

Life Cycle Assessment

Unit 3. Project with Open LCA Software



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Departamento de Ingenierías Química
y Biomolecular



UNIT 3

3.2. PROJECT WITH OPEN LCA SOFTWARE



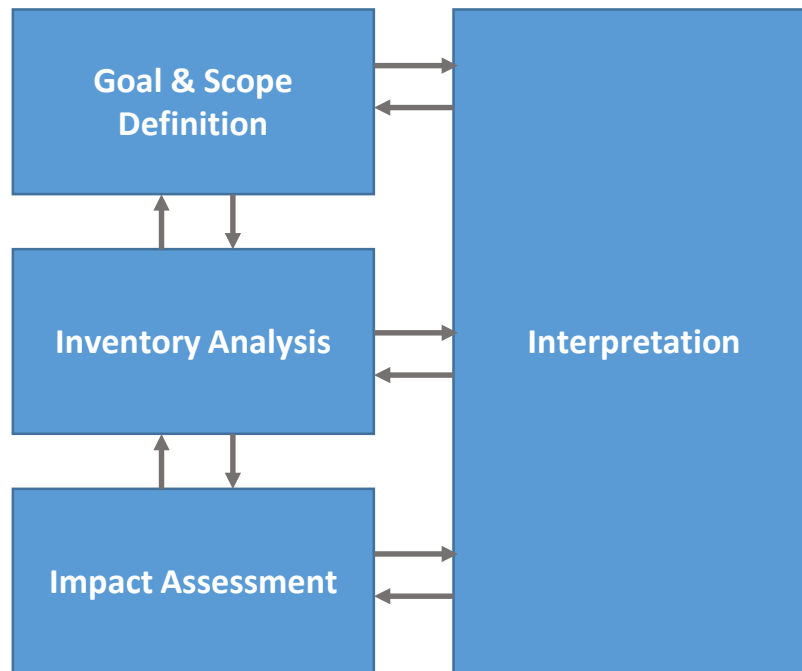
Jonathan Albo Sánchez, Antonio Domínguez Ramos, María Margallo Blanco, Javier Pinedo Alonso
Life Cycle Assessment (LCA) fundamentals

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?

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/UCGiahq1YZWK4pRXDVXuli6w/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 1.10.2

File Database Tools Help

Navigation

- DynDat
- NewDatabase
- Test
 - Projects
 - Product systems
- Processes
 - Dummy processes
 - End-of-life treatment
 - Energy carriers and technologies
 - Materials production
 - Systems
 - Transport services
- Flows
 - Deposited goods
 - Elementary flows
 - Emissions
 - End-of-life treatment
 - Energy carriers and technologies
 - Materials production
 - Production residues in life cycle
 - Systems
 - Transport services
 - Wastes
- Indicators and parameters
 - Impact assessment methods
 - Social indicators
 - Global parameters
 - Data quality systems
- Background data
 - Flow properties
 - Unit groups
 - Currencies
 - Actors
 - Sources
 - Locations

Welcome

The open source software for sustainability assessment.
For modeling the life cycle of things.
Licenced under the Mozilla Public Licence 2.0.
Created and maintained since 2006 by GreenDelta, Berlin
1.10.2 (Windows 64 bit)

You can make the calculation in openLCA faster. [Learn more.](#)

What is new in openLCA >

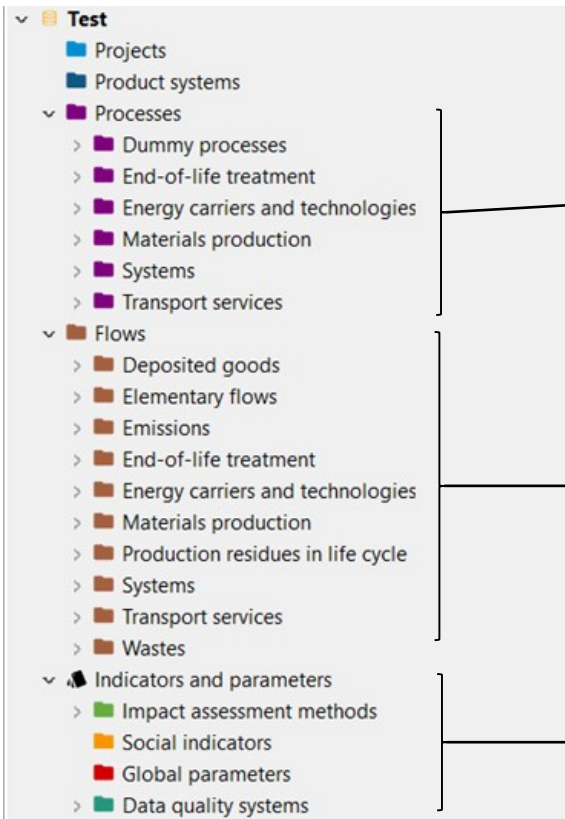
Getting started >

Manuals, case studies and data >

Welcome

0 items selected

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.

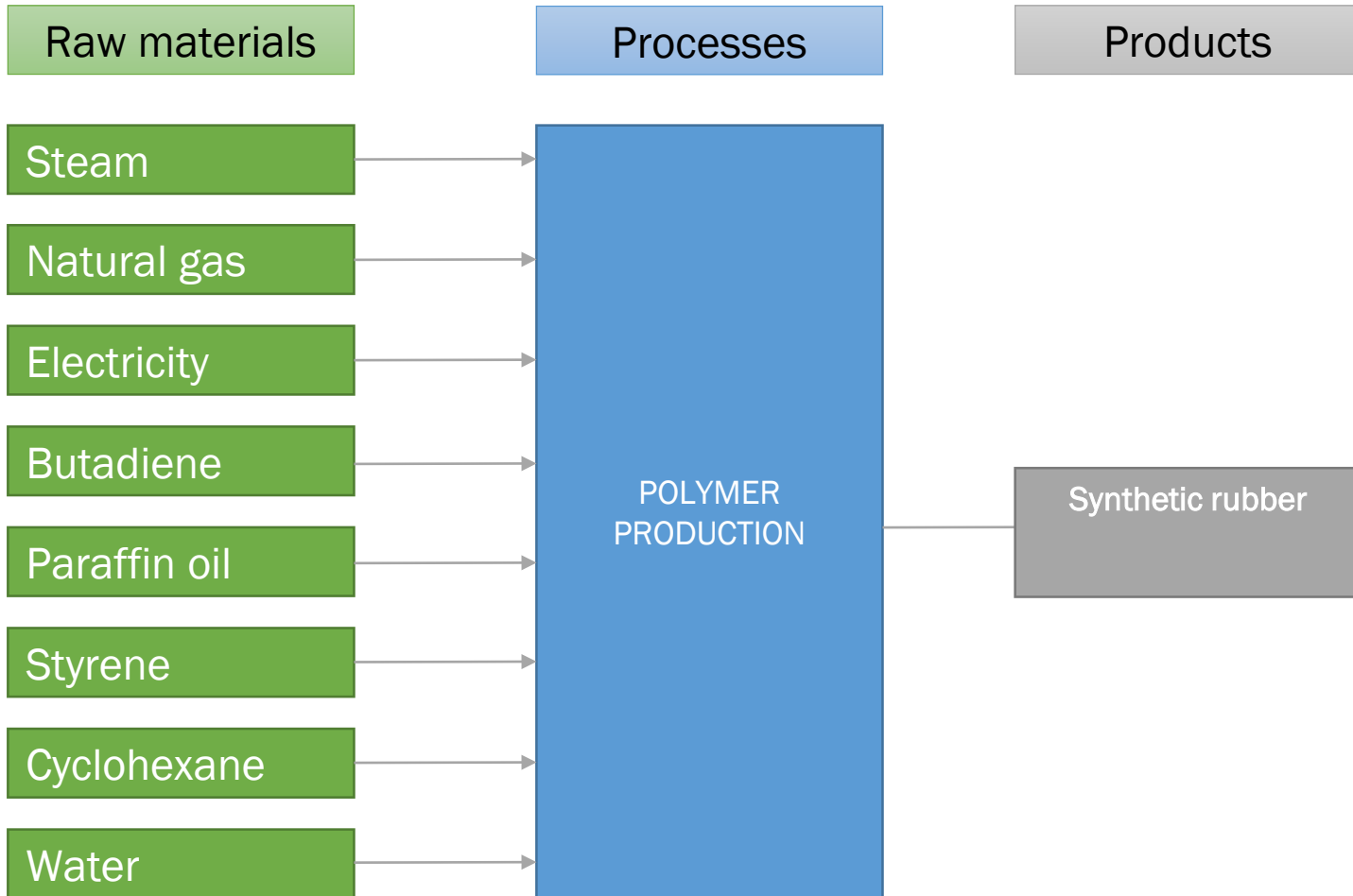
CASE STUDY: POLYMER PRODUCTION

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 ₂ O	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

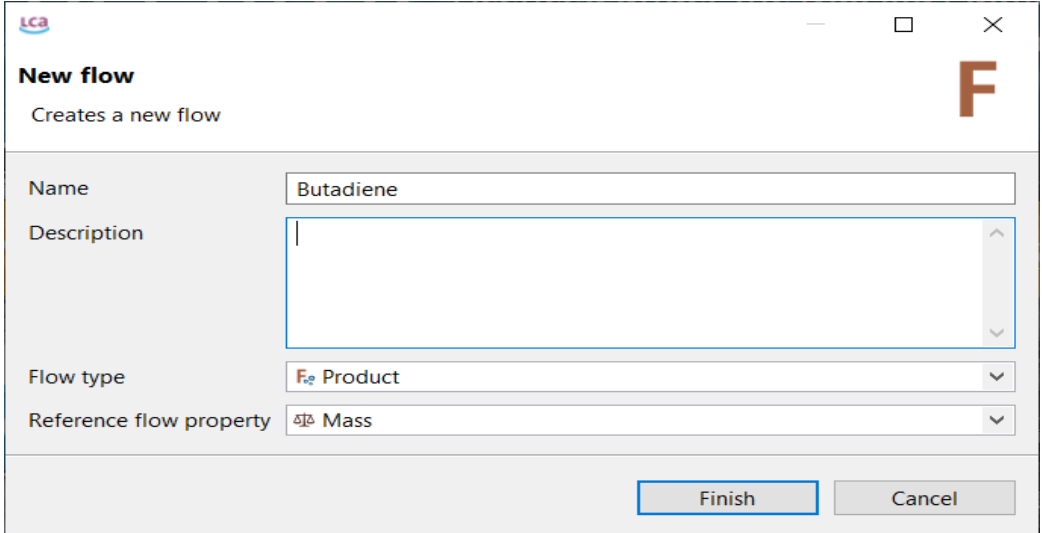
 Identify the **flows** that are already available and the ones that need to be created:

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)



The screenshot shows a software window titled "New flow" with the subtitle "Creates a new flow". The window contains the following fields and options:

- Name:** Butadiene
- Description:** (Empty text area)
- Flow type:** Product
- Reference flow property:** Mass

At the bottom right, there are two buttons: "Finish" and "Cancel".

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

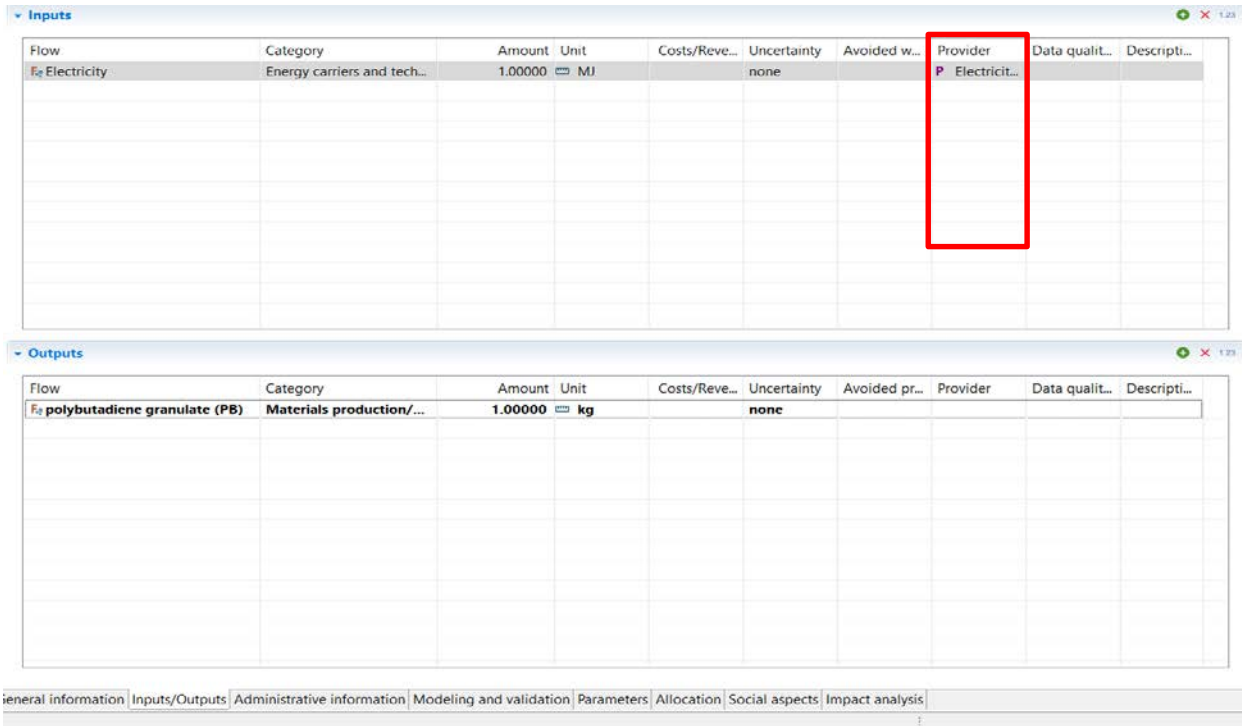
- **CRITICAL** (next slide)

The screenshot shows a 'New process' dialog box. The 'Name' field is filled with 'Styrene'. There are two unchecked checkboxes: 'Create a waste treatment process' and 'Create a new flow for the process (as quantitative reference)'. The 'Quantitative reference' field is empty. A tree view shows a folder structure with 'Wastes' and '_Myflows' expanded. Under '_Myflows', 'Styrene' is selected. The 'Finish' and 'Cancel' buttons are at the bottom right.

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).




The screenshot displays two tables: 'Inputs' and 'Outputs'. The 'Inputs' table has a red box around the 'Provider' column for the first row. The 'Outputs' table has a red box around the 'Provider' column for the first row. At the bottom, there is a navigation bar with tabs: 'General information', 'Inputs/Outputs', 'Administrative information', 'Modeling and validation', 'Parameters', 'Allocation', 'Social aspects', and 'Impact analysis'.

Flow	Category	Amount	Unit	Costs/Reve...	Uncertainty	Avoided w...	Provider	Data qualiti...	Descripti...
Electricity	Energy carriers and tech...	1.00000	MJ		none		P Electricity...		

Flow	Category	Amount	Unit	Costs/Reve...	Uncertainty	Avoided pr...	Provider	Data qualiti...	Descripti...
polybutadiene granulate (PB)	Materials production/...	1.00000	kg		none				

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.

General information

Name: Polymer production

Description:

Category: **_My processes**

Version: 00.00.005

UUID: 60c56317-38c1-469e-8d8c-fb2b957713da

Last change: 2020-04-12T20:19:06+0200

Infrastructure process:

Time

Start date: 14/04/2020

End date: 14/04/2020

Description:

New product system
Creates a new product system

Name: Polymer production

Reference process:

- > Materials production
- > Systems
- > Transport services
- > **_My processes**
 - P Butadiene
 - P Cyclohexane
 - P Parafinic oil
 - P Polymer production**
 - P Styrene

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
 System process
 Cut-off

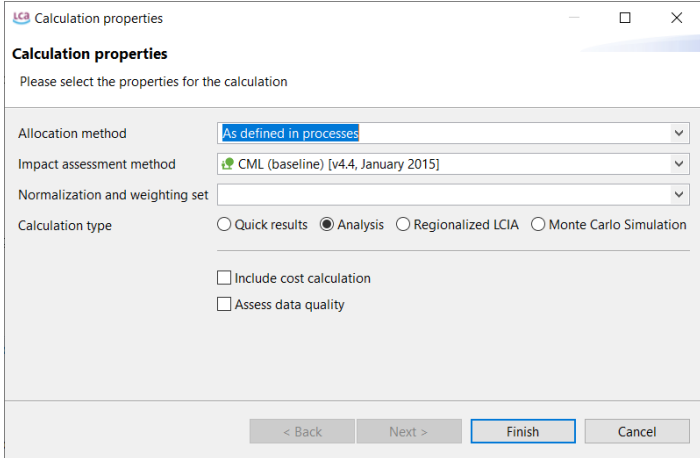
CASE STUDY: POLYMER PRODUCTION

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.



Calculation properties

Calculation properties

Please select the properties for the calculation

Allocation method: As defined in processes

Impact assessment method: CML (baseline) [v4.4, January 2015]

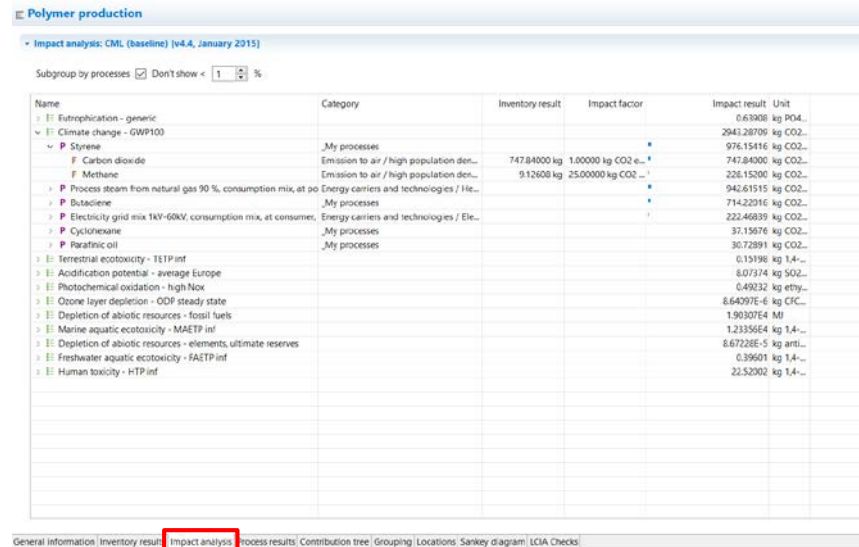
Normalization and weighting set:

Calculation type: Quick results Analysis Regionalized LCIA Monte Carlo Simulation

Include cost calculation

Assess data quality

< Back Next > Finish Cancel



Polymer production


Impact analysis: CML (baseline) [v4.4, January 2015]

Subgroup by processes Don't show < 1 > %


Name	Category	Inventory result	Impact factor	Impact result	Unit
Et: Eutrophication - generic				0.63008	kg PO4...
Et: Climate change - GWP100				2041.28706	kg CO2...
P Styrene	,My processes			976.15416	kg CO2...
F Carbon dioxide	Emission to air / high population den...	747.84000	1.00000 kg CO2 e...	747.84000	kg CO2...
F Methane	Emission to air / high population den...	9.12608	25.00000 kg CO2 e...	228.15200	kg CO2...
P Process steam from natural gas 90 %, consumption mix, at po	Energy carriers and technologies / He...			942.61515	kg CO2...
P Butadiene	,My processes			714.22016	kg CO2...
P Electricity grid mix 1kV-60kV, consumption mix, at consumers	Energy carriers and technologies / Ele...			222.46839	kg CO2...
P Cyclohexane	,My processes			37.15876	kg CO2...
P Paraffinic oil	,My processes			30.72891	kg CO2...
Et: Terrestrial ecotoxicity - TETP inf				0.15198	kg 1,4-...
Et: Acidification potential - average Europe				8.07374	kg SO2...
Et: Photochemical oxidation - high Nox				0.49032	kg etry...
Et: Ozone layer depletion - ODF steady state				6.64976	-6 kg CFC...
Et: Depletion of abiotic resources - fossil fuels				1.9930754	MJ
Et: Marine aquatic ecotoxicity - MAETP inf				1.235564	kg 1,4-...
Et: Depletion of abiotic resources - elements, ultimate reserves				8.67226E-5	kg arti...
Et: Freshwater aquatic ecotoxicity - FAETP inf				0.39601	kg 1,4-...
Et: Human toxicity - HTP inf				22.52002	kg 1,4-...

General information | Inventory results | **Impact analysis** | Process results | Contribution tree | Grouping | Locations | Sankey diagram | LCIA Checks


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=WpHWDLpZIOs>

 **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