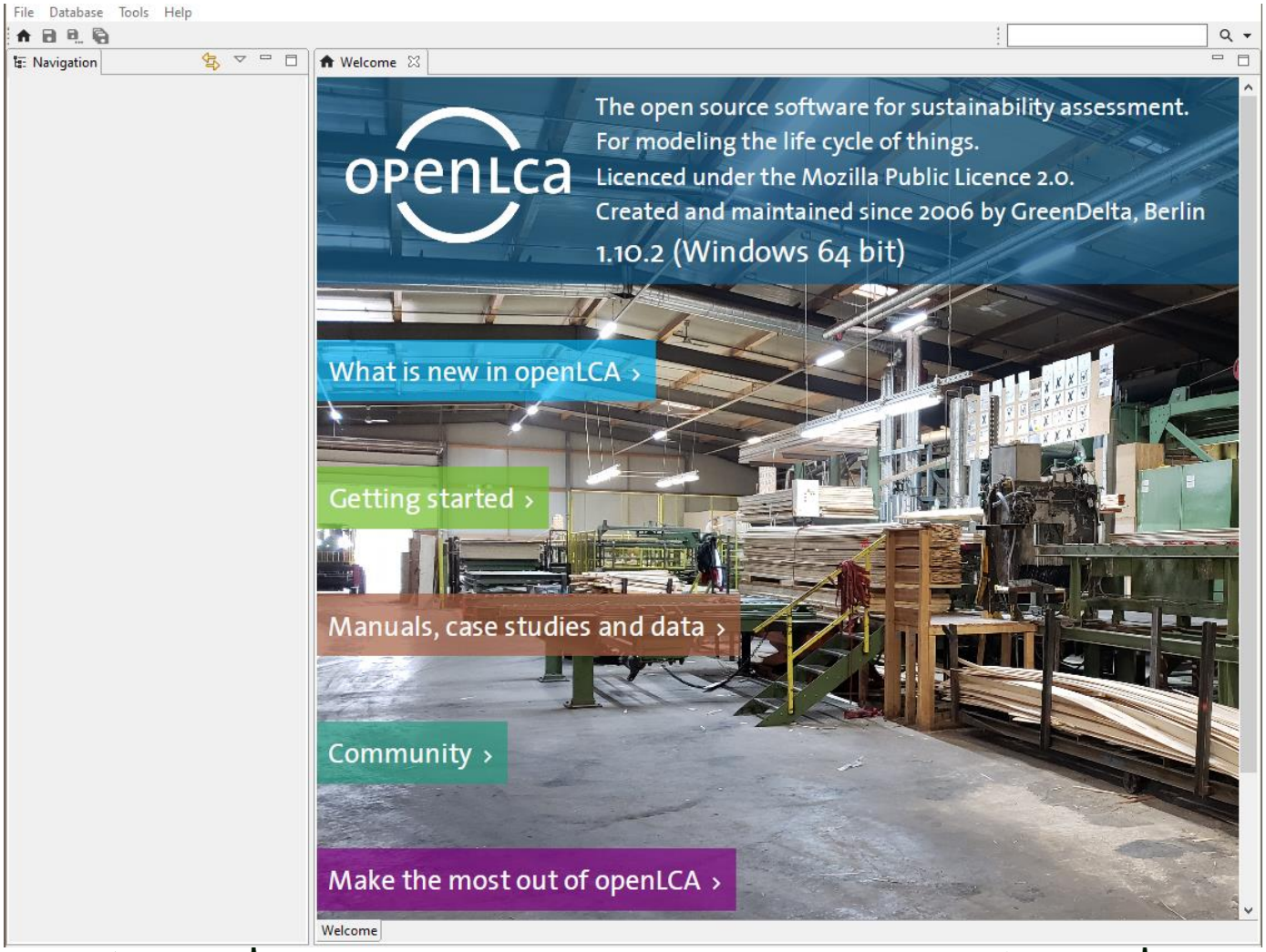


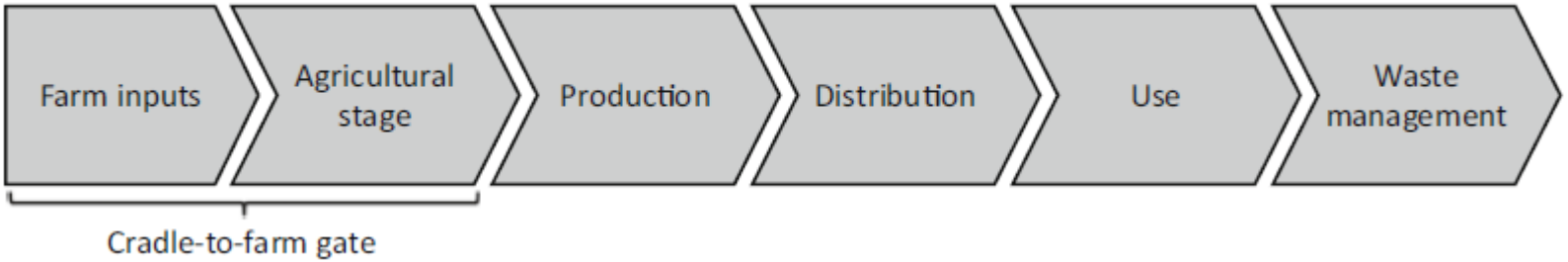
Exercise 1: LCA of conventional apple production

Source: MS Office Stock images

E.1. LCA of conventional apple production

The first stage of the life cycle is the production and transportation of inputs.

The second stage in the life cycle of food products is the agricultural stage.



Source: Longo S., 2017

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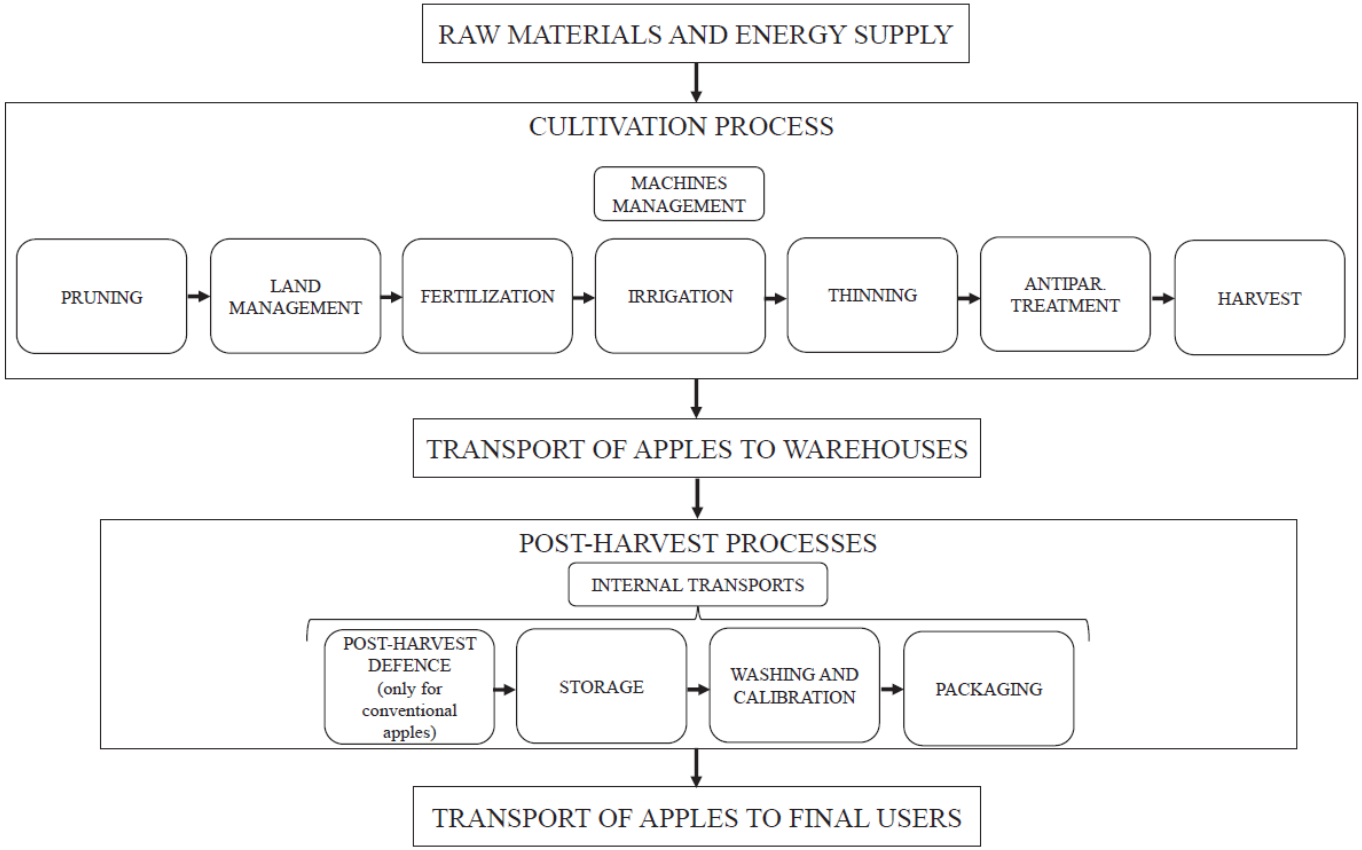
E.1. LCA of conventional apple production

- Goal & Scope: to assess the energy and environmental impacts of conventional apples cultivated in the North of Italy.
- Functional unit and system boundaries: The selected FU is 1 tonne of apples packed in 120 kg of carton and distributed to final consumers. The system boundaries include:
  - Raw materials and energy supply;
  - Cultivation of apples, including machines management, pruning, land management, fertilization, irrigation, thinning, antiparasitic treatment, harvest. This step also takes into account the final treatment of some input materials packaging
  - Transfer of apples to warehouses;
  - Post-harvest processes;
  - Transport of apples to final users

E.1. Svstem boundaries



Source: Longo S., 2017

E.1. Life Cycle Inventory

Cultivation Process

Input	Value
Fertilizers (kg)	6.5
Pesticides (kg)	1.29
Water (kg)	5.08 E+04
Diesel (MJ)	7.14 E+02
Electricity (kWh)	2.54
Plastic packaging (kg)	6.18 E-02
Cardboard (kg)	1.16 E-02
Lubricant oil (kg)	4.3 E-02
Batteries (kg)	9.4 E-02
Output	**Value**
Waste oil (kg)	4.3 E-02
Batteries (kg)	9.4 E-02
Branches and leaves (kg)	1.33 E+02

Post-harvesting Process

Input	Unit
Electricity (kWh)	165
Water (kg)	2900
Packaging (kg)	120

Transport Process

Transport	Distance	Vehicle
Regional	30 km (33.6 tkm)	Small truck

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Exercise 2. Sensitivity analysis to transport distance

- The aim of the task is to perform a life cycle assessment, which includes sensitivity analysis in the openLCA program
- Selected products: Packed apples
- Selected sensitivity parameter: Transport distance to the supermarket
- Functional unit: 1 ton of packed apples

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Exercise 3. Comparative LCA

- The aim of the task is to create a project for which a comparative life cycle impact assessment can be performed in the openLCA program
- Selected systems: harvesting and packaging of apples in Italy using electricity from the national grid and a second scenario using electricity from a solar farm.
- The functional unit used to create the model is: 1 ton of packed apples

Exercise 4. Bio-Ethanol Production

Source: MS Office Stock images

Goal & Scope

- Assess the environmental impact of the bio-Ethanol production in Brazil using Sugar cane as main Raw Material
- Functional Unit:1 ton of processed sugarcane.

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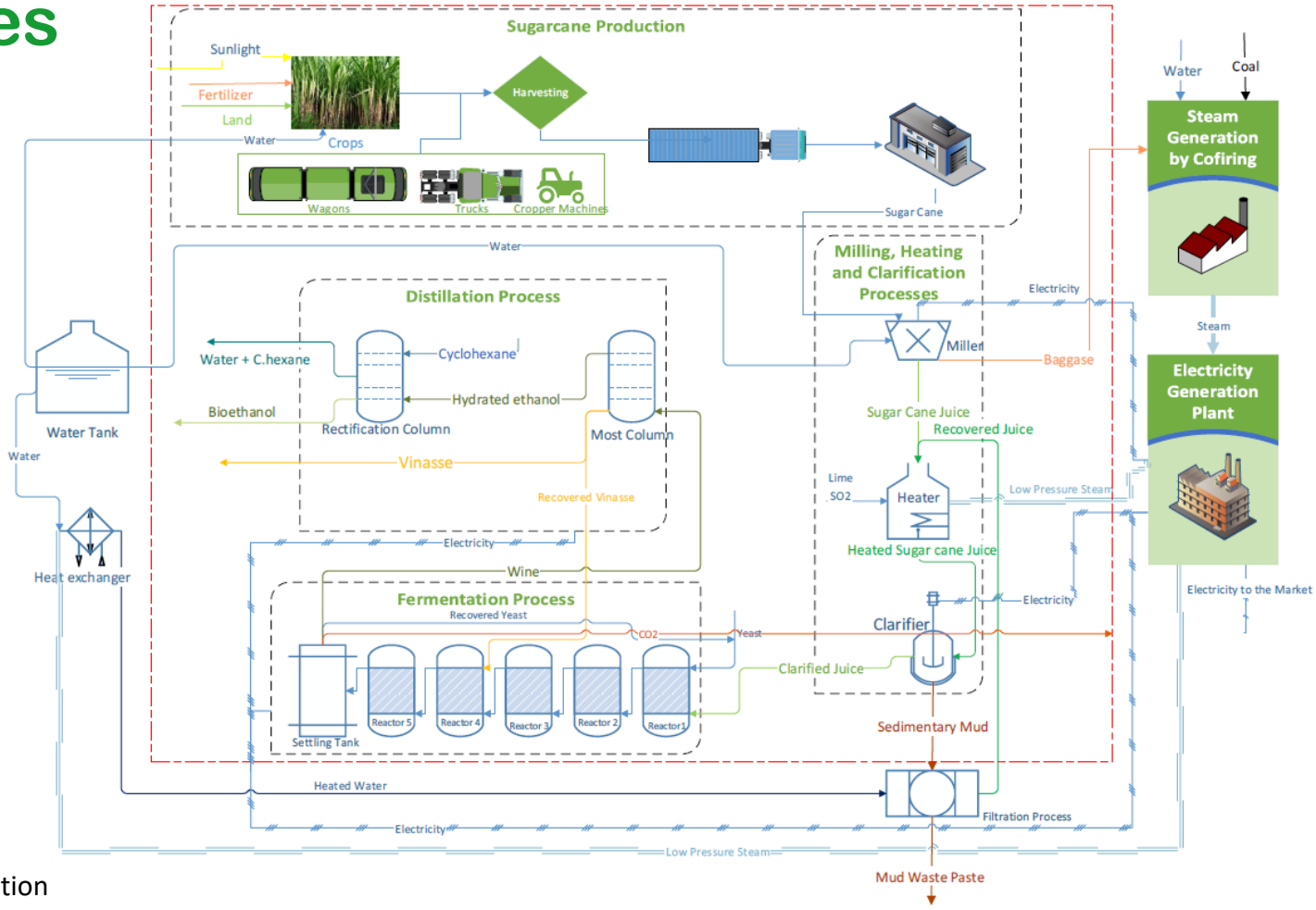
E.4. Bio-ethanol production in Brazil – System Boundaries



Source: Author's preparation

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E.4. Life Cycle Inventory

Agricultural Stage

Item	Amount
Land use	125 m2
Water	1.8 m3
Potassium fertiliser (K_2O)	3.8 kg
Nitrogen Fertiliser	1.6 kg
Phosphate fertilizer (P_2O_5)	1 kg
Harvesting machinery and tractors	1.8 tkm
Transport in trucks (transport, freight, lorry >32 metric ton, EURO4)	40 tkm
Output: Sugarcane	***1 ton***

Industrial Stage

Inputs	Amount
Sugarcane	1 ton
Water	451 L
Hydrated Lime	9.2 kg
Sulfur dioxide, liquid	6.3 kg
Fodder yeast	30.6 kg
methylcyclohexane	0.071 kg
Outputs	**Amount**
Sludge (waste)	70 kg
Bagasse (avoided product)	260 kg
Carbon dioxide, biogenic	67 kg
Wastewater	0.26 L
Ethanol	***65.73 kg***
Glycerine (avoided product)	1.07 kg
Vinasse	765 L

Exercise 5. Allocation by mass and economics

- The aim of the task is to create a project for which the potential impact results vary depending on how we allocate the impacts on the different products and co-products in openLCA program
- Selected systems: Production of bio-Ethanol in Brazil using Sugar cane as main Raw Material
- The functional unit used to create the model is: 1 ton of processed sugarcane.

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Synopsis

- OpenLCA is a powerful free-access software to perform Environmental Life Cycle Assessments. Databases are available for free or subject to purchase.
- Different cases in the agro-farming industry can be studied using the Ecoinvent 3.6 database as it was done today. Moreover, same cases can be used to perform stan-alone analysis, or comparative LCAs.
- Sensitivity analysis is an important aspect in the Interpretation phase; therefore, it is important to conduct it to understand what are the main variables responsible for the results behavior in an LCA model.
- Allocating by mass or by economic value, influences greatly the LCA results, as a different weighting at the calculation step is considered. Some systems can fit to mass or economic allocation, depending on the goal and on the type of product under assessment.

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References

- Longo, S., et al., 2017. Life Cycle Assessment of organic and conventional apple supply chains in the North of Italy. Journal of Cleaner production. http://dx.doi.org/10.1016/j.jclepro.2016.02.049

Thank you!