Life Cycle Assessment

Unit 3. Project with Open LCA Software

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UNIT 3
3.2. PROJECT WITH OPEN LCA SOFTWARE

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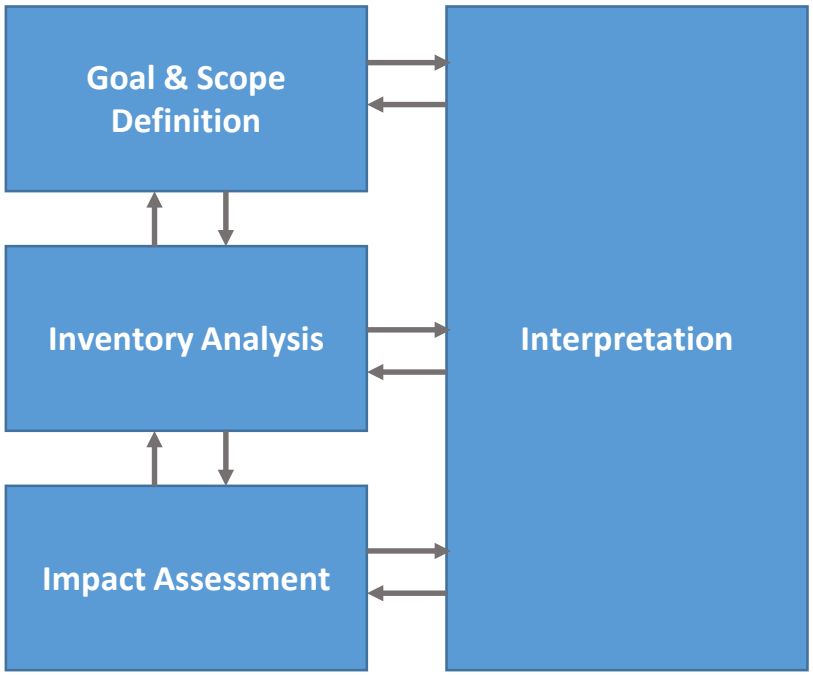
Life Cycle Assessment (LCA) fundamentals

INTRODUCTION TO OPENLCA SOFTWARE

LCA CONCEPT

Inter-linked stages in LCA

(iterative character)



Stages in LCA

1. Goal & Scope Definition

What? Process, product, service
Why? Reasons
To whom? Public & readership

2. Inventory Analysis

Inputs & outputs of energy, materials and emissions

3. Impact Assessment

How much environmental impact?

4. Interpretation

What is the best option?
What is the hot point throughout Life Cycle?

openLca

INTERNATIONAL STANDARD **ISO 14040** Second edition 2006-07-01
Environmental management—Life cycle assessment—Principles and framework

OPENLCA - OVERVIEW

✓Open software to perform LCA calculations available here:
http://www.openlca.org/

✓ Databases for calculations required available here:
https://nexus.openlca.org/

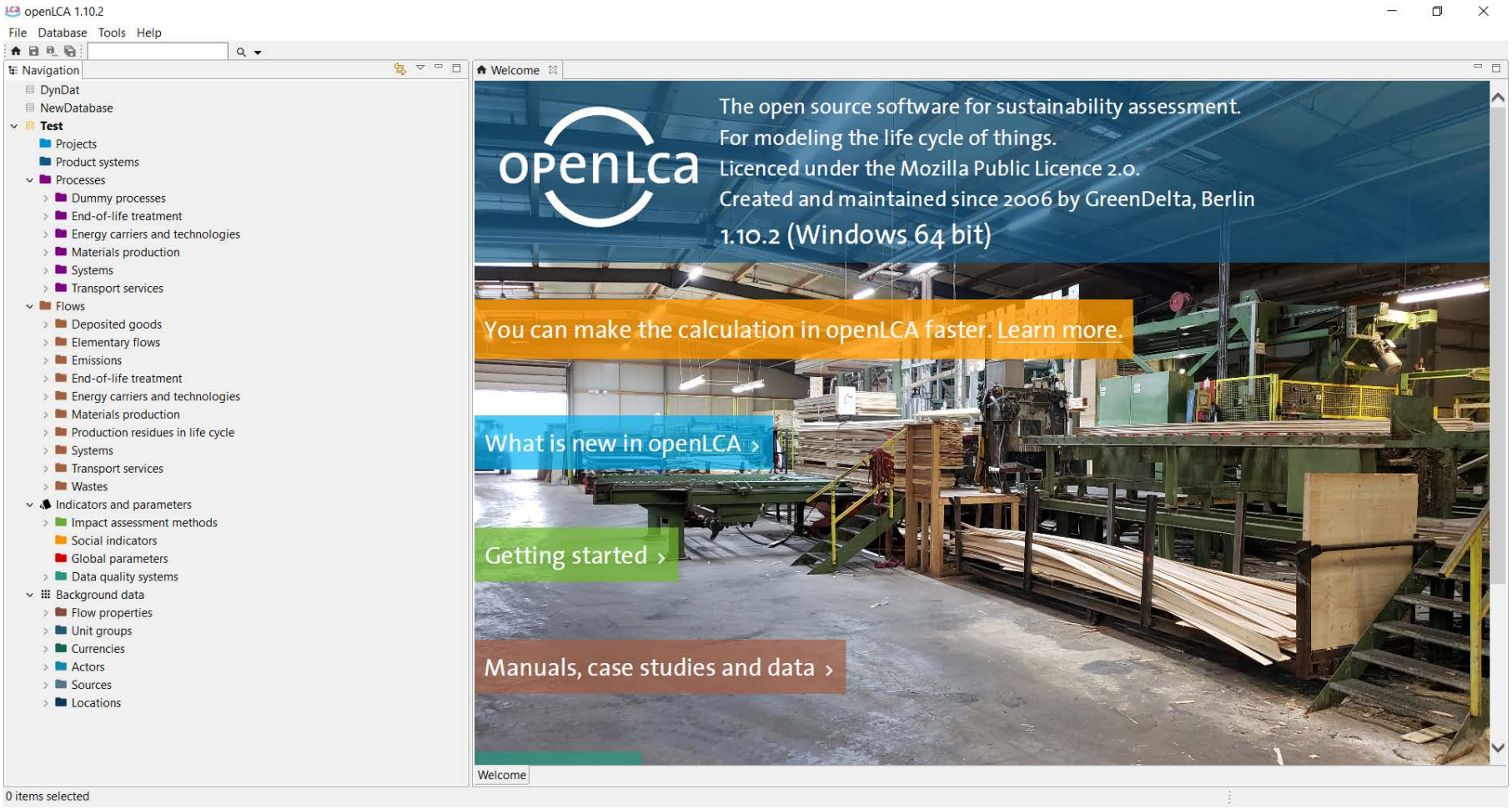
Tips:

- **ELCD** (European reference Life Cycle Database) can be a good alternative.
- For the impact assessment methods, opening **LCIA methods** can be useful.

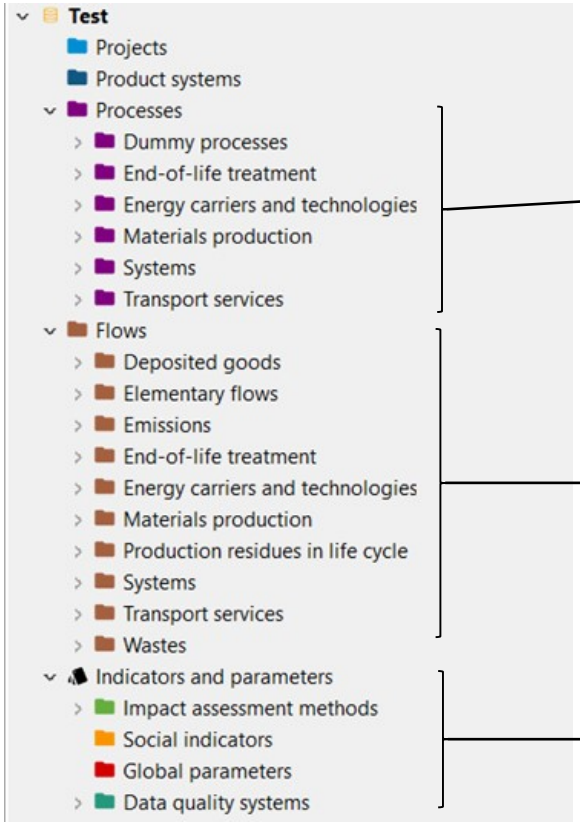
✓External support & guidance via OpenLCA official YouTube channel:
https://www.youtube.com/channel/UCGiahq1YZWK4pRXDVXuIi6w/playlists

OpenLCA, as most software, "only" provide numbers, the engineers must analyze them, get the relevant information, and adjust the message to the audience

OPENLCA - OVERVIEW



OPENLCA - OVERVIEW



Unit Processes: Individual operations to be carried out

- U-so (unit single operation): processes to be evaluated. Need to identify all the inputs and outputs
- Agg (aggregated): includes ALL the elementary flows to produce a certain product (resource)

Flows are the material/energy inputs/outputs of each process

- Intermediate flows: connect unit processes
- Elementary flows: raw material/emissions from/to the environment

We focus on impact assessment methods for the project

CASE STUDY: POLYMER PRODUCTION

- A polymer production plant (Cauchos Norteños S.L.) is implementing a corporate social responsibility (CSR) management system, and so they need a more environmentally friendly product.
- The CEO of the plant wants to identify and reduce the main impacting stages of its product life cycle.

- To do so, an LCA study is hired to your company, so your duty is to create a very short report for the CEO, which can include the answer to the original question, what can we do to have a greener product?

- The LCI for the polymer production is given in coming slides, thus the most time-consuming task has been already completed!

- You have to prepare a 5-slides presentation with the relevant information about your findings to convince the CEO.

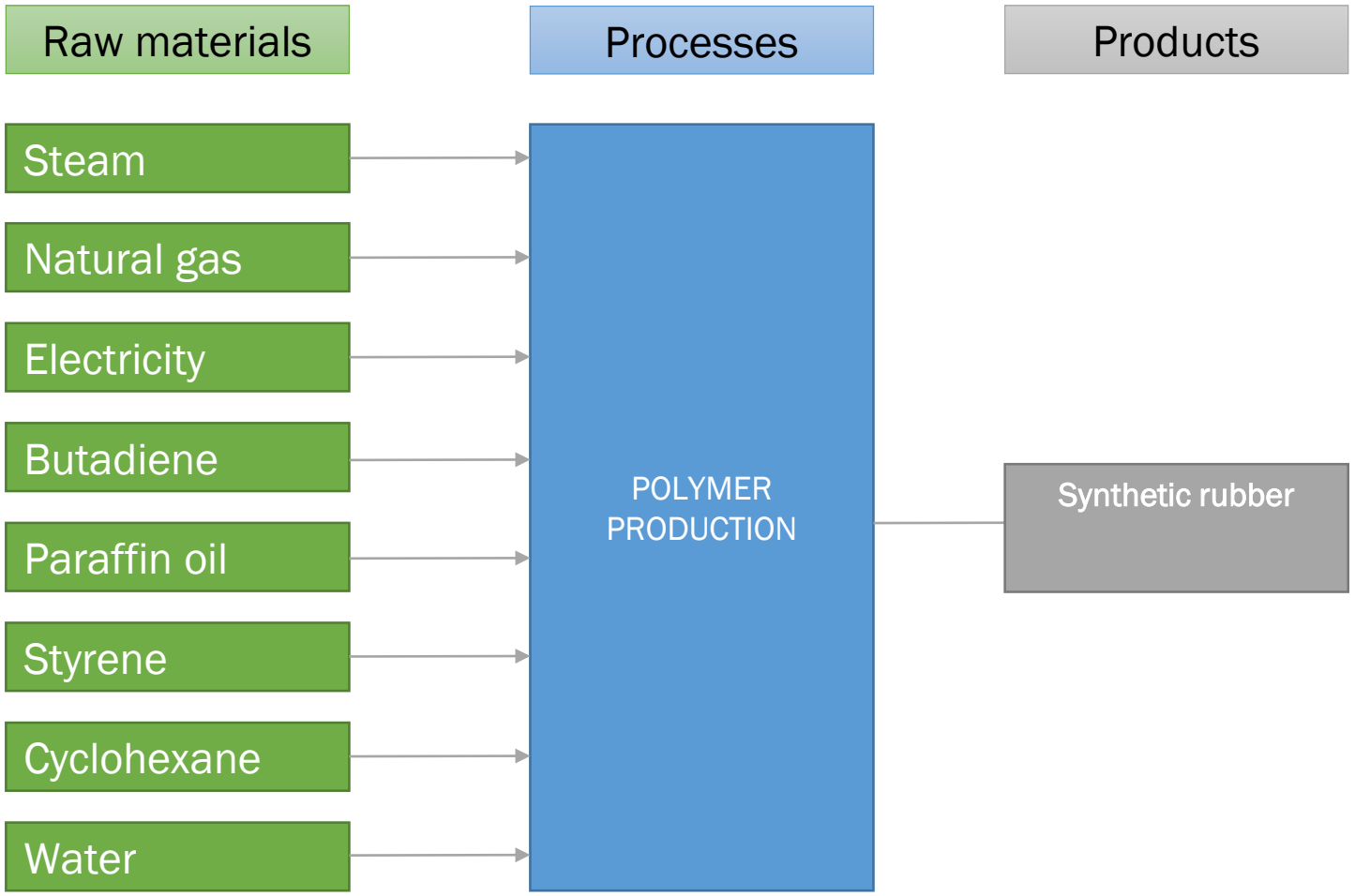
CASE STUDY: POLYMER PRODUCTION

CAUCHOS NORTEÑOS S.L. - INVENTORY		
	Value	Units
Energy		
Steam	1305873	GJ
Natural Gas	158955	GJ
Electricity	224001	GJ
Raw materials		
Butadiene	74280	T
Styrene	36798	T
Paraffin Oil	7353	T
Cyclohexane	1886	T
Water		
Water	125798	m^3
Air		
Cyclohexane (as NMVOC)	1886	T
Water		
THF (as COD)	40697	Kg
Soil		
Hazardous waste	522	T
Non-hazardous waste	2952	T
TOTAL PRODUCTION		
SYNTHETIC RUBBER	120886	T

CASE STUDY: POLYMER PRODUCTION

ELEMENTARY OUTPUT FLOW FOR EACH INDIVIDUAL PROCESS										
Flow	CO_2	CH_4	N_2O	SO_2	NO_X	NMVOC	COD	Hazard. waste	Non-hazard. waste	Units
Energy										
Steam	83.33	0.168	0.001	0.143	0.075	0.023	0.095	0	0	kg/GJ
Natural Gas	4.85E-03	3.17E-05	8.59E-08	2.18E-06	1.73E-05	1.50E-06	1.32E-06	0.00E+00	0.00E+00	kg/GJ
Electricity	135.00	0.27	0.00	0.92	0.48	0.02	0.11	0.00	0.00	kg/GJ
Raw materials										
Butadiene	1026	5.489	3.27E-08	2.286	2.04	2.21	0.397	0	0	kg/t
Styrene	2460	30.02	1.79E-03	6.67	4.51	2.78	2.61	0	0	kg/t
Parafinic Oil	457	1.87	8.75E-06	4.32	1.77	1.19	15.53	0	0	kg/t
Cyclohexane	1959	14.45	6.87E-03	5.25	3.55	2.37	3.87	0	0	kg/t
Water										
Water	2.36E-02	2.23E-07	3.02E-07	3.37E-05	5.15E-05	1.09E-05	7.87E-05	0	0	kg/m^3
Air										
NMVOC	0	0	0	0	0	1000	0	0	0	kg/T
Water										
COD	0	0	0	0	0	0	1	0	0	kg/kg
Soil										
Hazard. waste	0	0	0	0	0	0	0	1000	0	kg/t
Non-hazard.waste	0	0	0	0	0	0	0	0	1000	kg/t

CASE STUDY: POLYMER PRODUCTION



CASE STUDY: POLYMER PRODUCTION

Development

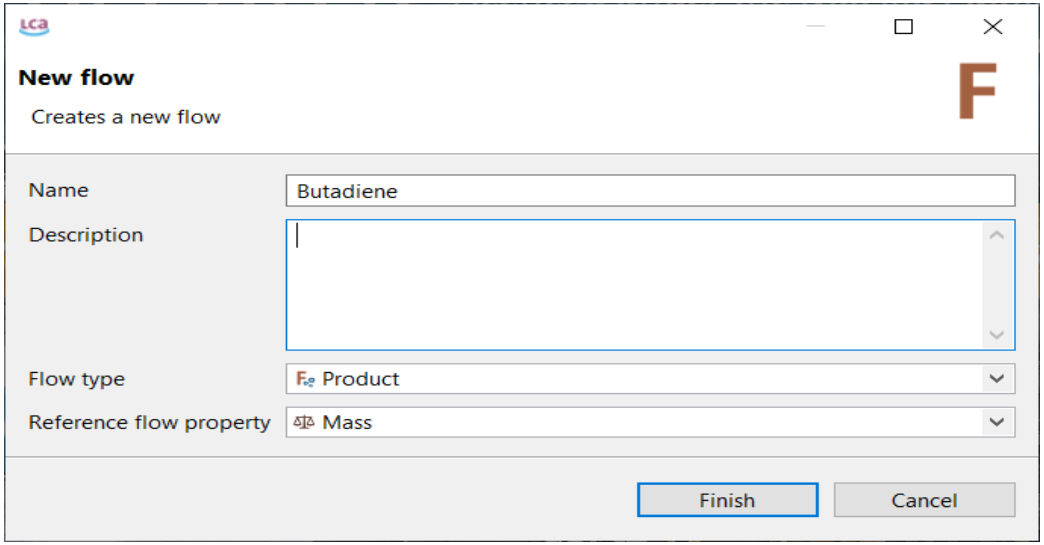
Identify the **flows** that are already available and the ones that need to be created:

Tips:

- Typical flows (i.e. steam, natural gas, water, etc.) can be directly taken from the OpenLCA inventory.
- Specific material flows (i. e butadiene) usually need to be created.

Info required:

- Name of the flow
- Type
  - Elementary (inputs)
  - Product
  - Waste
- Reference flow property (units)



CASE STUDY: POLYMER PRODUCTION

Development

- Identify the **processes** that are already available and the ones that need to be created:

  Tips:

  - Usually equivalent to the flows

  Info required:

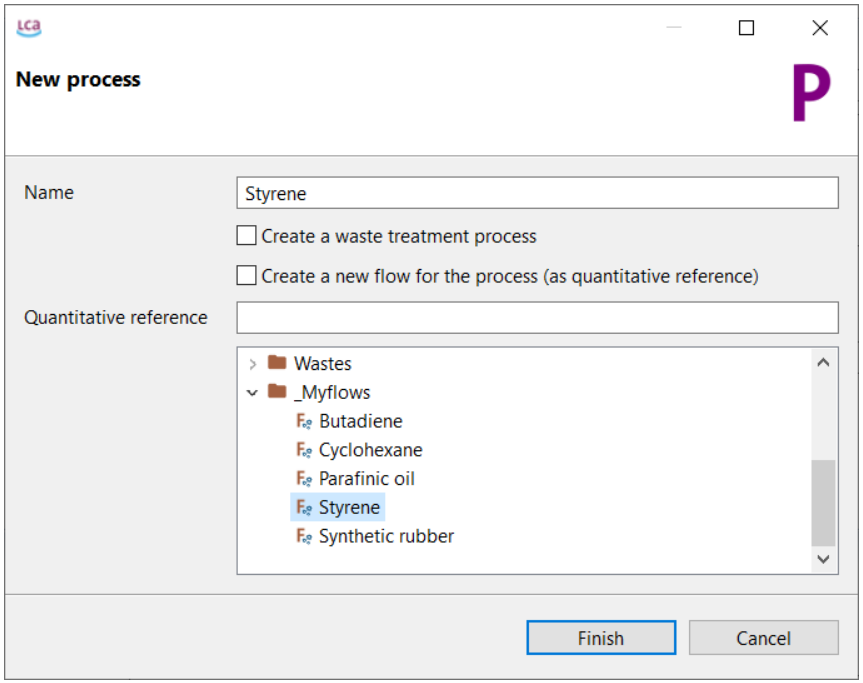
  - Name of the flow
  - Quantitative reference

  Definition of inputs/outputs:

  - Based on the LCI

  Definition of the provider

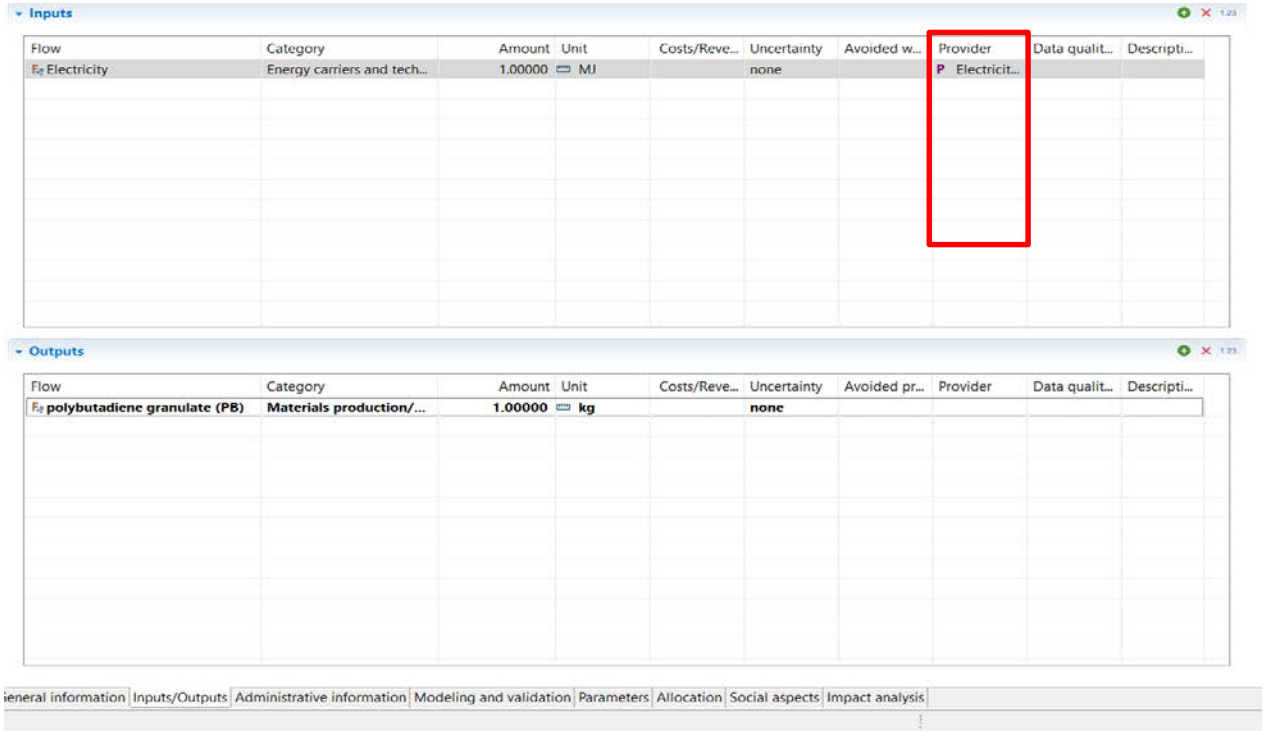
  - CRITICAL (next slide)



CASE STUDY: POLYMER PRODUCTION

Development

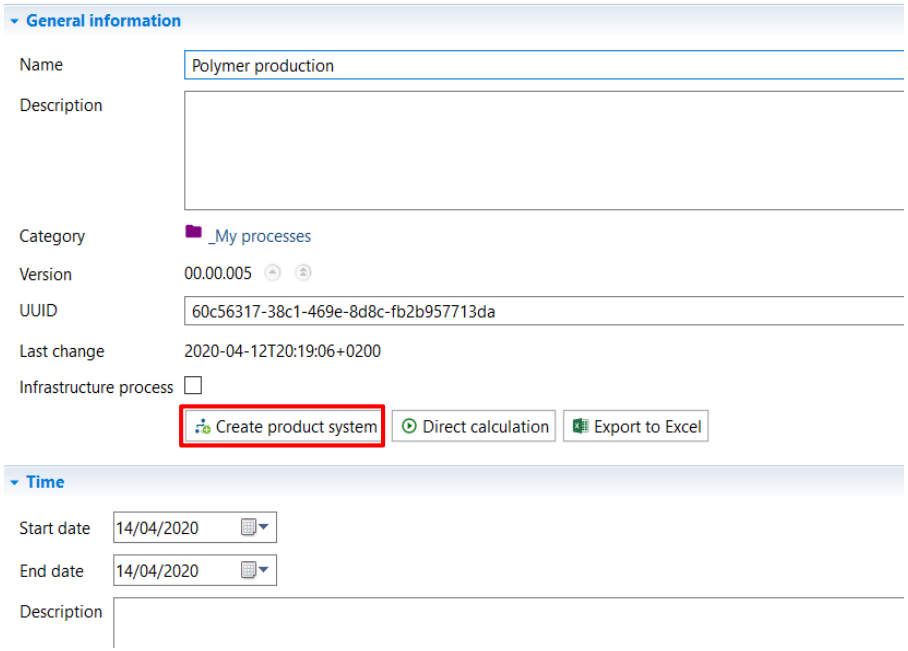
- **Definition of the provider:** it is mandatory to define a provider (process) for each flow. Remember, flows (intermediate materials for our process) does not have an impact by themselves but have the processes that generate these flows (as certain emissions that produce the impacts).

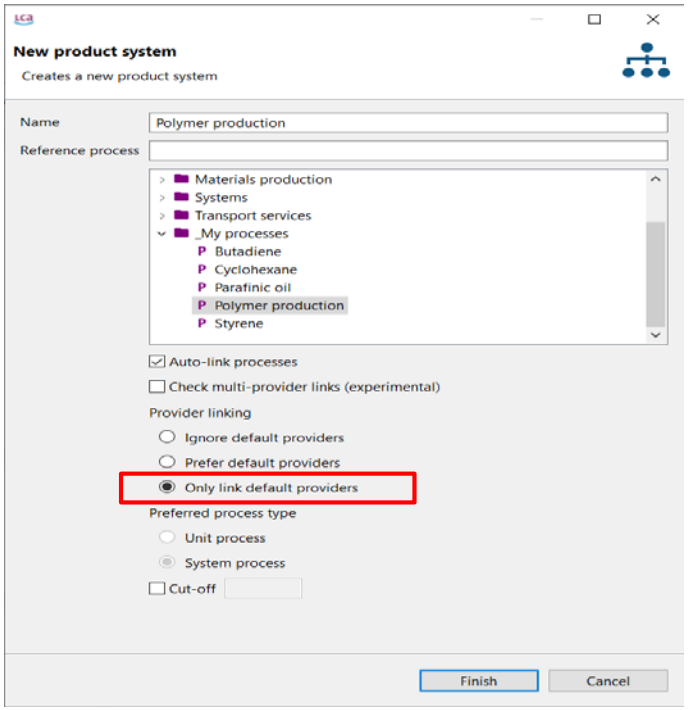


CASE STUDY: POLYMER PRODUCTION

Results

- **Create a product system:** it is necessary to adapt the product system of a certain process to our specific case study. To do so, the “provider linking” should be “only link default providers” to get just the providers (processes) that we have selected and not just the first one.

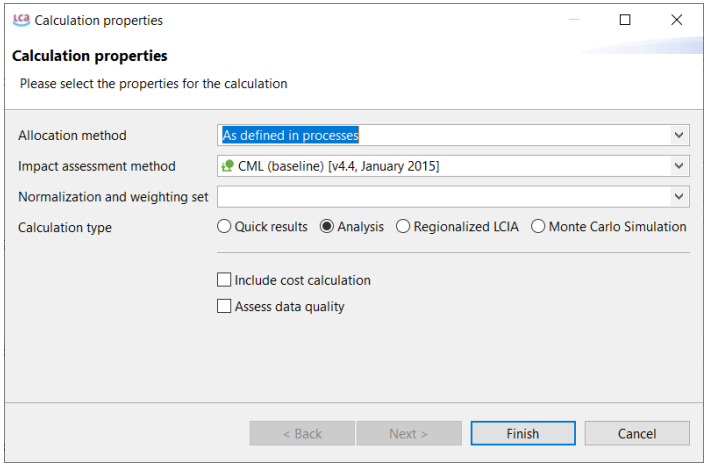




CASE STUDY: POLYMER PRODUCTION

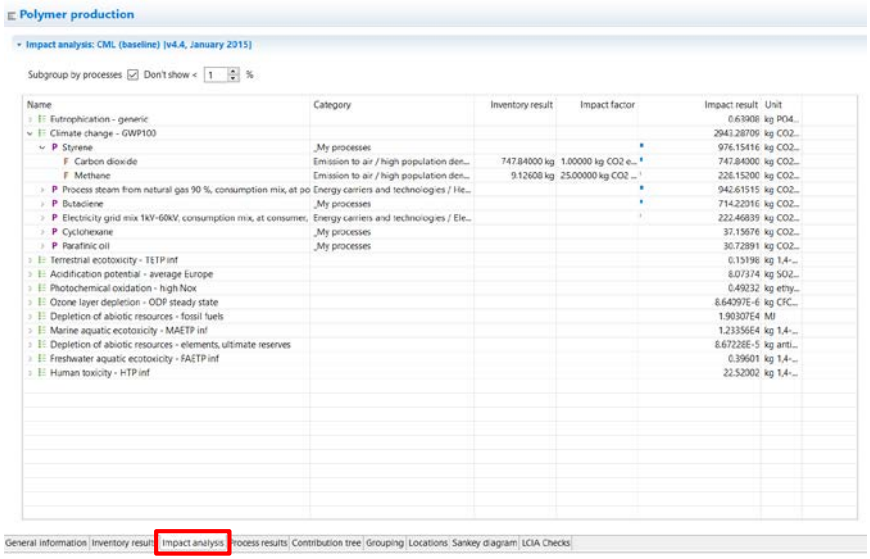
Results

- **Get the results:** once you ask to calculate the results, the proper impact assessment method should be selected.



- **Get the values:** available in the "impact analysis" tab.

Values are aggregated but can be also disaggregated to identify the process and the substance that produces the major impacts for each category.



OTHER CASE STUDIES

- **PET water bottles:** This tutorial is an LCA comparison of PET water bottles sold in Germany deriving from different production locations.

https://www.youtube.com/watch?v=r2Xdh5LT934

- **Ethanol vs. gasoline case study**: Example of using openLCA to compare the life cycle assessment of gasoline production with various ethanol production methods.

https://www.youtube.com/watch?v=WpHWDLpZlOs

- **Organic vs. conventional carrot production:** Tutorial and example of using openLCA to compare the LCA of organic carrots and carrots produced by conventional methods.

https://www.youtube.com/watch?v=q7kk_zz_qvU