

Introduction to openLCA



Cristina Rodríguez (GreenDelta)

September 24th-25th , 2014
Zurich, Switzerland



Day 1

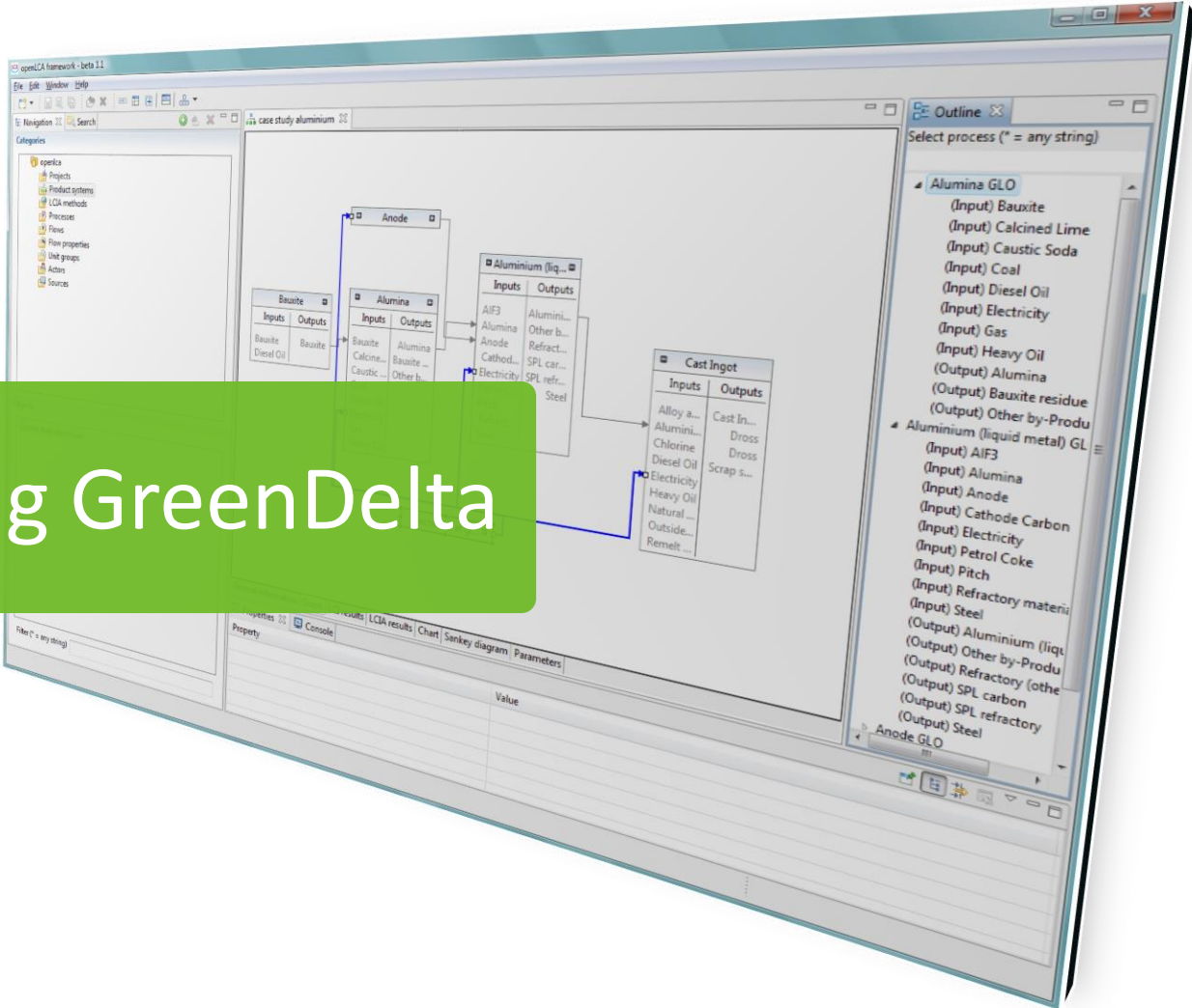
- Introduction to GreenDelta
- Introduction to openLCA
- Functions and features (overview)
- Installation
- First look at the software
- LCA data import
- Tips and tricks for dealing with openLCA
- Modelling
- Results analysis and interpretation
- Data export
- Sensitivity analysis



Day 2

- Allocation and system expansion
- Uncertainty analysis
- Life Cycle Costing
- Additional (new) features
- Experimental features
- Regionalised LCIA
- Ecoinvent 3

Introducing GreenDelta



GreenDelta background

- Founded by Dr. Andreas Citroth in 2004
- 10 employees (engineers, biologists, business administrators)
- Office in Berlin
- Business world-wide: sustainability research, life cycle assessments, databases, software for life cycle assessments and sustainability

GreenDelta team



- Our mixed team helps us to provide users with a range of perspectives and solutions



Andreas Ciroth
Founder & Managing Director



Michael Srocka
openLCA Technical Lead



Cristina Rodríguez
Environmental Consultant



Sarah Winter
Client Relations, LCA Modeling



Sebastian Greve
Software Developer



Martin Pluta
Web and Software Developer



Kathleen Kiehl
Client Relations, LCA Specialist

GreenDelta for openLCA

- Software expansion/adaptation
- Case studies
- Guided case studies
- Data acquisition
- Database compilation

GreenDelta for openLCA (II)

- Critical review (ISO 14040)
- LCA, LCC, SLCA
- Data management and hosting
- openCLA Training
- Service und Support

Customers



SIEMENS

Steelcase



Knoll



PE INTERNATIONAL



Customers



ADEME



Agence de l'Environnement
et de la Maîtrise de l'Énergie



S Y K E

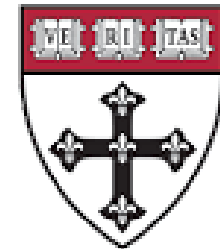
Finnish Environment Institute



Customers



Technical University of Denmark



CHALMERS

ETH

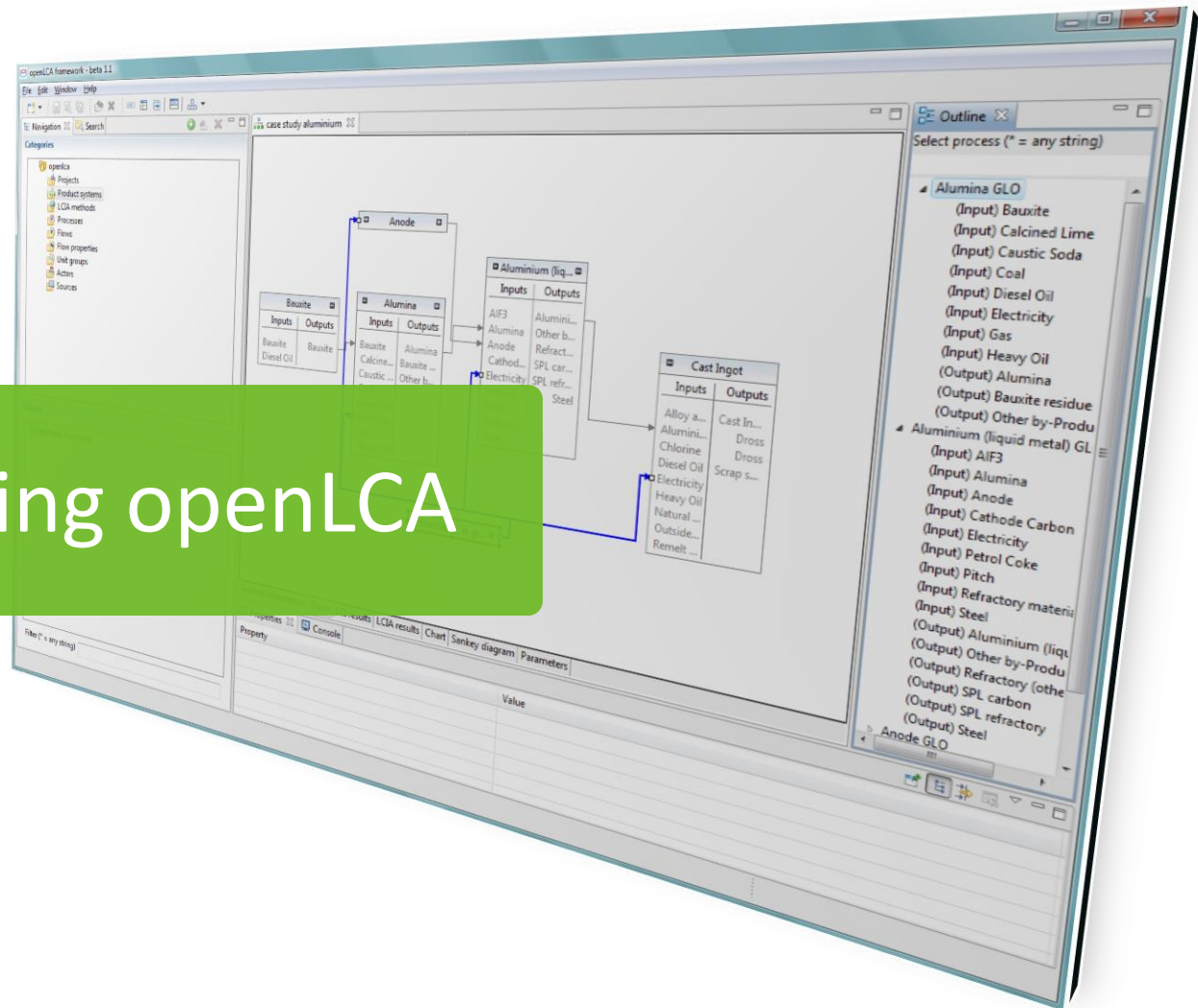
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE



Introducing openLCA



A free & professional approach to Life Cycle Assessment

- Completely open source
- Mac OS, Windows, and Linux
- Written in Java
- A truly international system with an established community of contributors and about 300 downloads per week

> 1,000 users



- Scalability and performance of leading software
- Customizable
- Intuitive user experience
- Upgrades keep you at the forefront of LCA software technology
- Quick, flexible, modern & expandable

openLCA: open source

- Mozilla public license 1.1
- Transparent: source code can be viewed and changed by anyone
- open source nature of the software makes it very suitable for use with sensitive data
- you can freely share both the software and any models you create, as long as the database license allows it

openLCA application

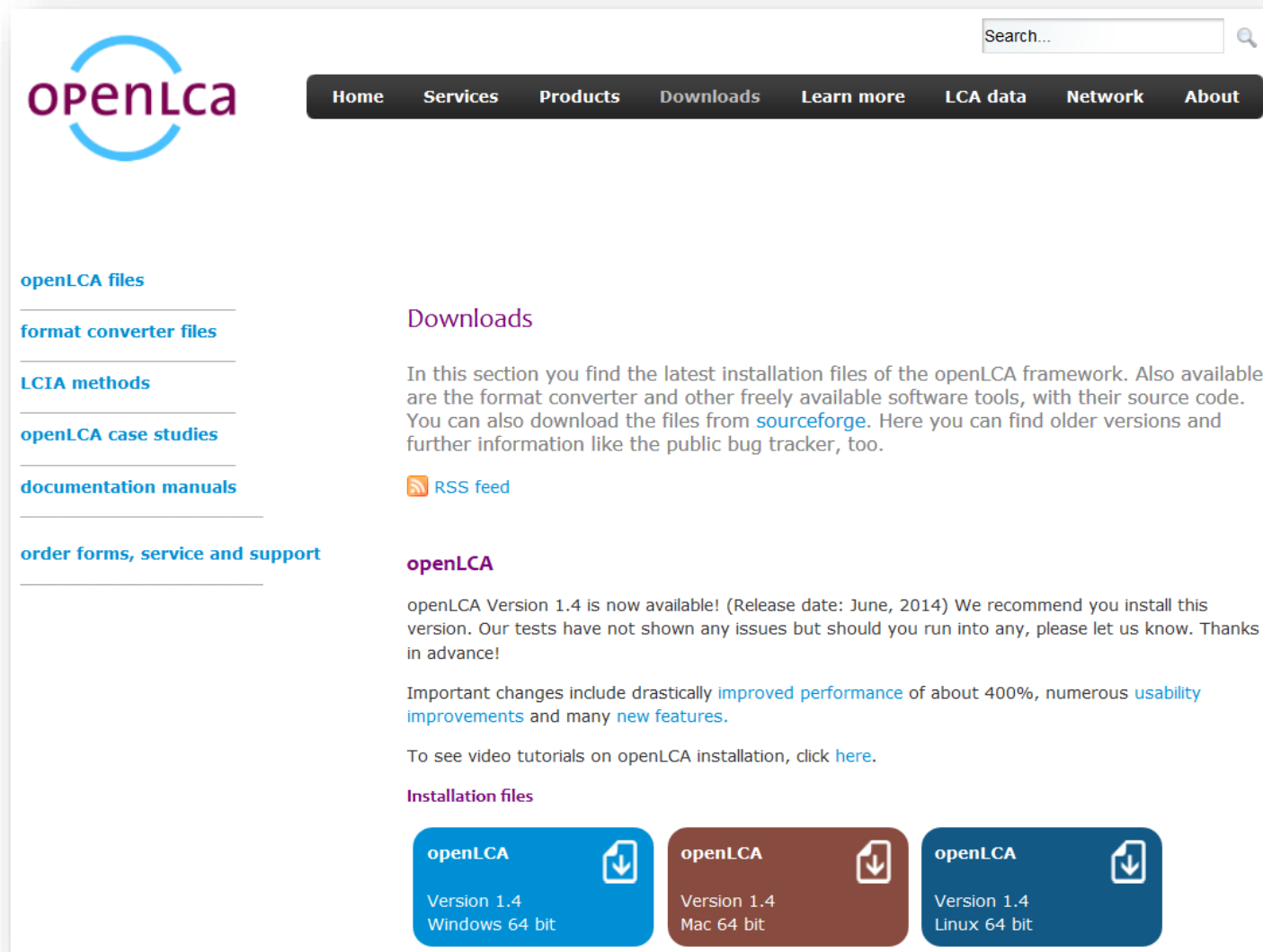
- LCA, LCC, SLCA
- Carbon & water footprints
- Environmental Product Declaration (EPD)
- US EPA's Design for the Environment label

- Integrated Product Policy (IPP) GreenDelta

openLCA.org

- Downloads (software, LCIA methods, ...)
- Videos, manuals, case studies
- Services (service contracts, training, critical reviews, hosting & data management solutions...)
- Forum

openLCA.org/downloads



The screenshot shows the openLCA.org website's download page. At the top left is the openLCA logo, a blue circle with the text 'openLca' in purple. To the right is a search bar with the placeholder text 'Search...'. Below the logo is a dark navigation bar with white text for 'Home', 'Services', 'Products', 'Downloads', 'Learn more', 'LCA data', 'Network', and 'About'. The main content area has a left sidebar with links: 'openLCA files', 'format converter files', 'LCIA methods', 'openLCA case studies', 'documentation manuals', and 'order forms, service and support'. The main content features a 'Downloads' section with a paragraph explaining the latest installation files and a link to 'sourceforge'. Below this is an 'RSS feed' icon and text. The 'openLCA' section announces Version 1.4 (June 2014) and lists improvements in performance and usability. It also includes a link to video tutorials. At the bottom, three download buttons are shown: 'openLCA Version 1.4 Windows 64 bit' (blue), 'openLCA Version 1.4 Mac 64 bit' (brown), and 'openLCA Version 1.4 Linux 64 bit' (dark blue). Each button has a white download icon.

openLCA

Search...

Home Services Products Downloads Learn more LCA data Network About

openLCA files

format converter files

LCIA methods


openLCA case studies

documentation manuals

order forms, service and support

Downloads

In this section you find the latest installation files of the openLCA framework. Also available are the format converter and other freely available software tools, with their source code. You can also download the files from [sourceforge](#). Here you can find older versions and further information like the public bug tracker, too.

 [RSS feed](#)




openLCA

openLCA Version 1.4 is now available! (Release date: June, 2014) We recommend you install this version. Our tests have not shown any issues but should you run into any, please let us know. Thanks in advance!

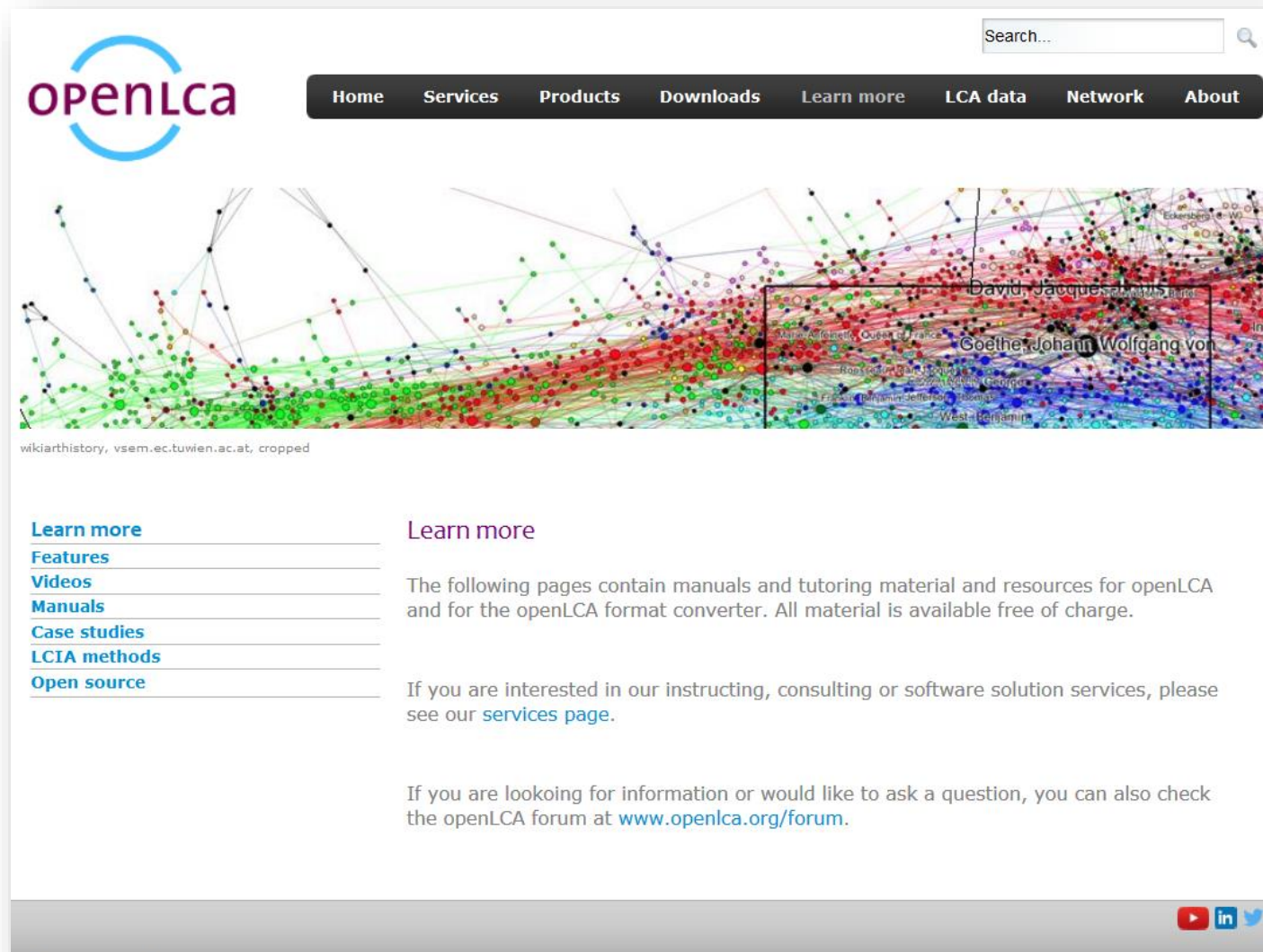
Important changes include drastically [improved performance](#) of about 400%, numerous [usability improvements](#) and many [new features](#).

To see video tutorials on openLCA installation, click [here](#).

Installation files

 openLCA Version 1.4 Windows 64 bit	 openLCA Version 1.4 Mac 64 bit	 openLCA Version 1.4 Linux 64 bit
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openLCA.org/learnmore



The screenshot shows the openLCA.org website. At the top left is the openLCA logo, consisting of the text "openLCA" in purple and blue with a blue circular graphic. To the right is a search bar with the text "Search...". Below the logo and search bar is a dark navigation bar with white text for "Home", "Services", "Products", "Downloads", "Learn more", "LCA data", "Network", and "About". The main content area features a large, colorful network graph visualization with nodes and connecting lines. Below the graph is a list of links under the heading "Learn more": "Features", "Videos", "Manuals", "Case studies", "LCIA methods", and "Open source". To the right of this list is a "Learn more" link and a paragraph of text: "The following pages contain manuals and tutoring material and resources for openLCA and for the openLCA format converter. All material is available free of charge." Below this is another paragraph: "If you are interested in our instructing, consulting or software solution services, please see our [services page](#)." At the bottom of the main content area is a final paragraph: "If you are looking for information or would like to ask a question, you can also check the openLCA forum at www.openlca.org/forum." At the bottom right of the page are social media icons for YouTube, LinkedIn, and Twitter.

Search...

Home Services Products Downloads Learn more LCA data Network About

Learn more

Features

Videos

Manuals

Case studies

LCIA methods

Open source

Learn more

The following pages contain manuals and tutoring material and resources for openLCA and for the openLCA format converter. All material is available free of charge.

If you are interested in our instructing, consulting or software solution services, please see our [services page](#).

If you are looking for information or would like to ask a question, you can also check the openLCA forum at www.openlca.org/forum.

YouTube LinkedIn Twitter

openLCA.org/services



[Home](#) [Services](#) [Products](#) [Downloads](#) [Learn more](#) [LCA data](#) [Network](#) [About](#)

[Services](#)

[Training](#)

[Service contracts](#)

Services

We and our partners provide a broad range of services in the context of openLCA:

- **Service contracts:** If you are using openLCA in a professional environment (a company, for example) a service contract may make sense. With a service contract: we guarantee response times, you are informed about changes in the software in due time, we are available for answering technical support questions.
- **Training:** GreenDelta provides regular training courses for openLCA in English, German, and Spanish. We offer training for beginners and advanced users inhouse, online and in Berlin. All courses contain theoretical as well as practical content, and illustrative case studies.
- **Guided case studies:** Typically, both openLCA and Life Cycle Assessment case studies are learned best in a practical application. Therefore we offer guided case studies, especially for those new to openLCA and to Life Cycle Assessment. A guided case study will be performed mainly by you, but at important milestones, from software installation to definition of goal and scope to inventory modeling to interpretation, we provide feedback and discuss modeling decisions and conclusions and interpretation. Of course, a non-disclosure agreement makes sure that you can share also sensitive information.
- **Critical reviews:** We perform critical reviews of LCA case studies according to ISO 14040 and 14044. With openLCA you can easily share your complete LCA models with your clients, as well as within the review panel.
- **Hosted solutions:** openLCA can interact with a ILCD database that serves users as a central repository for exchanging process data sets and also complete product system models (see [openLCA features](#) for more information). We offer hosting solutions for this database, so that you do not need to care for the technical hosting requirements.
- **Adaptions and extensions:** If openLCA (or other LCA software) does not meet your

openLCA.org/forum



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It is currently 02 Sep 2014 14:05

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FORUM	TOPICS	POSTS	LAST POST
openLCA 1.4	23	73	by aciroth 11 Aug 2014 13:46
Installation	25	103	by aciroth 02 Sep 2014 13:18
Modelling	78	236	by aciroth 27 Aug 2014 16:30
Data and Data Exchange	66	233	by aciroth 23 Aug 2014 09:17
Developer	13	45	by aciroth 26 Jun 2014 17:09
Other	17	52	by MartinaZ 11 Jun 2014 11:19
Version 1.2 test Forum for the July 2010 (+..) test round of openLCA	6	17	by aciroth 01 Jun 2013 12:48

LOGIN • REGISTER

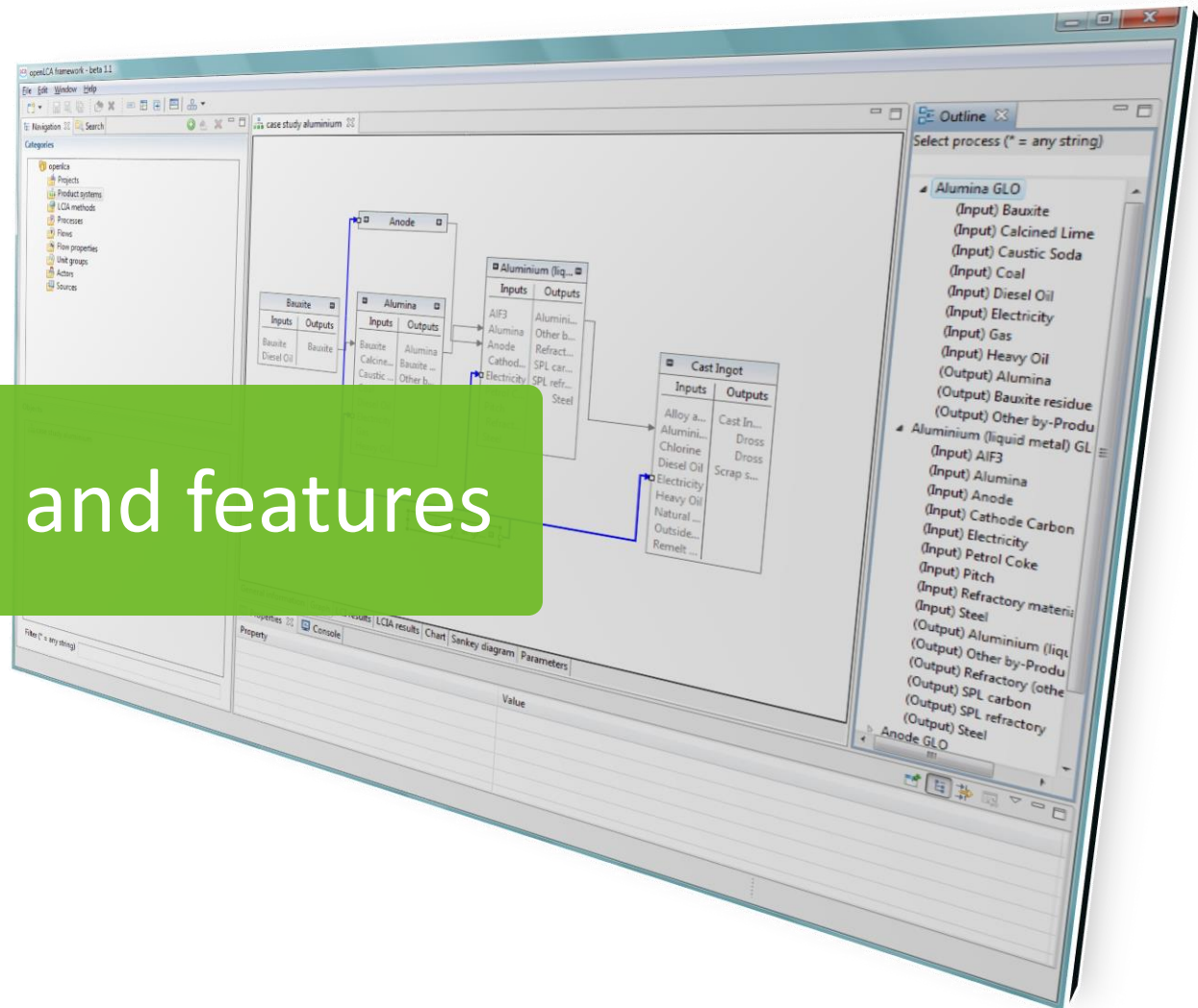
Username: Password: | Log me on automatically each visit

WHO IS ONLINE

In total there are **2** users online :: 0 registered, 0 hidden and 2 guests (based on users active over the past 5 minutes)
Most users ever online was **54** on 30 Jun 2013 00:22

Registered users: No registered users

Functions and features

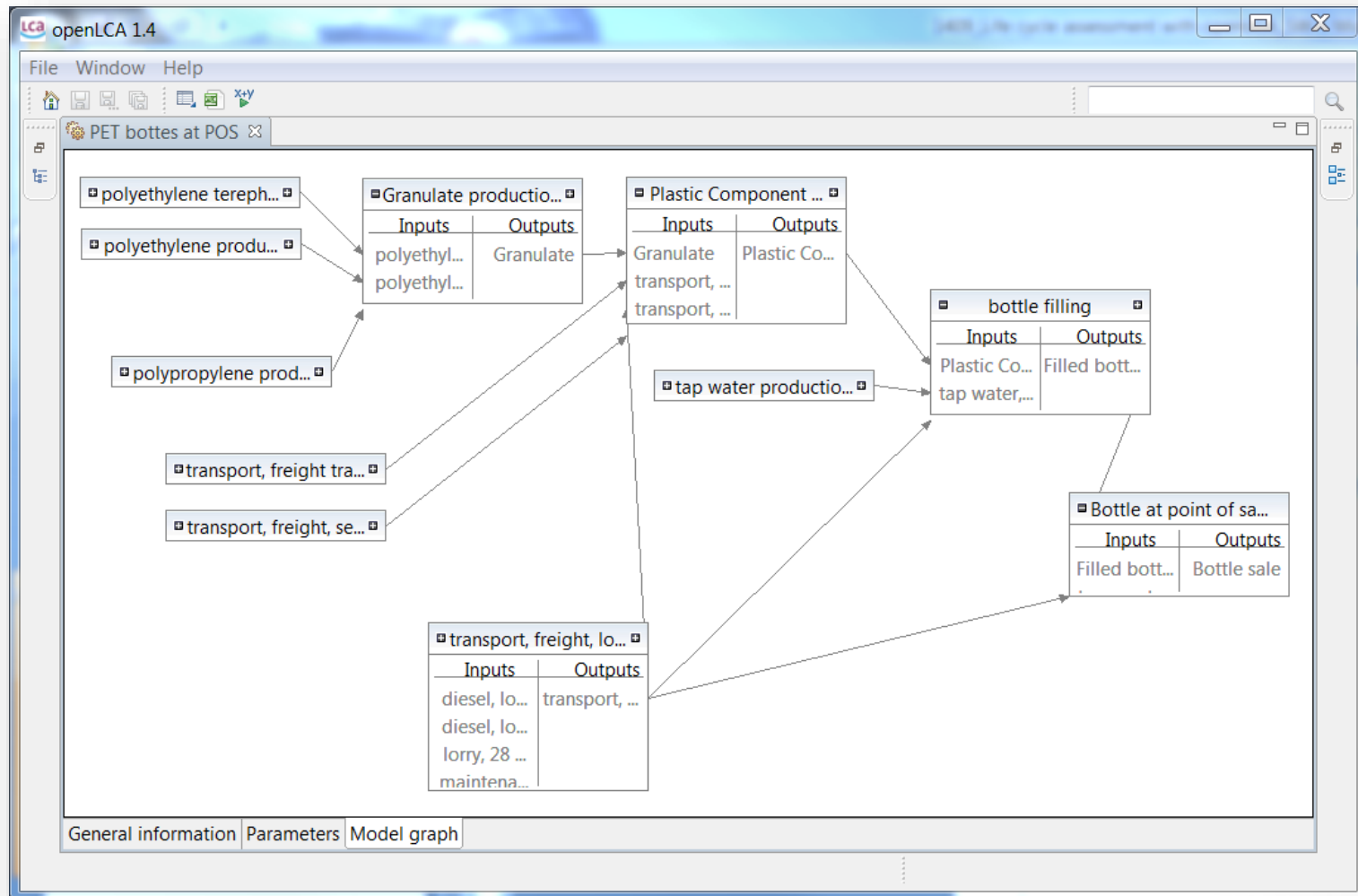


Graphical modelling of product systems

= Process networks

- Process networks can be created automatically and manually
- graphical modeling based on the Eclipse Graphical Editing Framework (GEF)
- Different product systems can be compared (=> project)

Graphic modelling of process networks based on Eclipse GEF



Allocation and system expansion for modelling multi-output processes

The screenshot shows the openLCA 1.4 software interface. The main window displays the 'Allocation' tab for the process 'Ethanol, denatured, corn dry mill - RNA'. The 'Default method' is set to 'Causal'. A 'Calculate default values' button is visible. Below this, there are two sections: 'Physical & economic allocation' and 'Causal allocation'. The 'Physical & economic allocation' section contains a table with columns for 'Product', 'Physical', and 'Economic'. The 'Causal allocation' section contains a table with columns for 'Flow', 'Direction', 'Category', 'Amount', and two columns for 'distillers ...' and 'Ethanol, ...'. The 'Navigation' pane on the left shows a tree view of processes, with 'fuels' expanded to show various ethanol products. The bottom of the window has a tabbed interface with 'Allocation' selected.

Navigation

- Processes
 - A:Agriculture, forestry and fishing
 - Air Transportation
 - Allocation
 - B:Mining and quarrying
 - biomass
 - fuels
 - Ethanol, 85%, at blending terminal, 20
 - Ethanol, 85%, blended, at service stati
 - Ethanol, denatured, at refueling statio
 - Ethanol, denatured, corn dry mill - RN
 - Ethanol, denatured, corn stover, bioch
 - Ethanol, denatured, forest residues, th
 - ethanol, denatured, mixed feedstocks,
 - Ethanol, denatured, switchgrass, bioch
 - Ethanol, denatured, wheat straw, bioch
 - others
 - production
 - C:Manufacturing
 - Case study Li-ion battery
 - Chemical Manufacturing
 - chemicals
 - Crop Production
 - D:Electricity, gas, steam and air conditioning
 - E:Water supply; sewerage, waste managem
 - F:Construction
 - Fabricated Metal Product Manufacturing
 - Forestry and Logging
 - G:Wholesale and retail trade; repair of mot
 - H:Transportation and storage

Allocation

Default method: Causal

Calculate default values

Physical & economic allocation

Product	Physical	Economic
Ethanol, denatured, corn dry mill - R...	1.0	1.0
distillers dried grains with solubles, ...	0.01	0.01

Causal allocation

Flow	Direction	Category	Amount	distillers ...	Ethanol, ...
Water, cooling, unspe...	Input	resource/i...	6.23000E4...	0.01	1.0
Gasoline, at refinery - ...	Input	Product fl...	266.00000 I	0.01	1.0
Energy, output - RNA	Input	Product fl...	3.95000E5...	0.01	1.0
Water, unspecified nat...	Input	resource/i...	1830.0000...	0.01	1.0
Energy, output - RNA	Input	Product fl...	8440.0000...	0.01	1.0
dummy_yeast paste, fr...	Input	Product fl...	60.00000 ...	0.01	1.0
Electricity, at grid, US, ...	Input	Product fl...	3310.0000...	0.01	1.0
Natural gas, combust...	Input	Product fl...	219.00000...	0.01	1.0
Electricity, at grid, US, ...	Input	Product fl...	436.00000...	0.01	1.0

General information | Inputs/Outputs | Administrative information | Modeling and validation | Parameters | Allocation | Costs

Modeling with parameters

- Parameters can be used instead of concrete values for inputs/outputs
- Define as simple value, formula or complex function
- Parameters can overwrite each other
- Available on different levels
 - process
 - product system
 - project
 - impact method
 - database

Local and global parameters

Excavator, technology mix, 100 kW, Construction - GLO

Parameters

Global parameters

type filter text

- @Configuration
- Experimental features
- Field Assist
- Global parameters**
- ILCD Network
- Locations
- Logging
- Number format
- Updates

Name	Value
Benzene_h	0.021
bucket_volume	1.1
CH4_h	0.72
CO_h	150.0
cycles_min	0.75
density	1.8
Dust_h	16.0
fuel_h	25.5
load_factor	0.6
N2O_h	3.0
NMVOH_h	29.0
NOx_h	520.0
sulphur_ppm	200.0
Toluene_h	0.003
Xylene_h	0.264

Preferences

Global parameters

Name	Amount	Uncertainty	Description
p0	1.0	none	

Dependent parameters

Name	Formula	Value	Descri
Benzene_t	Benzene_h*load_factor/performance*d...	4.58181818181818E-4	[24] [c
CH4_t	CH4_h*load_factor/performance*densi...	0.0157090909090909	[22] [c
CO_t	CO_h*load_factor/performance*density	3.27272727272727	[18] [c

Calculation of the inventory

- Calculation of life cycle inventory (using the “matrix method”)
- Results are clearly presented in two tables
- Result can be exported to Excel

Calculation methods in openLCA: **matrix method**

```
> A
          Diesel prod. Bauxite mining Alumina prod. Anode prod. Electrolysis Ingot casting
Diesel [kg]          1          -1.993          -0.6          -3.2           0           -0.1
Bauxite, at plant [kg] 0          1000.000        -2685.0          0.0           0           0.0
Alumina [kg]         0           0.000          1000.0          0.0          -1925          0.0
Anode [kg]           0           0.000           0.0          1000.0         -441           0.0
Aluminium (liquid metal) [kg] 0           0.000           0.0           0.0          1000          -874.0
Ingot [kg]           0           0.000           0.0           0.0           0          1000.0
```

```
> B
          Diesel prod. Bauxite mining Alumina prod. Anode prod. Electrolysis Ingot casting
Crude oil [kg]       -1.500000           0           0.00           0.00           0.00           0.00
Bauxite [kg]         0.000000        -1000           0.00           0.00           0.00           0.00
CO2 / CO2 equ. [kg]  0.302000           48          991.00          849.00          9789.00          368.00
NOx [kg]             0.000878           0           1.17           0.29           0.35           0.16
SO2 [kg]             0.001700           0           5.30           1.70           13.40           0.29
```

```
> f
          [,1]
Diesel [kg]          0
Bauxite, at plant [kg] 0
Alumina [kg]         0
Anode [kg]           0
Aluminium (liquid metal) [kg] 0
Ingot [kg]           1000
```

```
> s
          [,1]
Diesel prod.      11.345994
Bauxite mining    4.517378
Alumina prod.     1.682450
Anode prod.       0.385434
Electrolysis     0.874000
Ingot casting     1.000000
```

```
> g
          [,1]
Crude oil [kg]    -17.018990
Bauxite [kg]      -4517.378250
CO2 / CO2 equ. [kg] 11138.388062
NOx [kg]          2.556104
SO2 [kg]          21.593111
```

```
> |
```

$$s = A^{-1} \cdot f$$

$$g = B \cdot s$$

Example: inventory results

openLCA framework 1.2

File Edit Window Settings Help

organic viticulture organic viticulture - IPCC 2007

Life cycle inventory of organic viticulture (ecoinvent_n)

Inputs				Outputs			
Flow	Category	Flow property	Amount	Flow	Category	Flow property	Amount
Aluminium, 24% in bauxite, 11% in crude ore...	resource/in ground	Mass	8.8	1,4-Butanediol	emissions/air/high population de...	Mass	3.9
Anhydrite, in ground	resource/in ground	Mass	1.7	1,4-Butanediol	emissions/water/river	Mass	1.5
Barite, 15% in crude ore, in ground	resource/in ground	Mass	0.0	1-Pentanol	emissions/water/river	Mass	3.7
Basalt, in ground	resource/in ground	Mass	8.9	1-Pentanol	emissions/air/high population de...	Mass	1.5
Borax, in ground	resource/in ground	Mass	9.7	1-Pentene	emissions/air/high population de...	Mass	1.1
Bromine, 0.0023% in water	resource/in water	Mass	3.2	1-Pentene	emissions/water/river	Mass	2.8
Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn,...	resource/in ground	Mass	1.0	2,4-D	emissions/soil/agricultural	Mass	2.7
Calcite, in ground	resource/in ground	Mass	0.0	2-Aminopropanol	emissions/water/river	Mass	3.6
Carbon dioxide, in air	resource/in air	Mass	0.0	2-Aminopropanol	emissions/air/high population de...	Mass	1.4
Carbon, in organic matter, in soil	resource/in ground	Mass	1.2	2-Methyl-1-propanol	emissions/water/river	Mass	1.0
Chromium, 25.5% in chromite, 11.6% in crud...	resource/in ground	Mass	3.4	2-Methyl-1-propanol	emissions/air/high population de...	Mass	4.3
Chrysotile, in ground	resource/in ground	Mass	3.3	2-Methyl-2-butene	emissions/air/high population de...	Mass	2.6
Cinnabar, in ground	resource/in ground	Mass	3.3	2-Methyl-2-butene	emissions/water/river	Mass	6.2
Clay, bentonite, in ground	resource/in ground	Mass	0.0	2-Nitrobenzoic acid	emissions/air/high population de...	Mass	2.6
Clay, unspecified, in ground	resource/in ground	Mass	0.0	2-Propanol	emissions/air/high population de...	Mass	5.9
Coal, brown, in ground	resource/in ground	Mass	0.0	2-Propanol	emissions/water/river	Mass	1.1
Coal, hard, unspecified, in ground	resource/in ground	Mass	0.0	4-Methyl-2-pentanone	emissions/water/unspecified	Mass	5.4
Cobalt, in ground	resource/in ground	Mass	1.7	Acenaphthene	emissions/air/low population den...	Mass	6.8
Colemanite, in ground	resource/in ground	Mass	5.3	Acenaphthene	emissions/air/high population de...	Mass	1.6
Copper, 0.99% in sulfide, Cu 0.36% and Mo 8...	resource/in ground	Mass	3.5	Acenaphthene	emissions/air/unspecified	Mass	1.2
Copper, 1.18% in sulfide, Cu 0.39% and Mo 8...	resource/in ground	Mass	1.9	Acenaphthene	emissions/water/ocean	Mass	9.0
Copper, 1.42% in sulfide, Cu 0.81% and Mo 8...	resource/in ground	Mass	5.2	Acenaphthene	emissions/water/river	Mass	2.1
Copper, 2.19% in sulfide, Cu 1.83% and Mo 8...	resource/in ground	Mass	2.6	Acenaphthylene	emissions/water/ocean	Mass	5.6
Diatomite, in ground	resource/in ground	Mass	6.0	Acenaphthylene	emissions/water/river	Mass	1.3

General information Life cycle inventory Characterization

Impact assessment methods

- There are no impact assessment methods included by default in openLCA, but methods are available for free and can be easily imported
- It is possible to modify existing impact assessment methods in openLCA (impact categories and flows can be added / deleted; equivalence factors can be altered)
- It is also possible to create new impact assessment methods

Analysis and interpretation

- In openLCA many functions are available to evaluate the results and to track the origin of environmental effects:
- Various result and influence analyses
- Sankey Diagram
- Representation of the spatial distribution of emissions and resource consumption
- Grouping of processes is possible (e.g. by life cycle phase)
- ...

Contribution analyses

openLCA framework 1.2

File Edit Window Settings Help

organic viticulture Analysis result of organic viticulture

Process contributions

Flow: Potassium Order by: Total contributions Cut-off: 2 %

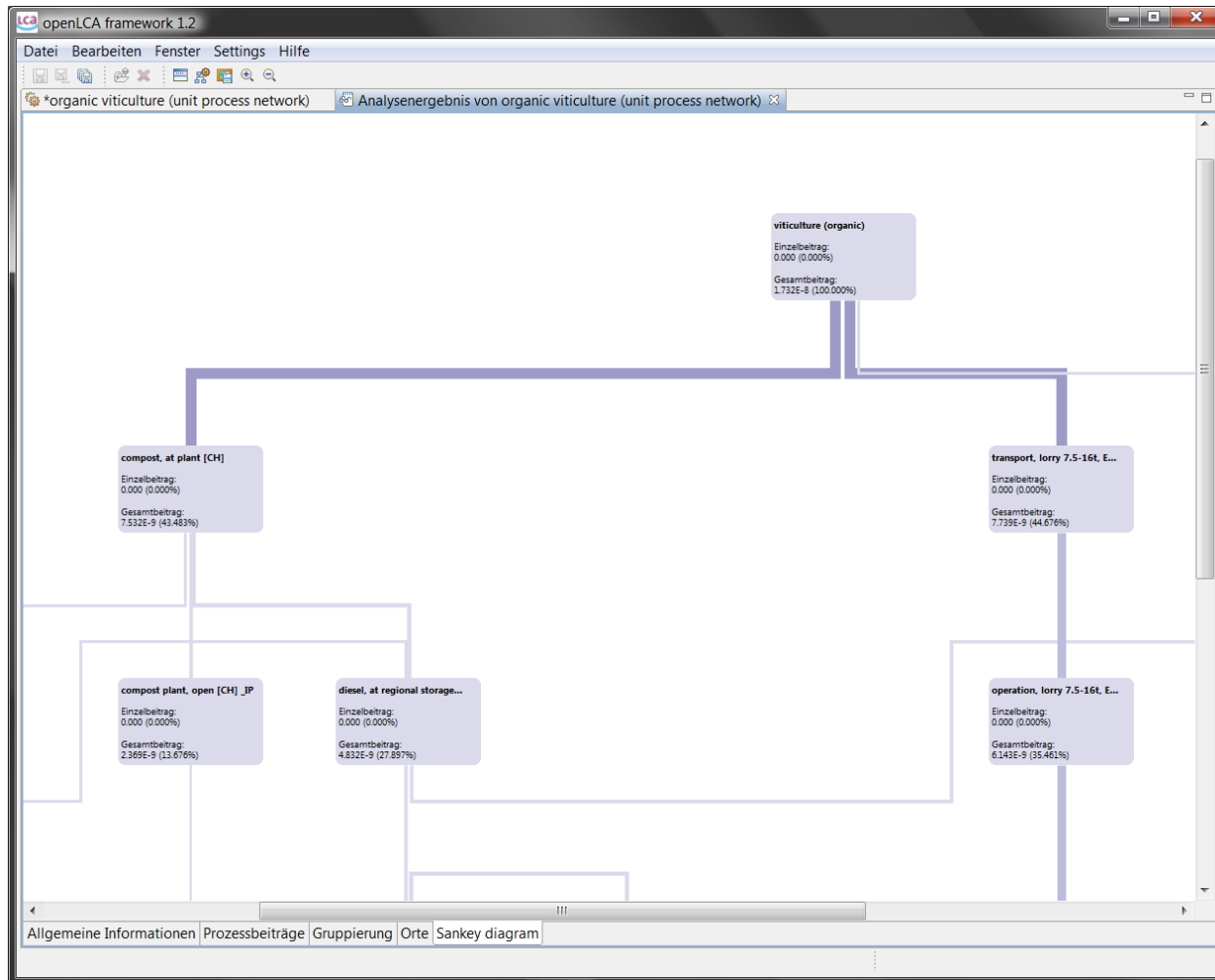
Contribution	Process	Total amount	Single amount	Unit
100.00%	viticulture (organic)	1.96949E-7	0.00000	kg
62.09%	horn meal, at regional storehouse	1.22290E-7	1.22290E-7	kg
29.77%	compost, at plant	5.86260E-8	5.86260E-8	kg
07.69%	transport, lorry 7.5-16t, EURO5	1.51379E-8	1.51379E-8	kg

Impact category: human health - ozone depletion Order by: Total contributions Cut-off: 2 %

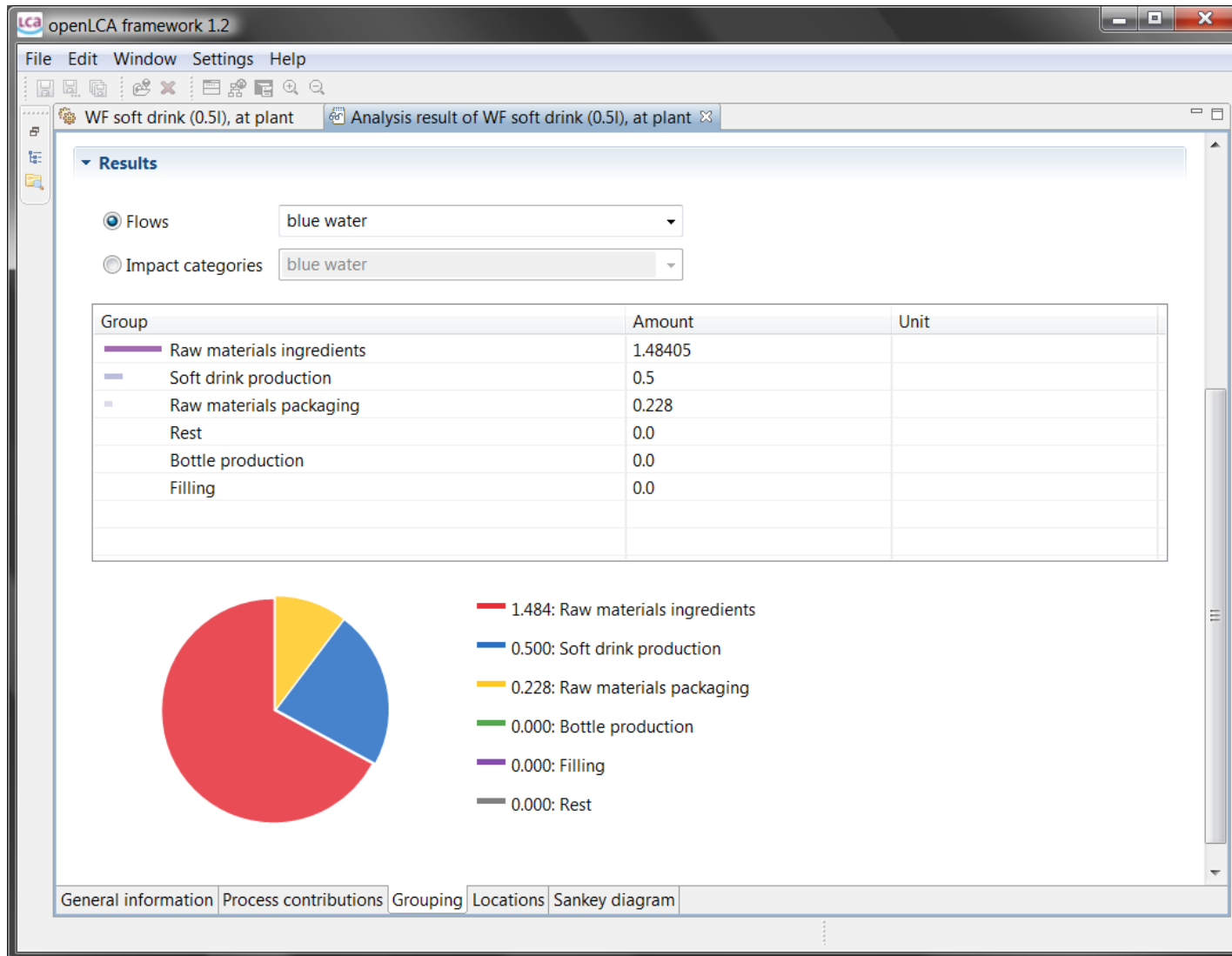
Contribution	Process	Total amount	Single amount	Unit
100.00%	viticulture (organic)	1.35836E-6	0.00000	points
63.04%	horn meal, at regional storehouse	8.56248E-7	8.56248E-7	points
16.42%	transport, lorry 7.5-16t, EURO5	2.23010E-7	2.23010E-7	points
16.18%	compost, at plant	2.19766E-7	2.19766E-7	points
04.37%	diesel, at regional storage	5.93365E-8	5.93365E-8	points

General information Process contributions Grouping Locations Sankey diagram

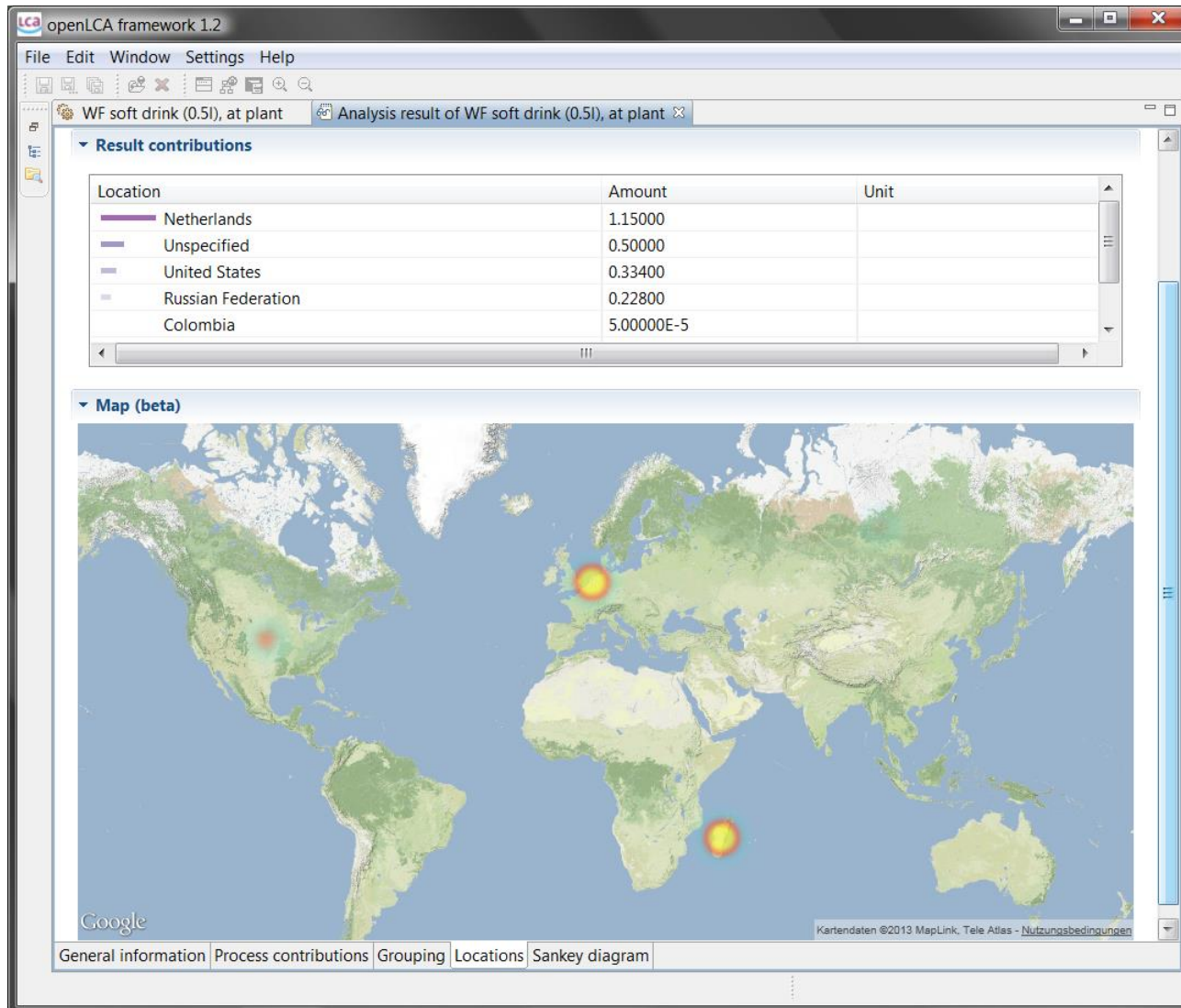
Sankey-Diagramm



Grouping

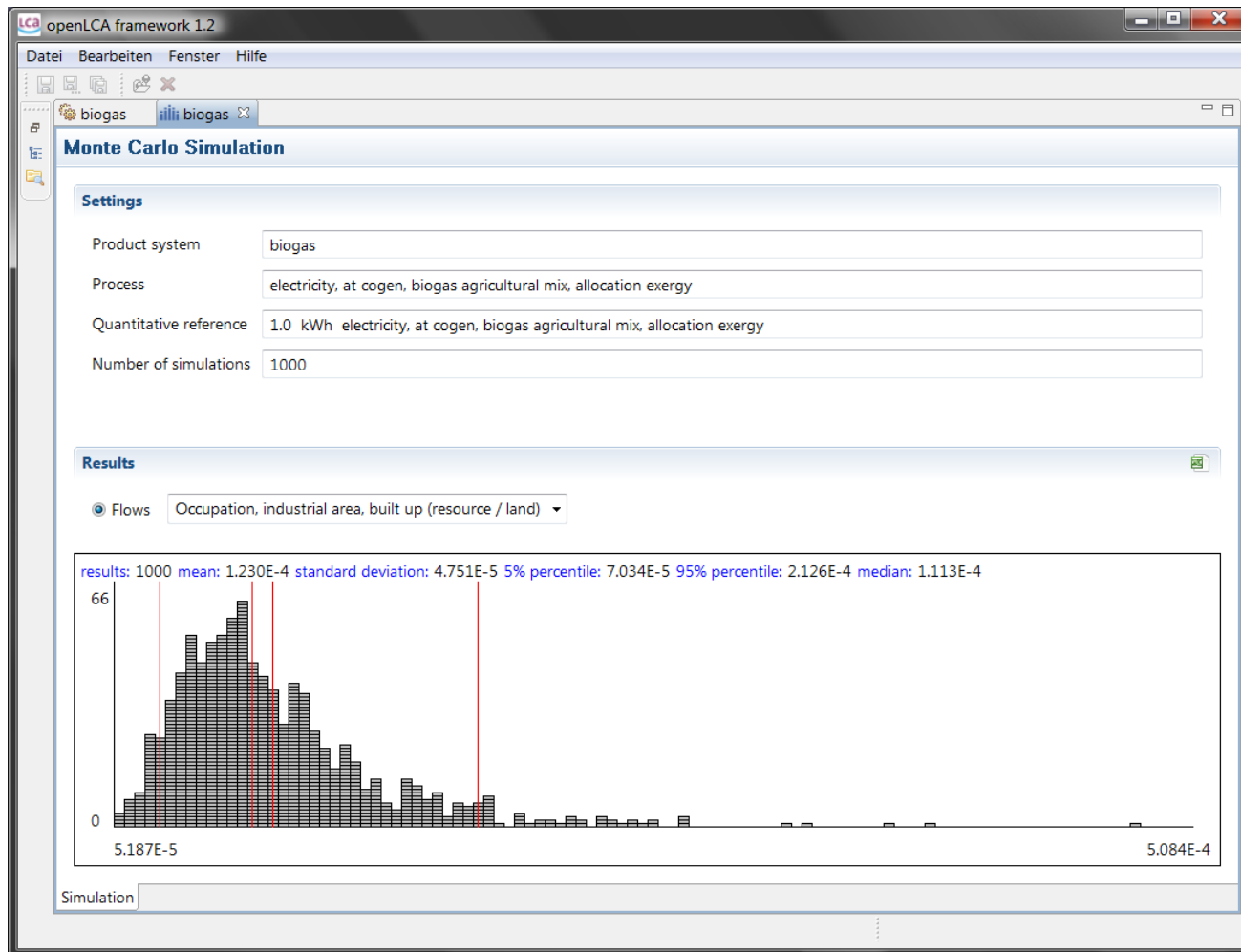


Localisation



Uncertainty analyses

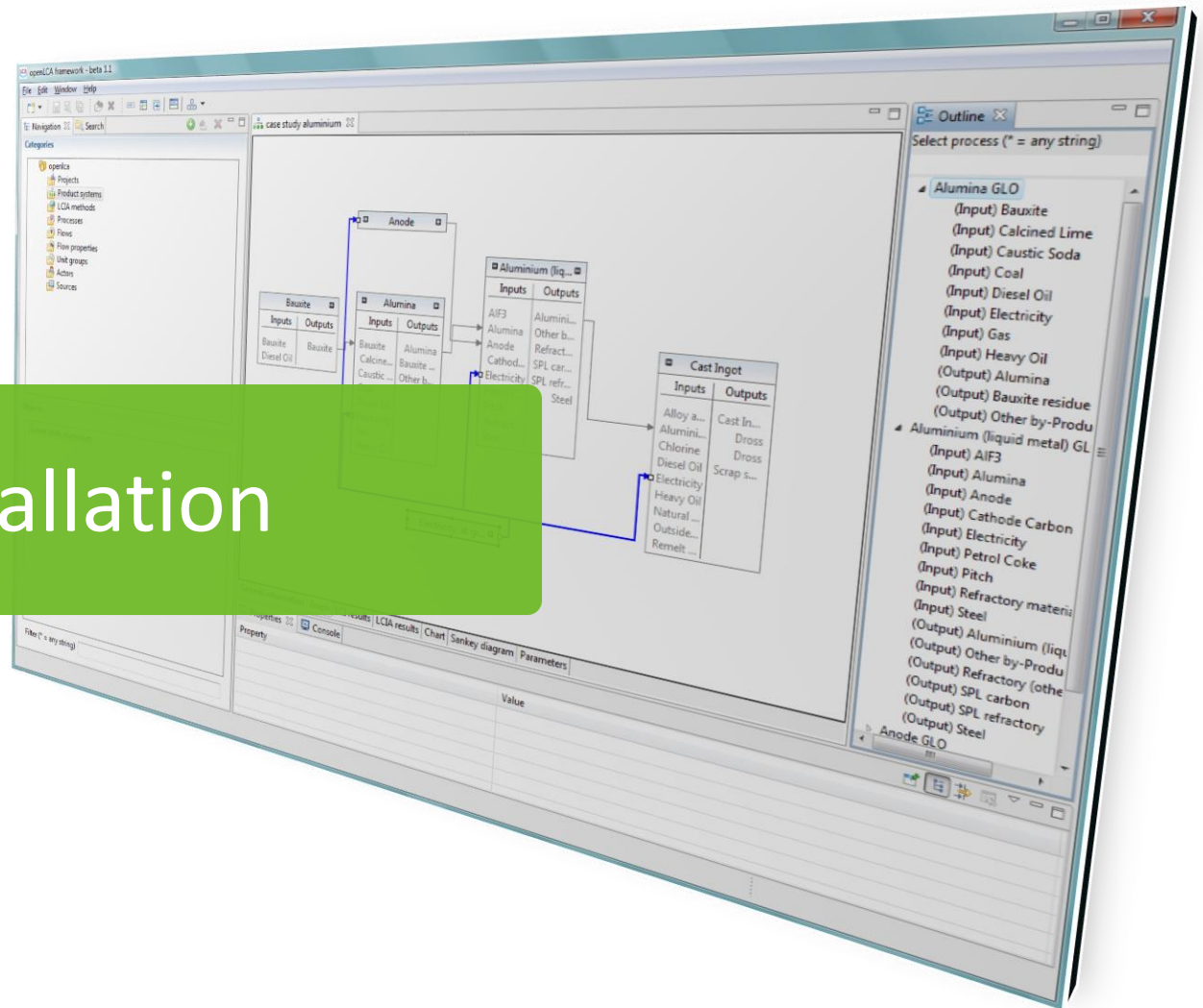
.. with Monte-Carlo-Simulation or pedigree approach



Further characteristics

- Separate calculation of costs possible
- Multiple languages
- Automatic error report
- Integrated static and dynamic help

Installation



System requirements

Software, required:

- Mac OS: Java Development Kit 8 (<http://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html>)

Software, optional:

- Windows 64 bit (for modern browser support): Microsoft Visual C++ 2010 Redistributable Package (x64) (<http://www.microsoft.com/de-de/download/details.aspx?id=14632>)
- Linux (for high performance calculations): libgfortran3

Hardware:

- CPU with 2 GHz or higher
- 1 GB RAM (for analyzing product systems with ~2500 processes, like ecoinvent 2)
- > 3 GB RAM (for analyzing product systems like ecoinvent 3)
- 500 MB free disk space + space for databases (e.g. ecoinvent 3 requires ~250 MB)

Download and installation of openLCA

Download openLCA at <http://openlca.org/downloads/>

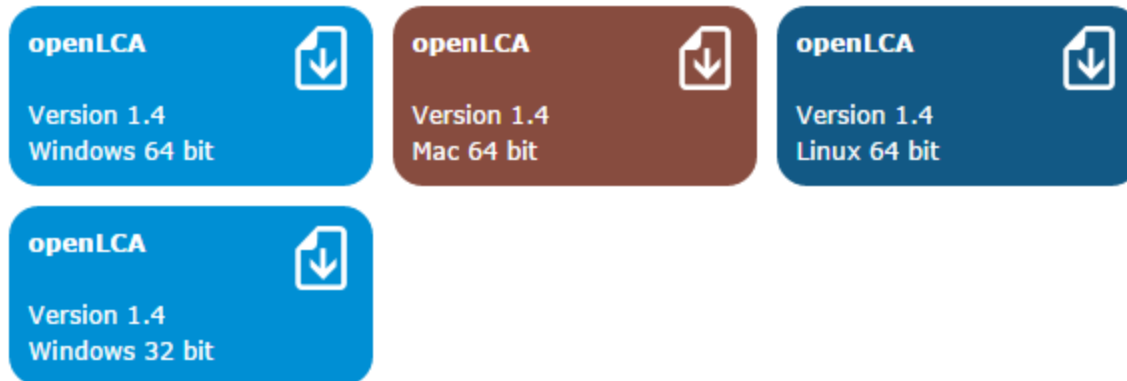
openLCA

openLCA Version 1.4 is now available! (Release date: June, 2014) We recommend you install this version. Our tests have not shown any issues but should you run into any, please let us know. Thanks in advance!

Important changes include drastically **improved performance** of about 400%, numerous **usability improvements** and many new features.

To see video tutorials on openLCA installation, click [here](#).

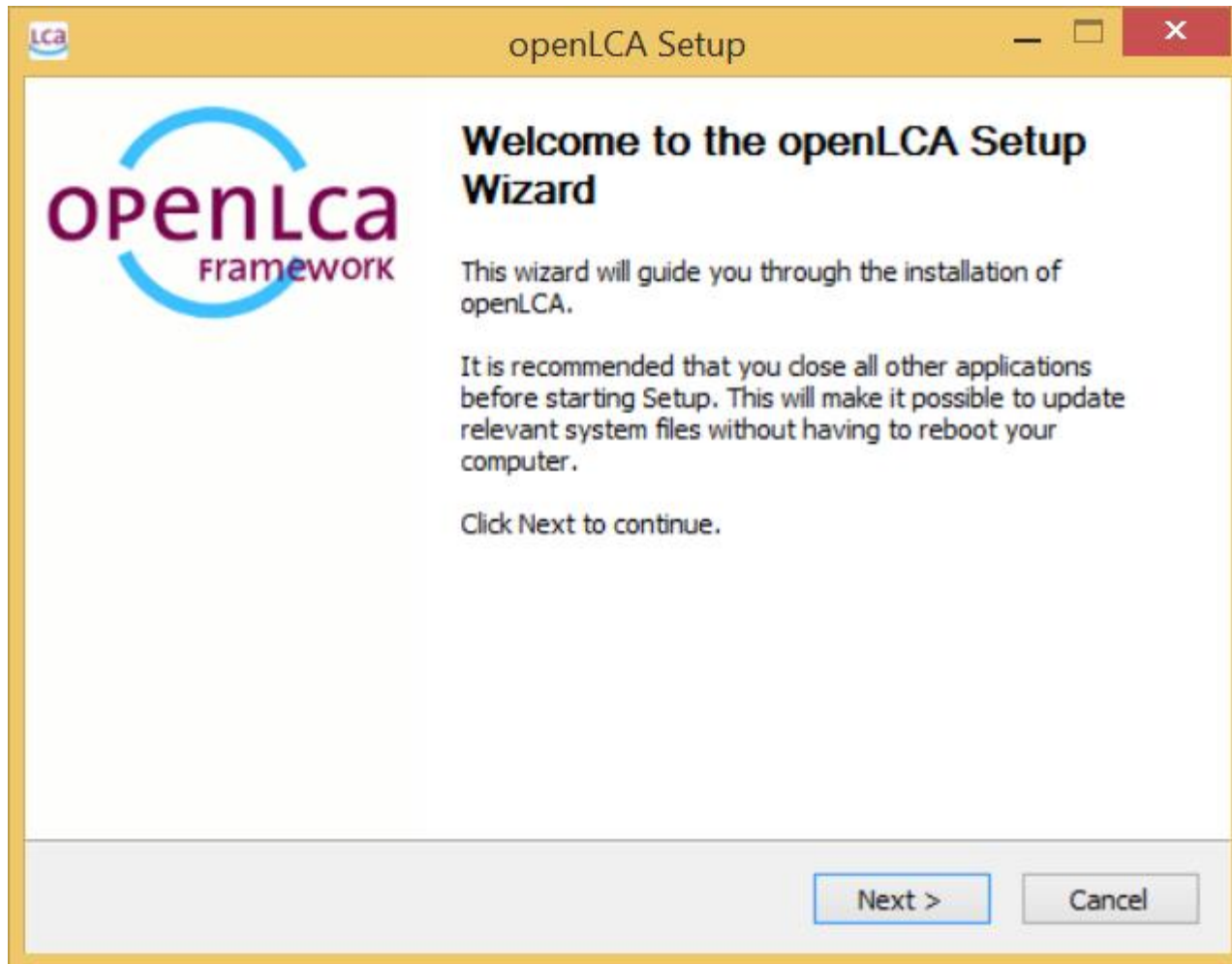
Installation files



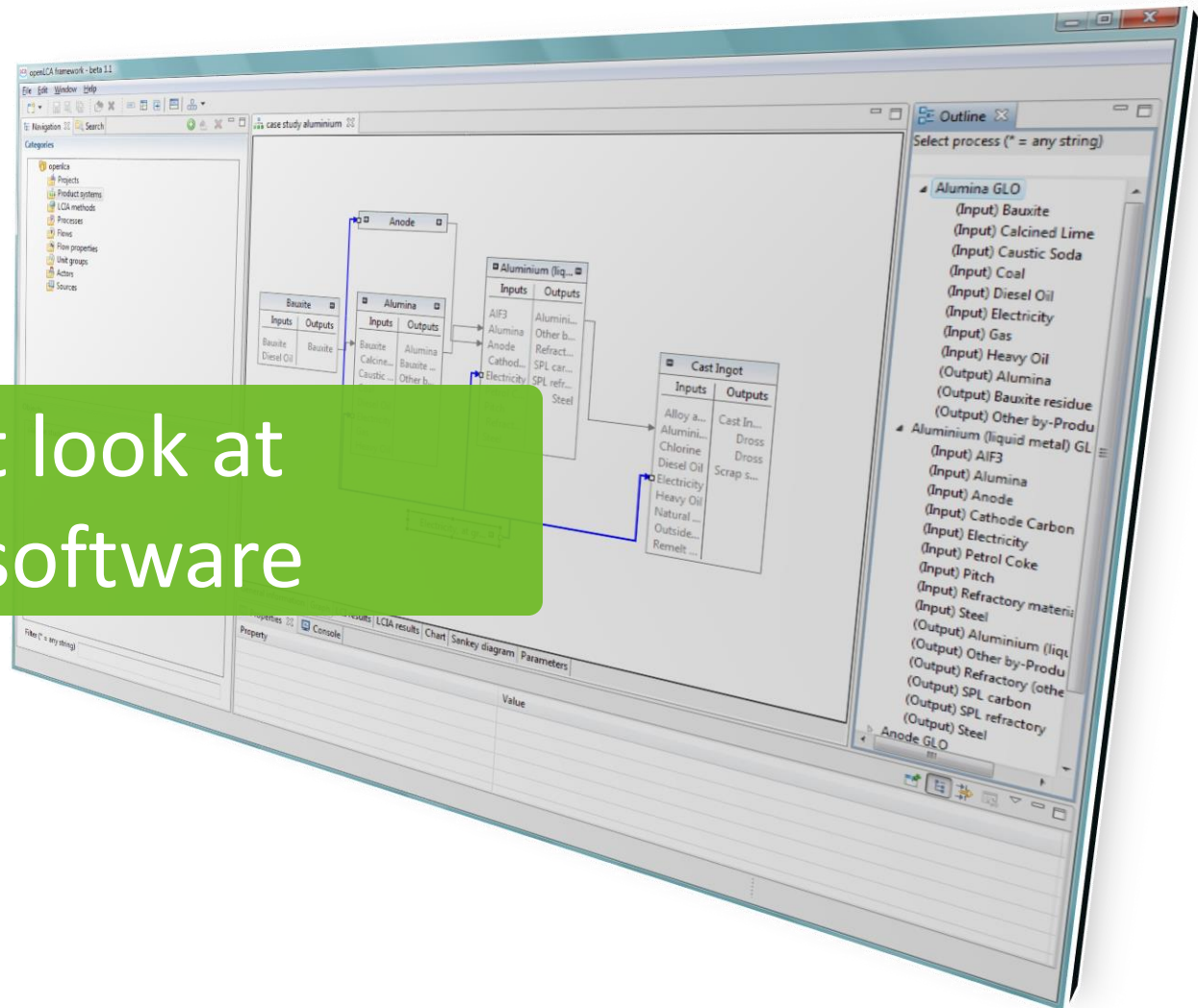
zip files for openLCA - just unzip and run openLCA, no installation needed, several versions of openLCA can be "installed" in parallel:

openLCA 1.4 Windows 64 bit
openLCA 1.4 Windows 32 bit

openLCA installer



First look at
the software



Welcome to openLCA!

The screenshot shows the openLCA 1.4 software interface. The window title is "openLCA 1.4". The menu bar includes "File", "Window", and "Help". On the left, a "Navigation" pane lists several databases: bioenergiedat, ecoinvent_3_cutoff(1), elcd, gabi_2013_professional, lca_commons_1.1, openlca_lcia_methods_1.4, probas_1, and schulungaugust14students. The main content area is titled "Welcome to openLCA!" and "Version 1.4 for Windows (64 bit)". It features a "GreenDelta" logo and text describing the software as high-performance, open source, and available for free. Below this, there are sections for "What's new", "Getting started", "Searching for and downloading data", "User Manuals", "Examples", and "Community". Four green callout boxes are overlaid on the interface: "Nexus" points to the "Searching for and downloading data" section; "Case Studies" points to the "Examples" section; "Forum" points to the "Community" section; and "Manuals" points to the "User Manuals" section.

openLCA 1.4

File Window Help

Navigation

- bioenergiedat
- ecoinvent_3_cutoff(1)
- elcd
- gabi_2013_professional
- lca_commons_1.1
- openlca_lcia_methods_1.4
- probas_1
- schulungaugust14students

Welcome

openLCA Welcome to openLCA!
Version 1.4 for Windows (64 bit)

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GreenDelta

What's new

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- drastically improved performance of about 400%
- numerous new features
- many improvements

Getting started

When you start openLCA the first time, it does not contain any data. With the new version of openLCA, it is really easy to get started. You can just import a database from an existing zolca-file and open it from the navigation on the left side. Then open the database with a simple double click.

This is explained in a video, [here](#)

Searching for and downloading data

A broad range of LCA databases are available in [openLCA nexus](#), where you can search for single data sets and also for complete databases, and download them into openLCA. The databases are all fit for openLCA, several databases can be combined.

This is also explained in a [video](#)

User Manuals

The online wiki for openLCA provides details about almost all features of openLCA. It is changing over time so check back from time to time.

New introductory and comprehensive [manuals](#) are also available online.

Examples

Here are cases that demonstrate how to use openLCA:

[Cases for the 1.3 version](#)

Community

An increasing number of people are using openLCA. Register in the [forum](#) to share your thoughts, ask questions, read answers and participate in the community.

0 items selected

Nexus

Case Studies

Forum

Manuals

Create a new database

openLCA 1.4.1 beta 4

File Window Help

Navigation

Welcome

openLCA Welcome to openLCA!
Version 1.4.1 beta 4 (Windows 64 bit)

High performance Life Cycle Assessment (LCA) and sustainability assessment software. Truly open source. Available for free. Created and maintained since 2006 by GreenDelta, Berlin. www.greendelta.com
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GreenDELTA

New database
Import database

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This is also explained in a [video](#)

LCIA method packs are available from the openLCA [download page](#)

User Manuals

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Examples

Community

Welcome

Right click on Navigation, select "New database"

Create a new database (II)

New database

Create a new database

Database name

Database type Local Remote

Database content Empty database
 Units and flow properties
 Complete reference data

Finish Cancel

Local or remote databases can be created

Different content available

Create a new database (III)

New database
Create a new database

Database name

Database type Local Remote

Host

Port

User

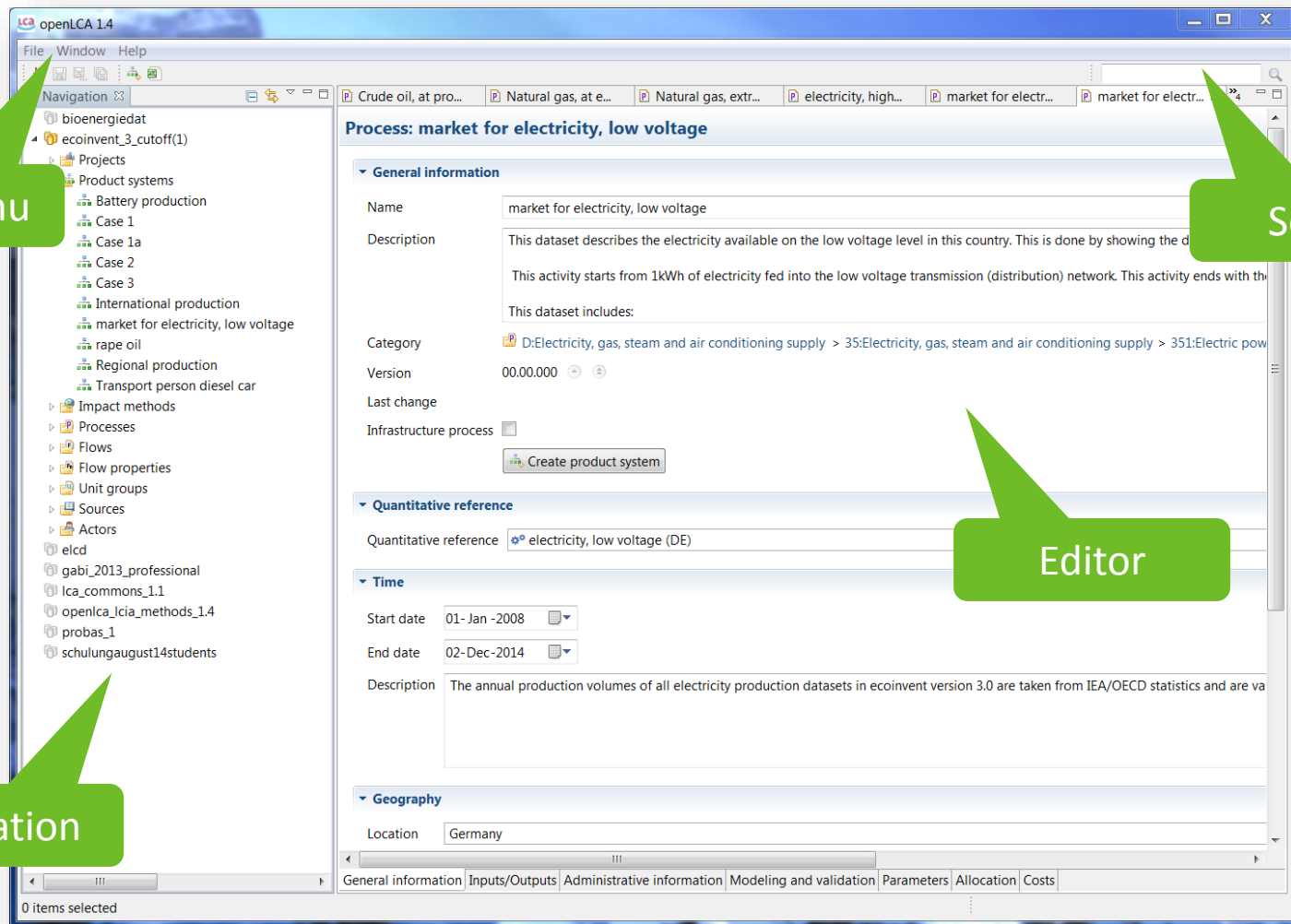
Password

The name should be the same as in the remote database

Exercise 1: start

- Install openLCA on your computer and run it.
- Create a local database.
- Accept default values.
- 5 min

Database view



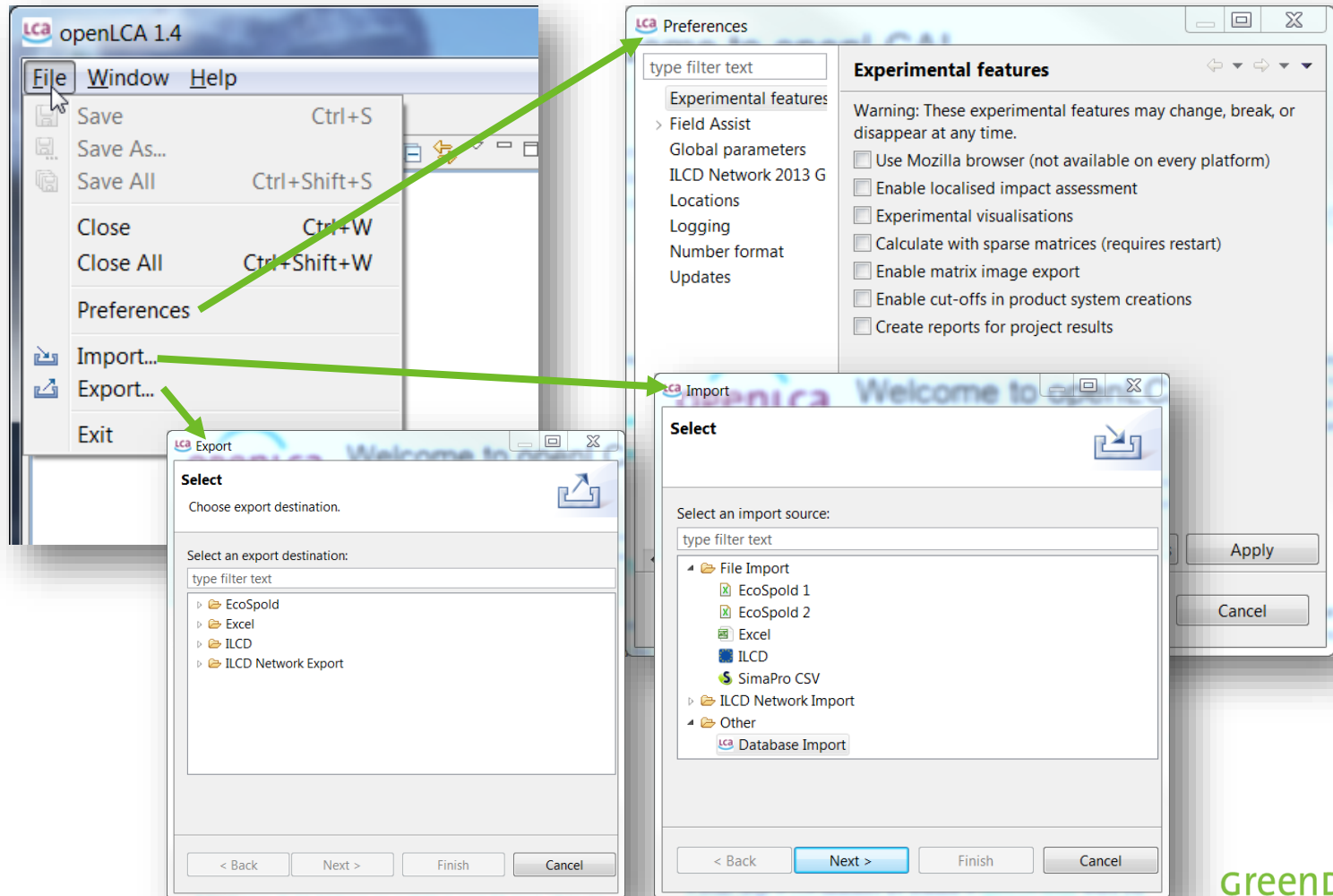
Main Menu

Search

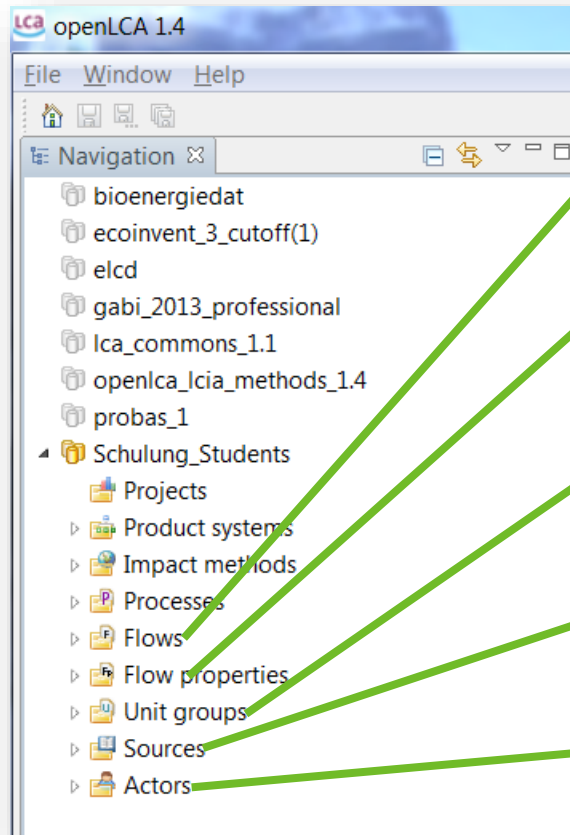
Editor

Navigation

Main menu functions



Database elements (I)



Flows: flow of products and materials

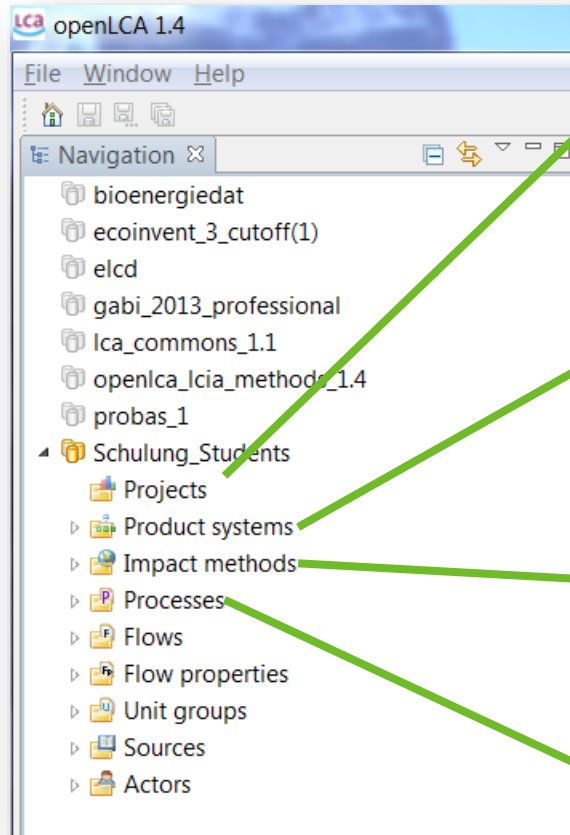
Flow properties: i.e. Length, Mass, etc

Unit groups: Groups of units

Sources: Literature

Actors: People who have provided data or modified models

Database elements (II)



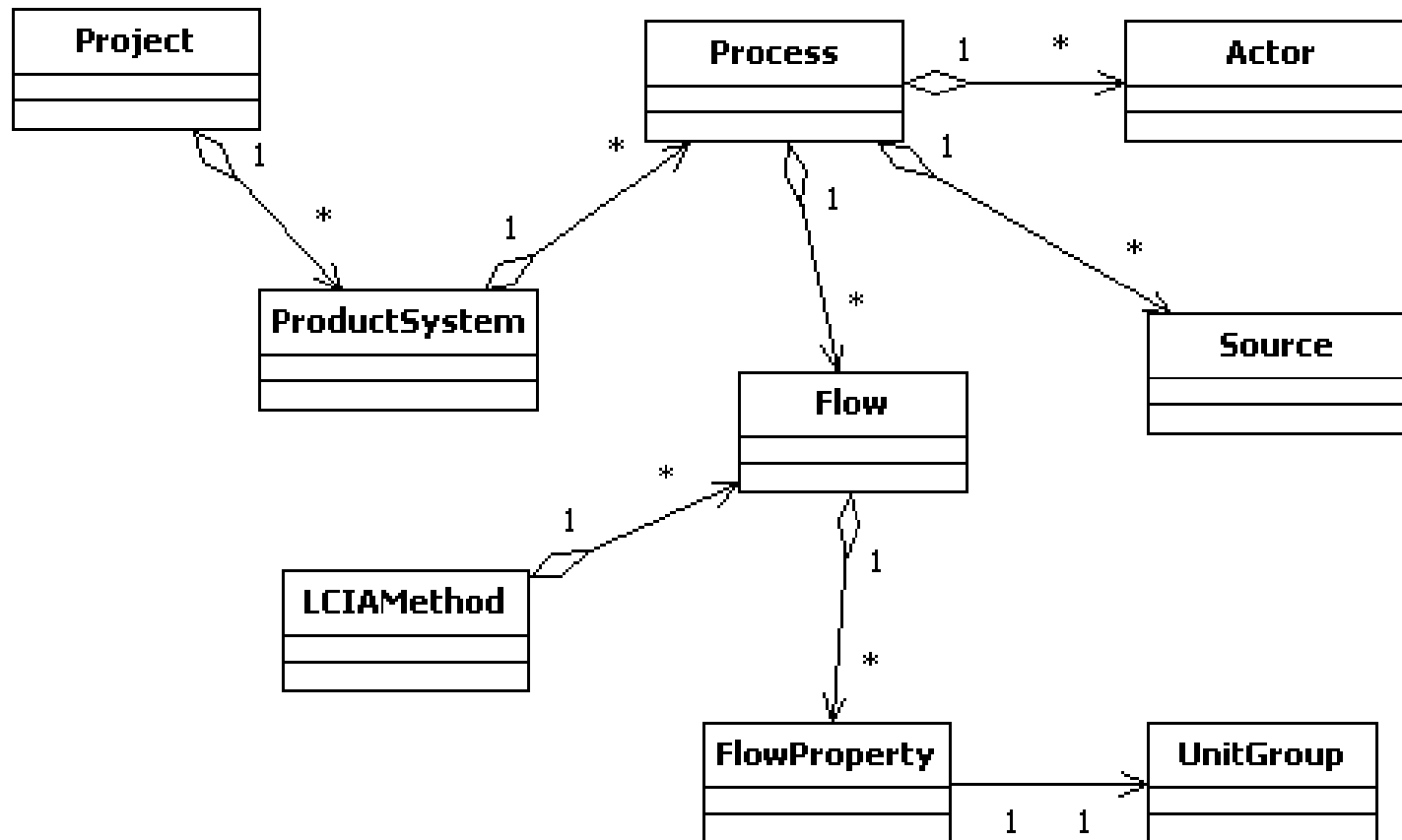
Projects: comparison of numerous product systems

Product systems: process networks (necessary to calculate inventory results and impact assessment)

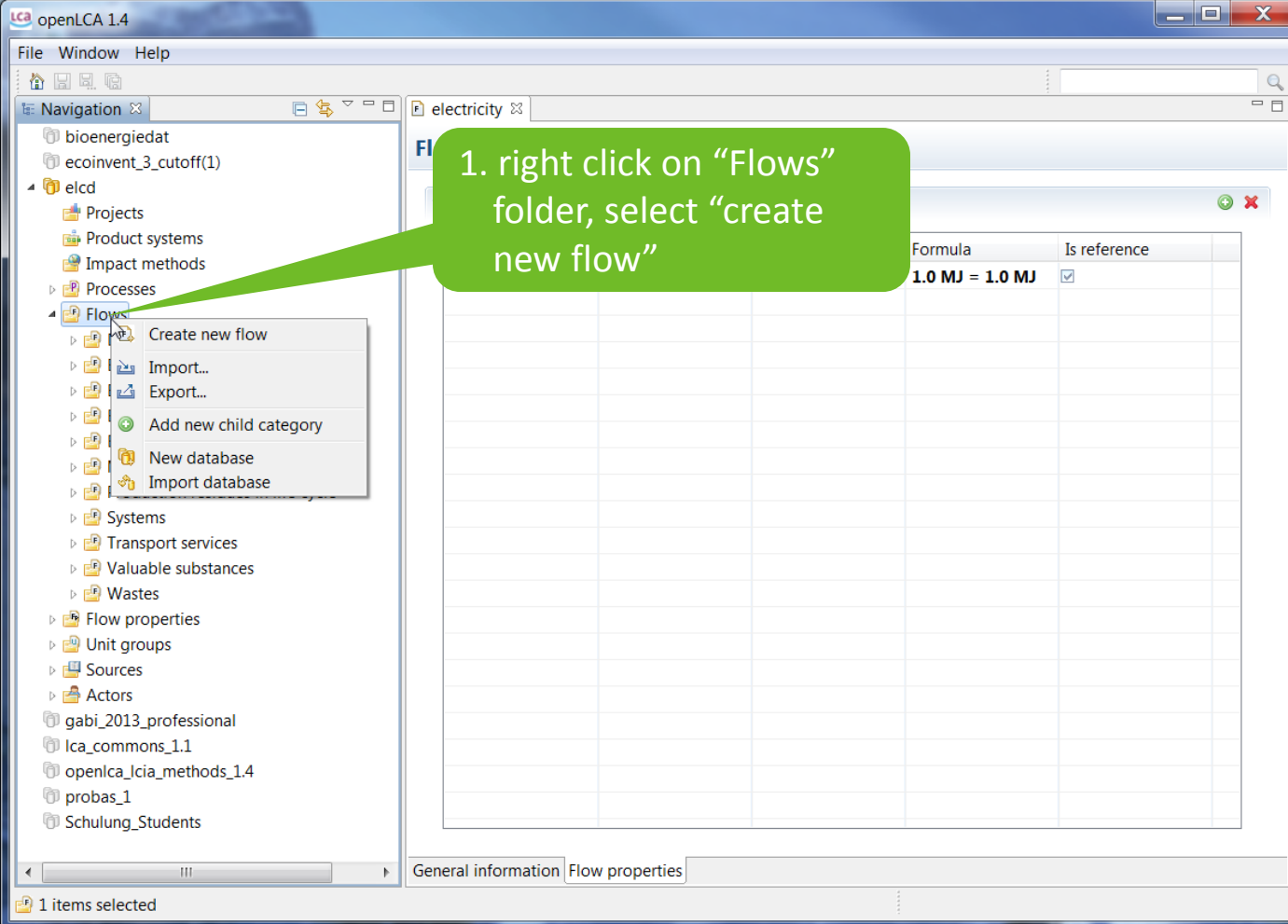
LCIA Methods: can be downloaded at openlca.org/downloads

Processes: Production or modification of materials/products

Element structure in openLCA



Flows: Create new flow (I)



The screenshot shows the openLCA 1.4 application window with the 'Navigation' pane on the left. The 'Flows' folder is selected, and a context menu is open. A green callout bubble points to the 'Create new flow' option. The main pane shows the 'electricity' dataset with a table of flow properties.

Navigation
bioenergielat
ecoinvent_3_cutoff(1)
elcd
 Projects
 Product systems
 Impact methods
 Processes
 Flows
 Systems
 Transport services
 Valuable substances
 Wastes
 Flow properties
 Unit groups
 Sources
 Actors
gabi_2013_professional
lca_commons_1.1
openlca_lcia_methods_1.4
probas_1
Schulung_Students

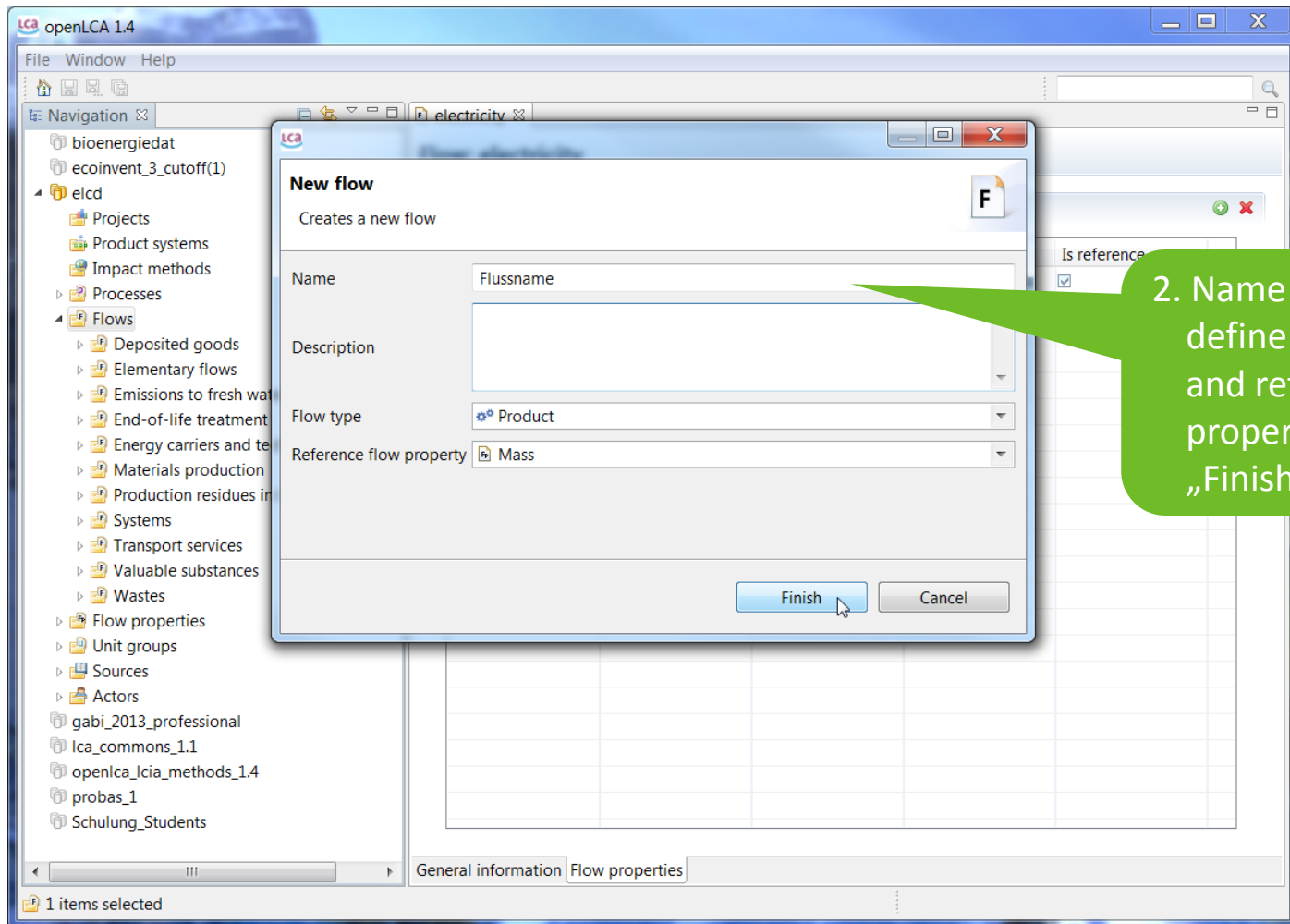
1. right click on “Flows” folder, select “create new flow”

Formula	Is reference
1.0 MJ = 1.0 MJ	<input checked="" type="checkbox"/>

General information | Flow properties

1 items selected

Flows: Create new flow (II)



Flows: Create new flow (III)

The screenshot shows the openLCA 1.4 interface. The left sidebar contains a navigation tree with categories like 'bioenergiedat', 'ecoinvent_3_cutoff(1)', 'elcd', 'Projects', 'Product systems', 'Impact methods', 'Processes', 'Flows', 'Systems', 'Transport services', 'Valuable substances', 'Wastes', 'Flow properties', 'Unit groups', 'Sources', 'Actors', and several databases. The 'Flows' category is expanded, and a context menu is open over it, showing options: 'Create new flow', 'Import...', 'Export...', 'Add new child category', 'New database', and 'Import database'. The main window displays the 'Flow: electricity' editor. The 'Flow properties' tab is selected, showing a table with the following data:

Name	Conversion factor	Reference unit	Formula	Is reference
Net calorific v...	1.0		1.0 MJ = 1.0 MJ	<input checked="" type="checkbox"/>

At the bottom of the editor, there are tabs for 'General information' and 'Flow properties'. The status bar at the bottom left indicates '1 items selected'.

3. A new flow window will open up in the editor. Additional flow properties can be added in the “Flow properties” tab, but don’t forget the conversion factor!

Flow: Information & properties

electricity

Flow: electricity

General information

Name: electricity

Description:

Category: Energy carriers and technologies > Electricity

Version: 00.00.000

Last change:

Infrastructure flow:

Flow type: Product

Used in processes

Additional information

CAS number:

Formula:

Location:

electricity

Flow: electricity

Flow properties

Name	Conversion factor	Reference unit	Formula
Net calorific v...	1.0	MJ	1.0 MJ = 1.0 MJ

Process: Create new process (I)

Navigation

- ▼ ecoinvent
 - Projects
 - Product systems
 - Impact methods
 - Processes
 - ▶ A: Agriculture, forestry and fishing
 - ▶ B: Manufacturing industries and construction
 - ▶ C: Construction
 - ▶ CC: Commercial services
 - ▶ D: Distribution
 - ▶ E: Electricity and heat
 - ▶ F: Chemical and allied products
 - ▶ G: Goods transport
 - ▶ H: Information and communication
 - ▶ J: Information and communication
 - ▶ L: Real estate activities
 - ▶ M: Professional, scientific and technical activities
 - ▶ N: Administrative and support service activities
 - ▶ Recycled Content cut-off
 - ▶ S: Other service activities
 - ▶ Case 1
 - ▶ Case 2
 - ▶ Case 3
 - ▶ International production
 - ▶ Flows
 - ▶ Flow properties
 - ▶ Unit groups
 - ▶ Sources
 - ▶ Actors
 - Ecoinvent
 - probas
 - schulungaugust14students
 - test

Welcome

Welcome to openLCA!

mac OS (x86_64)

and sustainability assessment software. Truly open source.
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[does this mean?](#)

GreenDelta

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1 Items selected

Process: Create new process (II)

New process
Creates a new process

Name:

Description:

Create a new product flow for the process

Filter:

Quantitative reference:

- SU:water transport
 - S1:Air transport
 - S11:Passenger air transport
 - S12:Freight air transport
 - S120:Freight air transport
 - transport, freight, aircraft**
 - transport, freight, aircraft
 - transport, freight, aircraft
 - transport, freight, aircraft
 - transport, freight, aircraft - GLO
 - transport, freight, aircraft - RER

Cancel Finish

Welcome

1 items selected

Welcome to openLCA!
4 for Mac OS (x86_64)

ent (LCA) and sustainability assessment software. Truly open source.
ned since 2006 by GreenDelta, Berlin. www.greendelta.com
inse ([what does this mean?](#))

2. Name process and select a quantitative reference

and open it from the navigation on the left side. Then open the database with a simple double click.

This is explained in a video, [here](#)

User Manuals

The online wiki for openLCA provides details about almost all features of openLCA. It is changing over time so check back from time to time.

New introductory and comprehensive [manuals](#) are also available online.

This is also explained in a [video](#)
LCIA method packs are available from the openLCA [download page](#)

Process: Create new process (III)

3. A new process window will open up in the editor. Additional flow can be added in the "Input/Output" tab.

Process: General information

The screenshot displays the openLCA 1.4 software interface. The main window is titled '*ammonium bicarbonate production - RER'. The left sidebar shows a navigation tree with the following items: bioenergiedat, ecoinvent_3_cutoff(1) (expanded), Projects, Product systems, Impact methods, Processes, Flows, Flow properties, Unit groups, Sources, Actors, elcd, gabi_2013_professional, lca_commons_1.1, openlca_lcia_methods_1.4, probas_1, and Schulung_Students. The main content area is titled 'Process: ammonium bicarbonate production' and is divided into several sections:

- General information**
 - Name: ammonium bicarbonate production
 - Description: Manufacturing process is considered with consumption of raw materials, energy, as well as infrastructure (excepting emission of waste-heat) are not included due to the lack of data. Transport and conditions. Inventory refers to 1 kg 100% ammonium bicarbonate. Data for consumption of energy used is von Däniken et al. 1995. (This is a dataset that was already contained in ecoinvent data guidelines for version 2 and it may not in all aspects meet the additional requirements of the e...)
 - Category: C:Manufacturing > 20:Manufacture of chemicals and chemical products > 201:Manufacture of...
 - Version: 00.00.000
 - Last change: (empty)
 - Infrastructure process:
 - Buttons: Create product system
- Quantitative reference**
 - Quantitative reference: ammonium bicarbonate (RER)
- Time**
 - Start date: 01-Jan-1995
 - End date: 03-Dec-2014
 - Description: Values based on data from the early 1990s.

At the bottom of the window, there is a tabbed interface with the following tabs: General information (selected), Inputs/Outputs, Administrative information, Modeling and validation, Parameters, Allocation, and Costs.

Process: Inputs/Outputs

The screenshot displays the openLCA 1.4 interface. The left sidebar shows a navigation tree with folders like 'ecoinvent_3_cutoff(1)', 'Projects', 'Product systems', 'Impact methods', 'Processes', 'Flows', 'Flow properties', 'Unit groups', 'Sources', 'Actors', 'elcd', 'gabi_2013_professional', 'lca_commons_1.1', 'openlca_lcia_methods_1.4', 'probas_1', and 'Schulung_Students'. The main window is titled '*ammonium bicarbonate production - RER' and shows the 'Process: ammonium bicarbonate production' details. The 'Inputs' table lists various electricity flows, and the 'Outputs' table lists ammonium bicarbonate, water, and another water flow.

Process: ammonium bicarbonate production

Inputs

Flow	Category	Flow pr...	Unit	Amount	Uncerta...	Default ...	Pedigre...
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.01094...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	8.53695...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.00247...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.00589...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.01287...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.00370...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.04495...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.03091...	lognor...	market ...	
⚙️ electricity, mediu...	351:Electric p...	Energy	kWh	0.00825...	lognor...	market ...	

Outputs

Flow	Category	Flow pr...	Unit	Amount	Uncerta...	Avoide...	Pedigre...
⚙️ ammonium bicar...	201:Manufact...	Mass	kg	1.0	none		
💧 Water	air/unspecifi...	Mass	kg	49.2	lognor...		
💧 Water	water/unspec...	Volume	m3	0.1908	lognor...		

General information | **Inputs/Outputs** | Administrative information | Modeling and validation | Parameters | Allocation | Costs

Process: Parameters (I)

The screenshot displays the openLCA 1.4 software interface. The main window is titled '*ammonium bicarbonate production - RER'. The left sidebar shows a navigation tree with various project and process folders. The main area is divided into two sections: 'Global parameters' and 'Input parameters'. The 'Input parameters' section contains a table with columns for Name, Value, Uncertainty, and Description. The 'Dependent parameters' section contains a table with columns for Name, Formula, Value, and Description. The bottom of the window features a tabbed interface with the 'Parameters' tab selected.

Parameters

Global parameters

Input parameters

Name	Value	Uncertainty	Description

Dependent parameters

Name	Formula	Value	Description

General information | Inputs/Outputs | Administrative information | Modeling and validation | **Parameters** | Allocation | Costs

Process: Parameters (II)

The screenshot displays the openLCA 1.4 interface. The main window shows a navigation tree on the left and a 'Parameters' dialog box in the center. The 'Parameters' dialog box is titled 'Parameters' and has a 'Global parameters' section and an 'Input parameters' section. The 'Input parameters' section contains a table with the following data:

Name	Value	Uncertainty
D1A	200.0	none
D1B	200.0	none
D1C	50.0	none
NB	1000.0	none
WEB	0.065	none
WFB	1.065	none
WHDPE	0.004	none
WPET	0.06	none
WPP	0.001	none
WW	1.0	none

Overlaid on the main window is the 'Preferences' dialog box. It has a 'type filter text' input field and a list of categories: 'Experimental features', 'Field Assist', 'Global parameters', 'ILCD Network 2013 G', 'Locations', 'Logging', 'Number format', and 'Updates'. The 'Global parameters' category is selected, and it shows a table with the following columns: 'Name', 'Amount', 'Uncertainty', and 'Description'. The table is currently empty.

Process: Parameters (III)

Process: Plane, technology mix, cargo, 68 t payload

Inputs

Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Default pro...	Pedigree un...
⚙️ kerosene	Energy carriers and...	Mass	kg	Spez_Verbr	none		
⚙️ cargo	Transport services/...	Mass	kg	1.0	none		

Click here to change the formula view

Outputs

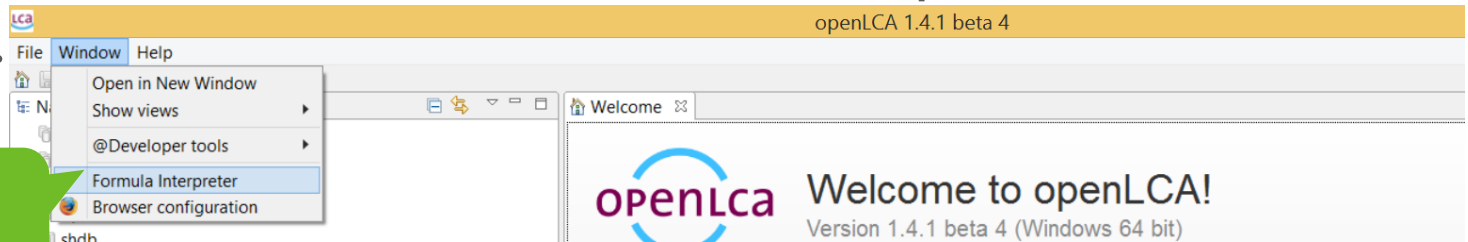
Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Avoided pr...	F ^
⚙️ cargo	Transport services/...	Mass	kg	1.0	none		
🌿 Sulfur dioxide	air/unspecified	Mass	kg	$(5.0E-5 * Spez_Verbr) * 1.0$	none		
🌿 Nitrogen dioxide	air/unspecified	Mass	kg	$(0.016321 * Spez_Verbr) * 1.0$	none		

Parameters: rules

- Parameter names...
 - ... must be written with small characters.
 - ... must be one word.
 - ... cannot contain special characters.
 - ... cannot have more than 255 characters.
- Parameter formulas...
 - ... can contain single values, simple equations, or complex functions including logical expressions.
 - ... do not contain units, so please add them in the comment field.
 - ... cannot have more than 255 characters.
- The amount of parameters is, theoretically, not limited.
- Use point (.) instead of comma (,) for the decimal numbers.

Parameters: checking formulas

- For complex formulas must use a certain format (e.g. Tan(a), trunc(c), etc.). Use the formula interpreter to find errors.

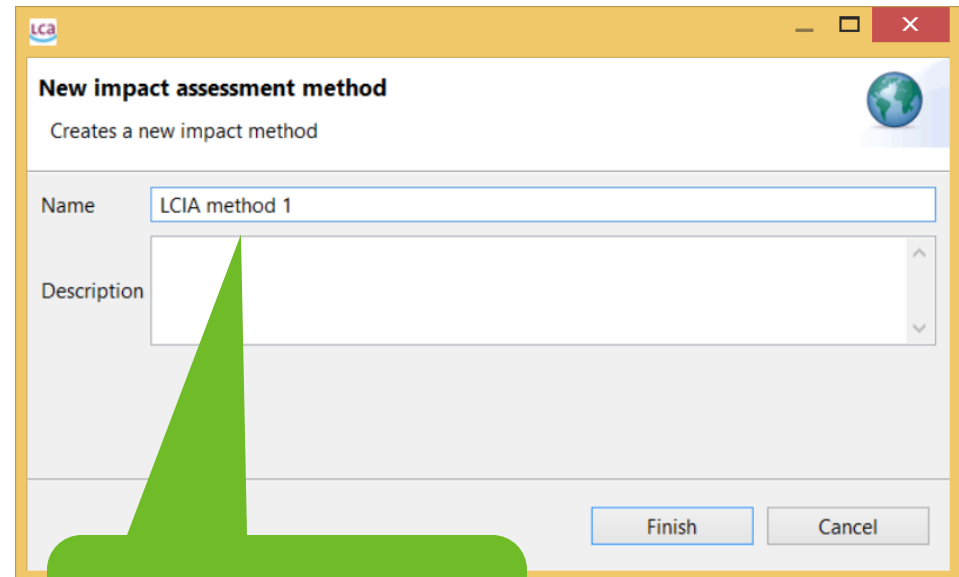
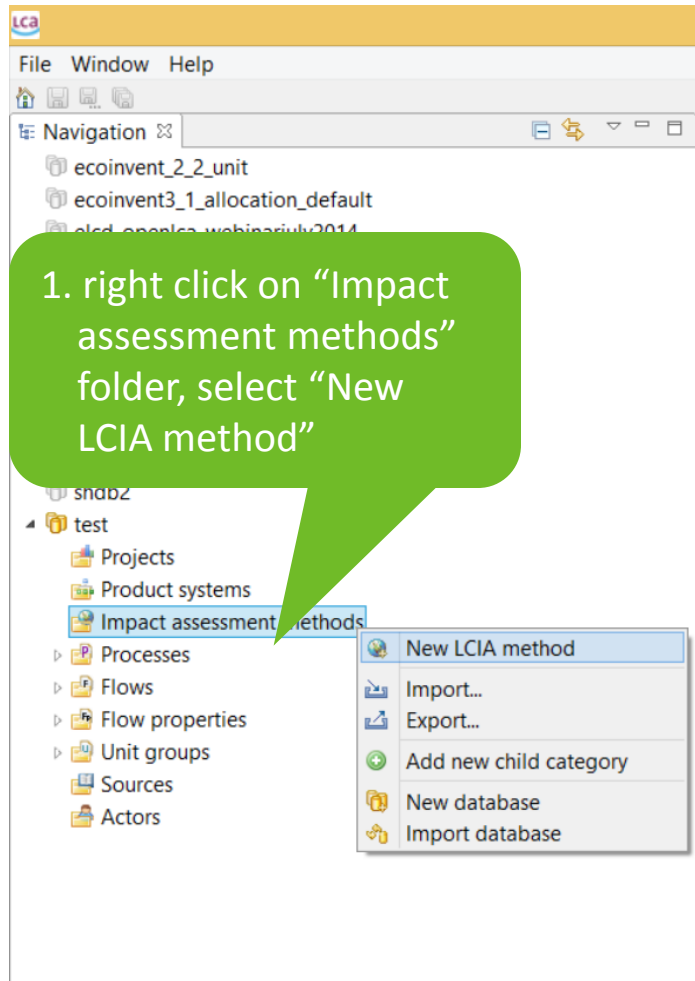


Select "Formula Interpreter" in "Window" menu

```
Console
Formula Interpreter
openLCA Formula Interpreter
type 'help' to display the help message

olca<< help
| evaluate an expression:          type in the expression and press enter, e.g. sin(42)
| define a variable:              type var <variable name> = <expression>, e.g. var a = sin(42)
| exit the interpreter:          type 'exit' or 'quit' and press enter
olca<<
```

Impact assessment methods: Creation (I)



Impact assessment methods: Creation (II)

*New LCIA method

Impact assessment method: New LCIA method

▼ **General information**

Name

Description

Version 00.00.000

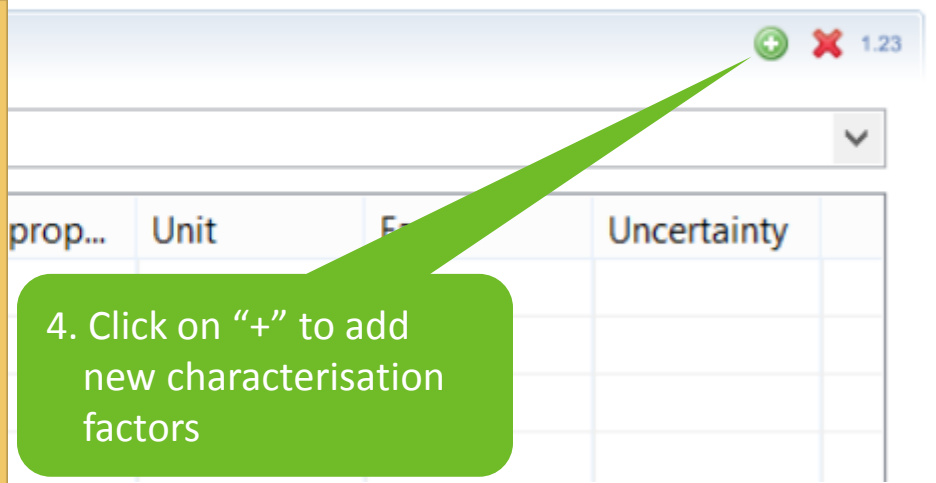
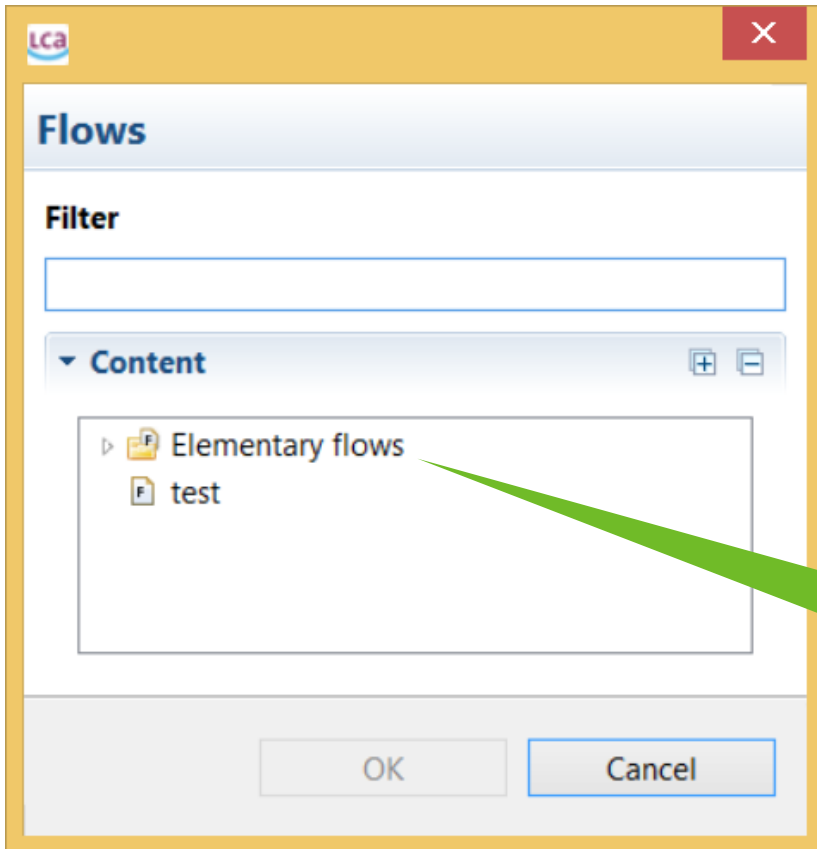
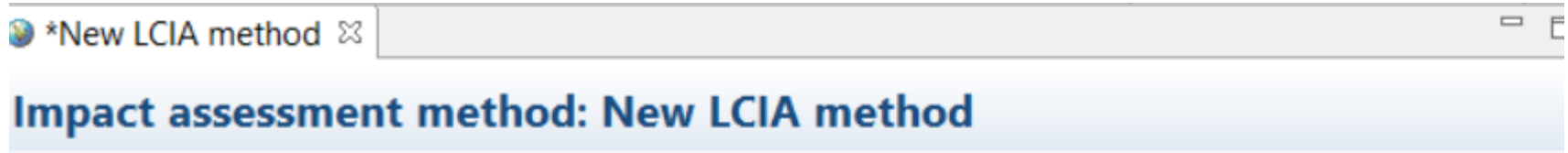
Last change 2014-09-23T00:04:21+0200

▼ **Impact categories**

Name	Description	Reference unit
Human toxicity		CTUh

3. Click on "+" to add new impact categories

Impact assessment methods: Creation (III)



Impact assessment methods: Creation (IV)

*New LCIA method

Impact assessment method: New LCIA method

Impact factors 1.23

Impact category: Human toxicity

Flow	Category	Flow property	Unit	Factor	Uncertainty
1,2,4-trichlorobenzene	air/high population de...	Mass	CTUh/kg	2*p1	none

6. Add value for the factor
(parameters can be used as in
processes!)

*New LCIA method

Parameters

Global parameters

Input parameters 1

Name	Value	Uncertainty	Description
p1	1.0	none	

Dependent parameters 1

Name	Formula	Value	Description

Impact assessment methods: Creation (V)

*New LCIA method

Impact assessment method: New LCIA method

Normalization and weighting sets

Normalization and weighting set	Impact category	Normalization factor	Weighting factor
newSet	Human toxicity	-	-

8. Click on the set name to automatically add the impact categories of the method

7. Click “+” to add new normalization/weighting set

Product system: Creation (I)

The screenshot shows the GreenDelta software interface. On the left is a navigation tree with categories like 'Projects', 'Product systems', 'Impact methods', 'Processes', 'Flows', 'Flow properties', 'Unit groups', 'Sources', and 'Actors'. The 'Processes' section is expanded, showing various process types. The main window displays the configuration for 'Process: Case 1'. The 'General information' tab is selected, showing fields for Name (Case 1), Description, Version (00.00.024), Last change (2014-09-08T14:46:13+0200), and Infrastructure process (unchecked). A green callout box points to the 'Create product system' button. Below the 'General information' tab are sections for 'Quantitative reference' (filled water bottle, point of sale) and 'Time' (Start: 09/2014, End: 09/2014). The bottom of the window shows a tabbed interface with 'General information' selected.

1. Click on “Create product system” in the General information tab

Product system: Creation (II)

2. Name the product system and select a reference process

3. Select the modelling options preferred

New product system
Creates a new product system

Name: Case 1

Description:

Filter:

Reference process:

- G:Wholesale and retail trade; repair of motor vehicles and motorcycles
- H:Transportation and storage
- J:Information and communication
- L:Real estate activities
- M:Professional, scientific and technical activities
- N:Administrative and support service activities
- Recycled Content cut-off
- S:Other service activities
- Case 1
- Case 2
- Case 3
- International production
- New Process

Add connected processes
 Connect with system processes if possible

Cancel Finish

KML: none
Map editor Text editor

Description:

General information Inputs/Outputs Administrative information Modeling and validation Parameters Allocation Costs

Product system: General information

The screenshot shows a software window titled "Product system: Case 1". The window has a menu bar with "Welcome", "New Process", and "Case 1". Below the menu bar, there is a section for "General information" with the following fields:

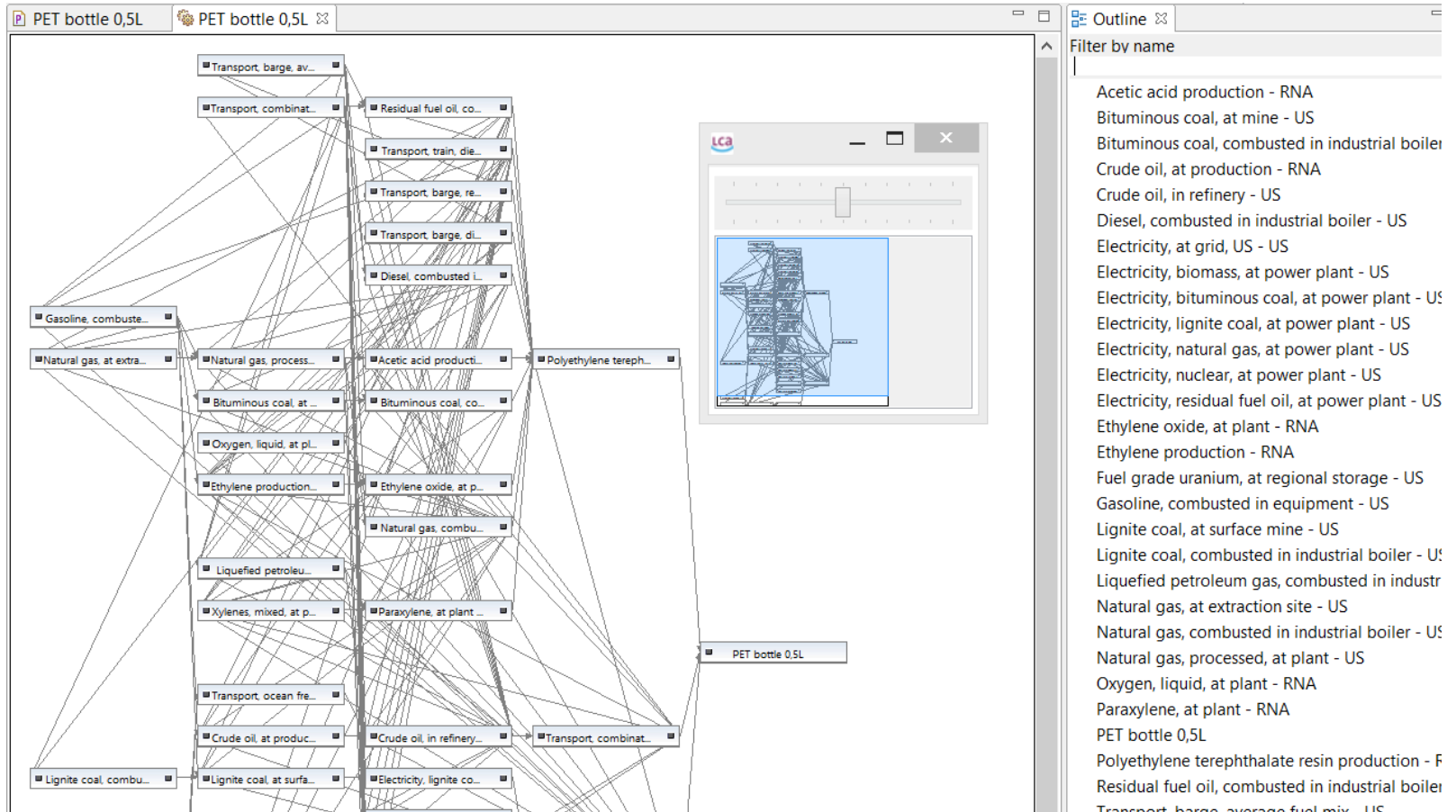
- Name: Case 1
- Description: (empty text area)
- Version: 00.00.000
- Last change: (empty)
- Calculate button: (with a small icon)

Below the "General information" section is a "Reference" section with the following fields:

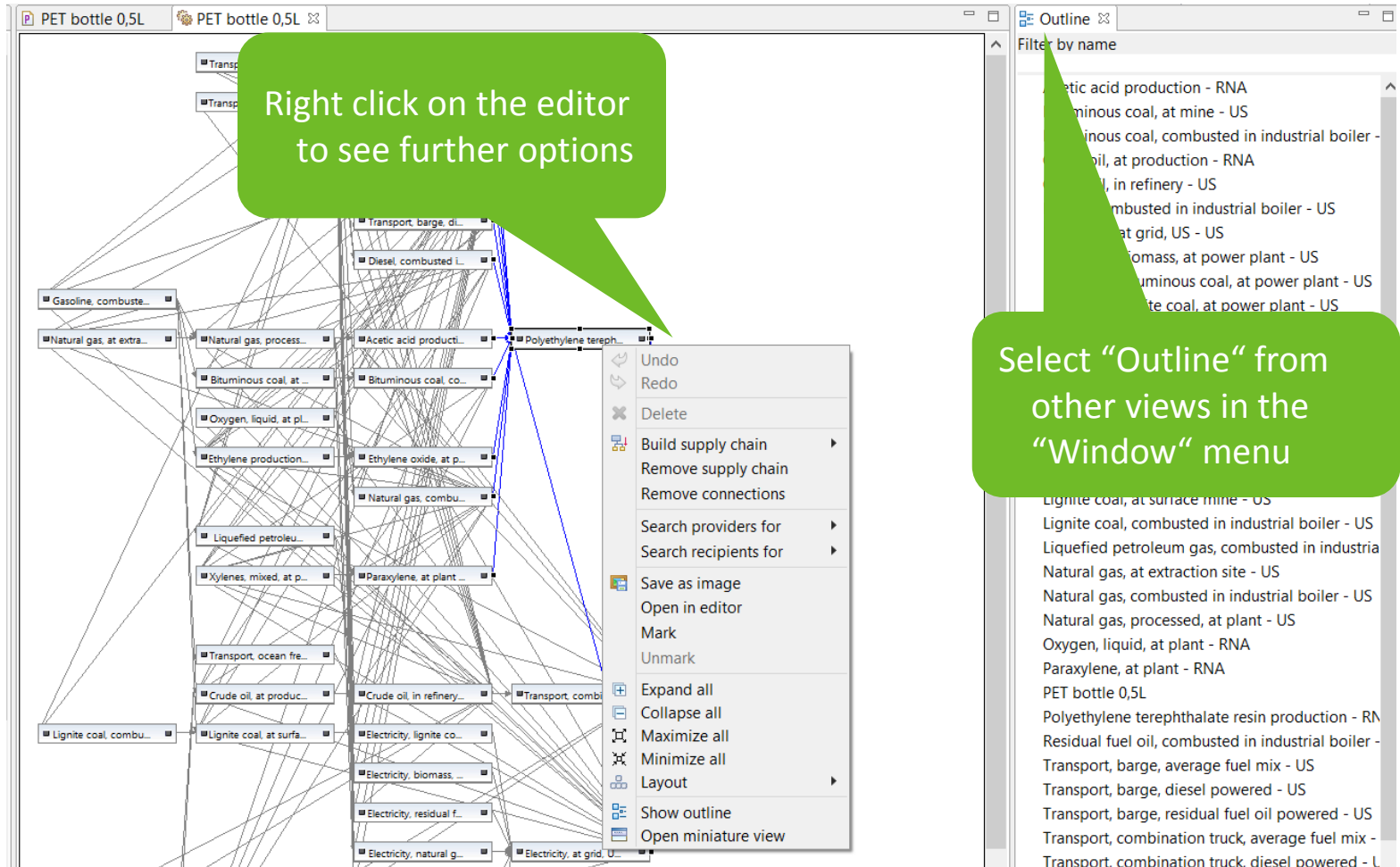
- Process: Case 1
- Product: filled water bottle, point of sale
- Flow property: Number of items
- Unit: Item(s)
- Target amount: 1000.0

At the bottom of the window, there is a tab bar with "General information", "Parameters", and "Model graph".

Product system: Model graph (I)



Product system: Model graph (II)



Product system: Calculation (I)

The screenshot displays the GreenDelta software interface. On the left is a navigation tree with categories like 'ecoinvent', 'Projects', 'Product systems', 'Impact methods', 'Processes', 'Flows', 'Flow properties', 'Unit groups', 'Sources', 'Actors', 'Ecoinvent', 'probas', 'schulungaugust14students', and 'test'. The main window is titled 'Product system: Case 1' and has three tabs: 'General information', 'Parameters', and 'Model graph'. The 'General information' tab is active, showing fields for 'Name' (Case 1), 'Description', 'Version' (00.00.000), and 'Last change'. A green callout box with a white border points to a green 'Calculate' button with a white arrow icon. Below the 'Calculate' button is a 'References' section with a dropdown menu showing 'Case 1' and a list of items including 'filled water bottle, point of sale', 'Number of items', and 'Item(s)'. On the right side, there is an 'Outline' window with a search bar and a list of product systems, including '1,1-difluoroethane production, HFC-152a -', '1,1-difluoroethane production, HFC-152a -', '1,1-dimethylcyclopentane to generic market', '1-propanol production - RoW', '1-propanol production - RER', '2,3-dimethylbutan to generic market for sol', '2-butanol production by hydration of buten', '2-butanol production by hydration of buten', '2-butanol production by hydration of buten', '2-methyl-2-butanol production - RER', '2-methyl-2-butanol production - RoW', '2-methylpentane to generic market for solve', '[sulfonyl]urea-compound production - RER', '[thio]carbamate-compound production - RER', '[thio]carbamate-compound production - Ro', 'acetaldehyde oxidation - RER', 'acetaldehyde oxidation - RoW', 'acetaldehyde oxidation - RoW', 'acetaldehyde oxidation - RER', 'acetaldehyde production - RER', 'acetaldehyde production - RoW', 'acetamide-anilide-compound production, u', 'acetamide-anilide-compound production, u', 'acetic acid production, product in 98% soluti', 'acetic acid production, product in 98% soluti', 'acetic anhydride production, ketene route -', 'acetic anhydride production, ketene route -', 'acetone production, liquid - RoW', 'acetone production, liquid - RER', 'acetylene production - RoW', 'acetylene production - CH', 'acrylic acid production - RER', 'acrylic acid production - RoW', 'acrylic binder production, product in 34% so', 'acrylic binder production, product in 34% so', 'acrylic dispersion production, product in 65%', 'acrylic dispersion production, product in 65%', 'acrylic varnish production, product in 87.5%', 'acrylic varnish production, product in 87.5%', 'acrylonitrile-butadiene-styrene copolymer p', 'acrylonitrile-butadiene-styrene copolymer p', 'activated bentonite production - RoW', 'activated bentonite production - DE', 'adipic acid production - RER', 'adipic acid production - RoW', 'agricultural machinery production, tillage -', 'agricultural machinery production, tillage -', 'agricultural machinery production, unspecifi', 'agricultural machinery production, unspecifi', 'agricultural trailer production - RoW'.

1. Click on "Calculate" in the General information tab.

Product system: Calculation (II)

Calculation properties
Please select the properties for the calculation

Allocation method: None

Impact assessment method: CML, 2001 (baseline)

Normalization/weighting set: [Empty]

Calculation type:
 Quick results
 Analysis
 Monte Carlo Simulation

Number of iterations: 100

Buttons: Save as default, Reset, Cancel, Calculate

2. Select calculation properties and click on Calculate.

Navigation tree (left):
- ecoinvent
- Projects
- Product systems
- Case 1
- Case 2
- Case 3
- International production
- market for electricity, low voltage
- Impact methods
- Processes
- A: Agriculture, forestry and fishing
- B: Mining and quarrying
- C: Manufacturing
- CCL Meerane Label Production
- D: Electricity, gas, steam and air conditioning
- E: Water supply; sewerage, waste management
- F: Construction
- G: Wholesale and retail trade; repair of motor vehicles
- H: Transportation and storage
- J: Information and communication
- L: Real estate activities
- M: Professional, scientific and technical activities
- N: Administrative and support service activities
- Recycled Content cut-off
- S: Other service activities
- Case 1
- Case 2
- Case 3
- International production
- New Process
- Flows
- Flow properties
- Unit groups
- Sources
- Actors
- Ecoinvent
- probas
- schulungaugust14students
- test

Process list (right):
- methane production, HFC-152a -
- methane production, HFC-152a -
- cyclopentane to generic market
- production - RoW
- production - RER
- butan to generic market for sol
- production by hydration of butene
- production by hydration of butene
- production by hydration of butene
- production by hydration of butene
- 2-methyl-2-butanol production - RER
- 2-methyl-2-butanol production - RoW
- 2-methylpentane to generic market for solv
- [sulfonyl]urea-compound production - RER
- [sulfonyl]urea-compound production - RoW
- [thio]carbamate-compound production - RER
- [thio]carbamate-compound production - Ro
- acetaldehyde oxidation - RER
- acetaldehyde oxidation - RoW
- acetaldehyde oxidation - RoW
- acetaldehyde oxidation - RER
- acetaldehyde production - RER
- acetaldehyde production - RoW
- acetamide-anilide-compound production, u
- acetamide-anilide-compound production, u
- acetic acid production, product in 98% soluti
- acetic acid production, product in 98% soluti
- acetic anhydride production, ketene route -
- acetic anhydride production, ketene route -
- acetone production, liquid - RoW
- acetone production, liquid - RER
- acetylene production - RoW
- acetylene production - CH
- acrylic acid production - RER
- acrylic acid production - RoW
- acrylic binder production, product in 34% so
- acrylic binder production, product in 34% so
- acrylic dispersion production, product in 65%
- acrylic dispersion production, product in 65%
- acrylic varnish production, product in 87.5%
- acrylic varnish production, product in 87.5%
- acrylonitrile-butadiene-styrene copolymer p
- acrylonitrile-butadiene-styrene copolymer p
- activated bentonite production - RoW
- activated bentonite production - DE
- adipic acid production - RoW
- adipic acid production - RoW
- agricultural machinery production, tillage - I
- agricultural machinery production, tillage - C
- agricultural machinery production, unspecifi
- agricultural machinery production, unspecifi
- agricultural trailer production - RoW

Product system: Calculation (III)

Results of Case 1

General information

Product system: Case 1
Allocation method: None
Target amount: 1000.0 Item(s) filled water bottle, point of sale
Impact method: CML, 2001 (baseline)
Export to Excel

Flow contributions

Flow: Hydrogen-3, Tritium - water/ocean

1.519E3 kBq: treatment of spent nuclear fuel, reprocessing - RoW
6.244 kBq: electricity production, nuclear, pressure water reactor - CN
0.019 kBq: zeolite production, powder - RoW
9.647E-3 kBq: zeolite production, powder - RER
0.016 kBq: Other

Impact contributions

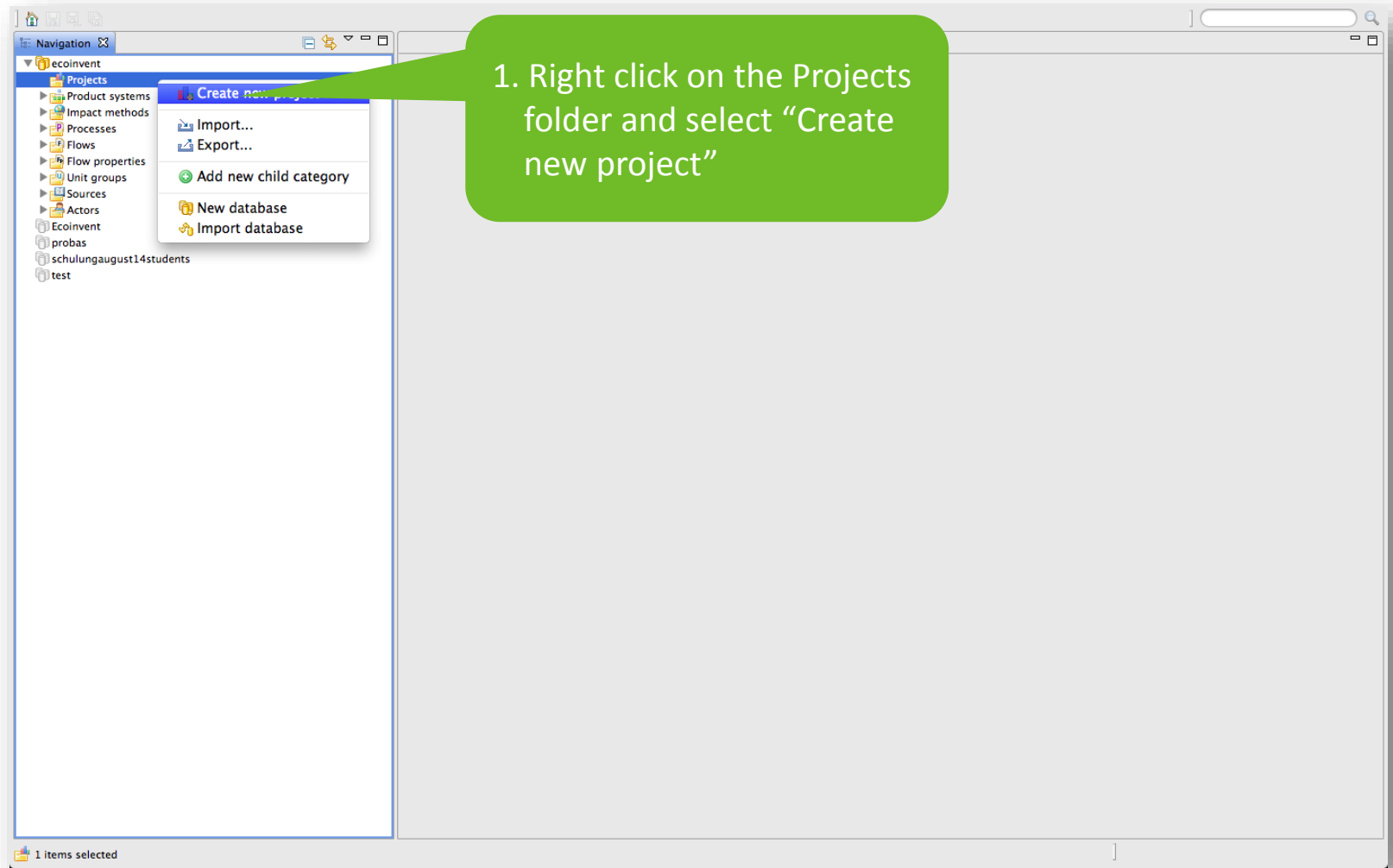
Impact category: Climate change - GWP100

9.273E3 kg CO2 eq.: transport, freight, lorry 16-32 metric ton, EUROS - RER
4.176E2 kg CO2 eq.: refinery gas, burned in furnace - Europe without Switzerland
3.426E2 kg CO2 eq.: diesel, burned in building machine - GLO

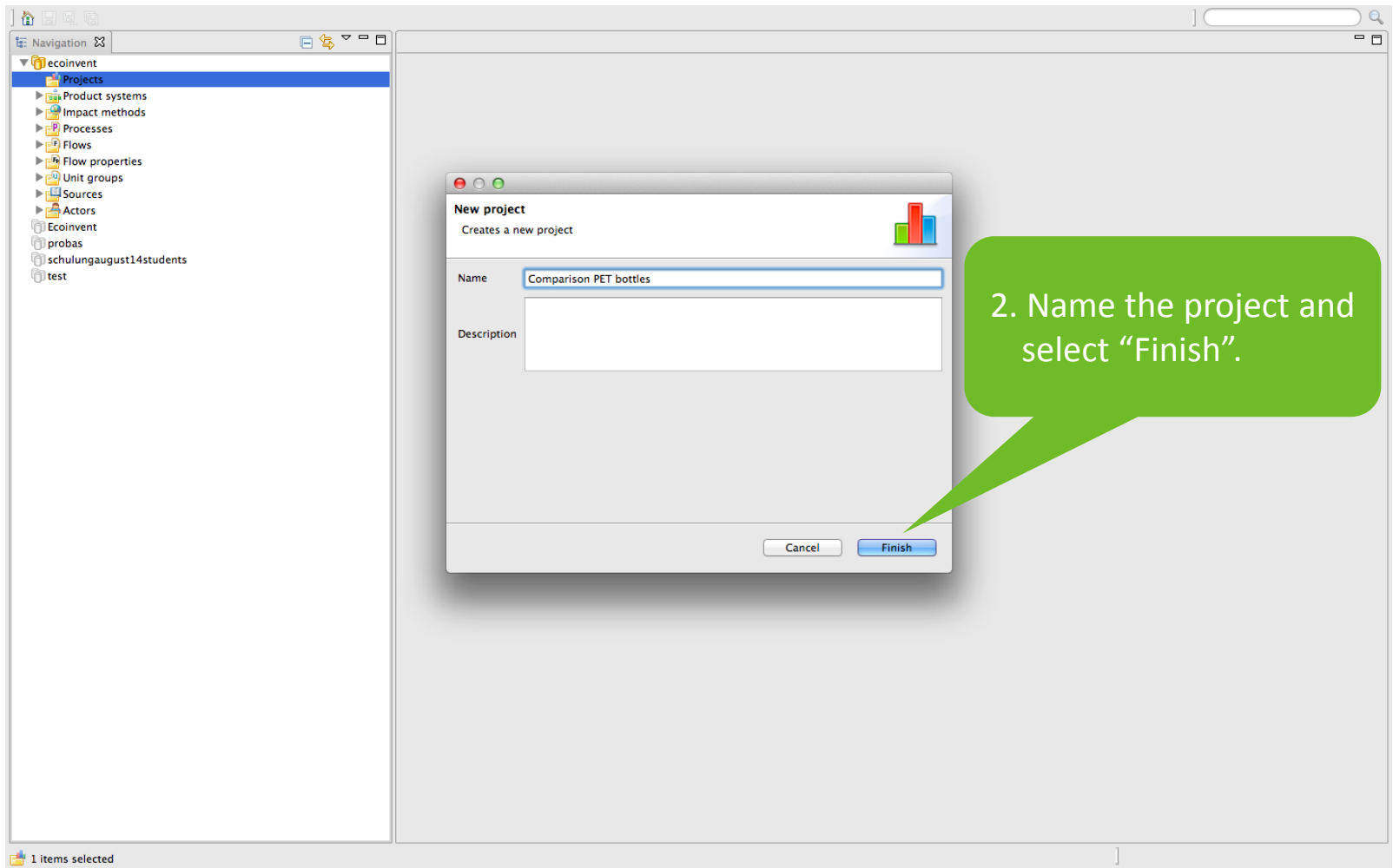
General information | **Inventory results** | LCIA Result | Process contributions | Flow contributions | Locations | Grouping

3. Check the tabs for inventory results, LCIA results, Contributions, etc.

Project: Creation (I)



Project: Creation (II)



Project: Creation (III)

3. A new tab with the project will appear in the editor window. Click on the green button to select different variants

Name	Product system	Allocation method	Flow	Amount	Unit
Variant 1	Case 1	None	filled water bottle, point of sale	1000.0	Item(s)
Variant 2	Case 2	None	filled water bottle, point of sale	1000.0	Item(s)
Variant 3	Case 3	None	filled water bottle, point of sale	1000.0	Item(s)

Parameter	Context	Variant 1	Variant 2	Variant 3

Project: Calculation (I)

The screenshot displays the OpenLCA software interface. On the left is a navigation tree with categories like 'ecoinvent', 'Projects', 'Product systems', 'Impact methods', 'Processes', 'Flows', 'Flow properties', 'Unit groups', 'Sources', 'Actors', 'ecoinvent', 'probas', 'schulungaugust14students', and 'test'. The main window is titled 'Project: Comparison PET bottles' and is divided into several sections:

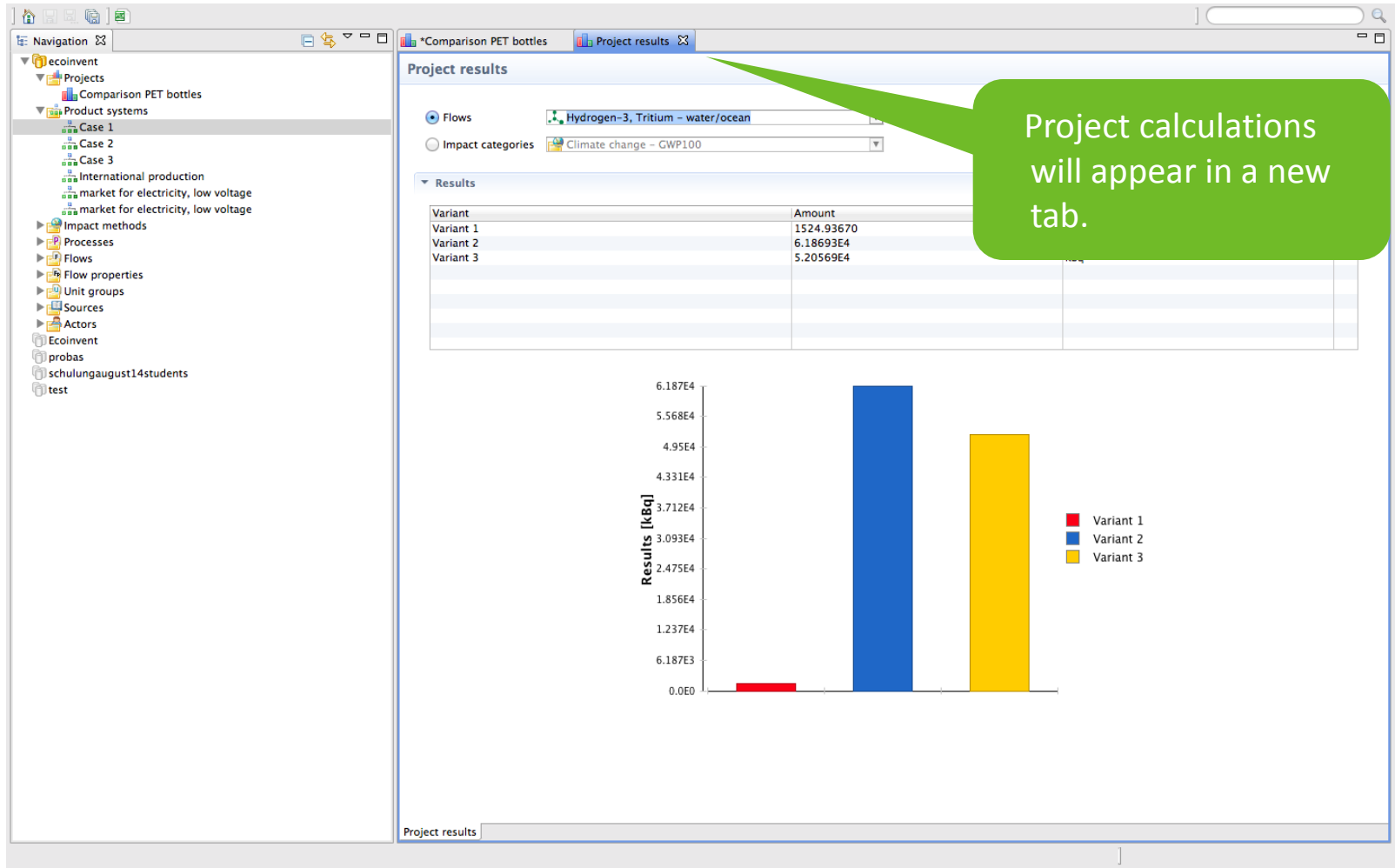
- General information:** Contains fields for Name (Comparison PET bottles), Description, Version (00.00.000), Last change (2014-09-10T09:50:22+0200), and LCIA Method (CML, 2001 (baseline)). A 'Calculate' button is located below these fields.
- Variants:** A table with columns for Name, Product system, and Unit. It lists three variants: Variant 1 (Case 1), Variant 2 (Case 2), and Variant 3 (Case 3).
- Parameters:** A table with columns for Parameter, Context, Variant 1, Variant 2, and Variant 3.

A green callout bubble points to the 'Calculate' button with the text: "Click on Calculate in the Project setup tab".

Name	Product system	Unit
Variant 1	Case 1	Item(s)
Variant 2	Case 2	Item(s)
Variant 3	Case 3	Item(s)

Parameter	Context	Variant 1	Variant 2	Variant 3

Project: Calculation (II)

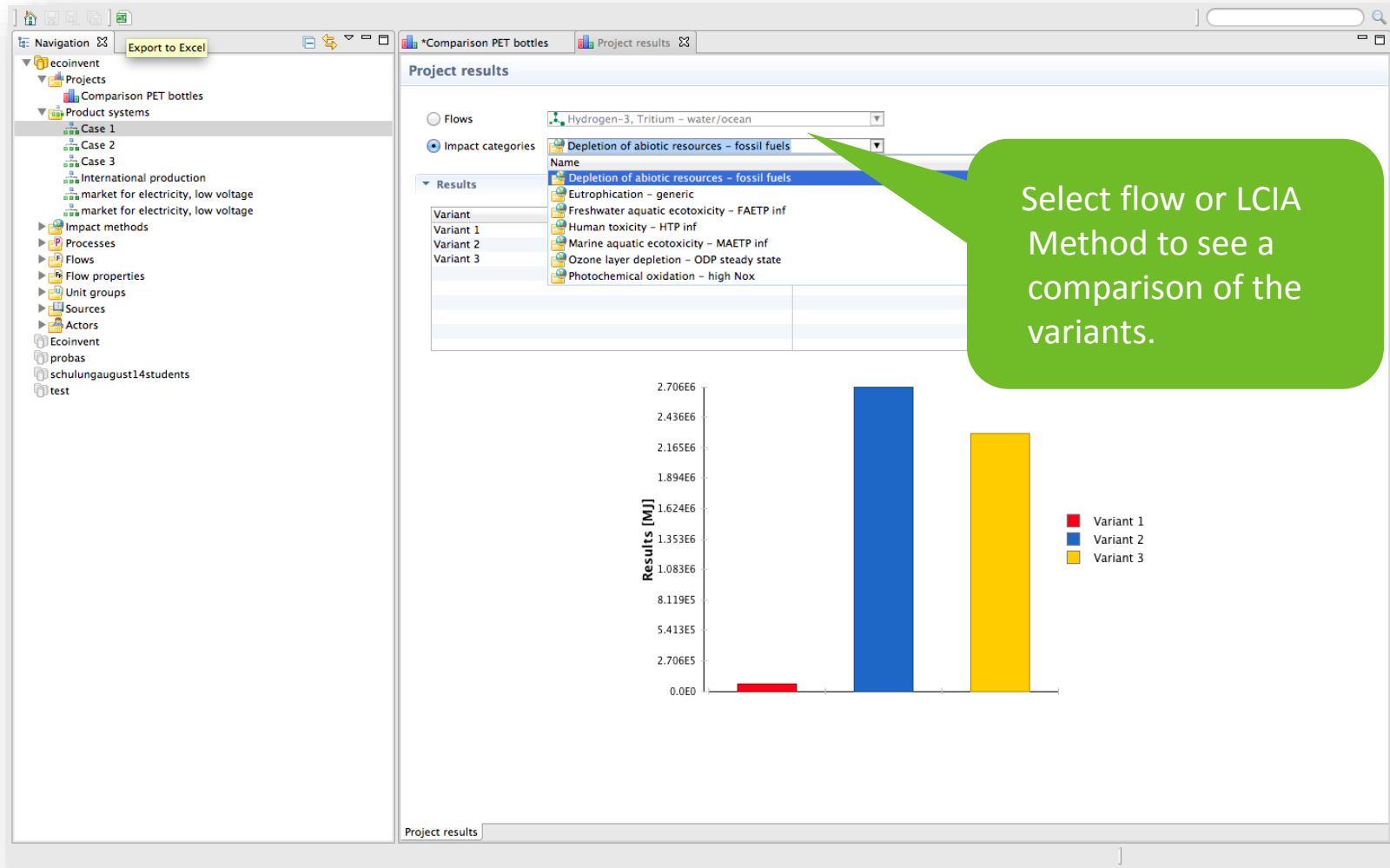


The screenshot displays the ecoinvent software interface. On the left is a navigation tree with a hierarchy: ecoinvent > Projects > Comparison PET bottles > Product systems > Case 1. The main window shows the 'Project results' tab for the flow 'Hydrogen-3, Tritium - water/ocean' under the impact category 'Climate change - GWPl00'. Below this, a table lists the results for three variants:

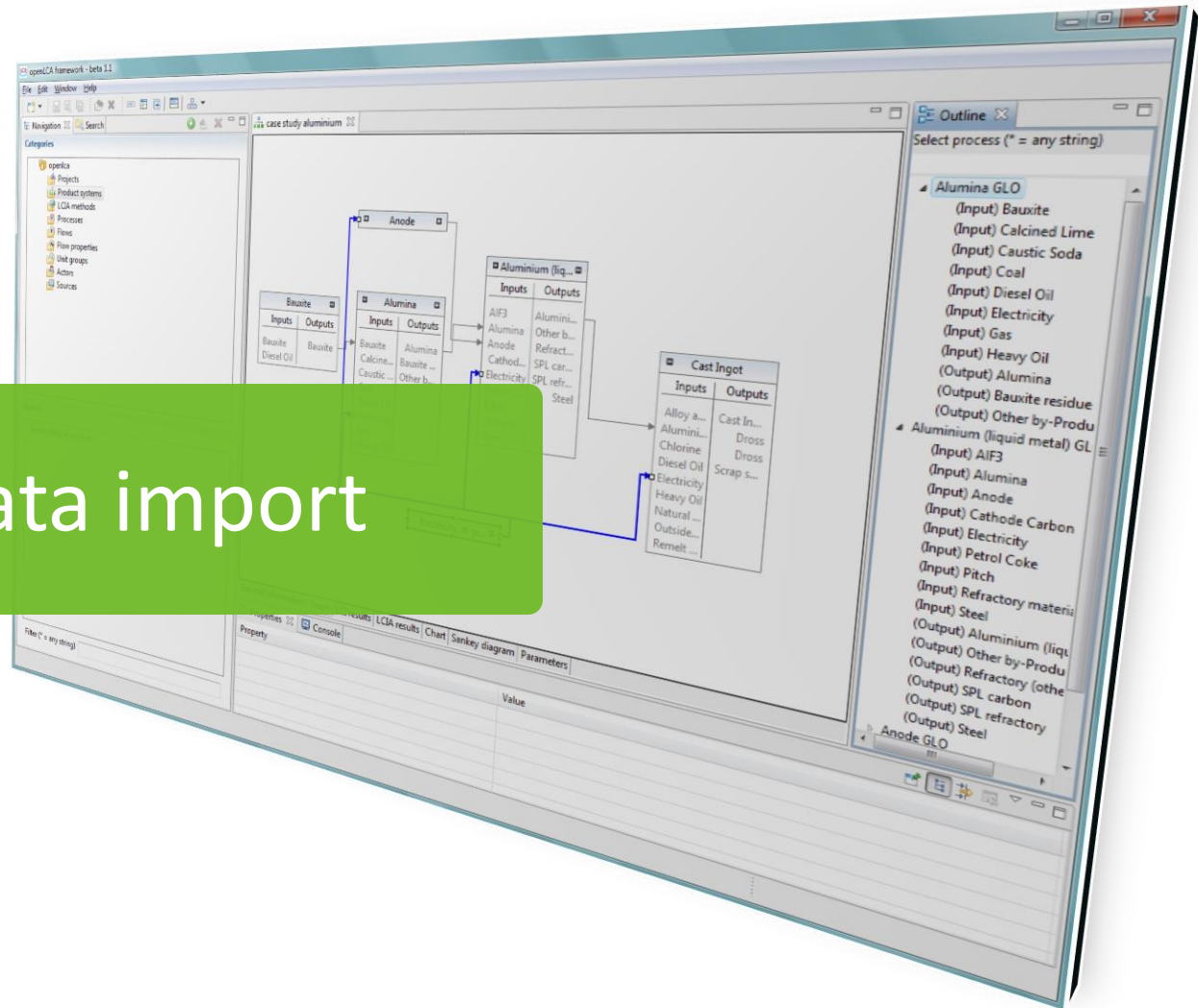
Variant	Amount
Variant 1	1524.93670
Variant 2	6.18693E4
Variant 3	5.20569E4

Below the table is a bar chart titled 'Results [kBq]' showing the values for Variant 1 (red), Variant 2 (blue), and Variant 3 (yellow). The y-axis ranges from 0.0E0 to 6.187E4. A green callout bubble points to the 'Project results' tab with the text: 'Project calculations will appear in a new tab.'

Project: Calculation (III)



LCA data import



Data management in openLCA

- New databases in openLCA are empty at first (with the exception of reference data), but data can be imported easily
- Supported Import und Export formats:
 - EcoSpold1
 - ILCD
 - EcoSpold2
 - Excel
 - SimaPro CSV
 - zolca
- It is possible to use more than one database; databases are independent of one another and only one database is “active” at a time, all of the others are “deactivated”
- It is possible to save own data; every element of the software can be personalised

Import of data sets (I)

The image shows the openLCA 1.4 software interface. The main window displays a "Welcome to openLCA!" message and a "What's new" section. The "File" menu is open, with the "Import..." option highlighted. A green callout bubble points to this option with the text "1. Go to File → Import".

The "Import" dialog box is open, showing a "Select" screen. It contains a search filter and a list of import sources. A green callout bubble points to the "Database Import" option with the text "2. Choose the data format".

1. Go to File → Import

2. Choose the data format

The "Import" dialog box includes the following elements:

- Search filter: "type filter text"
- Import sources list:
 - File Import
 - EcoSpold 1
 - EcoSpold 2
 - Excel
 - ILCD
 - SimaPro CSV
 - ILCD Network Import
 - Other
 - Database Import
- Navigation buttons: "< Back", "Next >", "Finish", and "Cancel".

Import of data sets (II)

Import EcoSpold

Assign units

Please select the flow property to which a unit should belong for the import process. Assign a conversion factor if unit is new.

Unit	Flow property	Reference unit	Conversion fact...	Formula
MJ	Energy	MJ	1.0	1.0 MJ = 1.0 MJ
kBq	Radioactivity	kBq	1.0	1.0 kBq = 1.0 kBq
kg	Mass	kg	1.0	1.0 kg = 1.0 kg
m2	Area	m2	1.0	1.0 m2 = 1.0 m2
m2*a	Area*time	m2*a	1.0	1.0 m2*a = 1.0 m2*a
m3	Volume	m3	1.0	1.0 m3 = 1.0 m3

< Back Cancel

4. Add conversion factors for new units

Import EcoSpold

Select import files

Please select the files to import into openLCA

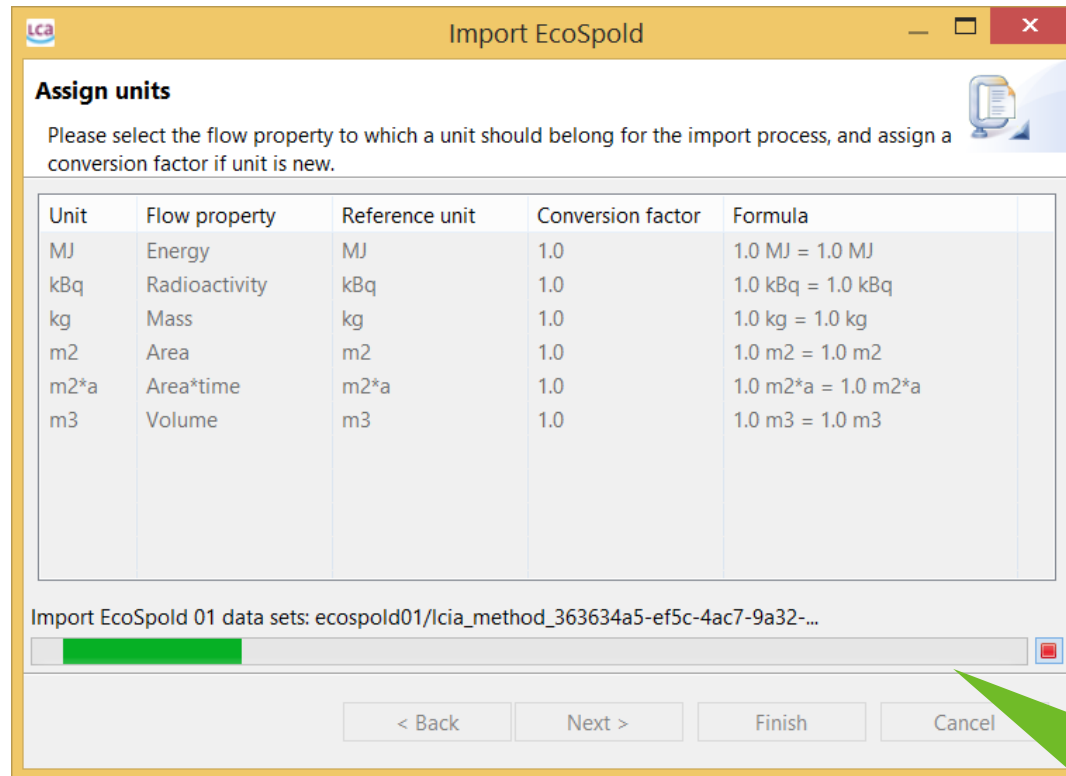
From directory: C:\ Choose directory...

- ▷ \$Recycle.Bin
- ▷ Documents and Settings
- ▷ Dokumente und Einstellungen
- ▷ ESD
- ▷ Intel
- ▷ PerfLogs
- ▷ Program Files
- ▷ Program Files (x86)
- ▷ ProgramData

< Back Next > Finish Cancel

3. Select the file from the corresponding directory

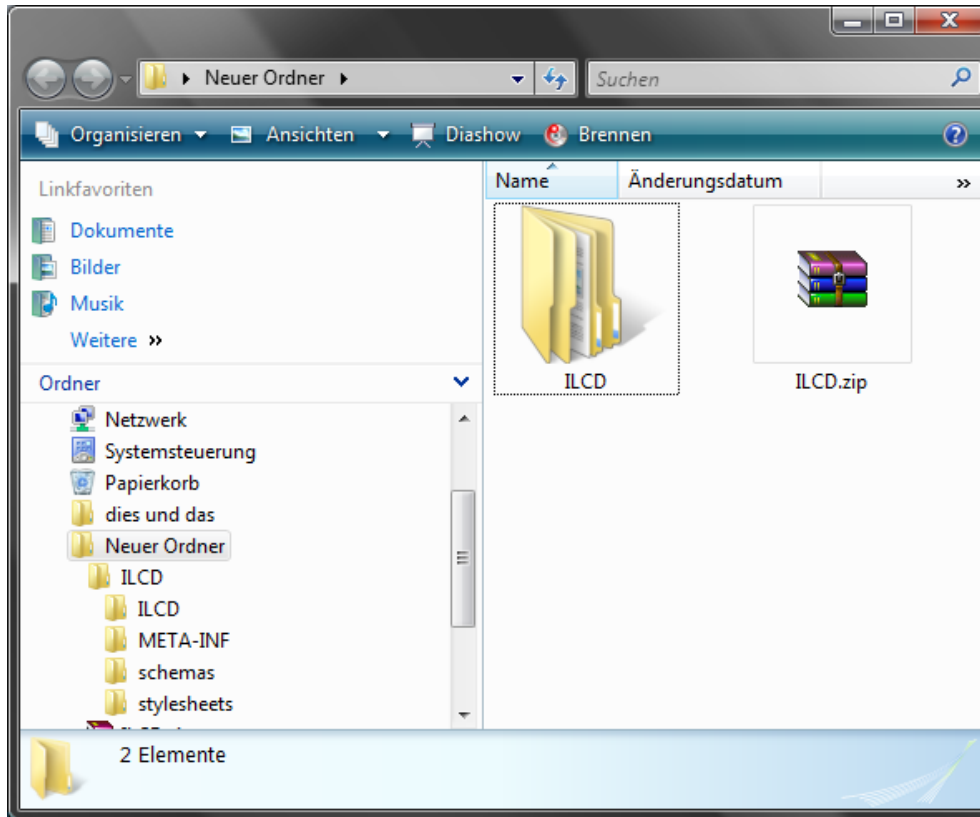
Import of data sets (III)



5. Data will be imported in your active database

Import of ILCD

- Data sets in ILCD must be imported as zip file:



Import of openLCA database

openLCA 1.4.1 beta 4

File Window Help

Navigation

Welcome

openLCA Welcome to openLCA!
Version 1.4.1 beta 4 (Windows 64 bit)

High performance Life Cycle Assessment (LCA) and sustainability assessment software. Truly open source. Available for free. Created and maintained since 2006 by GreenDelta, Berlin. www.greendelta.com
Licensed under the Mozilla Public License ([what does this mean?](#)).

GreenDelta

New database
Import database

What's new

For the 1.4 version, we completely redesigned and "renovated" openLCA. Results are

- **drastically improved performance** of about 400%
- **numerous usability improvements**
- **many new features**

Getting started

When you start openLCA the first time, it does not contain any data. With the new version of openLCA, it is really easy to get started. You can just import a database from an existing zolca-file and open it from the navigation on the left side. Then open the database with a simple double click.

This is explained in a video, [here](#)

Searching for and downloading data

A broad range of LCA databases are available in [openLCA Nexus](#), where you can search for single data sets and also for complete databases, and download them into openLCA. The databases are all fit for openLCA, several databases can be combined.

This is also explained in a [video](#)

LCIA method packs are available from the openLCA [download page](#)

User Manuals

The online wiki for openLCA provides details about almost all features of openLCA. It is changing over time so check back from time to time.

New introductory and comprehensive [manuals](#) are also available online.

Examples

Community

Welcome

openLCA Nexus

- Search for and download data
- Search for „provider, country, other location, category, price, and start of validity“ oder type search direct into search engine window
- Direct purchase/download of data fur use in openLCA

openLCA Nexus

The screenshot shows a web browser window with the URL <https://nexus.openlca.org>. The page features a navigation bar with links for 'openLCA Nexus', 'Databases', 'LCA data search', 'FAQs', and 'About'. On the right side of the navigation bar, there are links for 'Register', 'Login', a shopping cart icon with '0', and 'Go to openLCA.org'. The main content area includes the 'openLCA nexus' logo, a heading 'openLCA Nexus' with the tagline 'Your source for LCA data sets.', and a search input field with a 'Search' button. Below this, there are three columns of content: 'LCA databases' with a 'Browse databases' button, 'LCA data search' with a 'Search data sets' button, and 'About' with a 'Read more' button. The footer contains copyright information for GreenDelta GmbH 2014 and links to 'Imprint', 'Terms & Conditions', 'EULA', 'Privacy Policy', and 'Cookie Policy'. The 'GreenDELTA' logo is positioned in the bottom right corner of the page.

openLCA Nexus: The source for LCA data sets

https://nexus.openlca.org

Apple iCloud Facebook Twitter LinkedIn Wikipedia Yahoo News Popular Leo Linguee

openLCA Nexus Databases LCA data search FAQs About Register Login 0 Go to openLCA.org

openLCA nexus

openLCA Nexus
Your source for LCA data sets.

Search

LCA databases
openLCA Nexus contains a broad range of LCA databases, some for free and some for purchase. Data sets can be easily imported into openLCA.
[Browse databases](#)

LCA data search
This website contains a powerful search engine for LCA data that allows filtering requested data sets by e.g. database, location or year.
[Search data sets](#)

About
Basic idea of the openLCA nexus is to overcome isolated data silos in LCA, by creation of a coherent and consistent LCA data space.
[Read more](#)

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GreenDELTA

openLCA Nexus

The screenshot shows a web browser window with the URL `nexus.openlca.org/dataproviders`. The page title is "openLCA Nexus: The source for LCA data sets". The navigation bar includes "openLCA Nexus", "Databases", "LCA data search", "FAQs", "About", "Register", "Login", a shopping cart icon with "0", and "Go to openLCA.org".

The main content area features the "openLCA nexus" logo and the heading "openLCA Nexus Your source for LCA data sets." Below this, there are tabs for "All", "Free databases", and "For purchase databases".

A sidebar on the left lists "Data providers" with the following links: bioenergiesdat, ELCD, NEEDS, ProBas, USDA, ecoinvent, GaBi, LC-Inventories.ch, Ökobaudat, and Social Hotspots.

The main content area displays three database entries:

- ProBas Umweltbundesamt**: A German dataset library originally provided by the German Federal Environment Agency (Umweltbundesamt). It includes unit as well as aggregated processes, for the following topics: Energy, Materials & Products, Transportation services and Waste. A "new" badge is present. A "Browse" button is located to the right.
- USDA**: LCA database containing agricultural data sets with a US background, plus crosswalks to upstream Ecoinvent v.2.2 data sets, provided by the United States Department of Agriculture (USDA). A "new" badge is present. A "Browse" button is located to the right.
- ecoinvent**: A leading LCA database by the ecoinvent centre. We offer a fully valid ecoinvent license.

openLCA Nexus



www.LC-Inventories.ch



BIOENERGIE DAT

openLCA Nexus search engine

The screenshot displays the openLCA Nexus search engine interface. At the top, there is a navigation bar with links for 'openLCA Nexus', 'Databases', 'LCA data search', 'FAQs', and 'About'. On the right side of the navigation bar, there are links for 'Register', 'Login', a shopping cart icon with '0', and 'Go to openLCA.org'.

The main content area features the openLCA Nexus logo on the left and a search bar on the right. The search bar contains the text 'PET' and a 'Search' button. Below the search bar, the results are displayed as follows:

- Data provider** ✕
ecoinvent 82
- Country**
 - Switzerland 82
 - Vatican City 36
 - United Kingdom 36
 - Ukraine 36
 - Turkey 36
 - Sweden 36
 - Svalbard and Jan Mayens 36
 - Spain 36
 - Slovenia 36
 - Slovakia 36
 - More...
- Other location**
 - Europe 36
- Category**
 - agricultural means of production 1
 - biomass 5
 - chemicals 3
 - oil 34
 - plastics 2
 - transport systems 27
 - ventilation 1

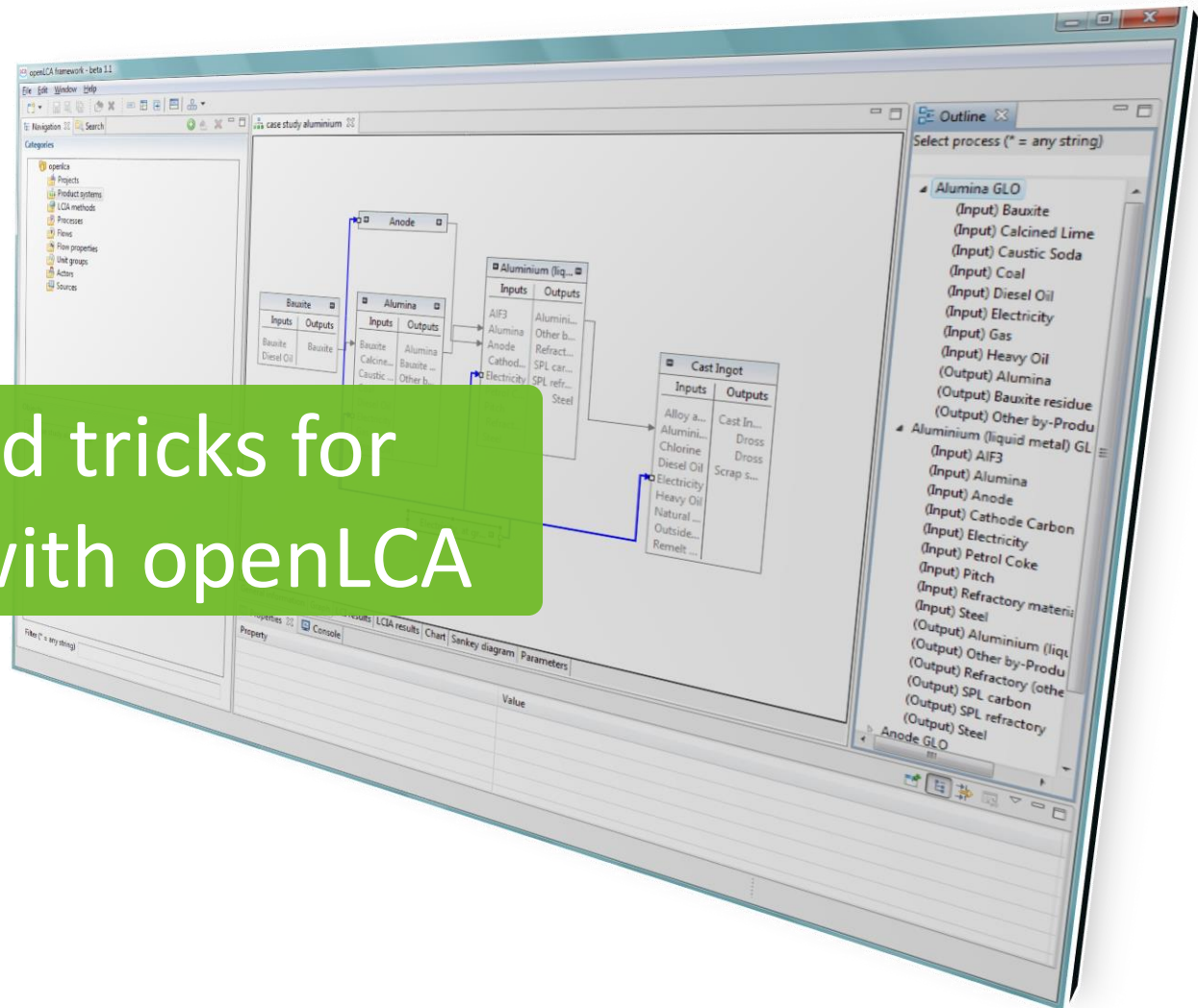
The search results are listed below the filters:

- 82 datasets in 28 ms
- disposal, flexible duct, aluminum/PET, DN of 125 (Switzerland)**
 - Data provider: ecoinvent
 - Category: waste management/building demolition
 - Version (internal): 1.0 Location: Switzerland
- flexible duct, aluminum/PET, DN of 125, at plant (Europe)**
 - Data provider: ecoinvent
 - Category: ventilation/production of components
 - Version (internal): 1.0 Location: Europe
- polyethylene terephthalate, granulate, amorphous, at plant (Europe)**
 - Data provider: ecoinvent
 - Category: plastics/polymers
 - Version (internal): 1.0 Location: Europe
- polyethylene terephthalate, granulate, bottle grade, at plant (Europe)**
 - Data provider: ecoinvent
 - Category: plastics/polymers
 - Version (internal): 1.0 Location: Europe

Exercise 2: import

- Import the openLCA database file “openlca4students.olca” in openLCA.
- Import the file “impact-methods.zip” (EcoSpold1) in the imported database.
- 10 min

Tips and tricks for dealing with openLCA



Basic commands

- **Open element:** double click
- **Copy element:** right mouse button → copy
- **Paste element:** right mouse button → paste
- **Delete element:** right mouse button → delete
- **Save element:** use saving symbol in the main menu
- **Save image:** right mouse button → save image
- **Minimise/maximise element:**



Basic commands

- If you double click on a flow in the process editor it will be opened in a separate window and can be

Modified:

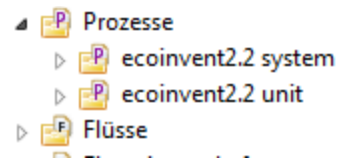
The screenshot shows the openLCA framework 1.2 interface. The main window displays the 'Process: Chlor-alkali electrolysis, average production mix, at plant' editor. The 'Inputs (Formula view)' table is visible, showing various input flows. A tooltip is visible over the 'Dummy_Disposal' input flow, showing its location and category.

Flow	Category	Flow type	Flow property	Unit	Resulting amount	Uncertainty distribution type
Bituminous coal, combustion in industrial boiler	Product...	Product...	Mass	kg	0.0244	No distribution
Dummy_Disposal	Location: US Category: Product and Waste Flows	Product...	Mass	kg	0.00123	No distribution
Dummy_Electricity, at grid, US	Product...	Product...	Energy	k...	0.00171	No distribution
Electricity, at grid, US	Product...	Product...	Energy	k...	0.32187	No distribution
Natural gas, combustion in industrial boiler	Product...	Product...	Volume	m ³	0.72973	No distribution
Residual fuel oil, combustion in industrial boiler	Product...	Product...	Volume	L	0.10681	No distribution
Sodium chloride, at plant	Product...	Product...	Mass	kg	0.0019194	No distribution

Flow	Category	Flow type	Flow property	Unit	Resulting amount	Uncertainty distribution type
Benzene	air/uns...	Elemen...	Mass	kg	1.9208E-8	No distribution
BOD5, Biological Oxygen Demand	water/...	Elemen...	Mass	kg	2.329E-4	No distribution
Carbon dioxide, biogenic	air/uns...	Elemen...	Mass	kg	6.3967E-5	No distribution

Folder structure

- Divide system and unit processes

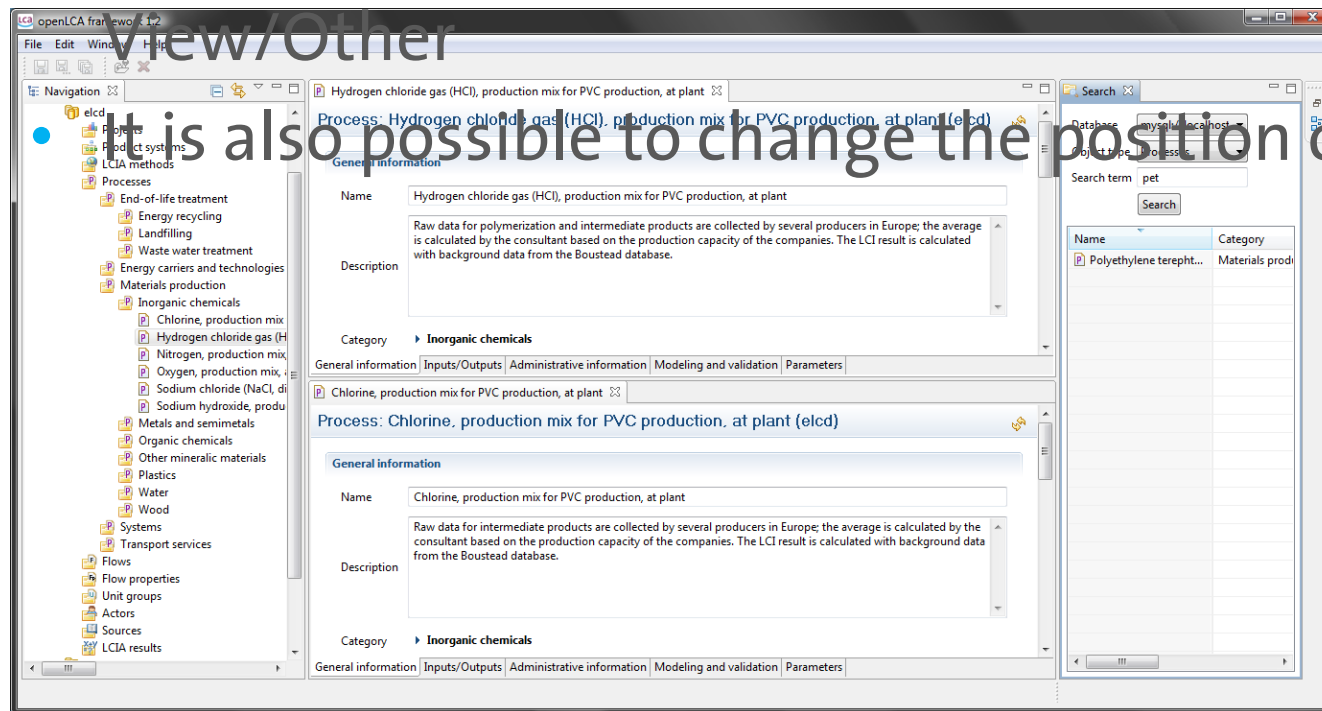


- Divide processes from different databases in one openLCA database
- Separate flows and processes

Do not change the folder structure of elementary flows, because LCIAM cannot find them anymore!!

Windows

- Often users have several elements open at the same time. It is recommended to close elements you don't need.
- To recover "missing" window: go to Window/Show



View/Other

It is also possible to change the position of a window

Search

- Search any element from the database

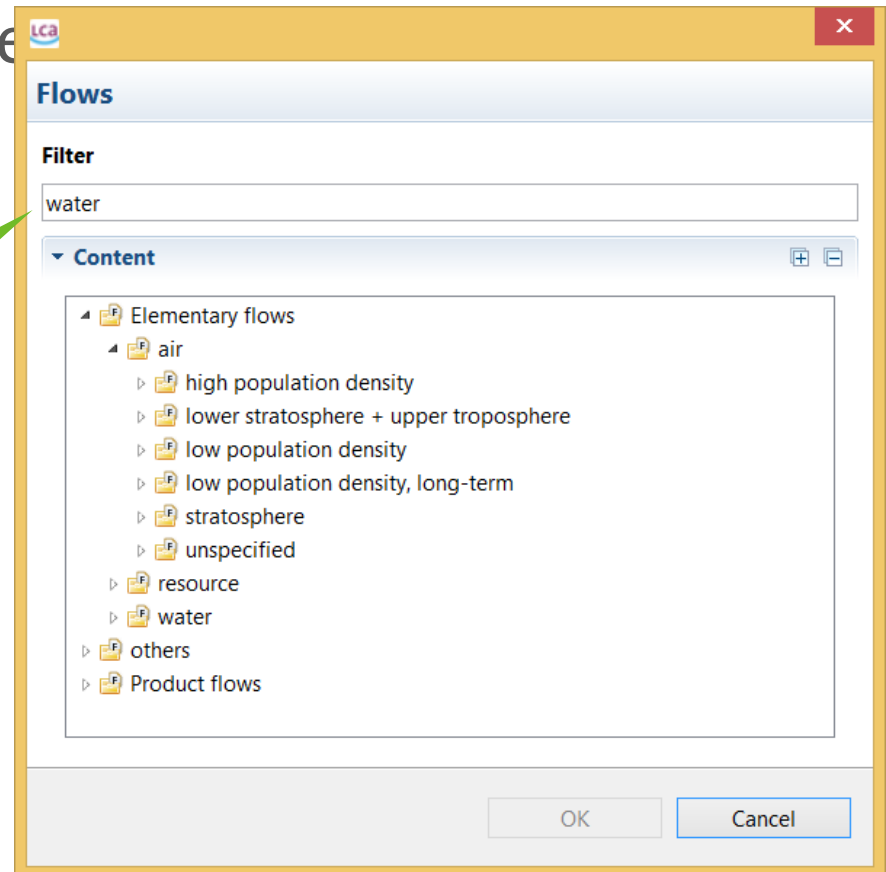
The screenshot shows the openLCA 1.4.1 beta 4 application window. The title bar reads "openLCA 1.4.1 beta 4". The menu bar includes "File", "Window", and "Help". Below the menu bar is a toolbar with icons for home, save, print, and search. A search bar at the top right contains the text "transport". The main window is divided into two panes. The left pane, titled "Navigation", shows a tree view of the database structure with "openlca4students" selected. The right pane, titled "Search result view", displays "Search results: transport (384Results)". The search results list includes items like "Transport person diesel car", "Case study Li-ion battery/basic processes", and "Transport, aircraft, freight - RNA". A green callout bubble with a white border points to the search bar, containing the text "Write the key words for the search".

Write the key words
for the search

Filter

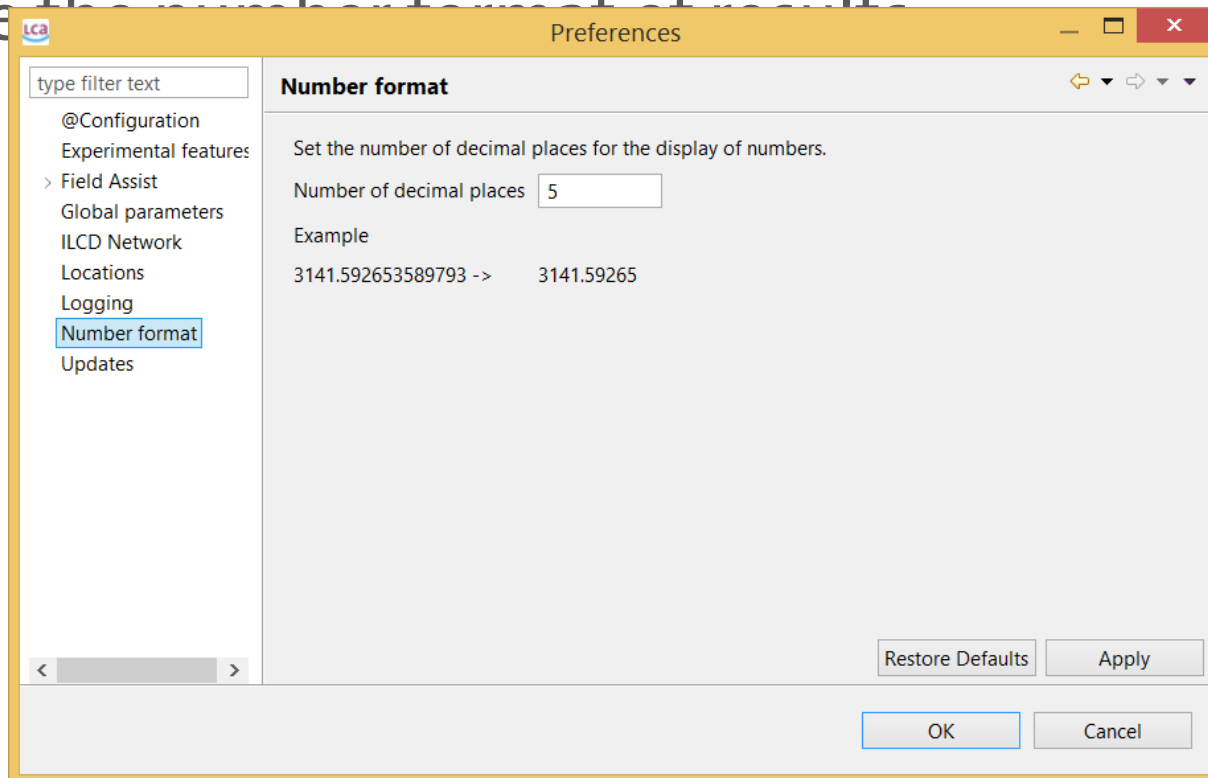
- The “Add new” editors contain a filter for facilitating the search of the desired e

Use the “Filter” when adding new flows to a process, select the reference process in a product system, etc.



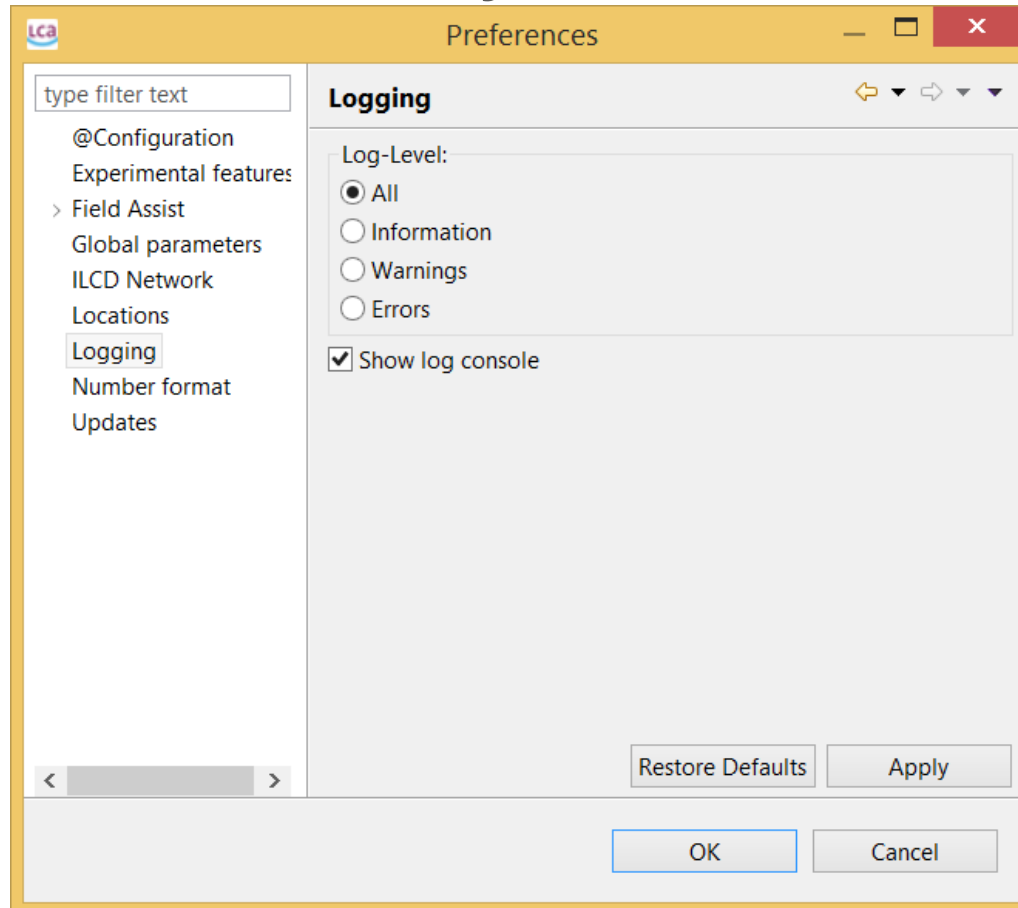
Numbers

- Use always a point for floating point numbers, a comma is not accepted (=> 1.5 instead of 1,5)
- Under File/Preferences/Number format you can choose the number format of results



Errors

- It is possible to report all errors in a log file automatically.

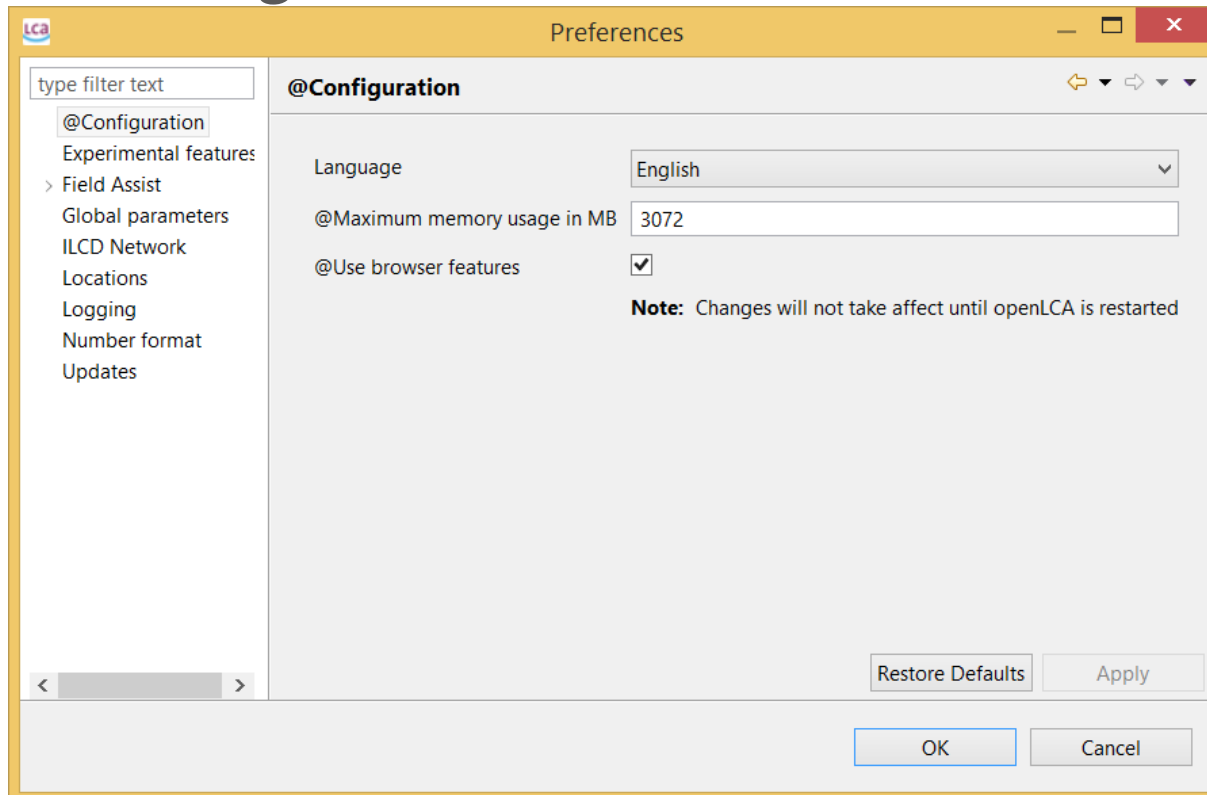


logging and check

The log file is rewritten every time openLCA is restarted!

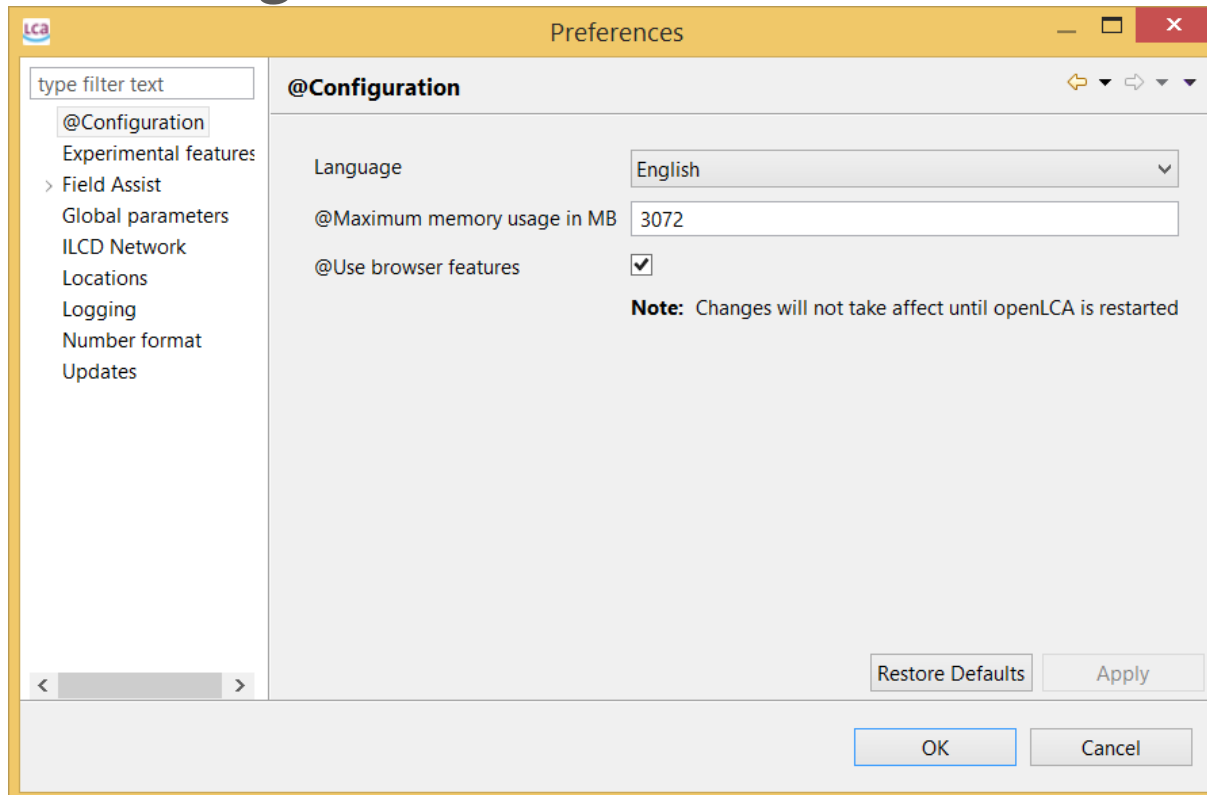
Language

- openLCA is available in Bulgarian, Chinese, English, French, German, Italian and Spanish.
- Change it under File/Preferences/@Configuration.



Memory usage

- Some databases required higher memory usage (e.g. ecoinvent 3) for the calculations.
- Change it under File/Preferences/@Configuration.



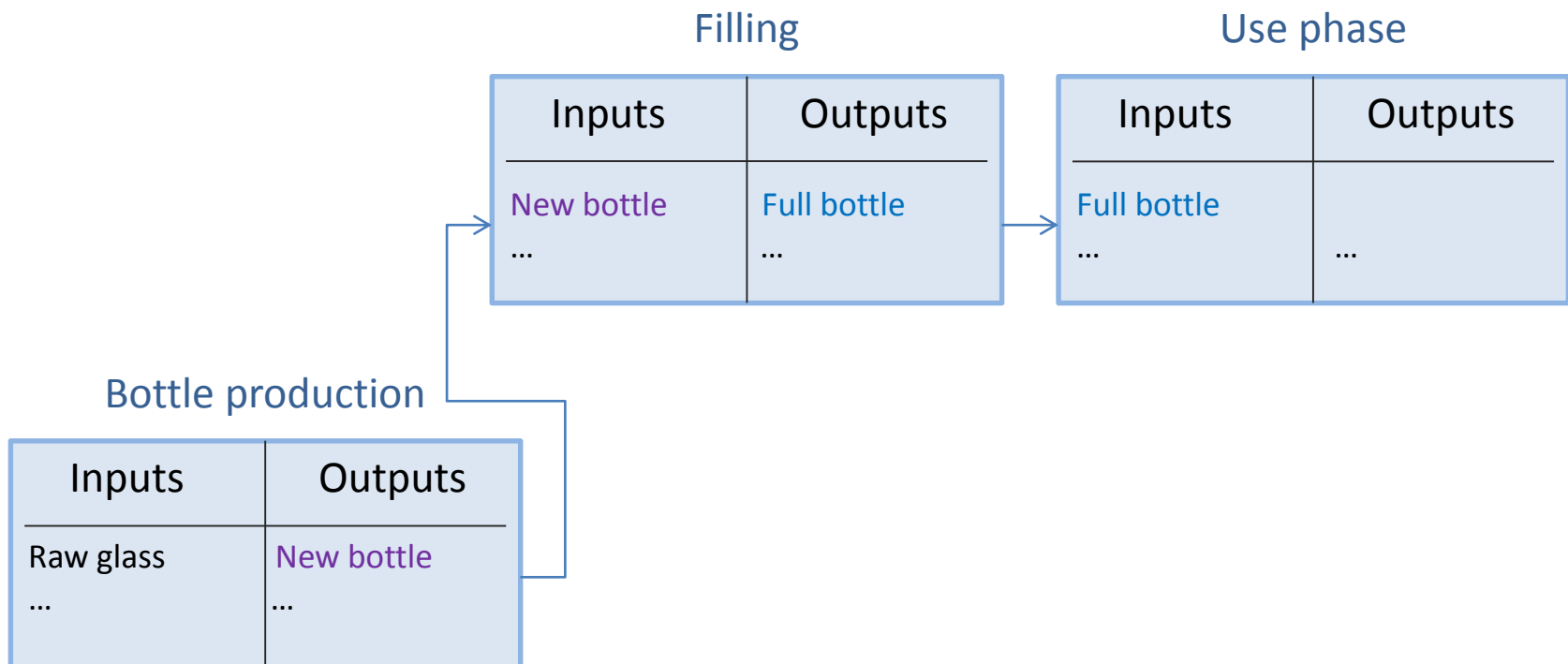
openLCA-data directory

- The openLCA-data folder is automatically created under in your user/Documents folder.
- The directory can be edited in the 'openLCA.ini' file contained in the openLCA folder with a text editor in

```
-clean
-nl
en
-data
@noDefault
-olcaDataDir
HERE THE FULL PATH OF THE NEW DIRECTORY
-olcaVersion
1.4.0
-vmargs
-Xmx4096M
-Dorg.openlca.core.updateSite=http://nexus.openlca.org/updateSite
```

Modelling with product flows

- Use different flow names for one flow that “hikes” through your product system



Modeling with product flows

- The default provider can be set for each exchange

openLCA 1.4.1 beta 4

*Transport, aircraft, freight - RNA

Process: Transport, aircraft, freight

Inputs

Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Default provider	Pedigree un...
* Kerosene, at refinery - RN...	Product flows	Volume	L	0.41991972...	none	None	
						None	
						Petroleum refining, at refinery - RNA	
						Crude oil, in refinery - RNA	

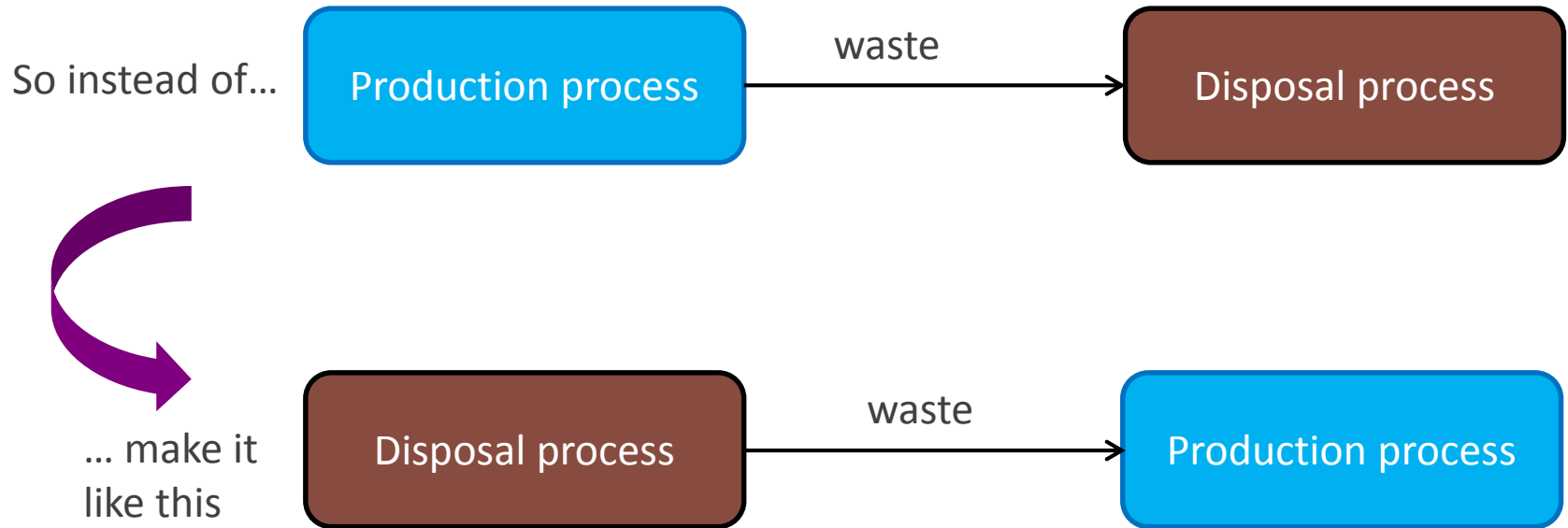
Modelling of waste

- "Reverse direction": Usual (production processes) is that donations to another process are something of value for the receiving process.
- Disposal processes aim to eliminate the receiving flow

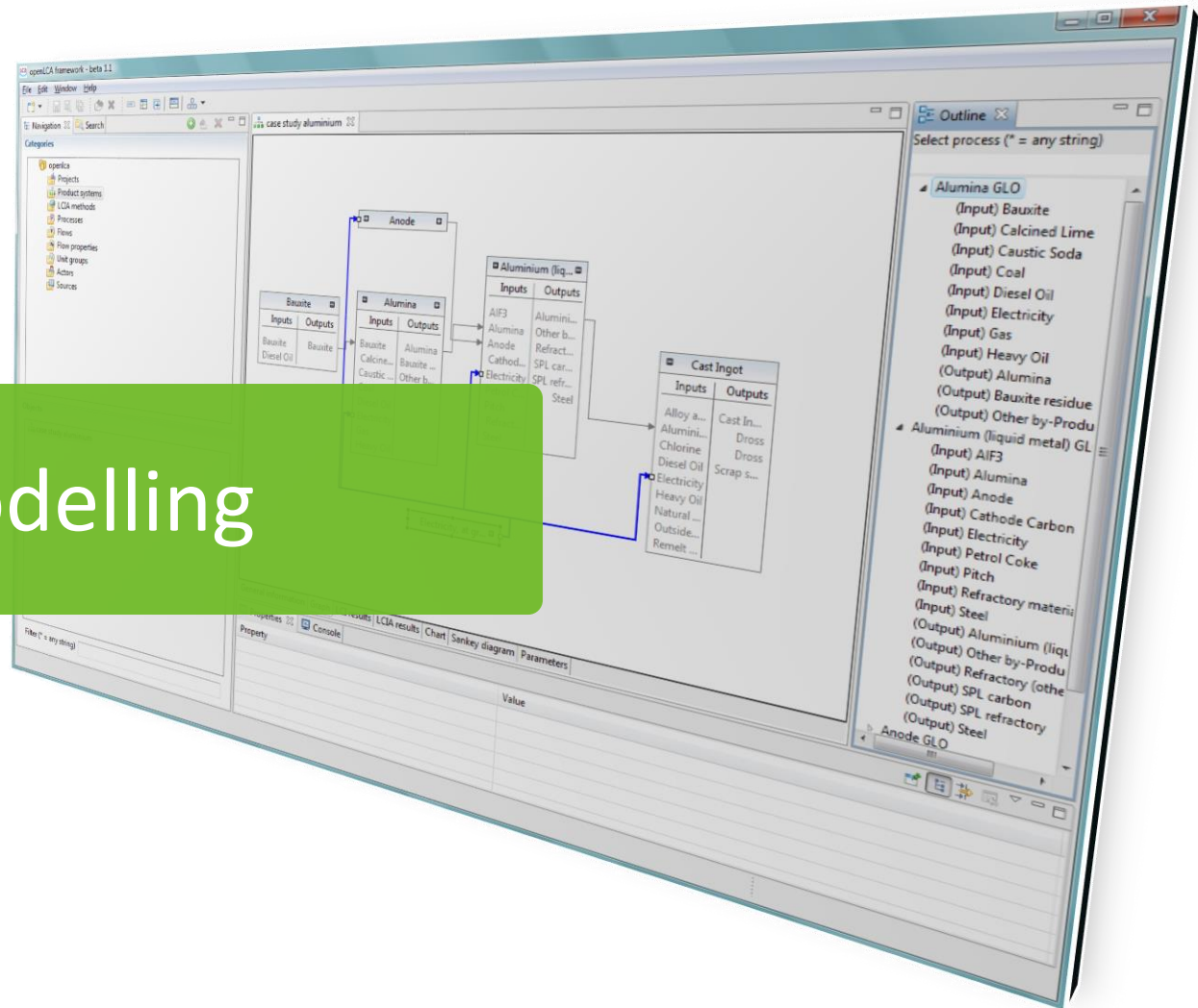
→ Model according to the "value flow direction":

Disposal as a service counter to the direction of material flow

Modelling of waste

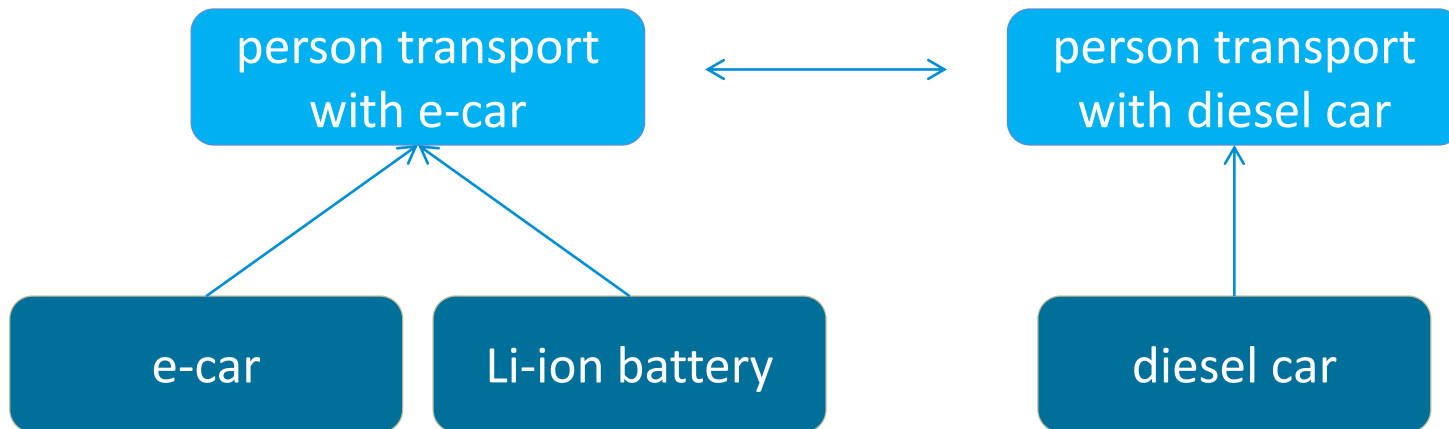


Modelling



Case study: Li-ion batteries in e-cars

- FU: 100,000 pkm



Case study: Assumptions

Li-ion battery:


Features battery	scenario 1	scenario 2
Weight	326 kg	250 kg
Amount of cells	192p à 1,45 kg	192p à 1,11 kg
Energy density	70 Wh/kg	180 Wh/kg
Product life	1.500 load cycles	2.500 load cycles
Consumption	17,115 kWh/100km	15,2 kWh/100km
Cruising range	134,12 km/load cycle	296,05 km/load cycle
Total cruising range	200.000 km	740.000 km
Required battery amount for 100,000km	0,5 p	0,135 p

Cars:

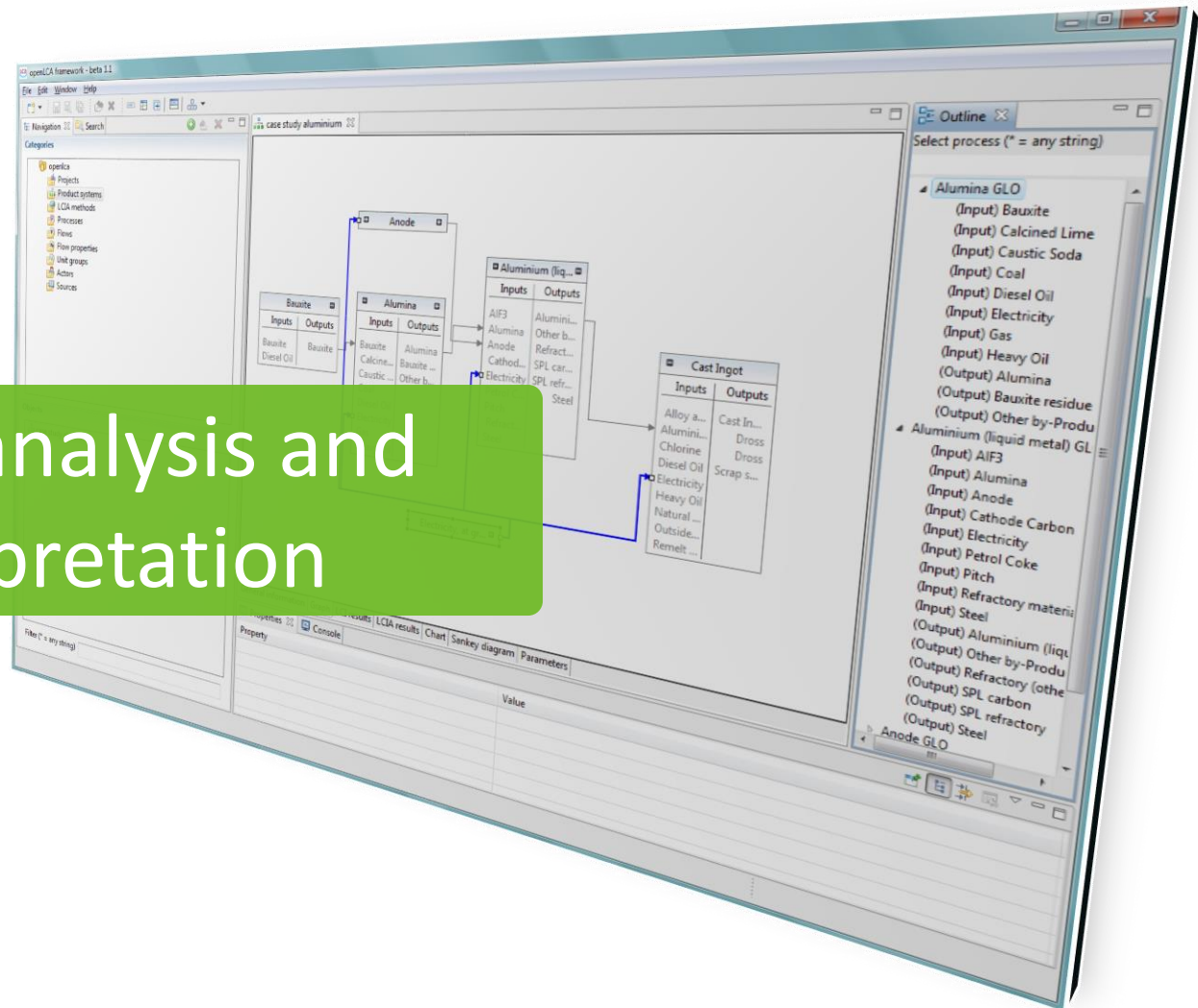
Features car	e-car	diesel car
Weight	1.381 kg (S1)	1.384 kg
	1.305 kg (S2)	
Product life	400.000 km	400.000 km

Exercise 3: Production phase of the battery

a) Analyze the graph of the product system “Battery production” in the database “openlca4students”. Then calculate the inventory of the product system. Which information can you derive from the inventory?

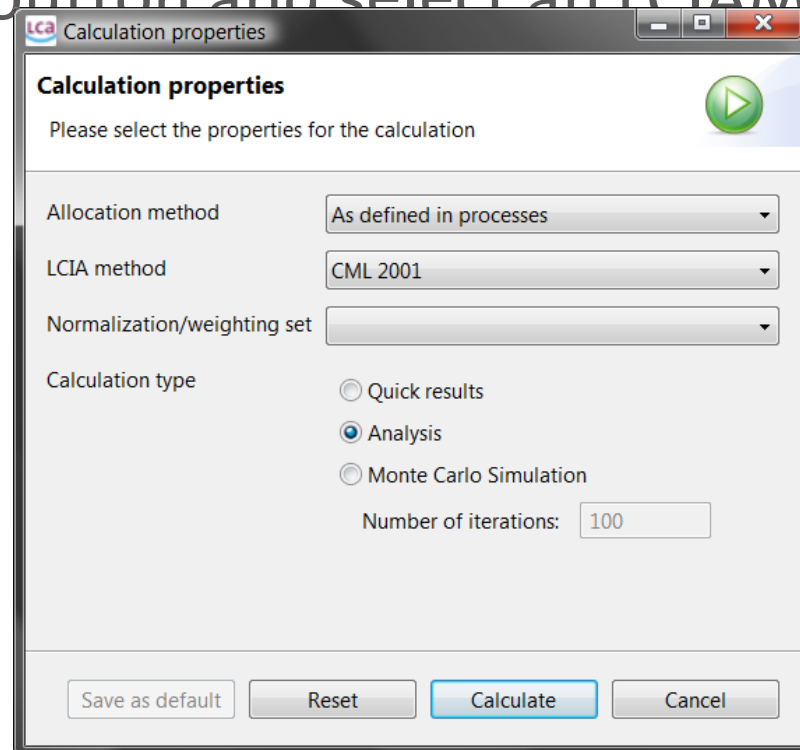
- Open the product system “Battery production”
- Go to the graph
- Calculate the material balance calculation using the buttons on the left top of the main menu  , quick calculation
- 10 min

Result analysis and interpretation



Analysis functions

- To run the analysis functions the product system needs to be recalculated.
- Click the calculation button and select an LCIAM and check „Analysis“



Analysis functions: contribution to the characterization

The screenshot displays the openLCA framework 1.2 interface. The left sidebar shows a navigation tree with categories like 'Product systems' and 'LCIA methods'. The main window is titled 'organic viticulture (unit process network)'. It features a 'Flow contributions' section with a pie chart and a legend. The 'Impact contributions' section also has a pie chart and a legend. A green speech bubble points to the 'Flow contributions' section, and another points to the 'Impact contributions' section.

Flow contributions

Flow: Particulates, < 2.5 um | Order by: Hot spots

Contribution	Value
transport, municipal waste collection, lorry 21t	7.652E-6 kg
electricity, at cogen ORC 1400kWh, wood, alloc.	1.776E-6 kg
heavy fuel oil, burned in refinery furnace	1.401E-6 kg
refinery gas, burned in furnace	6.368E-7 kg
heavy fuel oil, burned in industrial furnace 1MW	5.352E-7 kg
Rest	2.763E-6 kg

Impact contributions

Impact category: atmospheric ozone depletion - ODP 25a | Order by: Hot spots

Contribution	Value
transport, municipal waste collection, lorry 21t	1.282E-8 kg CFC-11-Eq
electricity, at cogen ORC 1400kWh, wood, alloc.	1.151E-8 kg CFC-11-Eq
heavy fuel oil, burned in refinery furnace	8.966E-9 kg CFC-11-Eq
refinery gas, burned in furnace	7.492E-9 kg CFC-11-Eq
heavy fuel oil, burned in industrial furnace 1MW	4.478E-9 kg CFC-11-Eq
Rest	8.925E-9 kg CFC-11-Eq

General information | Process contributions | Grouping | Locations | Sankey diagram

Specify what you want to watch. Subsequently, the results are shown in the diagram.

You can either look at "hot spots", or the "sum of the contributions"!

Analysis functions: process contributions

openLCA 1.4.1 beta 4

transport

*Battery production Analysis result of Battery production Quick results

Process contributions

Flow: Zinc - water/unspecified Cut-off: 0 %

Contribution	Process	Amount	Unit
75.86%	Ethylene oxide, at plant - RNA	0.00022	kg
09.83%	Polyethylene terephthalate, resin, at plant - RNA	2.88611E-5	kg
06.78%	Natural gas, extracted - RNA	1.99006E-5	kg
03.05%	Natural gas, at extraction site - RNA	8.95793E-6	kg
01.84%	Crude oil, extracted - RNA	5.39161E-6	kg
01.38%	Crude oil, at production - RNA	4.04537E-6	kg
00.66%	Sulfur, at plant - RNA	1.93028E-6	kg
00.43%	Hydrochloric acid, at plant - RNA	1.27126E-6	kg
00.10%	Polyvinyl chloride, resin, at plant - RNA	2.87042E-7	kg
00.07%	Polyethylene, linear low density, resin, at plant - RNA	2.04067E-7	kg

Impact category: climate change - GWP 100a Cut-off: 2 %

Contribution	Process	Amount	Unit
33.14%	Hot rolled sheet, steel, at plant - RNA	108.58189	kg CO2-Eq
19.18%	Electricity, bituminous coal, at power plant - US	62.85205	kg CO2-Eq
10.56%	Transport, combination truck, diesel powered - US	34.61704	kg CO2-Eq
07.78%	Natural gas, combusted in industrial boiler, at hydrocracker, f...	25.50630	kg CO2-Eq
06.49%	Soda powder, at plant - RNA	21.27902	kg CO2-Eq
04.43%	Manganese oxide	14.53002	kg CO2-Eq
04.01%	Ethylene oxide, at plant - RNA	13.15162	kg CO2-Eq
03.32%	Transport, train, diesel powered - US	10.89440	kg CO2-Eq
02.41%	Electricity, natural gas, at power plant - US	7.88966	kg CO2-Eq
02.22%	Lithium manganese oxide	7.25964	kg CO2-Eq

General information | Inventory results | LCIA Results | Process contributions | Process results | Flow contributions | Contribution tree | Grouping | Locations | Sankey diagram

Formula Interpreter

Analysis functions: process results

openLCA 1.4.1 beta 4

File Window Help

*Battery production Analysis result of Battery production Quick results transport

Process results

Process: Battery pack (S1) Cut-off: 0.01 %

Flow results

Inputs					Outputs				
Contribution	Flow	Upstream to...	Direct contri...	Unit	Contribution	Flow	Upstream to...	Direct contri...	Unit
100...	Dummy, Chemicals,...	3.54816E-5	0.00000	kg	100...	NM VOC, non-meth...	0.00108	0.00000	kg
100...	Dummy, Disposal, s...	0.02947	0.00000	kg	100...	Nitrate(water/unsp...	1.89655E-6	0.00000	kg
100...	Carbon dioxide, in ...	0.28262	0.00000	kg	100...	Ethane, 1,2-dibrom...	2.21457E-11	0.00000	kg
100...	Gasoline, combuste...	4.55712E-5	0.00000	m3	100...	Sulfide(water/unsp...	0.08757	0.00000	kg
100...	Diesel, combusted i...	0.02613	0.00000	m3	100...	Petroleum coke, at r...	0.03197	0.00000	kg
100...	Liquefied petroleu...	3.97621E-5	0.00000	m3	100...	Detergents, oil(wat...	1.97769E-5	0.00000	kg
100...	Dummy, Disposal, s...	0.11025	0.00000	kg	100...	Phenanthrenes, alky...	1.85839E-8	0.00000	kg
100...	Limestone, in groun...	9.32010	0.00000	kg	100...	Chrysene(air/unspe...	1.47806E-9	0.00000	kg
100...	Dummy, Disposal, s...	0.00635	0.00000	kg	100...	Ethane, 1,1,1-trichlo...	4.20792E-10	0.00000	kg

Impact assessment results

Process: Cathode, lithium-ion battery Cut-off: 0.01 %

Contribution	Impact category	Upstream total	Direct impact	Unit
23.44%	climate change - GWP 500a	75.20372	0.00000	kg CO2-Eq
23.01%	climate change - GWP 100a	75.38699	0.00000	kg CO2-Eq
21.90%	climate change - GWP 20a	75.54843	0.00000	kg CO2-Eq

General information | Inventory results | LCIA Results | Process contributions | Process results | Flow contributions | Contribution tree | Grouping | Locations | Sankey diagram

Formula Interpreter

Analysis functions: flow contributions

openLCA 1.4.1 beta 4

File Window Help

*Battery production Analysis result of Battery production Quick results transport

Flow contributions

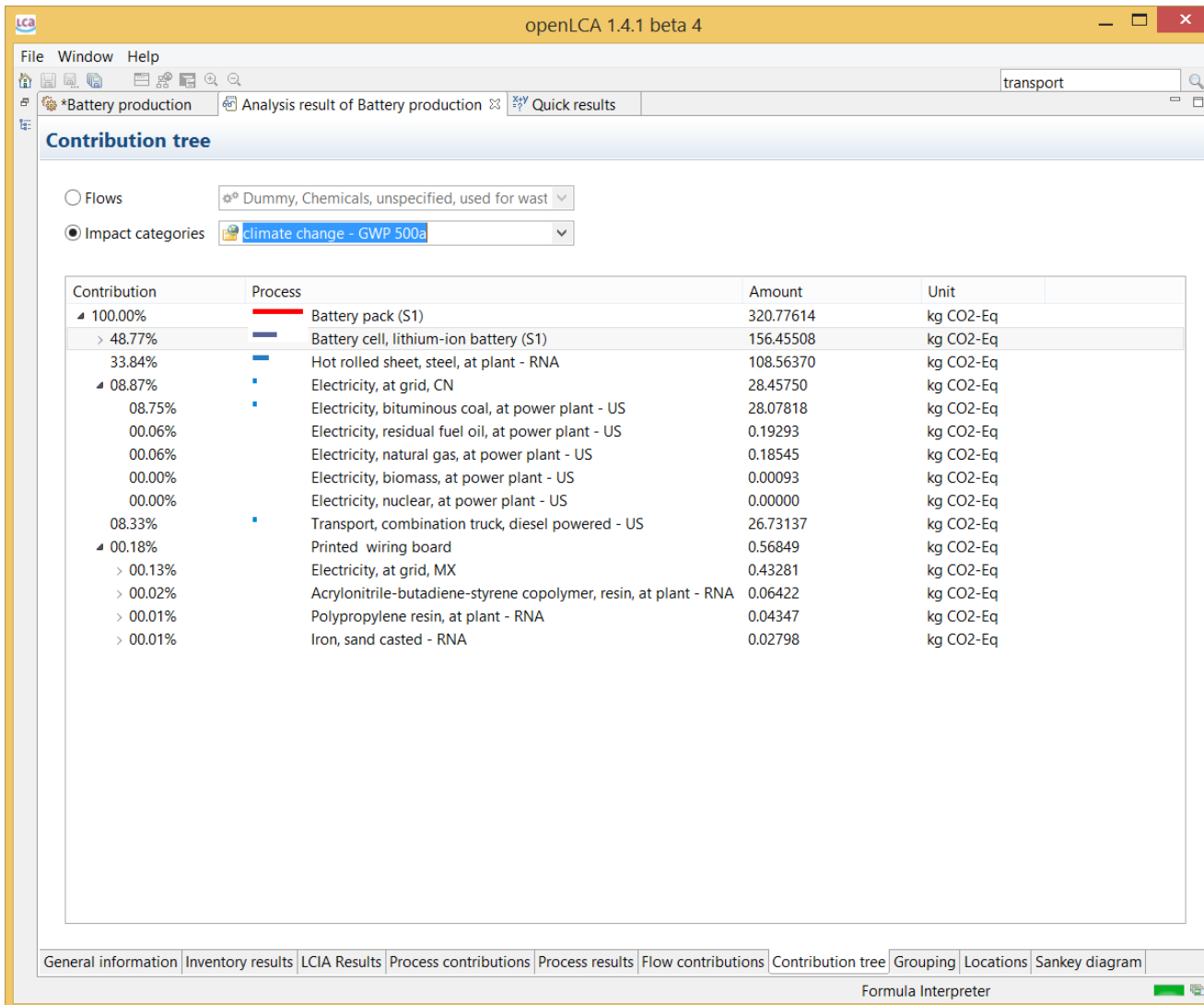
Impact category climate change - GWP 100a Cut-off 0 %

Contribution	Flow	Amount	Unit
94.05%	Carbon dioxide, fossil	308.19672	kg CO2-Eq
02.80%	Methane, fossil	9.17675	kg CO2-Eq
02.22%	Carbon dioxide, fossil	7.25964	kg CO2-Eq
00.60%	Carbon monoxide, fossil	1.97769	kg CO2-Eq
00.32%	Dinitrogen monoxide	1.06065	kg CO2-Eq
00.00%	Methane, tetrachloro-, R-10	0.00841	kg CO2-Eq
00.00%	Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	0.00385	kg CO2-Eq
00.00%	Methane, chlorotrifluoro-, CFC-13	0.00351	kg CO2-Eq
00.00%	Methane, dichloro-, HCC-30	4.69266E-5	kg CO2-Eq
00.00%	Methane, dichlorodifluoro-, CFC-12	6.96862E-7	kg CO2-Eq
00.00%	Methane, monochloro-, R-40	1.27153E-7	kg CO2-Eq
00.00%	Chloroform	3.26649E-8	kg CO2-Eq
00.00%	Methane, bromo-, Halon 1001	1.47638E-8	kg CO2-Eq
00.00%	NM VOC, non-methane volatile organic compounds	0.00000	kg CO2-Eq
00.00%	Nitrate	0.00000	kg CO2-Eq
00.00%	Ethane, 1,2-dibromo-	0.00000	kg CO2-Eq
00.00%	Sulfide	0.00000	kg CO2-Eq
00.00%	Petroleum coke, at refinery - RNA	0.00000	kg CO2-Eq
00.00%	Detergents, oil	0.00000	kg CO2-Eq
00.00%	Phenanthrenes, alkylated, unspecified	0.00000	kg CO2-Eq
00.00%	Chrysene	0.00000	kg CO2-Eq
00.00%	Ethane, 1,1,1-trichloro-, HCFC-140	0.00000	kg CO2-Eq
00.00%	TOC, Total Organic Carbon	0.00000	kg CO2-Eq
00.00%	Beryllium	0.00000	kg CO2-Eq
00.00%	Anthracene	0.00000	kg CO2-Eq
00.00%	Phosphorus trichloride	0.00000	kg CO2-Eq

General information | Inventory results | LCIA Results | Process contributions | Process results | Flow contributions | Contribution tree | Grouping | Locations | Sankey diagram

Formula Interpreter

Analysis functions: contribution tree



Analysis functions: grouping

The screenshot shows the openLCA 1.4.1 beta 4 interface. The 'Grouping' tab is active, displaying a list of processes under two groups: 'Other' and 'transport'. The 'transport' group is selected, and its processes are listed in a scrollable area. A green callout bubble points to the right-click context menu options (add, move) for a process name. Below the list, the 'Results' section shows a table with the following data:

Group	Amount	Unit
Other	272.83931074518324	kg CO2-Eq
transport	47.93682716786533	kg CO2-Eq

A pie chart at the bottom left visualizes the data, with a red slice for 'Other' and a blue slice for 'transport'. The legend indicates: 2.728E2 kg CO2-Eq: Other and 47.937 kg CO2-Eq: transport.

Add new groups and move (right click on process name) processes to them

Analysis functions: locations

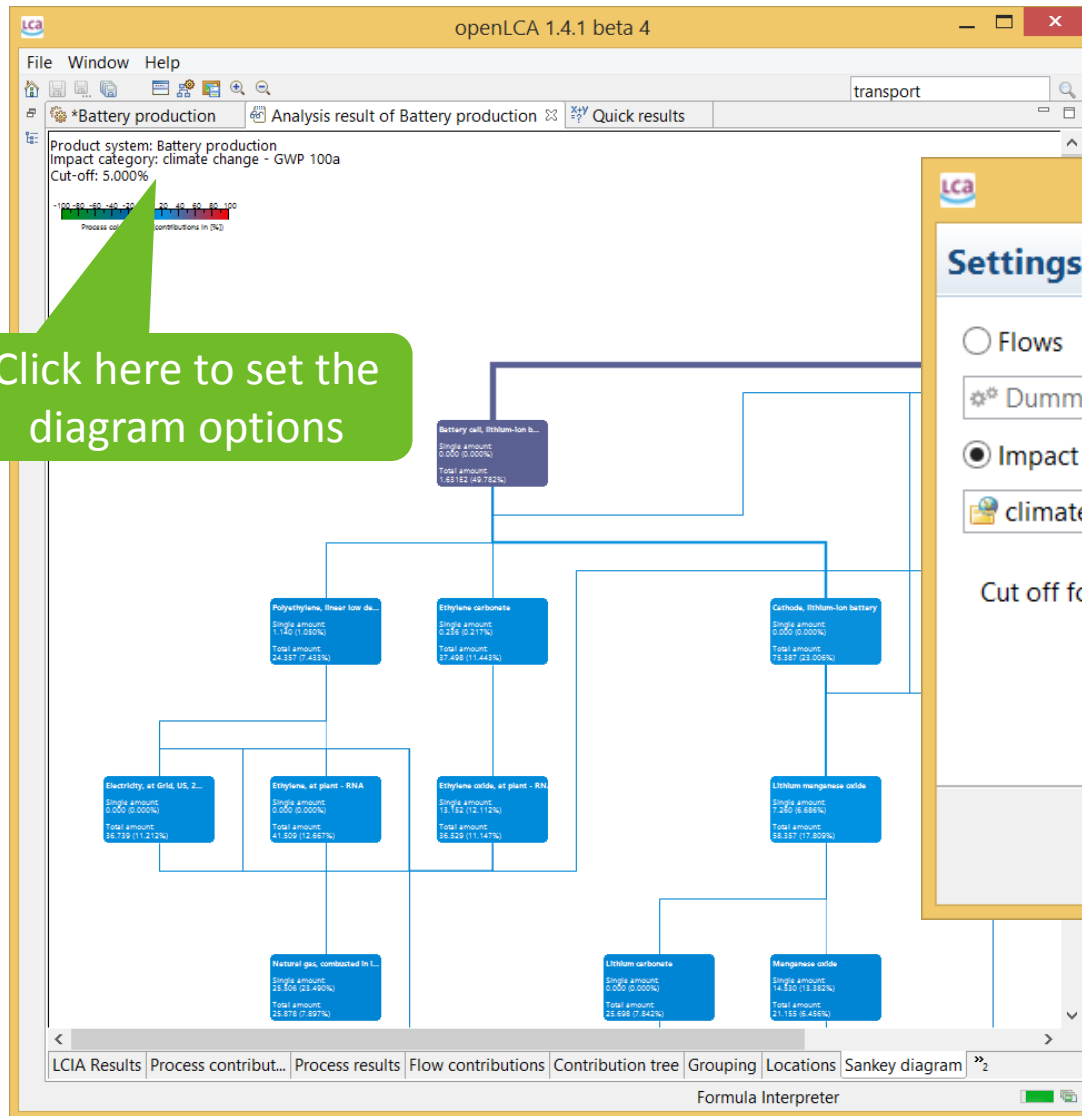
The screenshot shows the openLCA 1.4.1 beta 4 interface. The 'Locations' panel is active, displaying the following data:

Location	Amount	Unit
Northern America	178.44620	kg CO2-Eq
United States	119.38094	kg CO2-Eq
Other	22.94900	kg CO2-Eq

The map below the table shows North America with two heatmaps indicating high impact areas. A green speech bubble points to the map with the text: "If you don't see any points in the map, click 'reload'".

If you don't see any points in the map, click "reload"

Analysis functions: Sankey diagram



Settings for the Sankey diagram

Flows

Impact categories

Impact category: climate change - GWP 100a

Cut off for first layer (in %) 5.000

OK Cancel

Exercise 3: Production phase of the battery

b) Calculate the environmental impacts caused by the Li-ion battery with the LCIAM IPCC 2007 and interpret the results. Which processes contribute most to the impact category “climate change – GWP 20a” (without prechain)? How contributes the process “Acetic acid production” to the LCIA category “climate change – GWP 100a”?

- Go to the product system “Battery production” in the navigation and click with the right mouse button on “Analysis”
- Select IPCC 2007 as LCIAM
- Switch through the tabs to find the information you need
- 15 min

Exercise 4: Use phase of the battery

- a) Create a new process “Transport person e-car (average US) (S1)” with “Person transport” as quantitative reference. Use the following flows and amounts.

Inputs	Amount	Outputs	Amount
Battery pack (S1)	0.5E-5 pieces	Person transport	1 pkm
Car, electrically powered	0.25E-5 pieces		
Electricity, at grid, US 2008	0.17115 kWh		

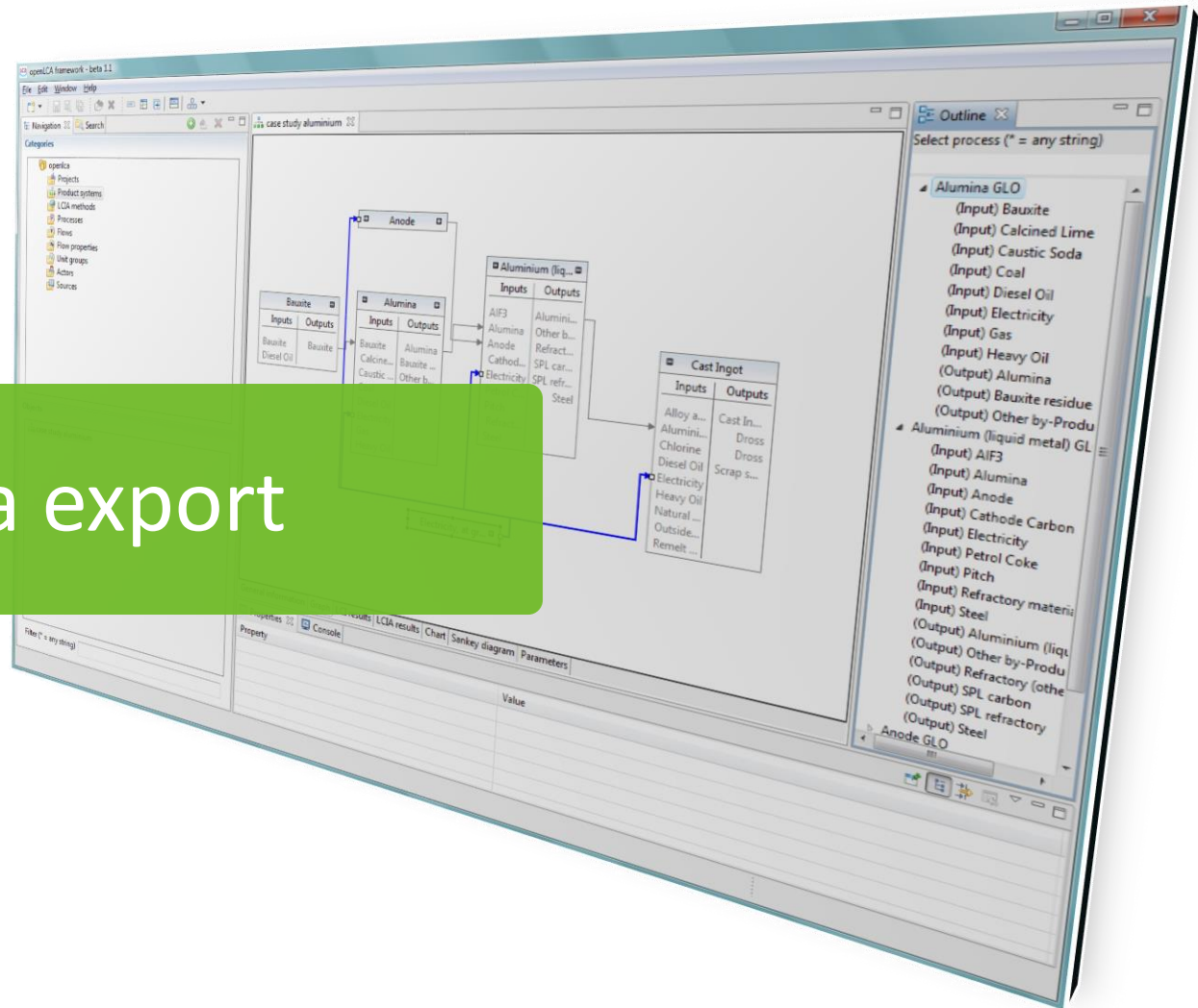
- Create the process in the folder Case study Li-ion battery/scenario 1
- Use the drag and drop function of openLCA
- 10 min

Exercise 4: Use phase of the battery

b) Calculate the environmental impacts of the production and the use phase of the battery with IPCC 2007. Which processes have the main contribution to the environmental load?

- Create a new product system “Transport person e-car (average US) (S1)” and select the same process as a reference.
- Add connected processes automatically.
- Set the target amount in respect to the FU.
- Calculate the inventory and the environmental impacts.
- 10 min

Data export



EcoSpold **export**

A vertical line on the left side of the slide, divided into four colored segments: blue (top), brown, green, and purple (bottom).

EcoSpold 1

- Processes
- Impact assessment methods

EcoSpold 2

- Processes

ILCD export

- Actors
- Flow properties
- Flows
- LCIA methods
- Processes
- Product systems
- Sources
- Unit groups

Excel export

- Processes
- Quick results
- Analysis results
- Monte Carlo simulation results
- Product systems:
 - Elementary flows
 - Product flows
 - LCIA factors

Other export formats

CSV-Matrix

- Graph of a product system

Images

- Diagrams

HTML

- Project report

openLCA script (.zolca)

- Complete databases

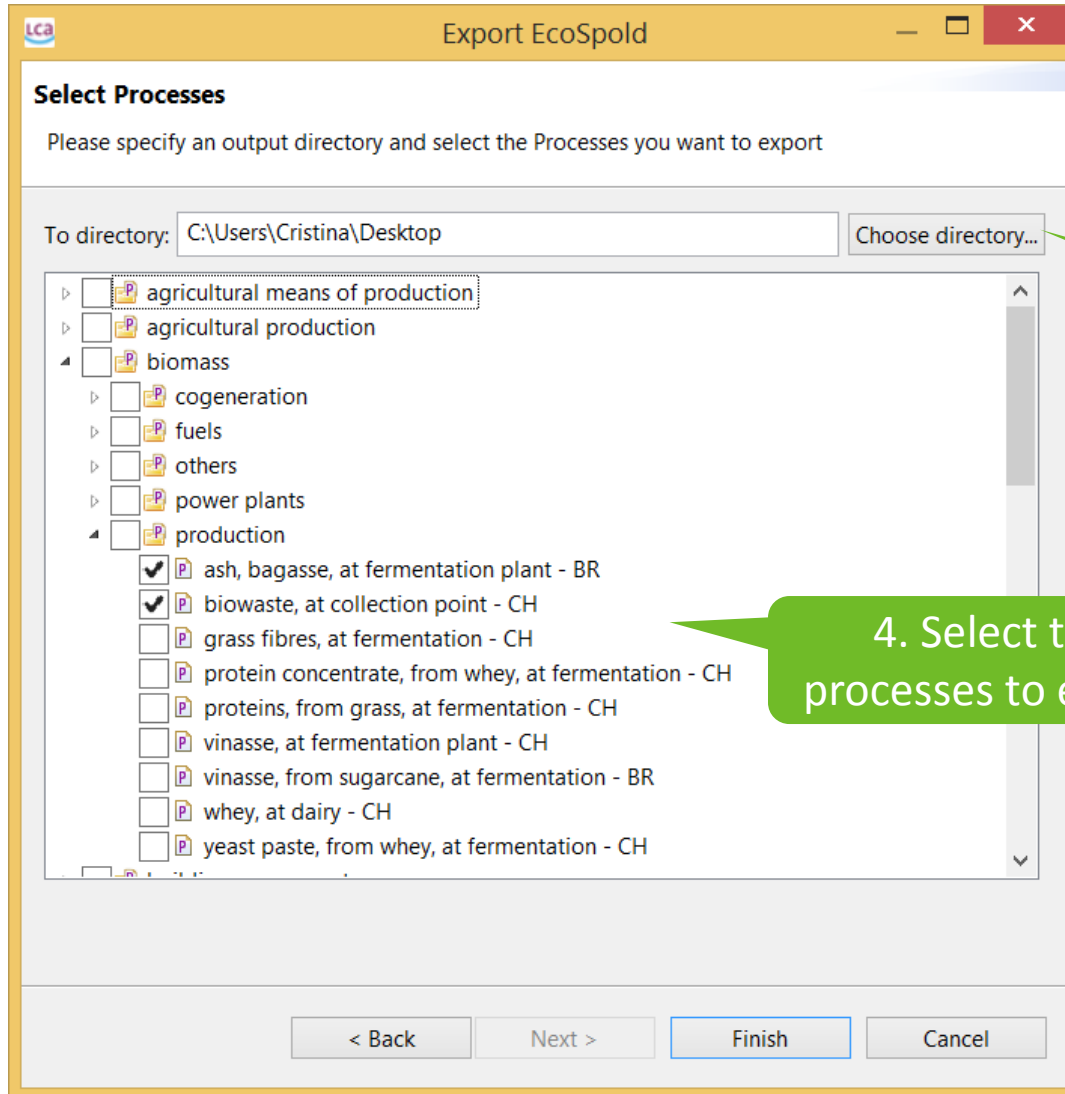
Example: process export (I)

The screenshot shows the openLCA 1.4.1 beta 4 interface. The 'File' menu is open, and the 'Export...' option is highlighted. A green callout box points to this option with the text '1. Select "Export" in File'. The 'Export' dialog box is also open, showing a tree view of export destinations. The 'EcoSpold' folder is selected, and its sub-items are checked: 'EcoSpold 2', 'Impact methods', and 'Processes'. A green callout box points to this selection with the text '2. Select format'. The dialog box has a search filter, navigation buttons ('< Back', 'Next >', 'Finish', 'Cancel'), and a 'Cancel' button at the bottom right.

1. Select "Export" in File

2. Select format

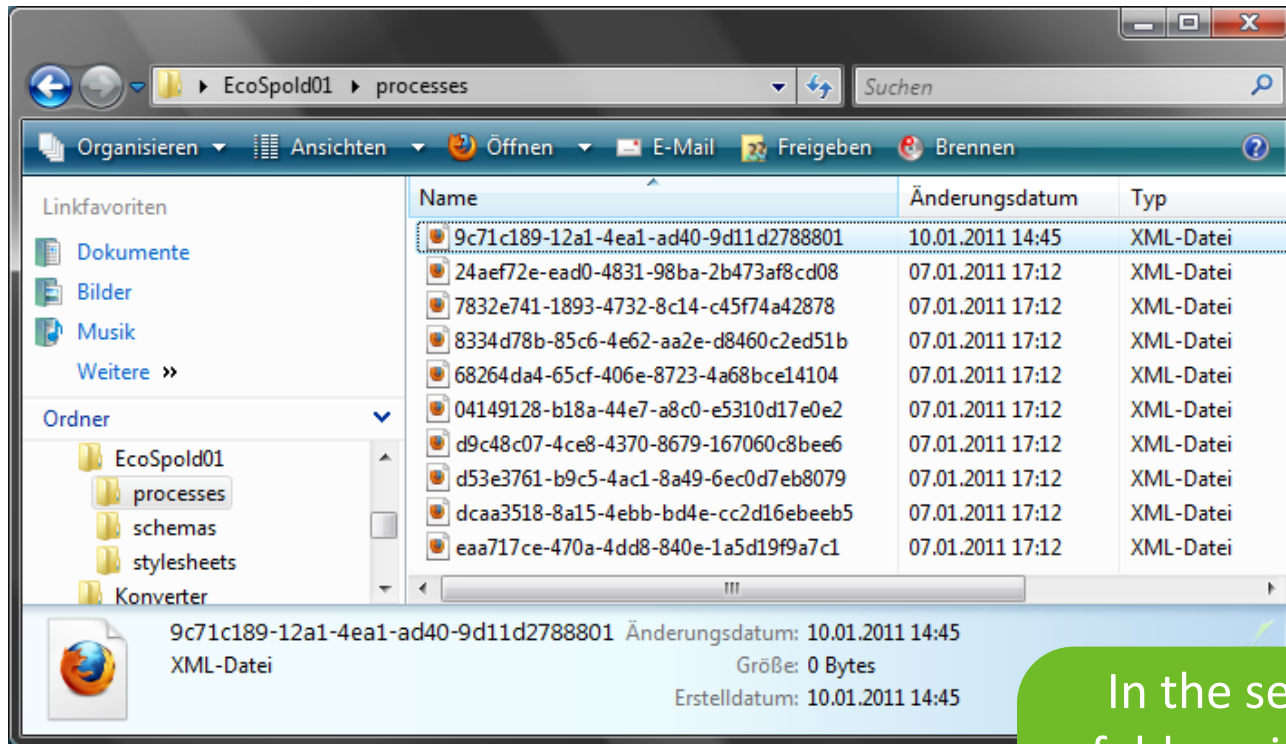
Example: process export (II)



3. Select the directory where data will be stored

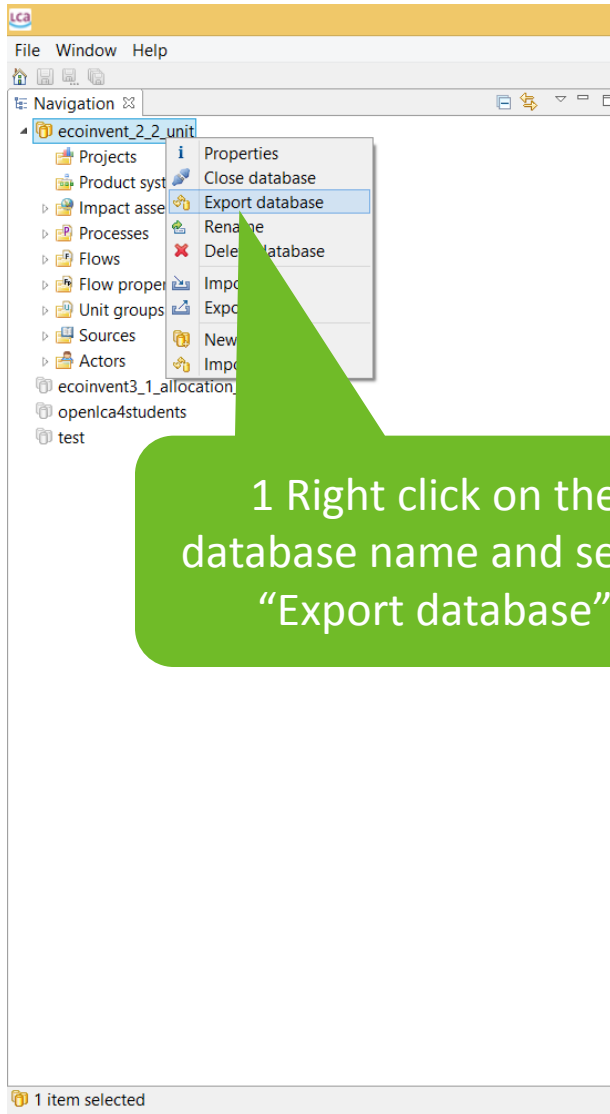
4. Select the processes to export

Example: process export (III)

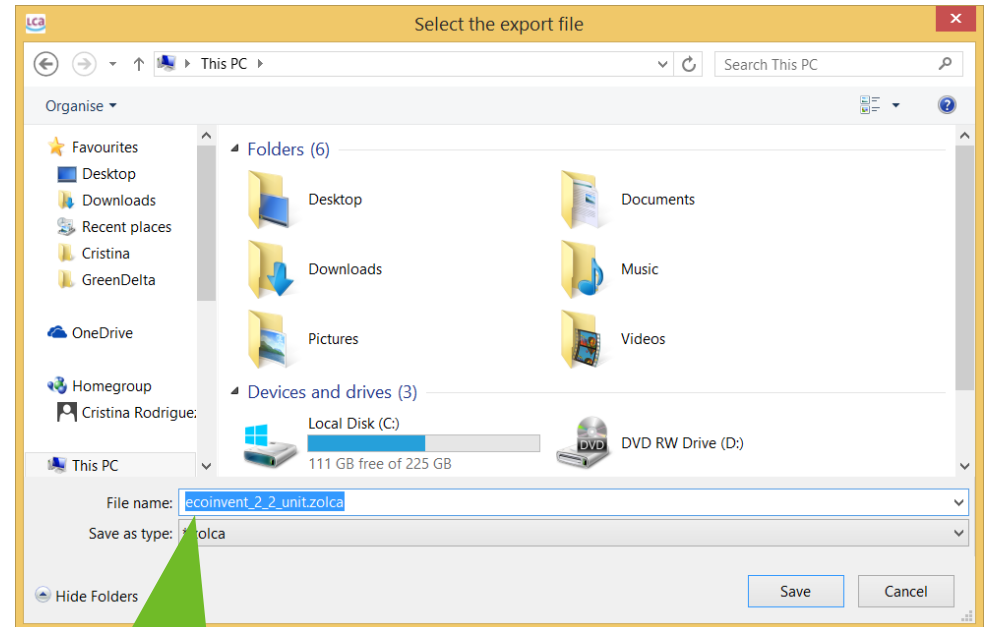


In the selected directory a folder with the name of the export format is created. For instance, Desktop\EcoSpold01\processes

Export of openLCA database



1 Right click on the database name and select "Export database"



2. Select the directory and name for the .zolca file

Using an ILCD network database

- Useful, if more than one person is working on one study.
- Data are uploaded into a database on a server and can be downloaded from each user with access to the server.

ILCD network database: import

1. Go to File → Import

2. Choose "ILCD Network import"

3. Select the server connection and the processes to import

openLCA 1.4

File Window Help

- Save Ctrl+S
- Save As... Ctrl+Shift+S
- Save All Ctrl+Shift+W
- Close Ctrl+W
- Close All Ctrl+Shift+W
- Preferences
- Import...
- Export...
- Exit

Welcome to openLCA!
openLCA 1.4.1 beta 4 (Windows 64 bit)

What's new

Import

Select

Select an import source:

type filter text

- File Import
 - EcoSpold 1
 - EcoSpold 2
 - Excel
 - ILCD
 - SimaPro CSV
 - ILCD Network Import
 - ILCD Network Import
 - Other
- Database Import

Network Import

Search

Search and select processes for the import

Connection: bioenergiesdat @ http://iai-uisserv1.iai.fzk.de/bed-ws/resource Change

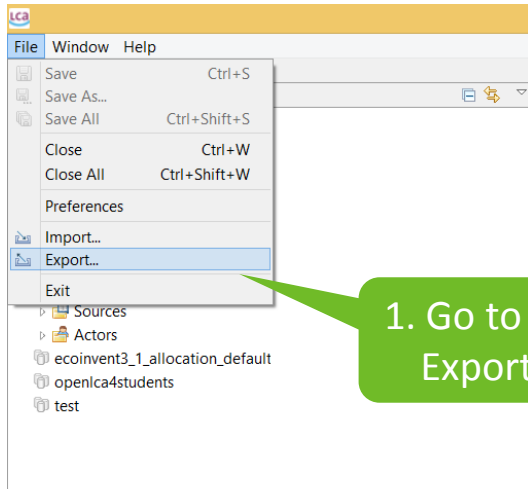
Process Search

Name	Location	Time	Type
------	----------	------	------

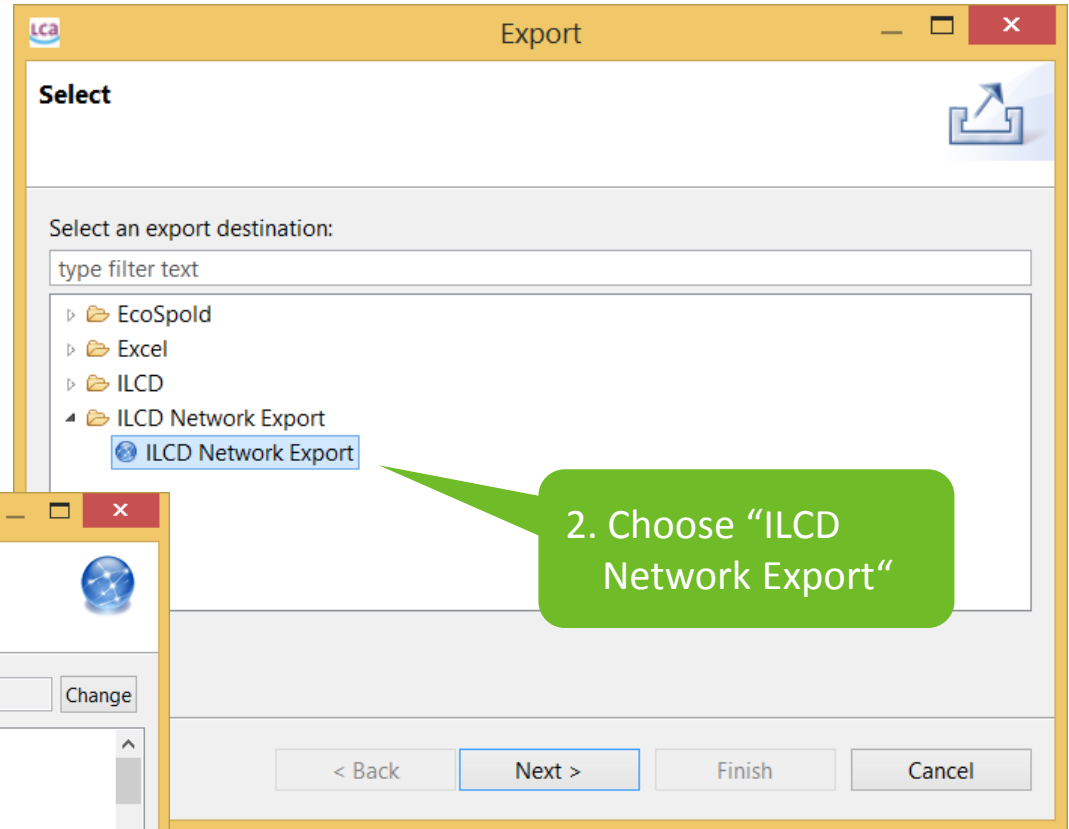
< Back Next > Finish Cancel

< Back Next > Finish Cancel

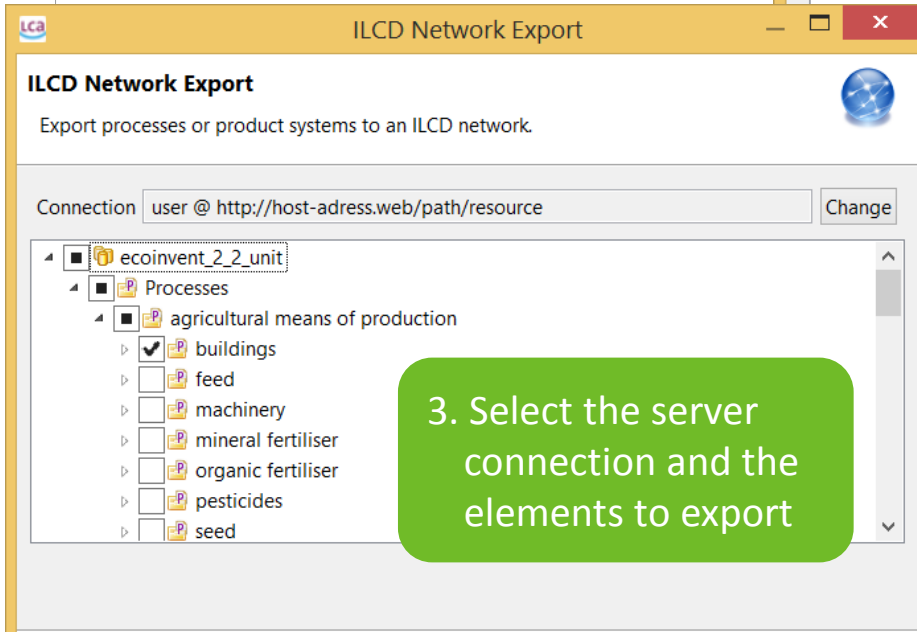
ILCD network database: export



1. Go to File → Export

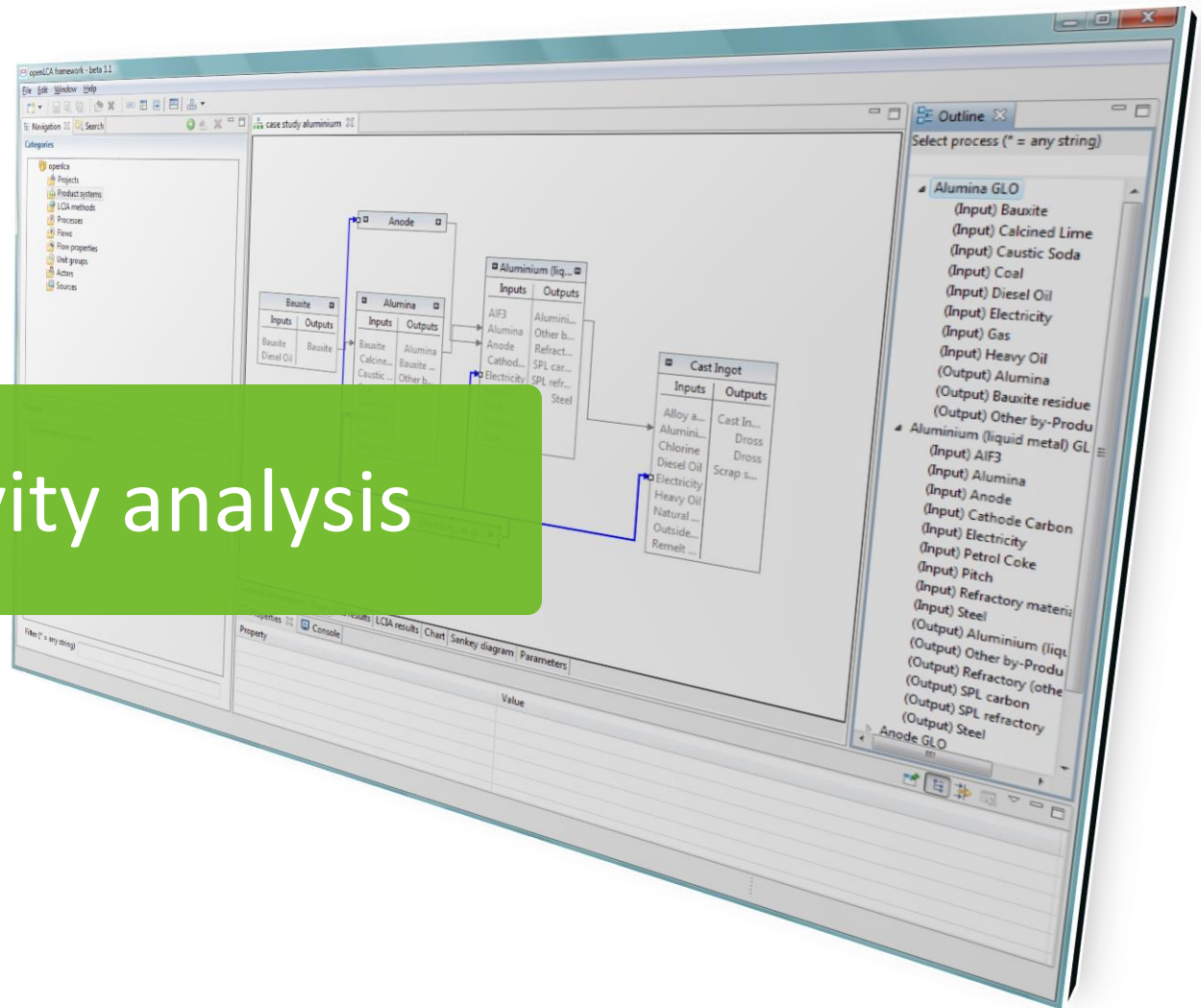


2. Choose "ILCD Network Export"



3. Select the server connection and the elements to export

Sensitivity analysis



Sensitivity analysis

“systematic procedures for estimating the effects of the choices made regarding methods and data on the outcome of a study”

(ISO 14040)

- Are results stable if you change specific aspects?
 - What happens if you expand your system boundaries?
 - What happens if you use other allocation methods?
 - What happens if you change your assumptions?
 -

Comparative assessments in openLCA: Projects

- Same or different product systems can be compared

The screenshot shows the 'Project: Project - example' window in openLCA. The 'General information' section includes fields for Name, Description, Version, and Last change. The 'LCIA Method' section is expanded. The 'Variants' section contains a table with the following data:

Name	Product system	Allocation method	Flow	Amount	Unit	Description
Variant1	Battery cell, lithium-ion batte...	None	Battery cell, lithium-ion batte...	1.0	Item(s)	
Variant2	Battery cell, lithium-ion batte...	None	Battery cell, lithium-ion batte...	1.0	Item(s)	
Variant3	Battery production	None	Battery pack (S1)	1.0	Item(s)	

Two green callout boxes provide additional context: 'Allocation methods can be compared' points to the 'Allocation method' column, and 'The target amount may vary between variants' points to the 'Amount' column.

Comparative assessments in openLCA: Projects

*Project - example

Project: Project - example

General information

Name Project - example

Description

Version 00.00.001

Last change 2014-09-23T22:28:15+0200

Report

The method and impact categories to display can be selected

LCIA Method

LCIA Method CML 2001

Normalization and weighting set

Impact category	Display	Report name	Description
acidification potential - average European	<input checked="" type="checkbox"/>	acidification potential - average Europe...	
acidification potential - generic	<input checked="" type="checkbox"/>	acidification potential - generic	
climate change - GWP 100a	<input checked="" type="checkbox"/>	climate change - GWP 100a	
climate change - GWP 20a	<input checked="" type="checkbox"/>	climate change - GWP 20a	
climate change - GWP 500a	<input checked="" type="checkbox"/>	climate change - GWP 500a	
climate change - lower limit of net GWP	<input checked="" type="checkbox"/>	climate change - lower limit of net GWP	

Comparative assessments in openLCA: Projects

*Project - example

Project: Project - example

General information

Name Project - example

Description

Version 00.00.001

Last change 2014-09-23T22:28:15+0200

Report

Once every variable is set, click "Report" to calculate results

LCIA Method

Variants

Parameters

Process contributions

Process	Report name	Description
Anode, lithium-ion battery	Anode, lithium-ion battery	

The contribution of different processes can be compared

Project: Report

openLCA 1.4.1 beta 4

File Window Help

*Project - example

Introduction

Section: Introduction

Text: In the following the results of the project are shown. This is a default template for the report. It contains the following placeholders:
<p>
changing the text of the sections,
adding or removing sections,

Component: [Dropdown]

Project Variants

Section: Project Variants

Text: This table shows the name and description of the variants as defined in the project setup. The variant names of the project setup are used for all charts and tables of the other report components.

Component: Variant description table

Selected LCIA

Section: [Dropdown]

Text: [Dropdown]

Project setup: [Dropdown]

1. Text descriptions for each sections can be added

2. The type of component to display in each section can be selected (e.g. tables, graphs)

Project: Report sections

*Project - example

Report sections

▼ General information

Title

▶ Introduction

▶ Project Variants

▶ Selected LCIA Categories

▶ LCIA Results

▶ Single Indicator Results

▶ Process Contributions

▶ Relative Results

☑ New section

Section

Text

New sections can be added

Or delete existing ones

Example: Project report

*Report-example

Report Viewer

Report Viewer

Variant	Description
Variant1	
Variant2	

Selected LCIA Categories

The table below shows the LCIA categories of the selected LCIA method of the project. Only the LCIA categories that are selected to be displayed are shown in the report. Additionally, a user friendly name and a description for the report can be provided.

LCIA category	Unit	Description
climate change - GWP 100a	kg CO2-Eq	
climate change - GWP 20a	kg CO2-Eq	
climate change - GWP 500a	kg CO2-Eq	

LCIA Results

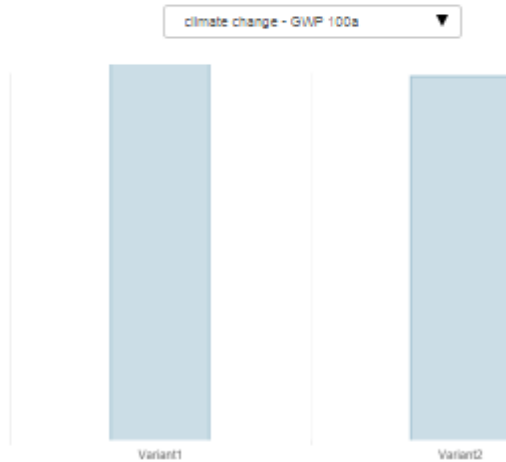
This table shows the LCIA results of the project variants. Each selected LCIA category is displayed in the rows and the project variants in the columns. The unit is the unit of the LCIA category as defined in the LCIA method.

LCIA category	Variant1	Variant2	Unit
climate change - GWP 100a	-1.35354e+2	-9.02359e+1	kg CO2-Eq
climate change - GWP 20a	-1.38358e+2	-9.22388e+1	kg CO2-Eq
climate change - GWP 500a	-1.33922e+2	-8.92811e+1	kg CO2-Eq

Example: Project report

Single Indicator Results

The following chart shows the single results of each project variant for the selected indicator. You can change the selection and the chart is dynamically updated.



Process Contributions

This chart shows the contributions of the selected processes in the project setup to the variant results of the selected LCIA category. As for the single indicator results, you can change the selection and the chart is dynamically updated.



Exercise 5: e-car vs. diesel powered car

a) Compare the environmental effects caused by the person transport of 100,000 pkm in an e-car with those caused by the person transport of 100,000 pkm in a diesel car. Use first the impact assessment method IPCC 2007, then USEtox. Which kind of transport is eco-friendlier?

- Create a new project and add the product systems “Transport person e-car (average US) (S1)” and “Transport person diesel car”
- Select the LCIAMs, first IPCC 2007, then USEtox and analyse the results
- 10 min

Exercise 5: e-car vs. diesel powered car

- b) Compare the environmental effects of the use of the e-car in different regions (average US, Chile, Mexico, and Norway). What happens?
 - Select first IPCC 2007, then USEtox as LCIAM's
 - 15 min

Modelling with parameters

- Useful for sensitivity analyses → What impact is the change in one aspect of my earnings?
- Useful for preliminary data: data can be changed easily at the end of your study.
- With different input values can create different versions of the life cycle.
- Reduces the likelihood of calculation errors.

Modelling with parameters

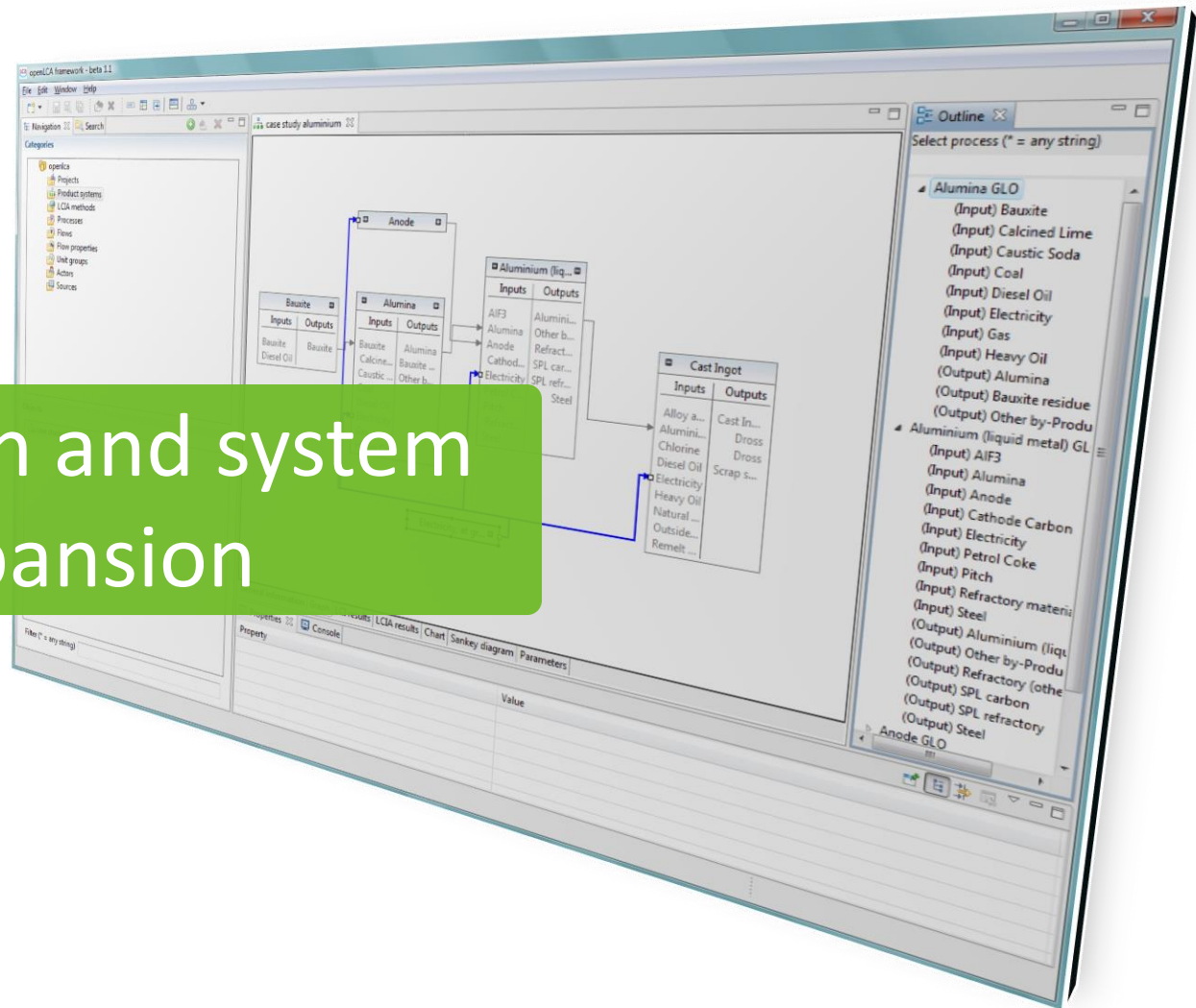
- Entry of calculation rules instead of concrete values
→ more flexibility
- Available on process, product system, LCIA method, project and database level
- Local and global parameters → parameters can overwrite each other!
- Parameters can be linked to other parameters (i.e. dependent parameters) → Loops are not allowed

Exercise 6: sensitivity analysis with parameters

The diesel car in our case study consumes 8l/100km. What happens, if it consumes 6l/100km and 10l/100km respectively?

- Create a parameter for the fuel consumption of the diesel car.
- The CO₂ emissions depend on the fuel consumption. 1l diesel causes around 2.26kg of CO₂ and 170mg particulates.
- 10 min

Allocation and system expansion



Multi-output processes

- Often multi-output processes
 - cow (milk, leather, meat)
 - Co-generation (heat, power)
 - Chloralkali electrolysis (natriumhydroxide, chloric gas, hydrogen)
- Usually you need for LCAs only processes with one output
- Two strategies:
 - Avoiding Allocation: System expansion
 - Elementary flows and products from multi-output processes mathematically divided into multiple processes (= allocation)

Allocation

“partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems”

(ISO 14040)

- Which allocation methods are possible?
Allocation methods in openLCA:
 - physical allocation
 - causal allocation
 - economic allocation

Example: co-generation

co-generation

Allocation

Default method:

Physical & economic allocation

Product	Physical	Economic
Electricity, at grid, US - RNA (2.00 MJ)	1.0	1.0
Heat, onsite boiler, hardwood mill, average, SE - RNA (1.00 MJ)	1.0	1.0

Causal allocation

Flow	Direction	Category	Amount	Electricity, at grid, US - RNA	Heat, onsite boiler, hardwood ...
Sulfur dioxide	Output	air/high po...	0.50000 kg	1.0	1.0
Carbon dioxide, fossil	Output	air/high po...	2.00000 kg	1.0	1.0
Crude oil, at production...	Input	Product flo...	3.00000 kg	1.0	1.0

Exercise 7: Causal allocation

- a) Open the process „co-generation unit“ and apply causal allocation.
- If you cannot find the process in the navigation use the search function.
 - Assumptions:
 - 60% of the emissions are caused by power production
 - 40% are caused by heat production
 - 5 min

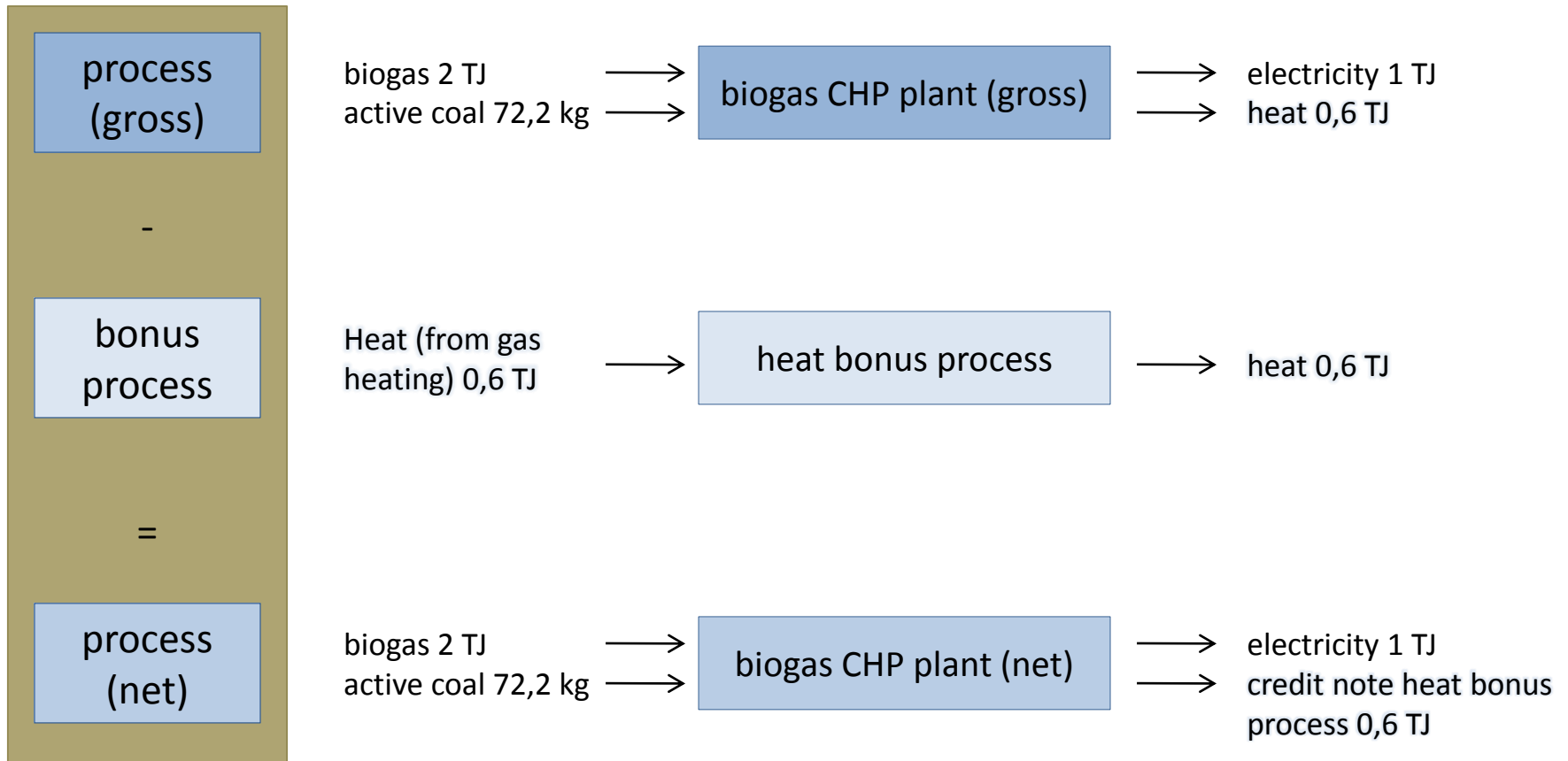
Exercise 7: Economic/physical allocation

b) Apply for the same process „co-generation unit“ now economical allocation.

- Assumptions:
 - Market value for electricity: 0.79 €/MJ
 - Market value for heat: 0.36 €/MJ
- 10 min

c) Apply now physical allocation.

System expansion



System expansion in openLCA

*Heat, onsite boiler, hardwood mill, average, SE - RNA

Process: Heat, onsite boiler, hardwood mill, average, SE

Inputs

Flow	Category	Flow propert...	Unit	Amount	Uncertainty	Default pro...	Pedic
⚙ Wood fuel, SE hardwoo...	Product flows	Mass	kg	0.0426236...	none		
⚙ Residual fuel oil, combu...	Product flows	Volume	l	1.0138630...	none		
⚙ Wood fuel, SE hardwoo...	Product flows	Mass	kg	0.0065590...	none		
⚙ Natural gas, combusted...	Product flows	Volume	m3	7.2418787...	none		
⚙ Liquefied petroleum ga...	Product flows	Volume	L	3.0208979...	none		

A process providing the avoided product flow should exist!

Check the box of "Avoided product" for the by-product

Outputs

Flow	Category	Flow propert...	Unit	Amount	Uncertain	Avoided product
⚙ Heat, onsite boiler, hard...	Product flows	Energy	MJ	1.0	none	
⚙ Electricity, onsite boiler,...	Product flows	Energy	kWh	0.0019196...	none	<input checked="" type="checkbox"/>

Exercise 8: System expansion

- Apply for the process „co-generation unit“ system expansion.
- Create a new process that creates only heat. Use

Inputs	Amount	Outputs	Amount
Natural gas, at extraction site	0.45 m ³	Heat, gas heating	1 MJ
		Carbon dioxide, fossil	73.8 kg
		Nitrogen oxides	0.0578 kg
		Sulfur dioxide	0.004 kg

- Create a new product system and have a look at the graph.
- 10 min

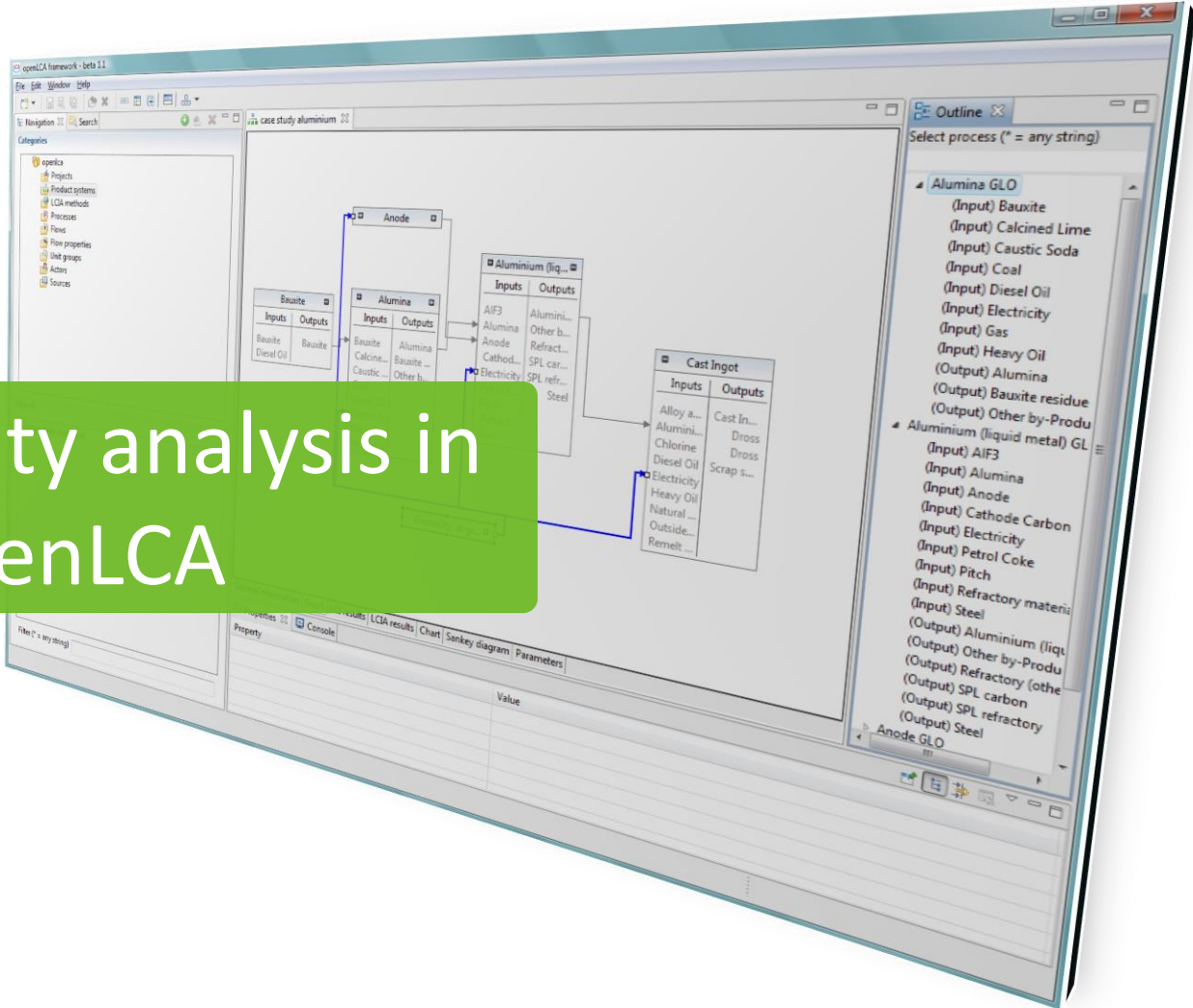
Free task: Life Cycle Assessment of a disposable shaver

- a) Create an LCA of a disposable shaver is produced in China and used in the United States.
- Some facts:
 - Shaver: head with 2 steel blades weighs 20g; handle is made of 200g ABS (Acrylonitrile-butadiene-styrene copolymer)
 - packing: 55g PET, 10 shaver in one package
 - The shaver can get used for 0.25m² skin, then they are dull
 - the shaver will get incinerated, not recycled
 - Grouping your model in production, use and disposal phases.
 - Describe your approach.
 - 30 min

Free task: Life Cycle Assessment of a disposable shaver

- b) Create your shaver environmentally friendly!
 - Apply common eco-design rules and produce a more environmentally friendly shaver.
 - Explain your approach and your results.
 - 30 min

Uncertainty analysis in openLCA



Types of uncertainty

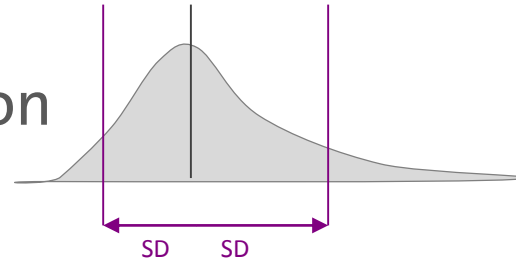
- Data uncertainties
 - Uncertainties through measurements and estimations
 - Uncertainties through the use of non-ideal data sets (region, technology, time period)
 - Uncertainties of consumer behaviour regarding use and disposal of products
 - ...
- Uncertainties in LCIAM due to lack of scientific knowledge
- ...

Data uncertainty: **basics**

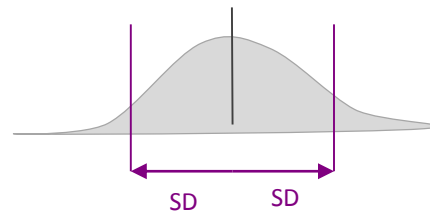
- It is basically not possible to measure error-free.
- But: Data uncertainty is in contrast to other uncertainties quite easy to handle with statistical methods (e.g. Monte Carlo simulation, Pedigree approach, interval calculations, with fuzzy logic approach or the Gaussian error propagation formulas)
 - Measurements have a distribution; the scope is defined as standard deviation.
 - Results have also a standard deviation and a mean as well as an average:
 - The median is the mean value (for 100 samples the 50th sample is the median).

Uncertainty distribution

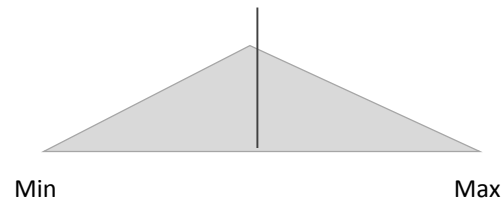
- Log-normal distribution



- Normal distribution



- Triangle distribution



- Uniform distribution



The Monte Carlo **simulation**

- Simulation varies entry data of the model calculation randomly according to the uncertainty distribution.
- An uncertainty distribution for the calculation result is provided.
- By a breakdown of the value ranges in individual intervals and the alternate drawing from different intervals, a more uniform distribution of the results is achieved, thereby reducing the number of iterations required.

The Monte Carlo simulation

- First, uncertainty data are added to all flows in the processes (Distribution, standard deviation, min / max, etc.); only for the reference output no uncertainty distribution is assumed.
 - Uncertainty data can be defined also for parameters and LCIA characterisation factors
- Then, in the calculation window the Monte Carlo simulation can be selected and the number of simulations can be entered.
- Uncertainties are calculated for each flow or impact

Adding uncertainty information

openLCA 1.4.1 beta 4

Transport, aircraft, freight - RNA

Process: Transport, aircraft, freight

Inputs

Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Default pro...	Pedigree un...
Kerosene, at refinery - RN...	Product flows	Volume	L	0.41991972...	none Edit		

1 Select "Edit" in the uncertainty field

Uncertainty

Uncertainty distribution: Logarithmic normal distribution

Geometric mean: 2.5

Geometric standard deviation: 0.9

OK Test Cancel

2. Define the values of the distribution

Starting the Monte Carlo simulation

The image shows a software interface for product lifecycle assessment. The main window is titled 'Product system: Case 1' and contains a 'General information' section with fields for Name (Case 1), Description, Version (00.00.000), and Last change. A 'Calculate' button is visible. A 'Calculation properties' dialog box is open, showing options for Allocation method (None), Impact assessment method (IPCC 2007), Normalization and weighting set, and Calculation type (Monte Carlo Simulation selected). The Number of iterations is set to 100. A green play button icon is in the top right of the dialog box.

1 Open a product system and click the calculation button

2. Select "Monte Carlo Simulation", the impact method and the number of iterations

Starting the Monte Carlo simulation

openLCA 1.4.1 beta 4

*Transport, aircraft, freight - RNA Transport, aircraft, freight Transport, aircraft, freight

Monte Carlo Simulation

Settings

Product system: Transport, aircraft, freight
Process: Transport, aircraft, freight
Quantitative reference: 1.00 t*km Transport, aircraft, freight - RNA
Number of simulations: 100

Progress

Start

Results

Flows: Benzene - water/unspecified
Impact categories: climate change - GWP 500a

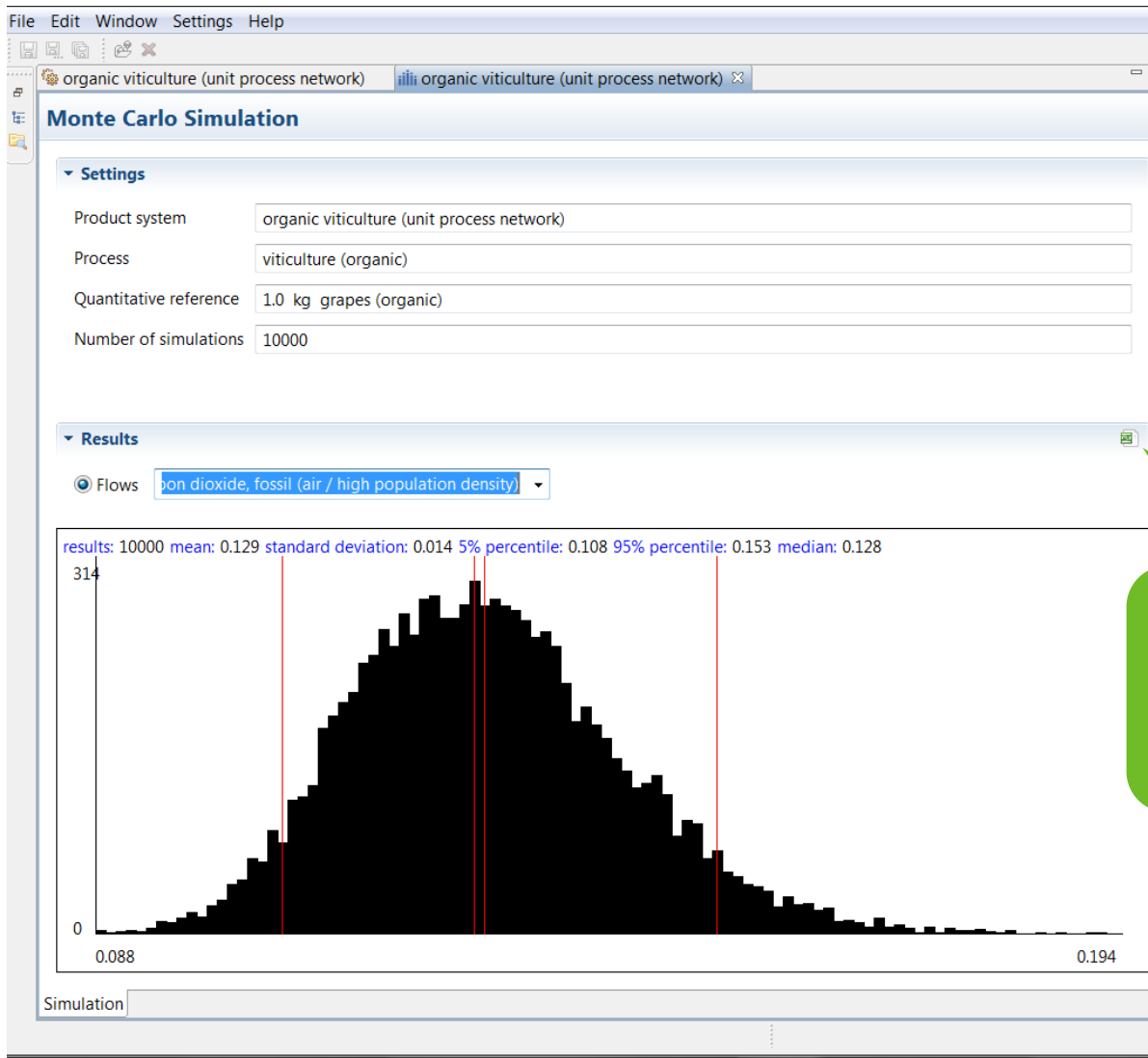
results: 1 mean: 0.000 standard deviation: 0.000 5% percentile: 0.000 95% percentile: 0.000 median: 0.000

1
0
0.000 0.000

3 Click "Start" to run the simulation

4 While the simulation runs, results for each flow and impact category can be shown

Results of the Monte Carlo simulation



5 Results can be exported as Excel

The Pedigree approach **in ecoinvent**

- Developed by Weidema and Wesnaes in 1996 as part of their NUSAP scheme to estimate all kinds of uncertainty
- A pedigree illustrates key aspects in a matrix:
 - Columns represent pedigree criteria
 - Lines represent qualitative characterisations of each criteria by expressing different levels of data quality or uncertainty
- Quantitative scores are assigned to each qualitative description
- The pedigree matrix was transferred in 1996 by **GreenDELTA**

The Pedigree approach **in ecoinvent**

Relevant
criteria

	1	2	3	4	5
Reliability					
Completeness					
Time					
Geography					
Technology					

Score

Qualitative
descriptors

The Pedigree approach **in ecoinvent**

	1	2	3	4	5
Reliability	1.00	1.05	1.10	1.20	1.50
Completeness	1.00	1.02	1.05	1.10	1.20
Time	1.00	1.03	1.2	1.20	1.50
Geography	1.00	1.01			1.10
Technology	1.00		1.50	1.50	2.00

Default uncertainty factors

The Pedigree matrix in openLCA

*Transport, aircraft, freight - RNA

Process: Transport, aircraft, freight

Inputs

Flow	Category	Flow proper...	Unit	Amount	Unce...	Def...	Pedigree uncertainty
* Kerosene, at refinery - RN...	Product flows	Volume	L	0.41991972...	none		Edit

1. Click "Edit" to add or modify the Pedigree uncertainty

Outputs

Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Avoided pr...	Pedigree un...
* Transport, aircraft, freight...	Product flows	Goods trans...	t*km	1.0	none		
Hydrocarbons, unspecified	air/unspecified	Mass	kg	0.00104611...	none		
Carbon monoxide, fossil	air/unspecified	Mass	kg	0.00441023...	none		
Carbon dioxide, fossil	air/unspecified	Mass	kg	1.05284715...	none		
Nitrogen oxides	air/unspecified	Mass	kg	0.00536646...	none		

The Pedigree matrix in openLCA

Pedigree matrix

Click on the matrix cells to select entries

Indicator score	1	2	3	4	5
Reliability	Verified data based on measurements	Verified data partly based on assumptions or non-verified data based on measurements	Non-verified data partly based on qualified estimates	Qualified estimate (e.g. by industrial expert)	Non-qualified estimates
Completeness	Representative data from all sites relevant for the market considered, over and adequate period to even out normal fluctuations	Representative data from > 50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from only some sites (<< 50%) relevant for the market considered or > 50% of sites but from shorter periods	Representative data from only one site relevant for the market considered or some sites but from shorter periods	Representativeness unknown or data from a small number of sites and from shorter periods
Temporal correlation	Less than 3 years of difference to the time period of the data set	Less than 6 years of difference to the time period of the data set	Less than 10 years of difference to the time period of the data set	Less than 15 years of difference to the time period of the data set	Age of data unknown or more than 15 years of difference to the time period of the data set
Geographical correlation	Data from area under study	Average data from larger area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown, distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)
Further technological correlation	Data from enterprises, processes and materials under study	Data from processes and materials under study (i.e. identical technology) but from different enterprises	Data from processes and materials under study but from different technology	Data on related processes or materials	Data on related processes on laboratory scale or from different technology

Base uncertainty: og: 1.2555818742947564

OK Cancel

2. Click in the different fields to rate the data quality, add a basic uncertainty and click „OK“.

Basic uncertainty

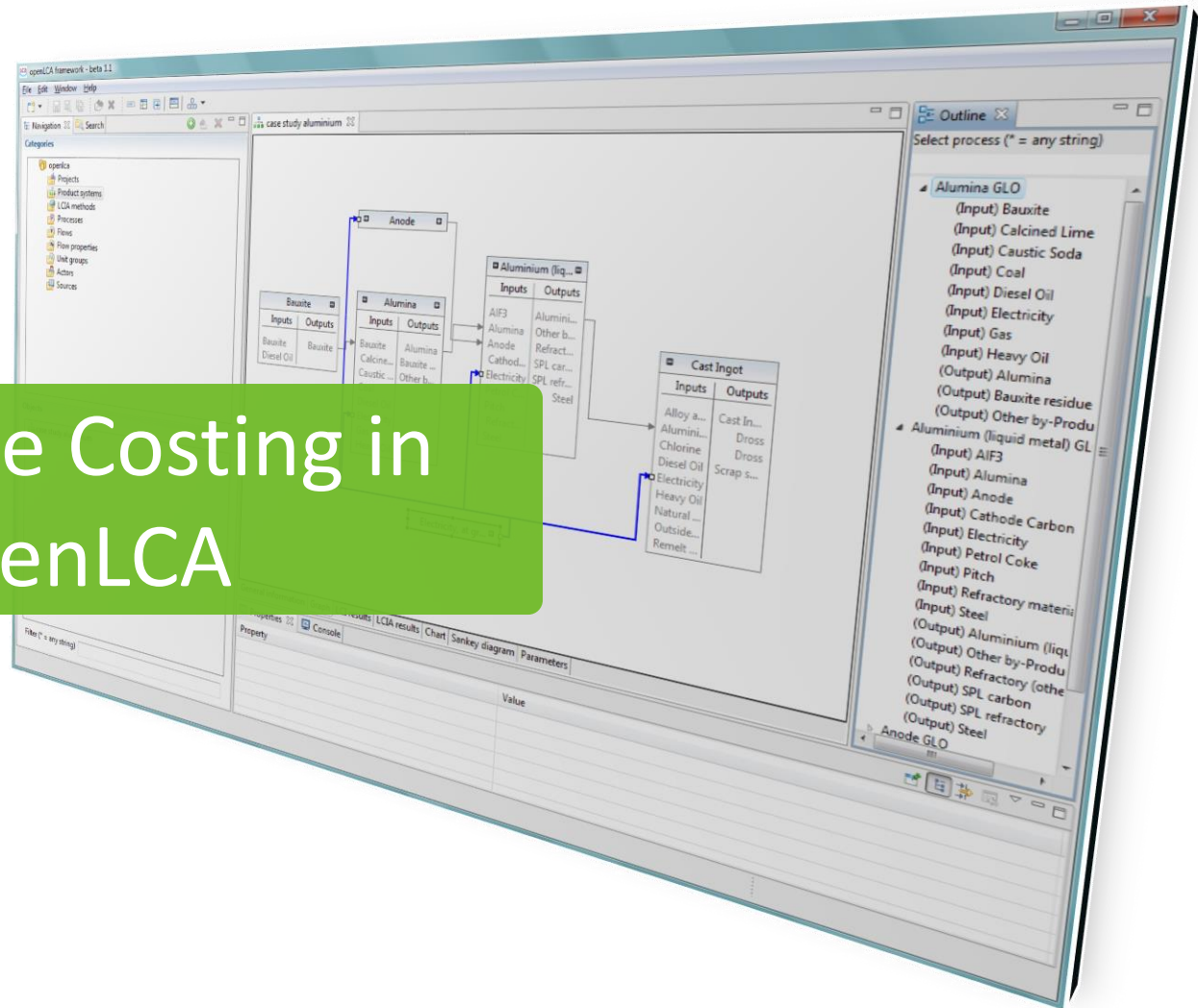
- Developed by the ecoinvent centre:

Basic uncertainty	Value
Energy requirement	1.05
Transportation services	2.00
Infrastruktur	3.00
CO2 in air	1.05
PM2.5 of combustion	3.00
Heavy metal in water	5.00
Radionuclides in water	3.00

Calculation of the Pedigree uncertainty

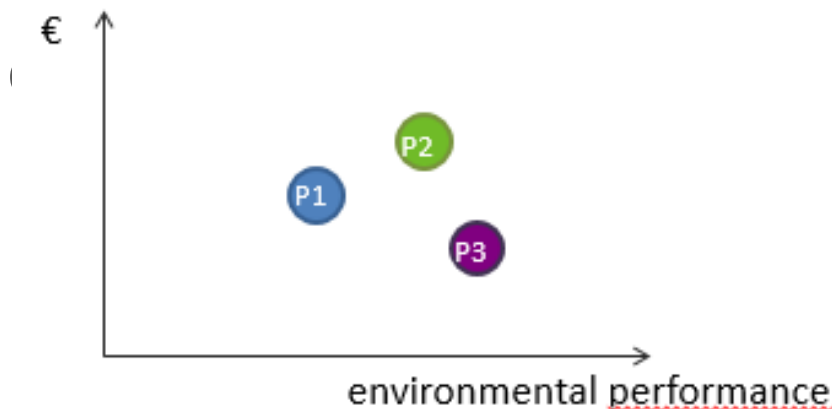
- So far the pedigree matrix is only used for documentation purposes!
- In later openLCA versions the pedigree values will be used to determine all uncertainty parameters to run a Monte Carlo simulation (Distribution, standard deviation, min / max, etc.)
- Derived uncertainties can then be calculated using the Monte Carlo simulation.

Life Cycle Costing in openLCA



Motivation of LCC

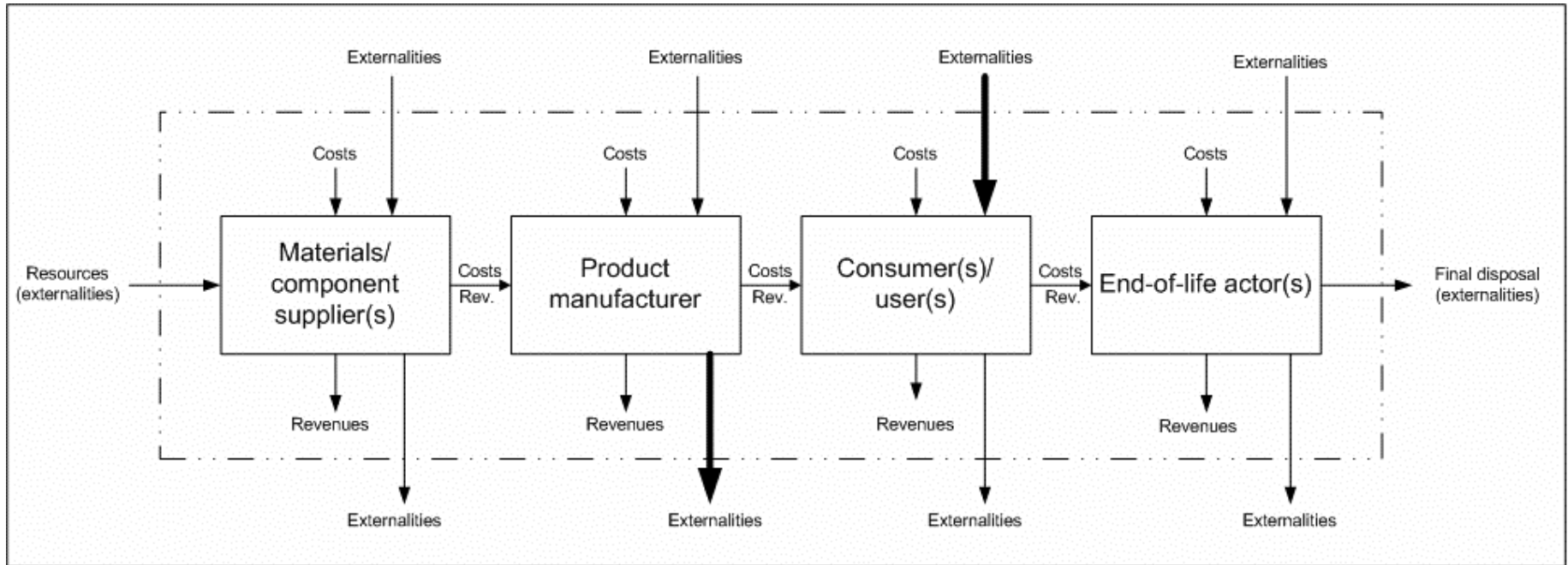
- LCC gives an overview over all costs that arise through the entire life cycle of a product.
- 2 perspectives: manufacturer and consumer
- Important for goods that entail high costs through maintenance (e.g. car or train) or for the comparison of different products
- Comparison of eco-



Example: The consumer perspective

	Opel Corsa	Fiat Punto	Citroen Advance
Purchase price	10,945 €	10,890 €	10,9990 €
Costs per year			
Buy price	1,977 €	2,164 €	1,936 €
Taxes, insurance, etc.	1,753 €	1,911 €	1,527 €
Operating costs	909 €	964 €	998 €
Repair costs	352 €	490 €	318 €
Total yearly costs	4,991 €	5,529 €	4,779 €

Scope of LCC



--- Economic system = boundaries of LCC

▭ Social and natural system: boundaries of social and environmental assessment

(Rebitzer G., Hunkeler D. (2003): Life Cycle Costing in LCM: Ambitions, opportunities, and limitations, Discussing a framework. In: Int J LCA 8 (5), pp. 253-256)

LCC in openLCA

- Two possibilities:
 - Costs are treated as environmental impacts (costs are emissions)
 - Costs are considered as elementary flows
 - Use of the costs tab in the process editor
 - Only cost categories can be considered

The costs tab option is currently only included process documentation purposes → No calculation is available!

Option 1: Costs as elementary flows

- In a first step, specific or general cost flows are defined (e.g. [(material costs) for PET], [(labour costs) for engineers], [(transport costs) for road transportation], etc.).
- These cost flows are assigned to processes (treated as emissions).
- It is recommended to create a new impact assessment method which adds up the cost flows. Different cost categories (→ impact categories) can be defined (e.g. manufacturing costs, transport costs, disposal costs, ...)

Option 1: Procedure in openLCA (I)

- Creation of costs flows as elementary flows

The screenshot displays the openLCA 1.4.1 beta 4 application window. The left-hand side features a navigation tree with the following structure:

- ecoinvent_2_2_unit
- ecoinvent3_1_allocation_default
- olcateacher
 - Projects
 - Product systems
 - Impact assessment methods
 - Processes
 - Flows
 - chemicals
 - Elementary flows
 - final-waste-flow
 - LCC
 - energy costs
 - material costs
 - personell costs
 - transport costs
 - non-material

The main window is titled 'Flow: energy costs' and contains a 'Flow properties' table:

Name	Conversion f...	Reference unit	Formula	Is reference
Market va...	1.0	EUR	1.0 EUR = 1...	<input checked="" type="checkbox"/>

At the bottom of the window, there are two tabs: 'General information' and 'Flow properties', with the latter being the active tab.

Option 1: Procedure in openLCA (II)

- Adding costs flows to processes (outputs)

Process: Blade, steel LCC

Inputs

Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Default
⚙️ Steel, billets, at plant - US	Product flows	Mass	g	2	none	
⚙️ Electricity, at grid, CN	Product flows	Energy	kWh	0.05	none	

Outputs

Flow	Category	Flow proper...	Unit	Amount	Uncertainty	Avoided
⚙️ Blade, steel_LCC	Product flows	Number of ...	Item(s)	1	none	
📊 energy costs	LCC	Market valu...	EUR	0.2*0.05	none	
📊 personell costs	LCC	Market valu...	EUR	0.004	none	
📊 material costs	LCC	Market valu...	EUR	0.02*0.90	none	

Option 1: Procedure in openLCA (III)


- Creation of an impact assessment method

▼ Impact categories

Name	Description	Reference unit
Energy costs		EUR
Material costs		EUR
Personnel costs		EUR
Transport costs		EUR

Impact assessment method: LCC

▼ Impact factors

Impact category  Energy costs

Flow	Category	Flow property	Unit	Factor	Uncertainty
energy costs	LCC	Market value US 2000, bulk prices	EUR/EUR	1.0	none

Option 1: Procedure in openLCA (IV)

- Calculate the product system costs results with the openLCA method




LCIA Results

LCIA Results

Impact category	Result	Reference unit
Material costs	0.21268	EUR
Transport costs	0.05000	EUR
Personnel costs	0.10050	EUR
Energy costs	0.06646	EUR

Impact contributions

Impact category  Material costs

Contribution	Process	Amount	Unit
 74.99%	Use phase shaver, ABS, 2 blades LCC - US	0.15950	EUR
 16.93%	Blade, steel LCC - GLO	0.03600	EUR
 07.50%	Shaver handle, ABS LCC - GLO	0.01595	EUR

Option 2: Costs tab in the process editor

- Cost categories are defined on the process level. Values are assigned to these cost categories.

Process costs

▼ Shaver, ABS, 2 blades, packaged with PET_LCC

Cost category	Amount	Fixed ...
Local taxes	500.0	No

New cost entry

Cost category: Construction Expenses

Amount: 1000.0

Fixed costs:

OK Cancel

1. Add a cost to the process

2. Select the cost category and introduce amount

Inputs/Outputs Administrative in... Modeling and vali... Parameters Allocation Process costs »1

Free exercise: LCC of a shaver

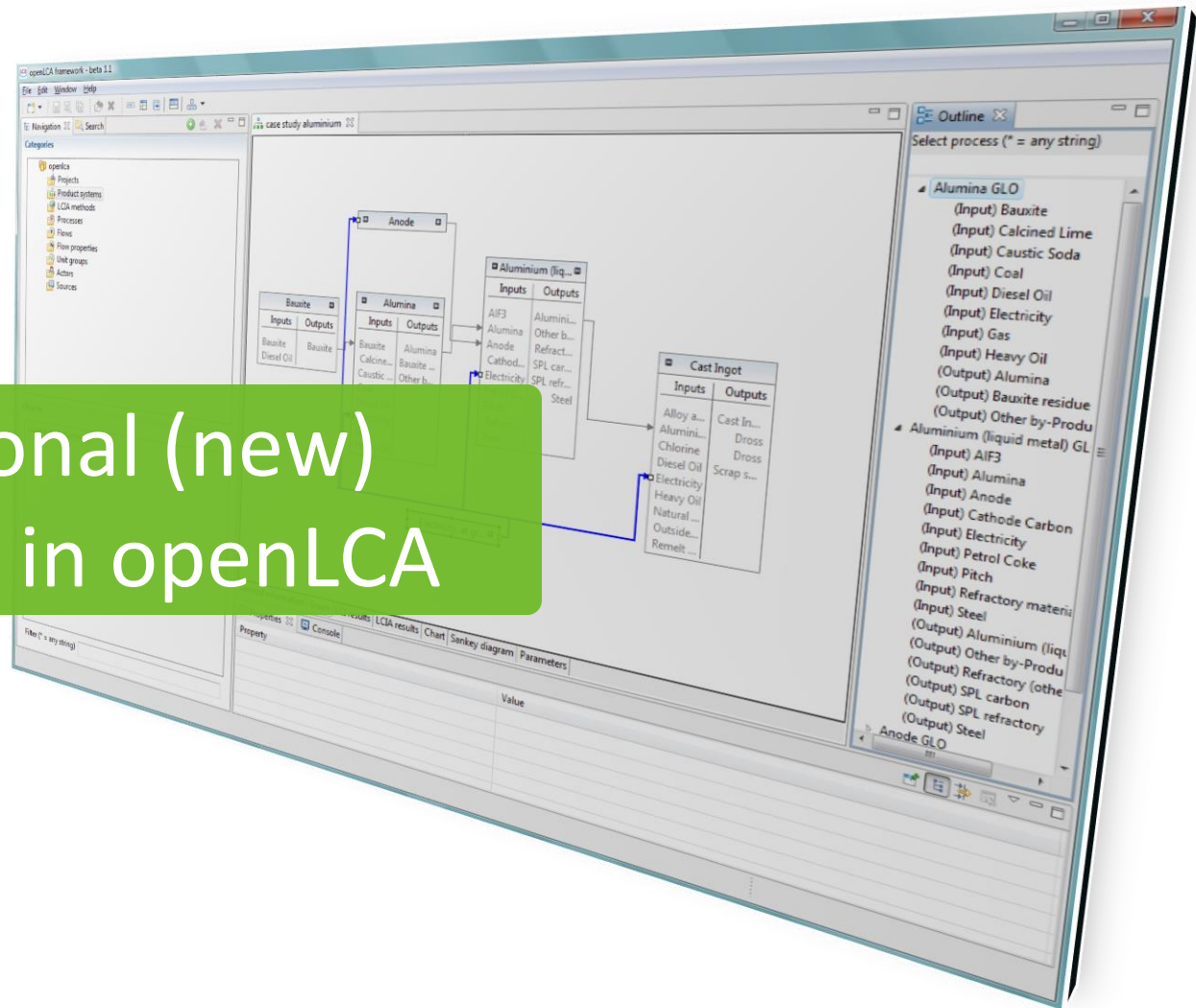
Create for your shaver models a comparative cost analysis from a consumer perspective.

- A few prices:

Product	Price
disposable shaver, 2 blades	0.89 EUR for 5 pieces
tap water, incl. waste water treatment	5EUR/m ³ (\Rightarrow 0.005 EUR/kg)
shaving foam	2.69 EUR for 200ml

- Describe your procedure.
- 15 min

Additional (new) features in openLCA



Elements **usage**

- Available for any element of the database.
- Results can be filtered.

The screenshot displays a software interface with a list of elements on the left and a usage table on the right. The 'Carbon monoxide' element is selected, and a context menu is open over it. The usage table shows various applications of carbon monoxide, with a filter 'ad' applied.

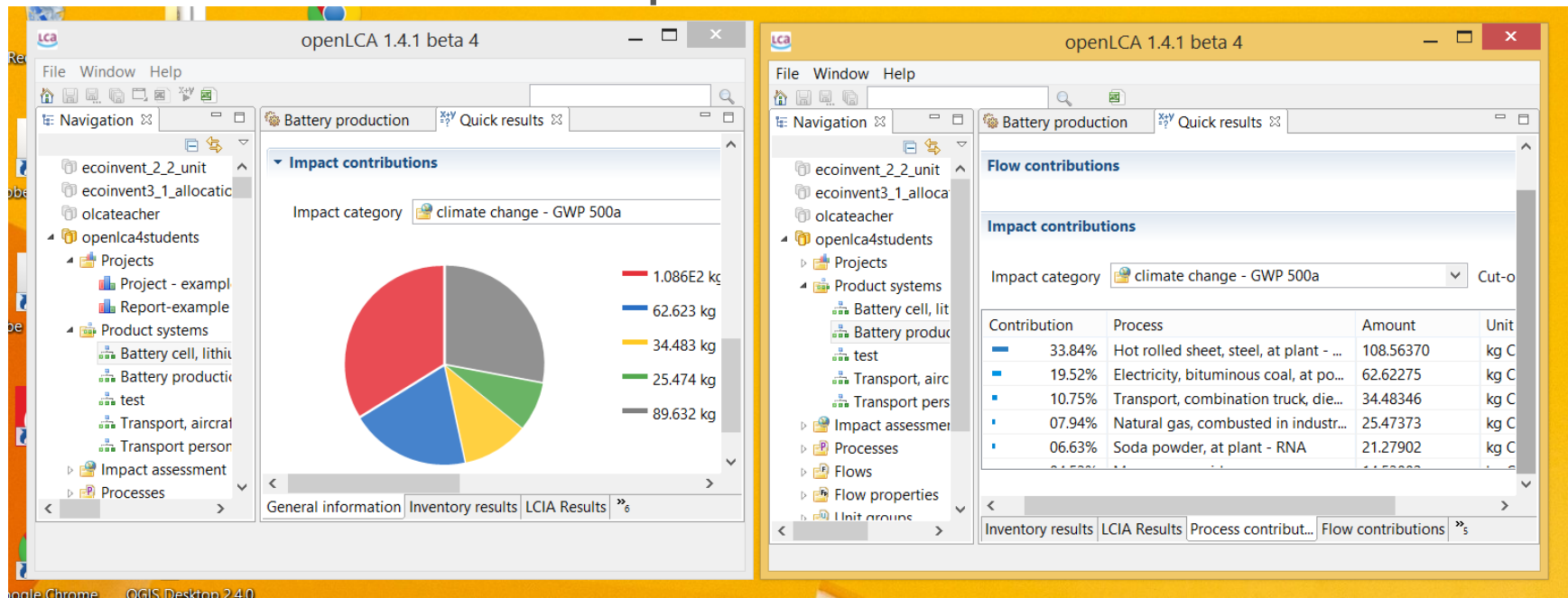
Usage of: Carbon monoxide, fossil

Filter results:

Type	Name
P	Acrylonitrile-butadiene-styrene copolymer, resin, at plant, CTR
P	Fuel grade uranium, at regional storage
P	Natural gas, combusted in industrial boiler, at hydrocracker, for butadiene
P	Forest residue, processed and loaded, at landing system
🌐	selected LCI results, additional

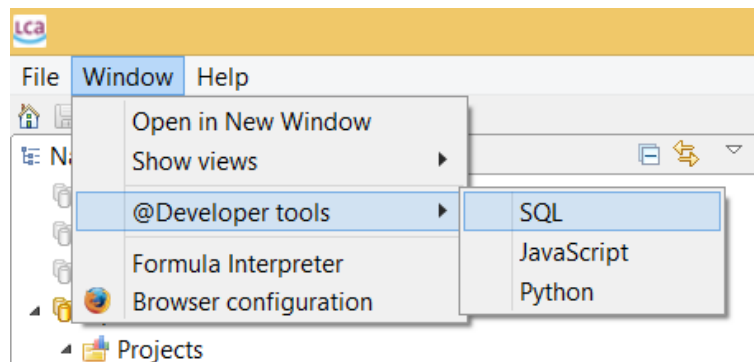
Multiple windows view

- Select Window/Open in New Window to open a new openLCA window
- It can be worked in parallel within the same database



Developer tools

- SQL Query Browser, JavaScript and Python editors.



SQL Query Browser

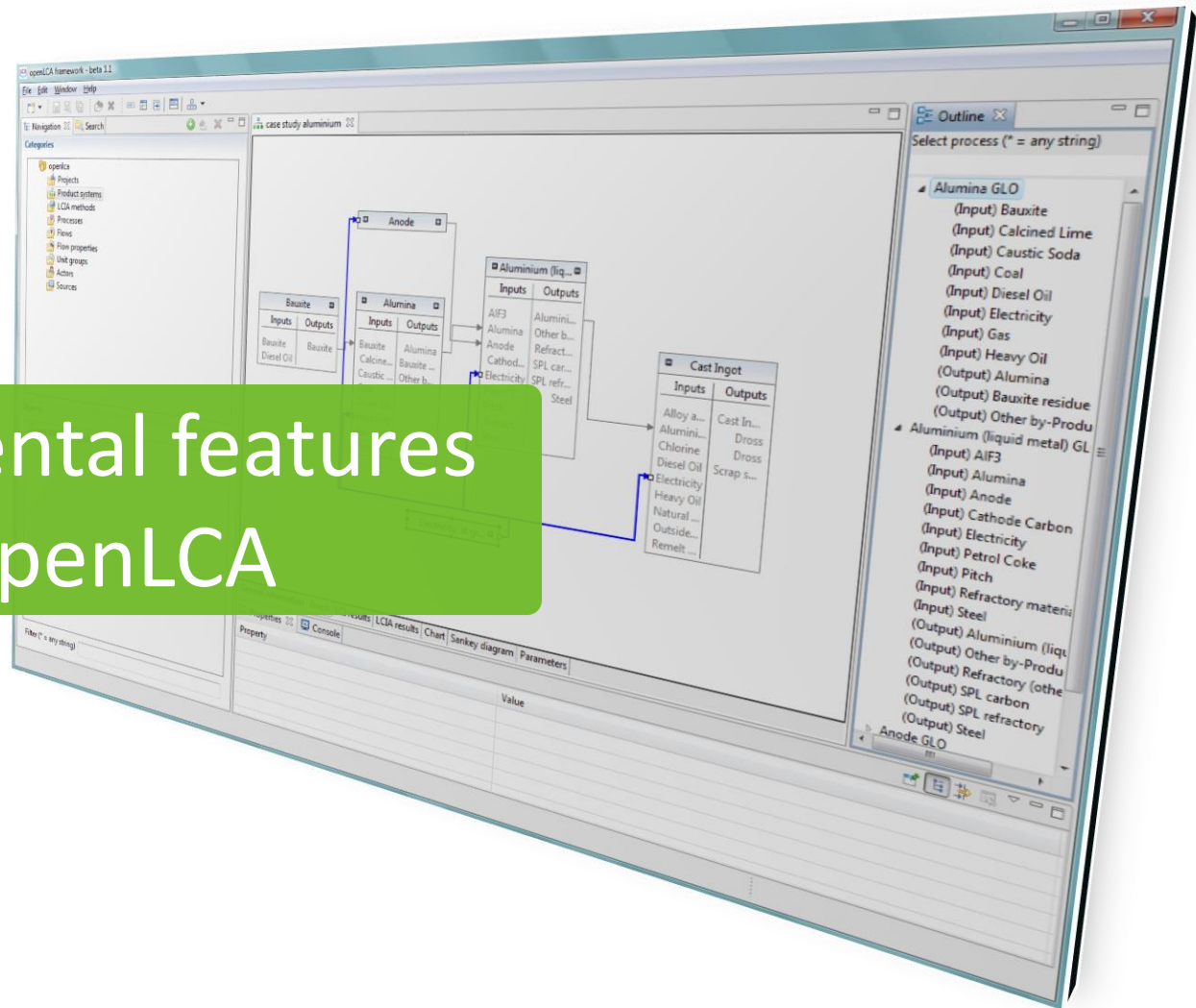
SQL Statement

```
select name, cas_number, formula from tbl_flows
```

Results

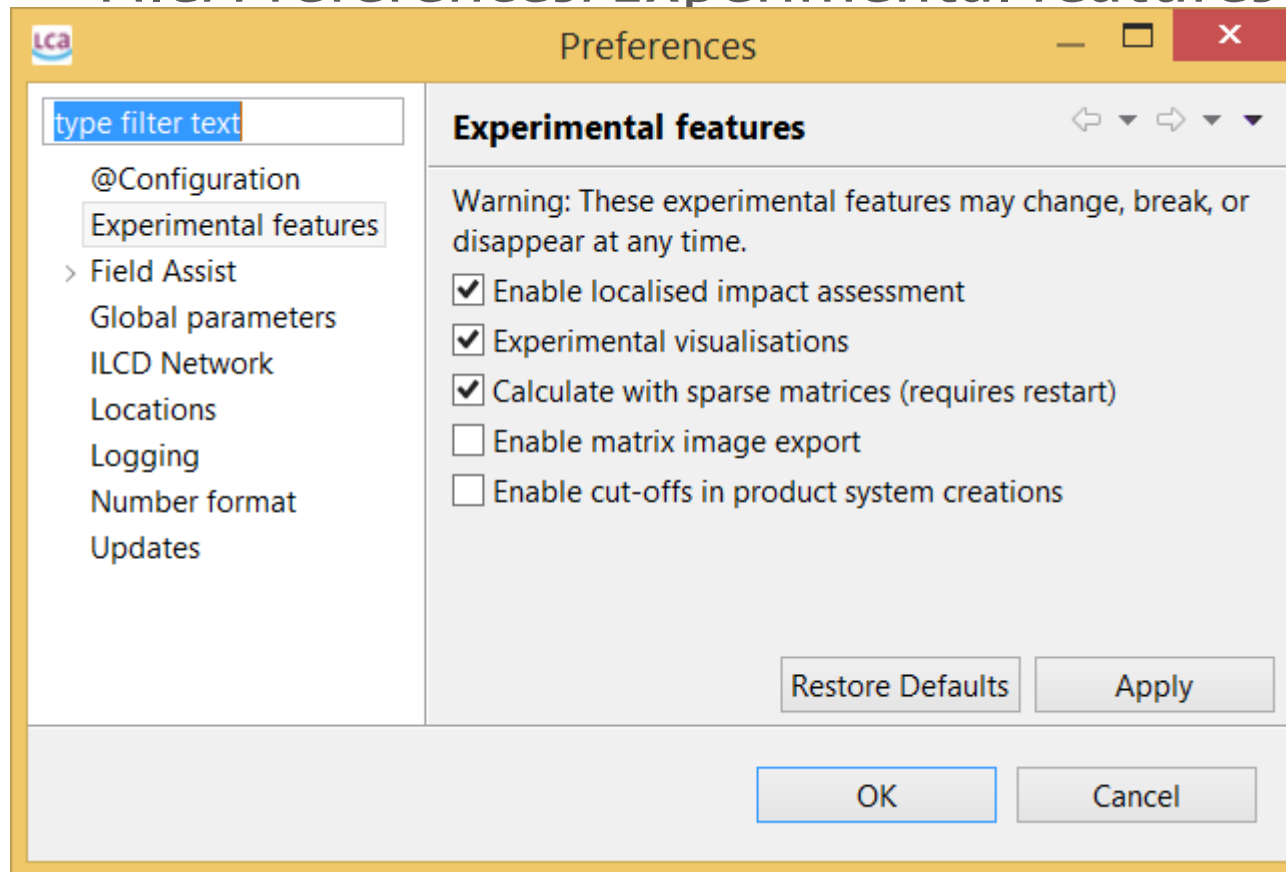
NAME	CAS_NUMBER	FORMULA
Ethene, tetrachloro-	000127-18-4	C2Cl4
Florasulam	145701-23-1	C12H8F3N5O3S
Nitrite	014797-65-0	NO2 -
Xenon-137	014835-21-3	Xe-137
Ethyl cellulose	009004-57-3	NULL
Sulfate	014808-79-8	SO4--
Aniline	000062-53-3	C6H7N
Transformation, from traffic area, road network	NULL	CORINE 122a
Cesium-137	010045-97-3	Cs-137
Chlorosulfonic acid	007790-94-5	HSO3Cl
Manganese	007439-96-5	Mn

Experimental features in openLCA



Experimental features

- They can be activated under File/Preferences/Experimental features



Product system **Statistics**

- Available in the product system editor
- It provides information about the number of processes, the process links, etc.

Product system statistics

General statistics:

Number of processes	81
Number of process links	230
Connected graph / can calculate?	yes
Technology matrix	81 x 81
Reference process	Battery pack (S1)

[Recalculate](#)



Product system **Statistics** (II)

Product system statistics

Processes with highest in-degree (linked inputs):

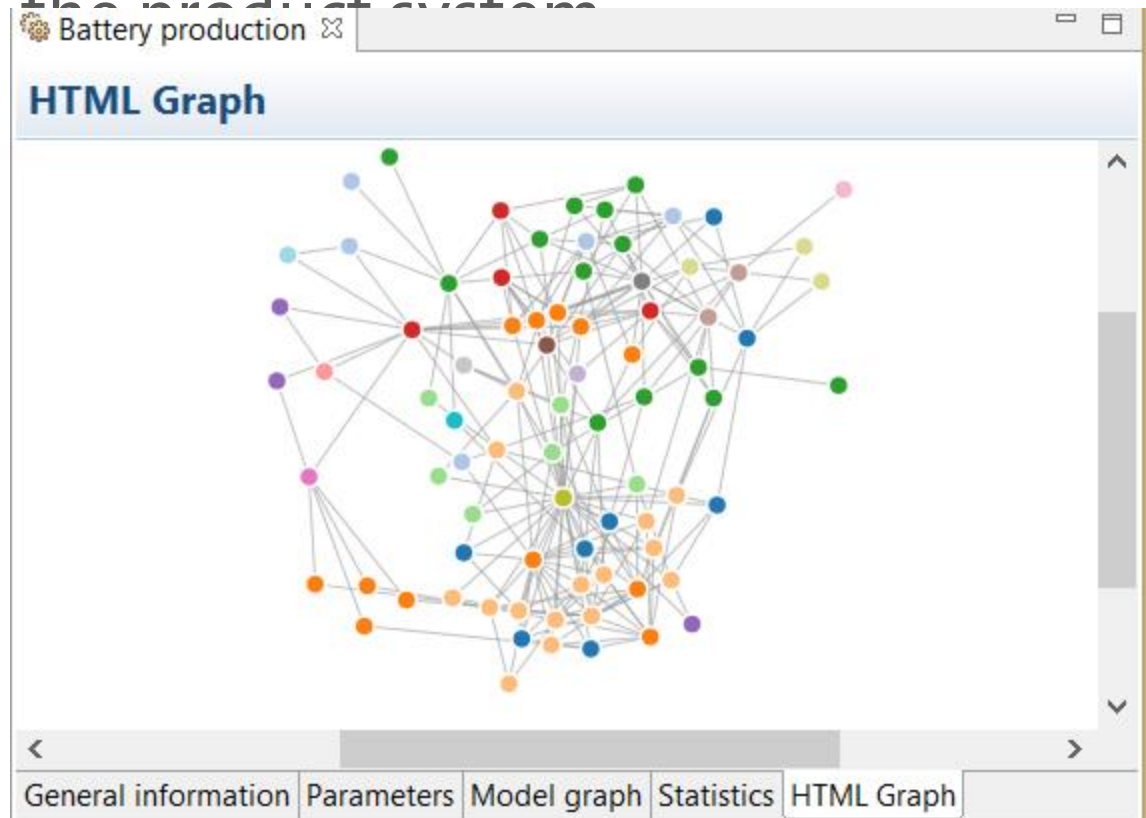
	Number of input links	Process
	8	Lithium carbonate
	8	Battery cell, lithium-ion battery (S1)
	7	Ethylene dichloride-vinyl chloride monomer, at plant
	7	Electricity, at Grid, US, 2008
	7	Ethylene, at plant

Processes with highest out-degree (linked outputs)

	Number of output links	Process
	27	Electricity, at Grid, US, 2008
	18	Transport, train, diesel powered

Experimental visualisations: HTML Graph

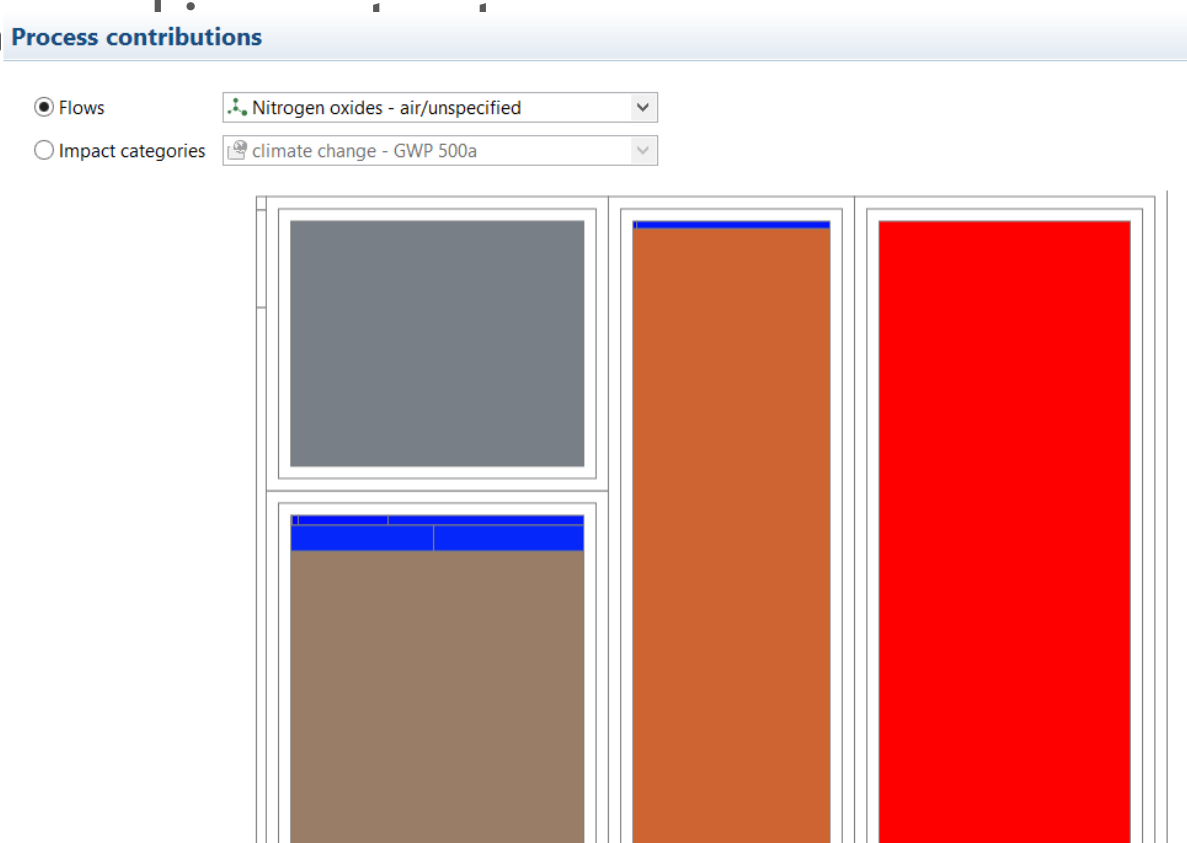
- Available in the product system editor.
- It provides visual representation of the process links in the product system.



Experimental visualisations:

Treemap

- Available in the quick results and analysis editors.
- It visually represents the direct process contributions per flow

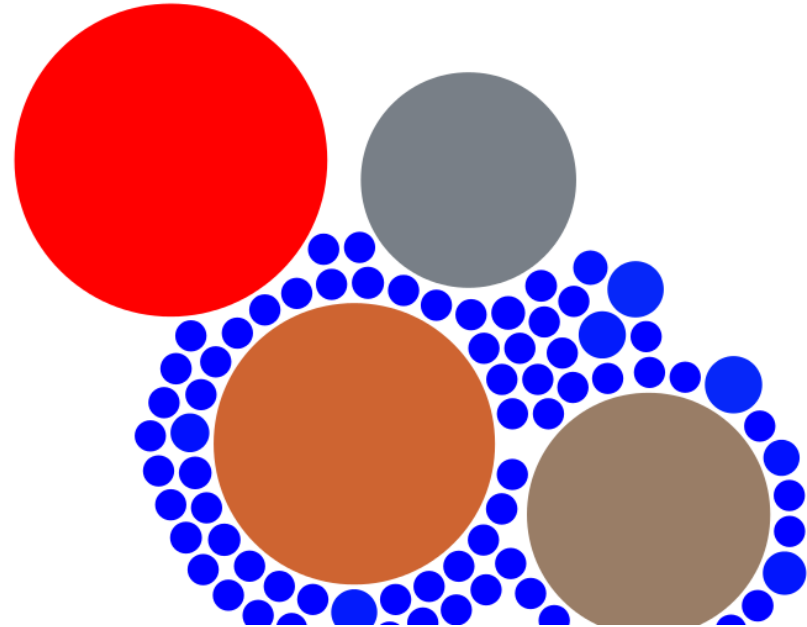


Experimental visualisations: Bubble chart

- Available in the quick results and analysis editors.
- It visually represents the direct process contributions per flow

Process contributions

Flows Impact categories



Experimental visualisations: Sun burst

- Available in the analysis editor.
- It visually represents the total process contributions per flow

Sun burst

Flows

Octadecane - water/unspecified

Impact categories

climate change - GWP 500a



Other experimental features

- Spare matrix calculation: calculates with a different, sparse matrix approach; saves some memory but is still experimental.
- Localised impact assessment:
 - New features in the impact method editor are added to deal with shape files.
 - A new calculation option is shown in the “Calculation properties” menu:

Calculation properties

Please select the properties for the calculation

Allocation method: None

Impact assessment method: ecological scarcity 2006

Normalization and weighting set: [Empty]

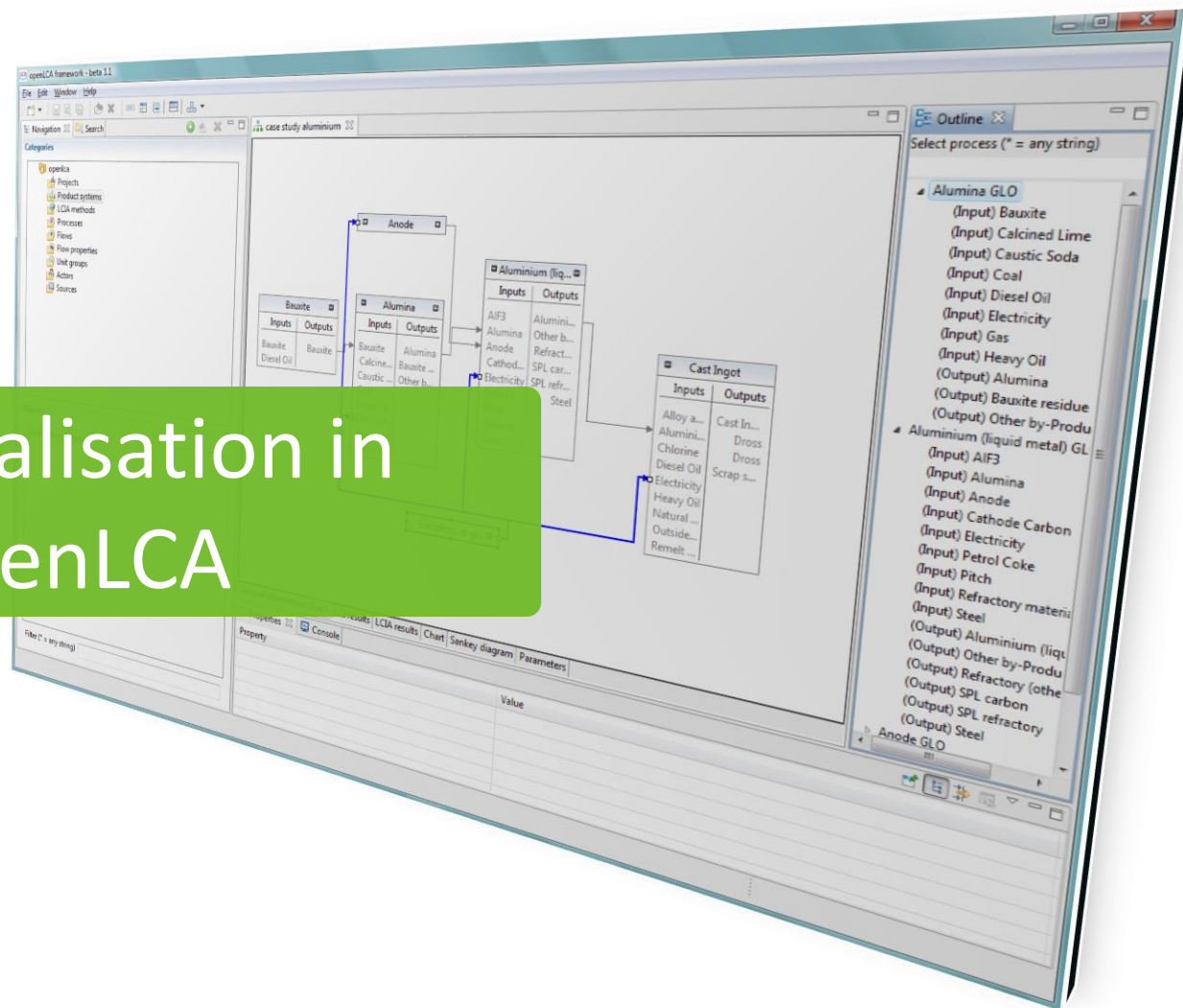
Calculation type:

- Quick results
- Analysis
- Regionalized LCIA
- Monte Carlo Simulation

Number of iterations: 100

Save as default | Reset | Calculate | Cancel

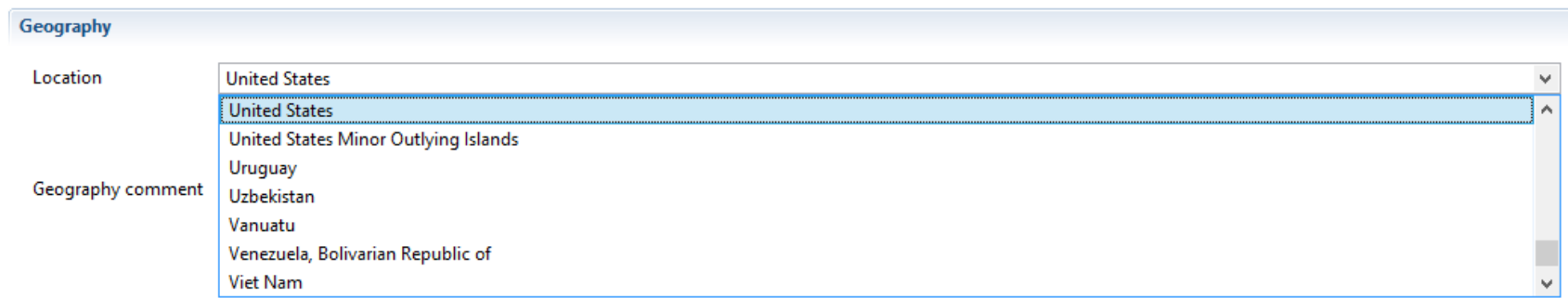
Regionalisation in openLCA



Extension of locations in openLCA (I)

Traditional approach:

- A list of locations available under File/Preferences/Locations.
- The geographic information of the locations was limited to a pair of latitude, longitude data.
- The processes could only use locations from the pre-defined list.



Extension of locations in openLCA (II)

New approach:

- The list of locations available in the database is shown in File/Edit locations.
- KML data can be added to each location (polygons, lines, points):
 - Import of kmz/xml files with geographic data.
 - Write the coordinates in the “Text editor”.
 - Draw the polygons, lines or points in the KML editor.



Geography

Location Switzerland

KML Polygon [8.60,47.77 ... 8.60,47.77] (location)

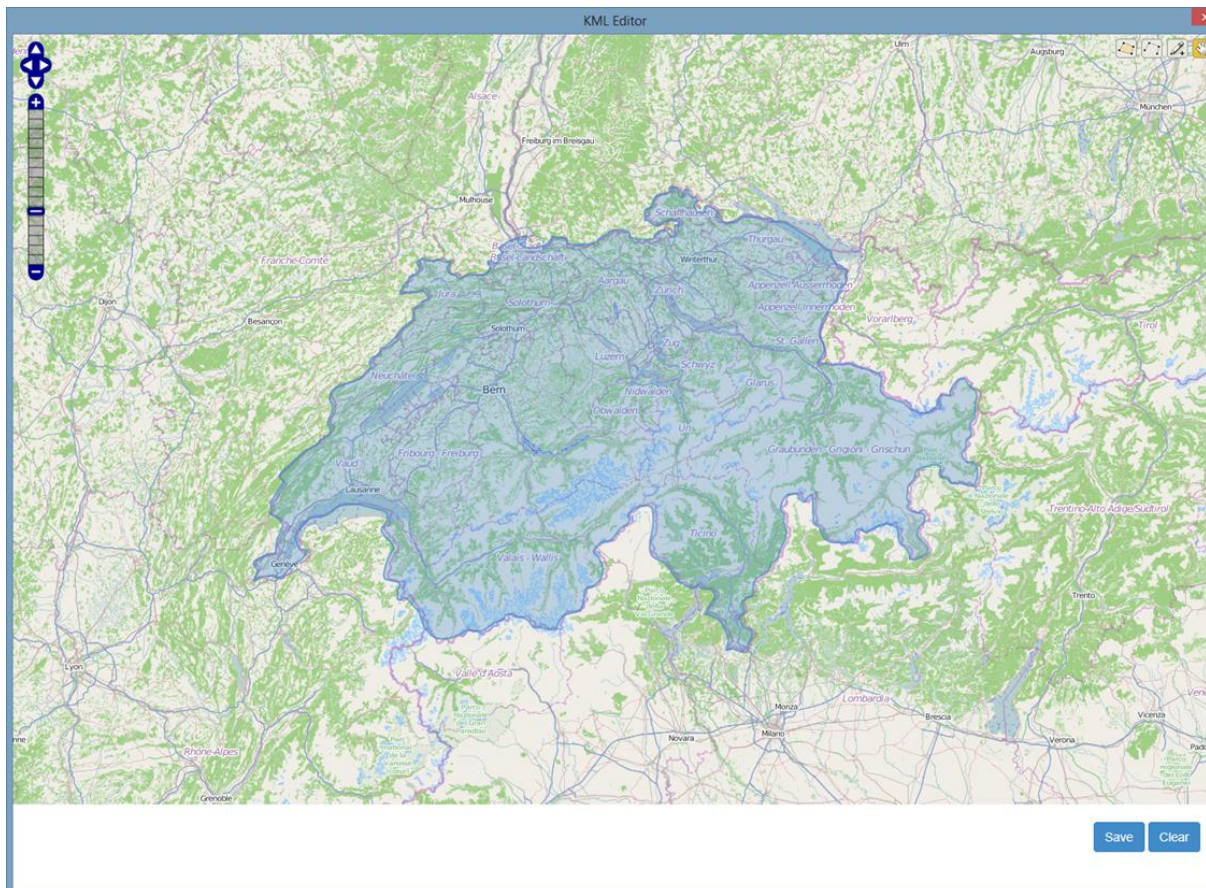
Map editor Text editor

Description European average values

editor.

Extension of locations: KML editor (map)

- KML map editor in the “Edit locations” editor:



Extension of locations: KML editor (text)

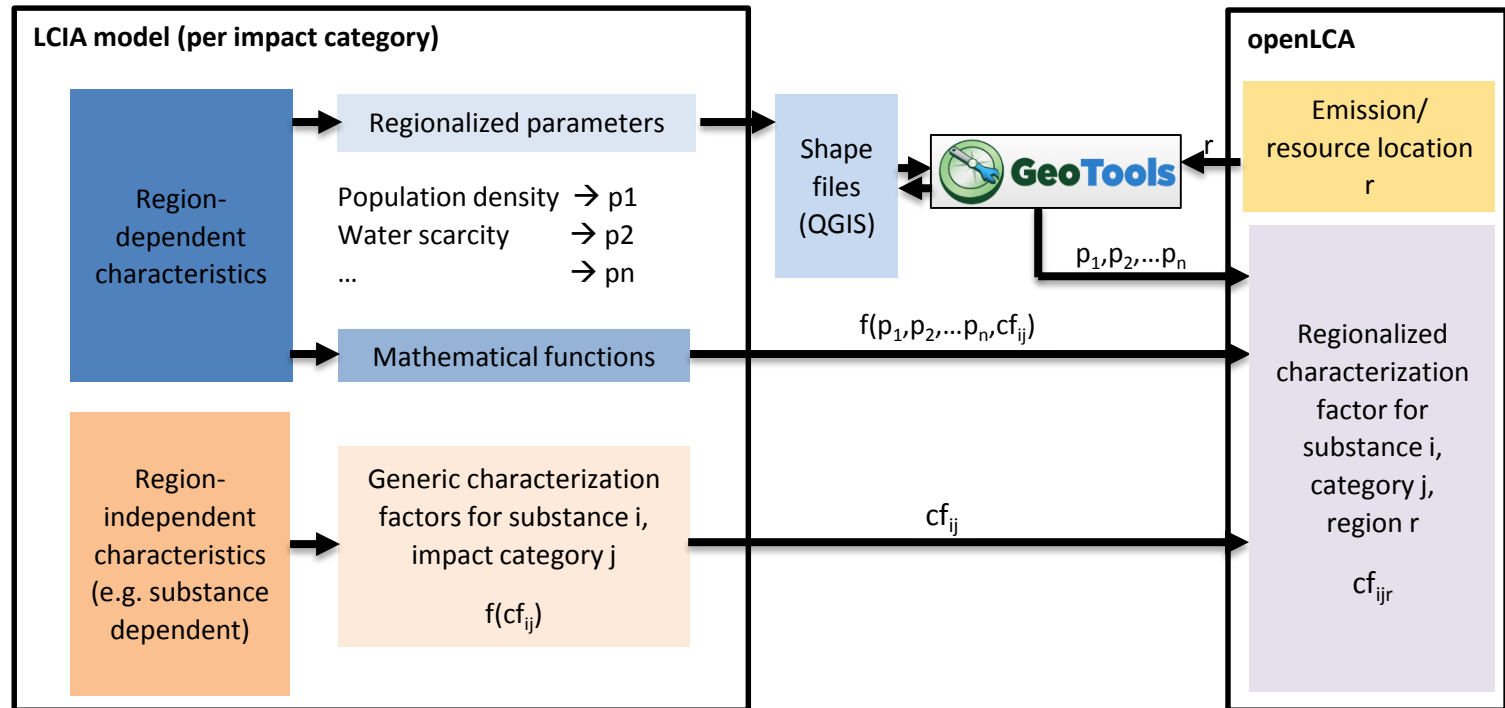
- KML text editor for the checking or modifying the geographic information:



```
KML Editor
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.0">
  <Document>
    <name>Switzerland</name>
    <Placemark>
      <MultiGeometry>
        <Polygon>
          <outerBoundaryIs>
            <LinearRing>
              <coordinates>8.60410486,47.77439768 8.60761886,47.76225372 8.61743738,47.75731862 8.62983972,47.76279633 8.63500736,47.78460378 8.64410242,47.79101166 8.65702152,47.7...
```


Regionalised LCIA methods in openLCA

- Idea:
 - Parameterization of LCIA methods



Parameterization of LCIA methods

- Formulas for calculating the characterisation factors (CFs) can be defined
 - Input and dependent parameters can be used as in the process data sets

▼ Impact factors 🟢 🚫 1.23

Impact category 🗺️ Land use ▼

Flow	Category	Flow property	Unit	Factor	Uncertainty
Occupation, arable	resource/land	Area*time	m2*a	$(0.60 * \text{ratio_biom}) / \text{SA_CF}$	lognormal: gmean=1.36 g...
Occupation, construction site	resource/land	Area*time	m2*a	$(0.44 * \text{ratio_biom}) / \text{SA_CF}$	lognormal: gmean=1.00 g...
Occupation, forest, intensive	resource/land	Area*time	m2*a	$(0.04 * \text{ratio_biom}) / \text{SA_CF}$	lognormal: gmean=9.09E-...
Occupation, forest, intensive, clear-c...	resource/land	Area*time	m2*a	$(0.18 * \text{ratio_biom}) / \text{SA_CF}$	lognormal: gmean=0.41 g...

Parameters

▶ Global parameters

▼ Input parameters

Name	Value	Uncertainty	Description
🌐 ratio_biom	1.0	uniform: min=0.21 max=1.97	from shapefile: ecoregions_with_biome_ratio
SA_CF	0.44	none	Settlement Area Characterization Factor
SA_EF	300.0	none	Settlement Area Ecofactor


Shapefiles containing regional characteristics


- Regional characteristics affecting the CFs can be defined with parameters:
e.g. population density, precipitation variability, etc.
- Data for those characteristics is contained in shapefiles, which can be imported to openLCA
- Parameters are extracted during the shapefile import

Shape file parameters

Files

Location  C:\Users\Cristina\openLCA-data-1.4\databases\regionalised_example\olca_...

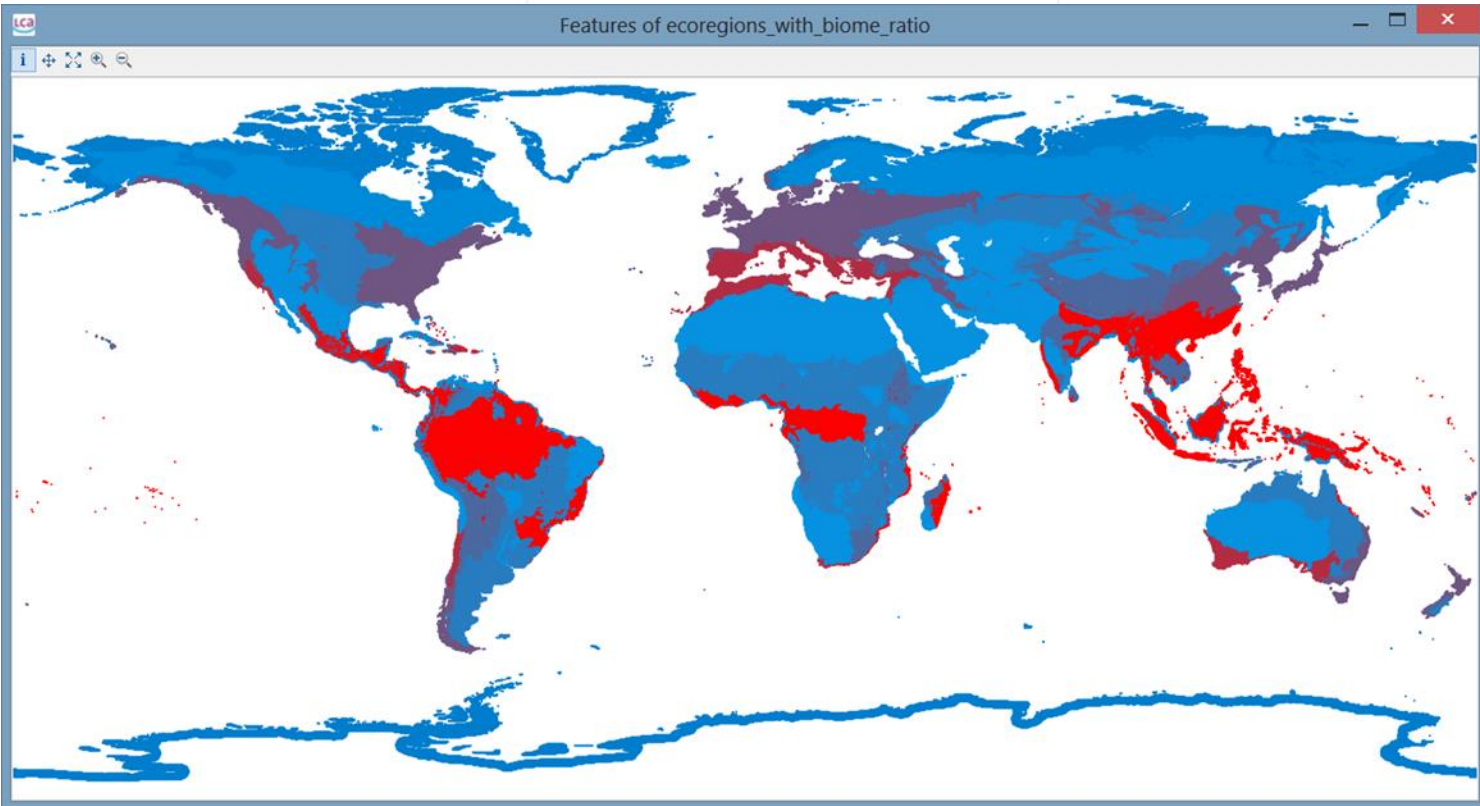
 Import...

 Evaluate for existing locations

Shapefiles containing regional characteristics

Parameters of ecoregions_with_biome_ratio

Name	Minimum	Maximum
CLS_CODE	0.0	1144.0
ECO_ID_U	10000.0	17109.0
ECO_NUM	1.0	99.0
ratio_biom	0.20929077	1.96750671



Binding shapefiles and LCIA method parameters

- Parameters of shapefiles can be bound to input parameters
- Default value of parameters is used for normal calculations and formula evaluation
- In regionalized assessment the parameter value derived from the shapefile is used for the formula

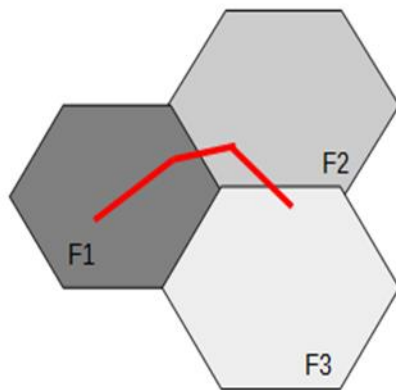
▼ Input parameters

Name	Value	Uncertainty	Description	External source
ratio_biom	1.0	none		▼
Ecofactor	610.0	none		ecoregions_ratio_biomes

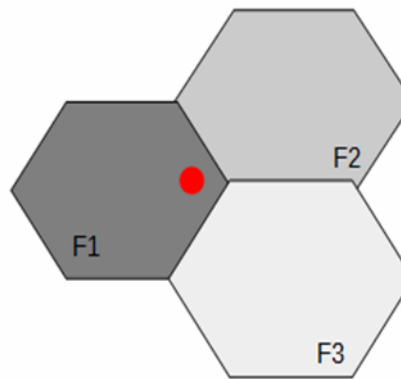
Calculation framework

Linking of process locations and LCIA methods spatial units

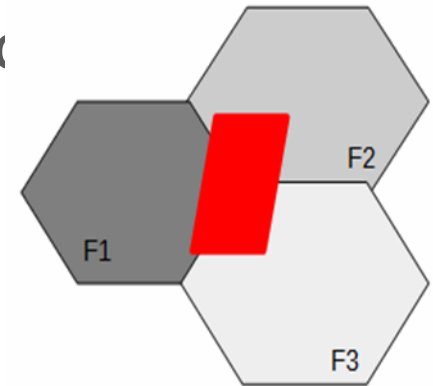
- GeoTools libraries integrated in openLCA
 - The intersection between shapefiles features and process geometries is calculated.



ed me



or ea



$$(p(F1)*L(F1) + p(F2)*L(F2) ...) / L$$

$$p(F1)$$

$$(p(F1)*A(F1) + p(F2)*A(F2) ...) / A$$

Calculation framework

Regionalised LCIA calculation

- Creation of a regionalised result matrix for the inventory (GR)
- Creation of a regionalised LCIA matrix (CR)
- Creation of the regionalised LCIA result (RR)

$$RR = CR * GR$$

Regionalised LCIA: Calculation procedure

- Select the “Regionalised LCIA” option in the calculation properties window:

→ The regionalised LCIA

Calculation properties

Please select the properties for the calculation

Allocation method: None

Impact assessment method: ecological scarcity 2013 (per country and biome)

Normalization and weighting set:

Calculation type:

- Quick results
- Analysis
- Regionalized LCIA
- Monte Carlo Simulation

Number of iterations: 100

Save as default | Reset | Calculate | Cancel


Regionalised LCIA: Calculation procedure


- To reduce the calculation time for complex systems, it is recommended to evaluate the intersections with the existing database locations when the impact method is defined.

Shape file parameters

Files

Location  C:\Users\Cristina\openLCA-data-1.4\databases\regionalised_example\olca_...

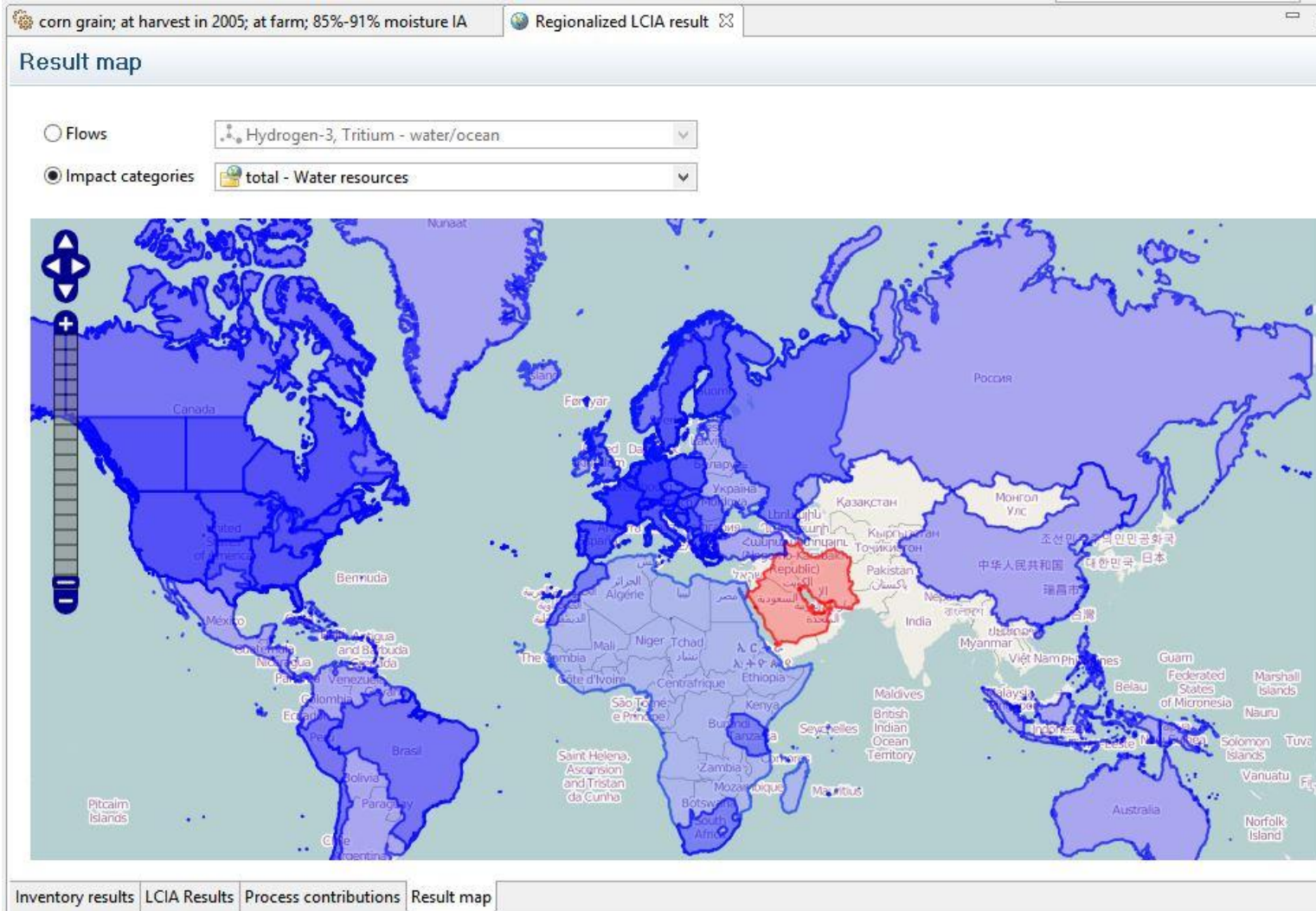
 Import...

 Evaluate for existing locations

Parameters of ecofactors_renamed

Name	Minimum	Maximum
f_x Critical F	0.004	1646.6
f_x Current F	0.0	761.0
f_x Ecofactor	0.0	2.0E7
f . Normalizat	2 614	2 614

Regionalised LCIA: Results



Exercise: Regionalised impacts of corn production

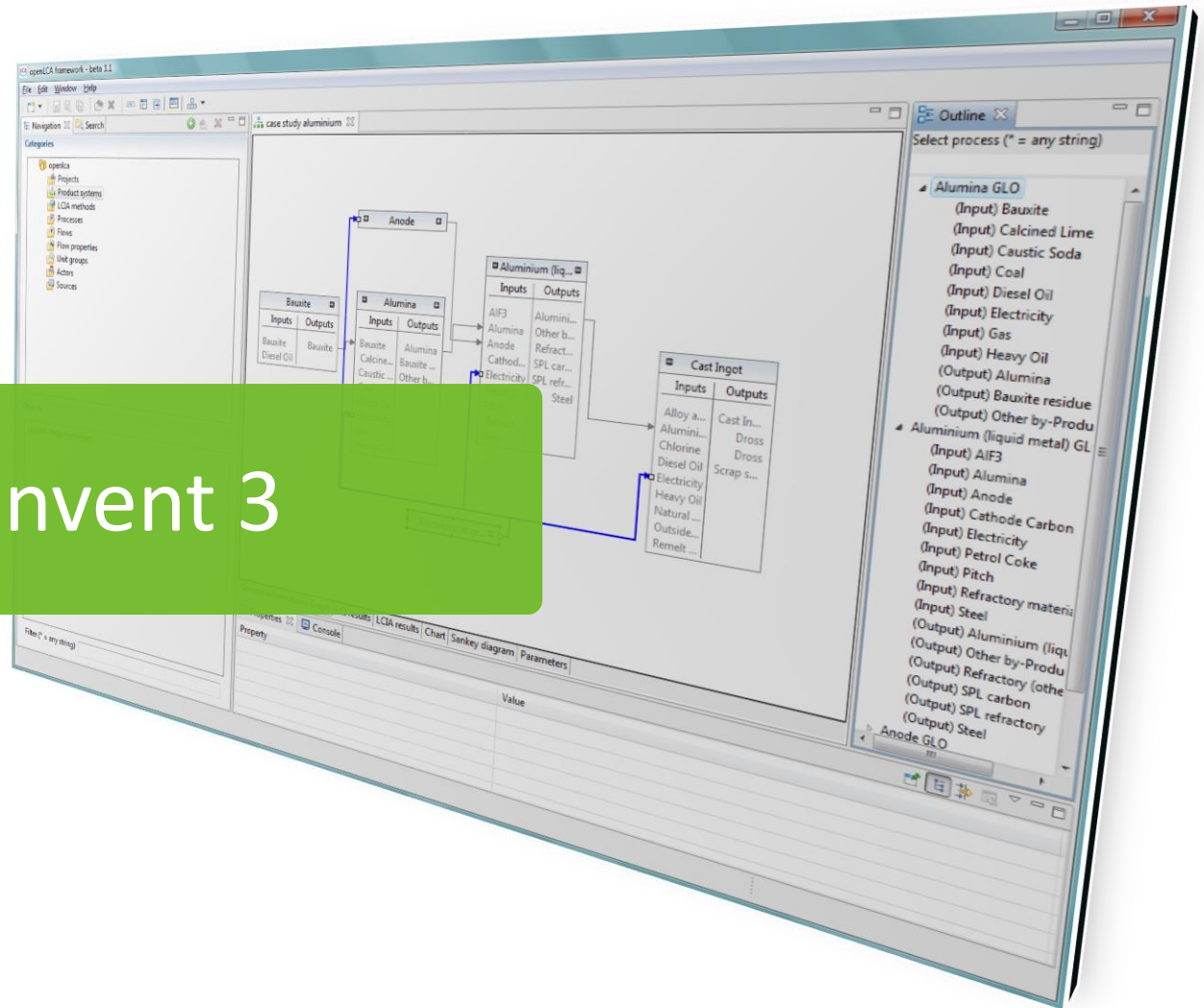
Import the database “regionalised lcia4students”. Bind the parameters in the LCIA method to the shapefiles parameters. Then calculate regionalised LCIA results of the process “corn grain; at harvest in 1996; at farm; 85%-91% moisture” for the US states of:

- Nevada (NE)
- Iowa (IA)
- Illinois (IL)

Which state has lower environmental impacts?

- 10 min


ecoinvent 3



Ecoinvent 3 Overview

- Third version of the ecoinvent database, developed by the Swiss ecoinvent Centre, with technical modifications respect to version 2:
 - Data format
 - Market modelling
 - Around 8000 “Activity” data sets (former process data sets)

Ecoinvent 3, Details

- 
- Data format
 - Market modelling
 - New data?
 - Consequences for openLCA

Ecoinvent 3, Data format

- In ecoinvent 2, Ecopsold 1:
 - No parameters,
 - Only two languages,
 - Usually process=product
 - No IDs, processes were identified by location, time, unit and name
 - It only had processes and metadata
 - Each flow had only one unit
- Ecospold 2;
 - Parameters
 - Different data sets (Activity, flow, etc.)
 - Unique Ids
 - “Intelligence” in data format

EcoSpold 2

```
<?xml version="1.0" encoding="utf-8"?>  
<ecoSpold xmlns="http://www.EcoInvent.org/EcoSpold02">  
  <childActivityDataset>  
    <activityDescription>  
      <activity id="0a5c6801-e080-4b4e-b029-b80b73a54fd7" activityNameId="11916431-4240-4fb7-b7a2-90f90e35c400" parentActivityId="d63fcb68-86ed-4554-ab3c-b4ba5c7b0">  
        <activityName xml:lang="en">titanium zinc plate production, without pre-weathering</activityName>  
        <includedActivitiesStart xml:lang="en" />  
        <includedActivitiesEnd xml:lang="en">The dataset describes the production of titanium zinc alloy from primary zinc and the fabrication of titanium zinc pla</includedActivitiesEnd>  
        <generalComment>  
          <text xml:lang="en" index="2">[This is a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requi</text>  
          <text xml:lang="en" index="1">The production steps pre-alloying, melting, casting, rolling, coiling, stretch forming and cutting are approximated using "</text>  
        </generalComment>  
      </tag>  
    </activity>  
    <classification classificationId="aeaec32d-b5a4-44e0-bb50-26c0f4fe3d37">  
      <classificationSystem xml:lang="en">EcoSpold01Categories</classificationSystem>  
      <classificationValue xml:lang="en">metals/extraction</classificationValue>  
    </classification>  
    <classification classificationId="6fe7bc2b-4be4-48f7-92b0-f27dea9053ce">  
      <classificationSystem xml:lang="en">ISIC rev.4 ecoinvent</classificationSystem>  
      <classificationValue xml:lang="en">2420:Manufacture of basic precious and other non-ferrous metals</classificationValue>  
    </classification>  
    <geography geographyId="0e0e1020-7d7e-11de-9ae2-0019e336be3a">  
      <shortname xml:lang="en">DE</shortname>  
      <comment>  
        <text xml:lang="en" index="1">Data from a leading titan zinc plate producer in Germany. Applicable for Europe.</text>  
      </comment>  
    </geography>  
    <technology technologyLevel="3">  
      <comment>  
        <text xml:lang="en" index="1">Induction furnace for all the pre-alloying and melting steps, roll stands with 5 rolling pairs for the rolling step. Coilin</text>  
      </comment>  
    </technology>  
    <timePeriod startDate="1997-01-01" endDate="2013-12-31" isDataValidForEntirePeriod="false" />  
    <macroEconomicScenario macroEconomicScenarioId="d9f57f0a-a01f-42eb-a57b-8f18d6635801">  
      <name xml:lang="en">Business-as-Usual</name>  
    </macroEconomicScenario>  
  </activityDescription>  
  <flowData>  
    <intermediateExchange id="8fcd8ca4-28b0-46dd-bf9e-54c44bc0c82e" unitId="487df68b-4994-4027-8fdc-a4dc298257b7" casNumber="007440-66-6" amount="1.06" intermedi</intermediateExchange>  
    <name xml:lang="en">zinc</name>  
    <unitName xml:lang="en">kg</unitName>  
    <comment xml:lang="en">(1,4,1,3,1,5,3)</comment>  
    <comment>EcoSpold01Location=RER</comment>  
    <uncertainty>  
      <lognormal meanValue="1.06" mu="0.06" variance="0.01" varianceWithPedigreeUncertainty="0.0121" />  
    </uncertainty>  
  </flowData>  
</childActivityDataset>  
</ecoSpold>
```


EcoSpold 2

- Flow properties (before only in ILCD format): water content, etc., different units possible

```
<elementaryExchange id="d567a064-d1e0-4905-96e5-23f4684d10f4" unitId="487df68b-4994-4027-8fdc-a4dc298257b7" casNumber="022537-50-4" amount="1.5714E-07" eleme
<name xml:lang="en">Tin, ion</name>
<unitName xml:lang="en">kg</unitName>
<comment xml:lang="en">This flow is issued during the process "contouring, brass". Contouring, brass is used as a proxy for rolling and colling of titanium
<uncertainty>
  <lognormal meanValue="1.5714E-07" mu="-15.67" variance="0.81" varianceWithPedigreeUncertainty="1.02" />
  <pedigreeMatrix reliability="5" completeness="5" temporalCorrelation="5" geographicalCorrelation="5" furtherTechnologyCorrelation="5" />
</uncertainty>
<property propertyId="c74c3729-e577-4081-b572-a283d2561a75" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">carbon content, fossil</name>
  <unitName xml:lang="en">dimensionless</unitName>
</property>
<property propertyId="6d9e1462-80e3-4f10-b3f4-71febd6f1168" amount="0" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">water in wet mass</name>
  <unitName xml:lang="en">kg</unitName>
</property>
<property propertyId="67f102e2-9cb6-4d20-aa16-bf74d8a03326" amount="1" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">wet mass</name>
  <unitName xml:lang="en">kg</unitName>
</property>
<property propertyId="6399c14b-db78-445d-a47b-c0cb966a1b25" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">carbon content, non-fossil</name>
  <unitName xml:lang="en">dimensionless</unitName>
</property>
<property propertyId="a9358458-9724-4f03-b622-106eda248916" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">water content</name>
  <unitName xml:lang="en">dimensionless</unitName>
</property>
<property propertyId="3a0afd1d6-04c3-41c6-a3da-92c4f61e0eaa" amount="1" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">dry mass</name>
  <unitName xml:lang="en">kg</unitName>
</property>
<property propertyId="a301a838-7975-4d89-9e74-8eb77ad03cd1" amount="0" isDefiningValue="false" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">carbon content</name>
  <unitName xml:lang="en">dimensionless</unitName>
  <comment xml:lang="en">carbon content on a dry matter basis (reserved; not for manual entry)</comment>
</property>
<property propertyId="f2283db2-62e4-467f-b9ac-c4f45be563b4" amount="0" isDefiningValue="false" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">carbon allocation</name>
  <unitName xml:lang="en">kg</unitName>
  <comment xml:lang="en">carbon content per unit of product (reserved; not for manual entry)</comment>
</property>
<compartment subcompartmentId="e47f0a6c-3be8-4027-9eee-ds251784f708">
  <compartment xml:lang="en">water</compartment>
  <subcompartment xml:lang="en">unspecified</subcompartment>
```

EcoSpold 2

- Flow properties: details for each process data set
 - e.g.: Flow: “Tin, ion”; Summary: water content (o), C content (o), etc. (!)

```
<elementaryExchange id="d567a064-d1e0-4906-96e5-23f4684d10f4" unitId="487df68b-4994-4027-8fdc-a4dc298257b7" casNumber="022537-50-4" amount="1.5714E-07" eleme
<name xml:lang="en">contouring, brass</name>
<unitName xml:lang="en">kg</unitName>
<comment xml:lang="en">This flow is issued during the process "Contouring, brass". Contouring, brass is used as a proxy for rolling and colling of titanium
</comment>
<uncertainty>
  <lognormal meanValue="1.5714E-07" mu="-15.67" variance="0.81" varianceWithPedigreeUncertainty="1.02" />
  <pedigreeMatrix reliability="5" completeness="5" temporalCorrelation="5" geographicalCorrelation="5" furtherTechnologyCorrelation="5" />
</uncertainty>
<property propertyId="c74c3729-e577-4081-b572-a283d2561a75" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">carbon content, fossil</name>
  <unitName xml:lang="en">dimensionless</unitName>
</property>
<property propertyId="6d9e1462-80e3-4f10-b3f4-71febd6f1168" amount="0" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">water in wet mass</name>
  <unitName xml:lang="en">kg</unitName>
</property>
<property propertyId="67f102e2-9cb6-4d20-aa16-bf74d8a03326" amount="1" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">wet mass</name>
  <unitName xml:lang="en">kg</unitName>
</property>
<property propertyId="6399c14b-db78-445d-a47b-c0cb966a1b25" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">carbon content, non-fossil</name>
  <unitName xml:lang="en">dimensionless</unitName>
</property>
<property propertyId="a9358458-9724-4f03-b622-106eda248916" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">water content</name>
  <unitName xml:lang="en">dimensionless</unitName>
</property>
<property propertyId="3a0afd1d-04c3-41c6-a3da-92c4f61e0eaa" amount="1" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">dry mass</name>
  <unitName xml:lang="en">kg</unitName>
</property>
<property propertyId="a301a838-7975-4d89-9e74-8eb77ad03cd1" amount="0" isDefiningValue="false" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">
  <name xml:lang="en">carbon content</name>
  <unitName xml:lang="en">dimensionless</unitName>
  <comment xml:lang="en">carbon content on a dry matter basis (reserved; not for manual entry)</comment>
</property>
<property propertyId="f2283db2-62e4-467f-b9ac-c4f45be563b4" amount="0" isDefiningValue="false" unitId="487df68b-4994-4027-8fdc-a4dc298257b7">
  <name xml:lang="en">carbon allocation</name>
  <unitName xml:lang="en">kg</unitName>
  <comment xml:lang="en">carbon content per unit of product (reserved; not for manual entry)</comment>
</property>
<compartment subcompartmentId="e47f0a6c-3be8-4027-9eee-ds251784f708">
  <compartment xml:lang="en">water</compartment>
  <subcompartment xml:lang="en">unspecified</subcompartment>
```

EcoSpold 2

- Flow properties: details for each process data set
 - Auto generated flow properties

```
*****<outputGroup>2</outputGroup><CR LF>
*****</intermediateExchange><CR LF>
*****<intermediateExchange id="eb369ed2-ccf9-449f-b7ff-3aleda104871" unitId="487df68b-4994-4027-8fdc-a4dc298257b7" amount="0" intermediateExc
*****<name xml:lang="en">palladium</name><CR LF>
*****<unitName xml:lang="en">kg</unitName><CR LF>
*****<property propertyId="40ca2c51-2da6-4351-bd4c-d6f181fc7d55" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_2</name><CR LF>
*****</property><CR LF>
*****<property propertyId="13706ab5-1a8c-42fd-8329-c93266943c87" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_16</name><CR LF>
*****</property><CR LF>
*****<property propertyId="db2e27d1-47cd-4180-8416-4f79369de00c" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_6</name><CR LF>
*****</property><CR LF>
*****<property propertyId="3db02346-808f-4eb6-9232-317a23c63484" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_7</name><CR LF>
*****</property><CR LF>
*****<property propertyId="9909d836-d0a3-45ed-a8d6-62f5febcb763e" amount="100"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_21</name><CR LF>
*****</property><CR LF>
*****<property propertyId="9c38ea07-adcd-4018-8636-eb32382f39a7" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_5</name><CR LF>
*****</property><CR LF>
*****<property propertyId="e2bdc7a2-bfb2-4db4-9fa2-12e46f767097" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_19</name><CR LF>
*****</property><CR LF>
*****<property propertyId="9676ed7d-a99c-40ed-9ff5-55081521ad8b" amount="37.91"><CR LF>
*****<name xml:lang="en">EcoSpold01Allocation_undefined_8</name><CR LF>
*****</property><CR LF>
*****<property propertyId="a9358458-9724-4f03-b622-106eda248916" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45"><CR LF>
*****<name xml:lang="en">water content</name><CR LF>
*****<unitName xml:lang="en">dimensionless</unitName><CR LF>
```

EcoSpold 2

- “Intelligence” in data format:
 - Child and parent data sets:
 - “parent data set: a dataset referred to by a child dataset as the dataset from which field values in the child dataset are to be inherited to the extent defined, i.e. parent datasets serve as basis of their associated child datasets. “ (ecoinvent.org)
 - “Only geographical inheritance is allowed in the ecoinvent v3 database, i.e. some regional datasets (such as Brazilian soybean production) might be modelled as a child dataset of the global dataset. “ (ecoinvent.org)

EcoSpold 2

- “Intelligence” in data format: child and parent data sets
 - Child and parent data sets:
 - “In child datasets values can be set to relate to the corresponding value in the parent dataset. When such a related value is changed in the parent dataset it is automatically changed in the child dataset as well.”
 - “it is automatically changed” → better: it is meant to be automatically changed.
 - Idea: save space; avoid redundancies.
 - In current ecoinvent database: values for all the child data sets present; redundancies exist
→ (possible) task for software developers: keep redundant information consistent

Ecoinvent 3, market modelling

- Basically, products are not exchanged directly between processes, but through a market
 - Advantage: more flexible modelling of process chains
 - However, the current version is linked → flexibility lost
 - But...different default “system models”:
“system model; a model describing how activity data sets are linked to form product systems. A system model may determine factors such as whether to use allocation (and which type of allocation) or substitution [...], or whether to use average or marginal suppliers. It may also affect how by-product treatments are assessed.”
 - Originally two system models: “Allocation, ecoinvent default” and “Consequential, substitution, long-term”.
 - From version 3.0.1 also “cut-off” model.

Ecoinvent 3, market modelling

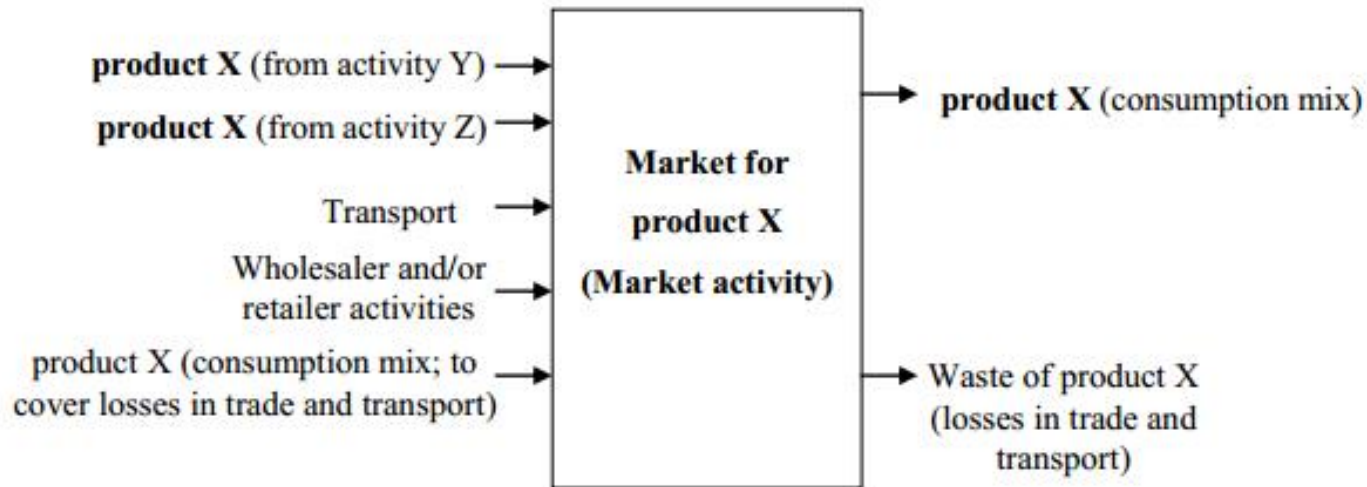
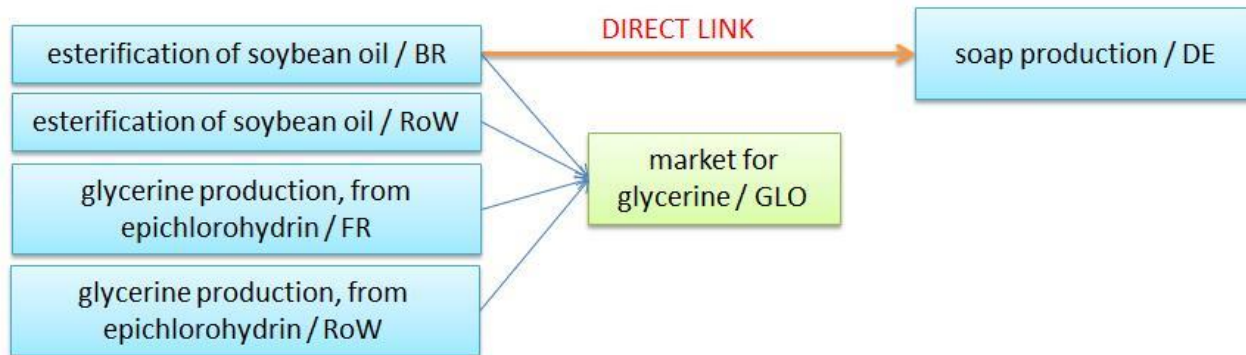


Figure 4.2. A market activity with its intermediate exchanges. Texts in brackets are not part of the name of the exchange.

(ecoinvent methodology report
p.17)

Ecoinvent 3, market modelling

- Example for the difference between each system model:
 - Direct link: Consequential model
 - Market: Attributional / default model



(ecoinvent.org)

Ecoinvent 3, example: market for banana

Welcome Search result view market for banana - GLO

Process: market for banana

Inputs

Flow	Category	Flow property	Unit	A
transport, freight, inland waterw...	502:Inland water transp...	Goods transpo...	t*km	0
transport, freight train - RoW	491:Transport via railwa...	Goods transpo...	t*km	0
transport, freight train - CH	491:Transport via railwa...	Goods transpo...	t*km	1
transport, freight train - CN	491:Transport via railwa...	Goods transpo...	t*km	0
transport, freight, lorry, unspecif...	492:Other land transport...	Goods transpo...	t*km	0
transport, freight, sea, transocea...	501:Sea and coastal wat...	Goods transpo...	t*km	0
transport, freight train - Europe ...	491:Transport via railwa...	Goods transpo...	t*km	0
transport, freight train - US	491:Transport via railwa...	Goods transpo...	t*km	0
banana - GLO	012:Growing of perenni...	Mass	kg	1

3.1 allocation default

Outputs

Flow	Category	Flow property	Unit	A
banana - GLO	012:Growing of perenni...	Mass	kg	1

Ecoinvent 3, example: banana production

Welcome Search result view market for banana - GLO banana production - GLO

Process: banana production

Inputs

Flow	Category	Flow property	Unit	A
⚙️ ammonium nitrate, as N - GLO	201:Manufacture of basi...	Mass	kg	0
⚙️ electricity, low voltage - ASCC	351:Electric power gene...	Energy	kWh	5
⚙️ electricity, low voltage - AT	351:Electric power gene...	Energy	kWh	4
⚙️ electricity, low voltage - AU	351:Electric power gene...	Energy	kWh	1
⚙️ electricity, low voltage - BA	351:Electric power gene...	Energy	kWh	6
⚙️ electricity, low voltage - BE	351:Electric power gene...	Energy	kWh	6
⚙️ electricity, low voltage - BG	351:Electric power gene...	Energy	kWh	2
⚙️ electricity, low voltage - BR	351:Electric power gene...	Energy	kWh	3
⚙️ electricity, low voltage - CA-AB	351:Electric power gene...	Energy	kWh	2
⚙️ electricity, low voltage - CA-BC	351:Electric power gene...	Energy	kWh	5
⚙️ electricity, low voltage - CA-MB	351:Electric power gene...	Energy	kWh	3
⚙️ electricity, low voltage - CA-NB	351:Electric power gene...	Energy	kWh	1
⚙️ electricity, low voltage - CA-NF	351:Electric power gene...	Energy	kWh	2

3.1 allocation default

Outputs

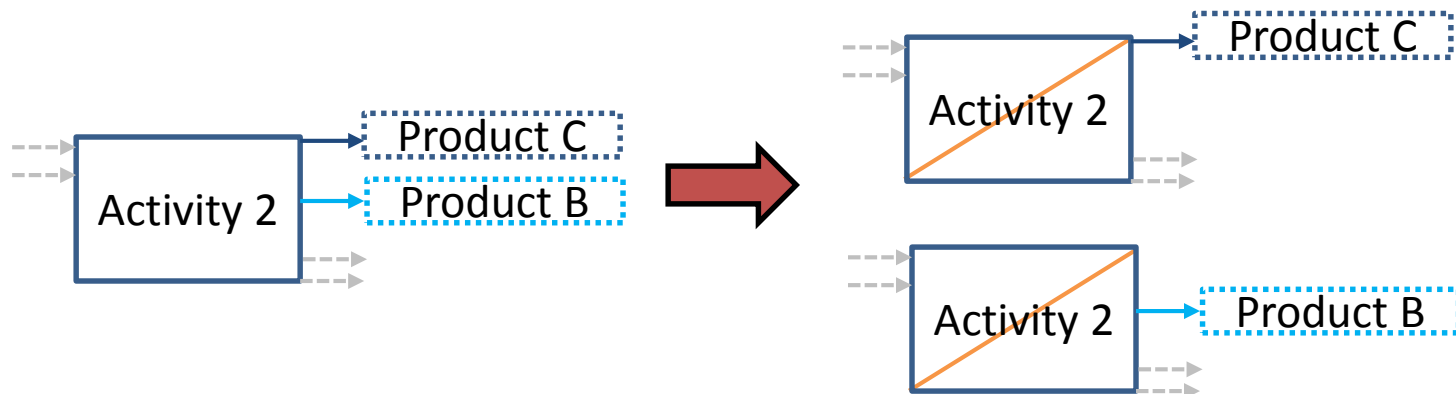
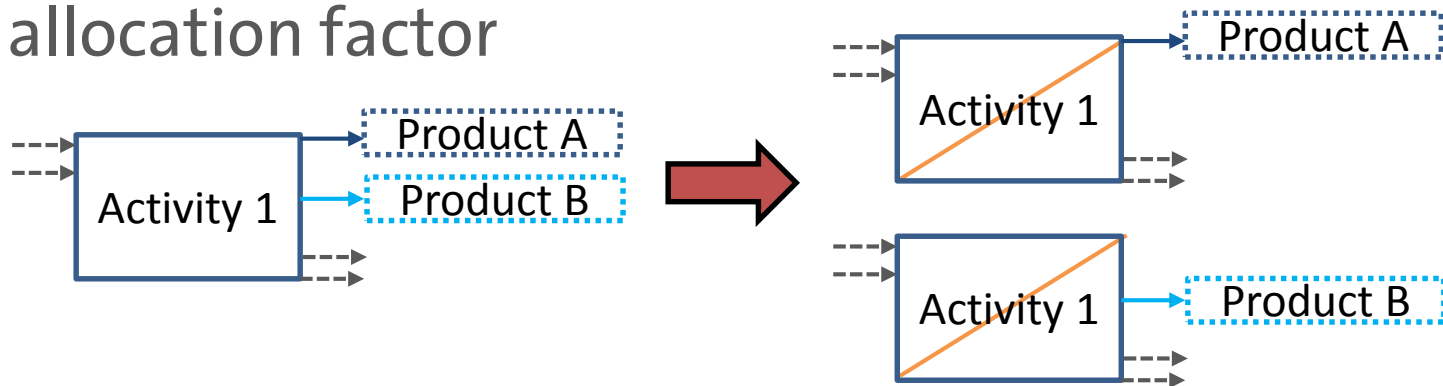
Flow	Category	Flow property	Unit	A
⚙️ banana - GLO	012:Growing of perenni...	Mass	kg	1
🌿 Ammonia	air/low population dens...	Mass	kg	1
🌿 Nitrogen oxides	air/low population dens...	Mass	kg	2
🌿 Dinitrogen monoxide	air/low population dens...	Mass	kg	1
🌿 Zinc	soil/agricultural	Mass	kg	-

Ecoinvent 3, **system models**

- Common rules:
 - By-products/wastes identified as materials for treatment are moved to the input with negative sign.
 - Intermediate inputs without activity link specified, are linked to the local market activity data set.
 - Data sets with “combined” products are divided into an equivalent number of data sets.
 - For “joint” products:
 - Allocation (partitioning)
 - System expansion (substitution)

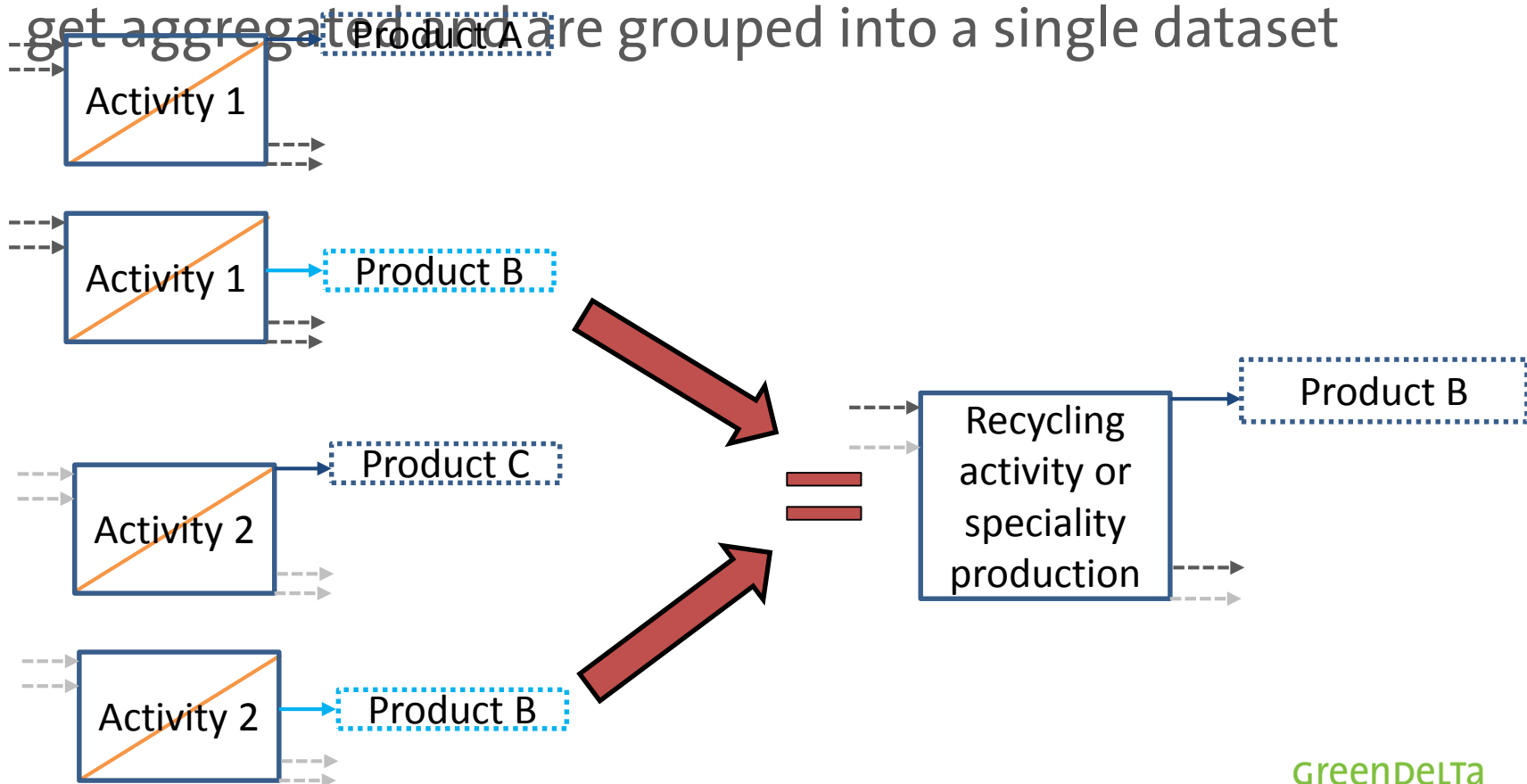
Ecoinvent 3, allocation model

- Divide the data sets into new activities according the allocation factor



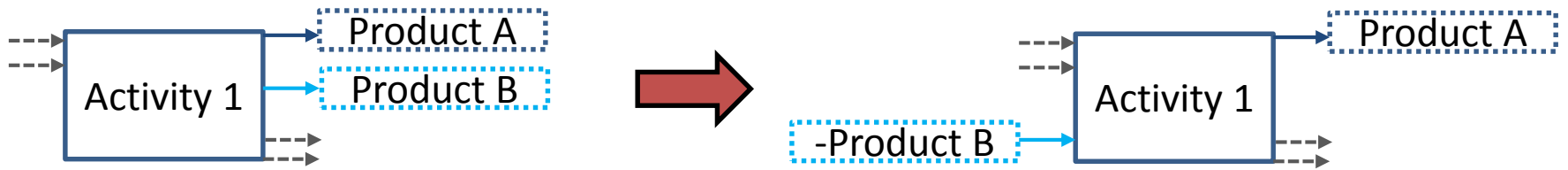
Ecoinvent 3, allocation model

- After allocation, all activities producing the same marketable by-product yielded from a treatment activity get aggregated and are grouped into a single dataset

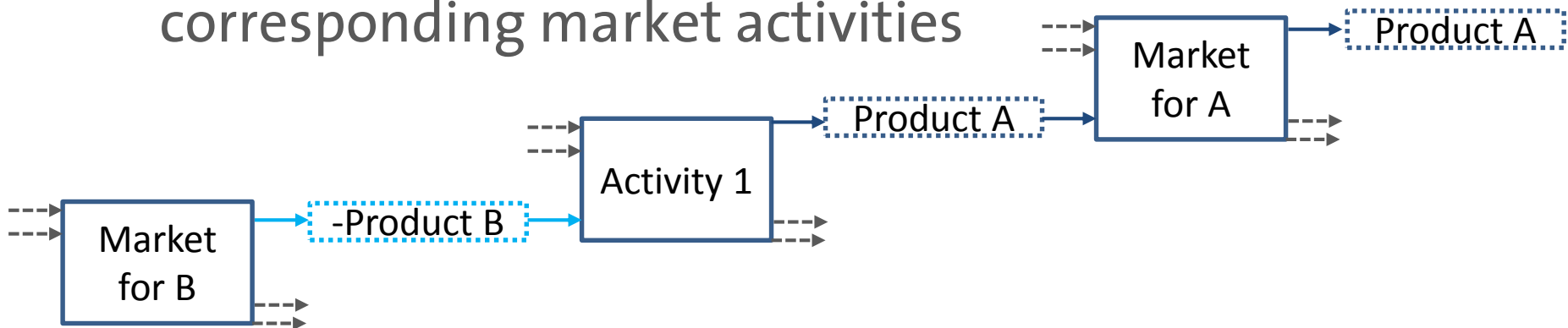


Ecoinvent 3, substitution model

- All by-products are moved to the input side with negative sign



- All inputs and outputs are linked to their corresponding market activities



Ecoinvent 3, cut-off model

- Based on the Recycled Content, or Cut-off, approach.
- Primary (first) production of materials is always allocated to the primary user of a material.
- If a material is recycled, the primary producer does not receive any credit for the provision of any recyclable materials. As a consequence, recyclable materials are available burden-free to recycling processes, and secondary (recycled) materials bear only the impacts of the recycling processes.
- Furthermore, producers of wastes do not receive any credit for recycling or re-use of products resulting out of any waste treatment.

e.g.: recycled paper? Waste incineration?

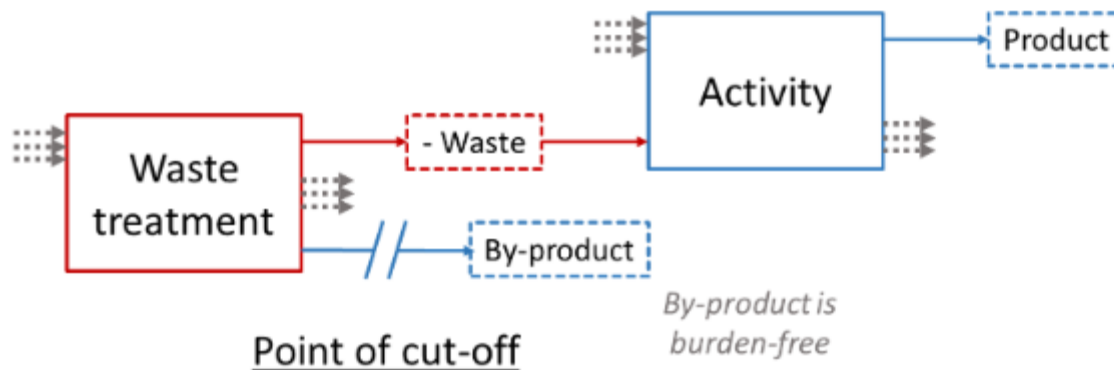
Ecoinvent 3, cut-off model (II)

- All technosphere flows are classified as:
 - ordinary by-product (treated just as common products, but they are not reference)
 - recyclable material (“Materials with no or little economic value that can serve as the input or resource for a recycling activity”), or
 - waste (“Materials with no economic value, and no interest in their collection without compensation“)

http://www.ecoinvent.org/fileadmin/documents/en/System_Models/System_model_description_and_specification-Cutoff.pdf

Ecoinvent 3, cut-off model (IV)

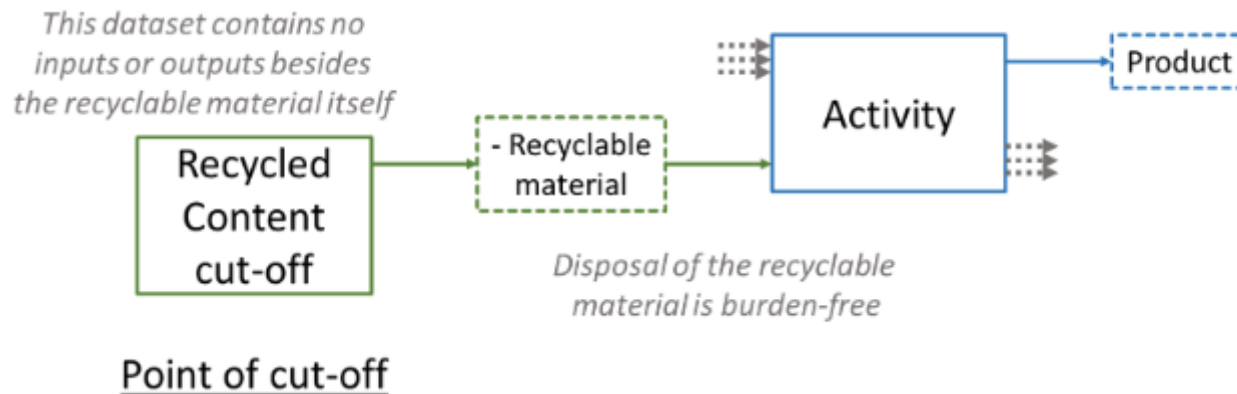
- Waste products handling: by-product is burden-free



http://www.ecoinvent.org/fileadmin/documents/en/System_Models/System_model_description_and_specification-Cutoff.pdf

Ecoinvent 3, cut-off model (V)

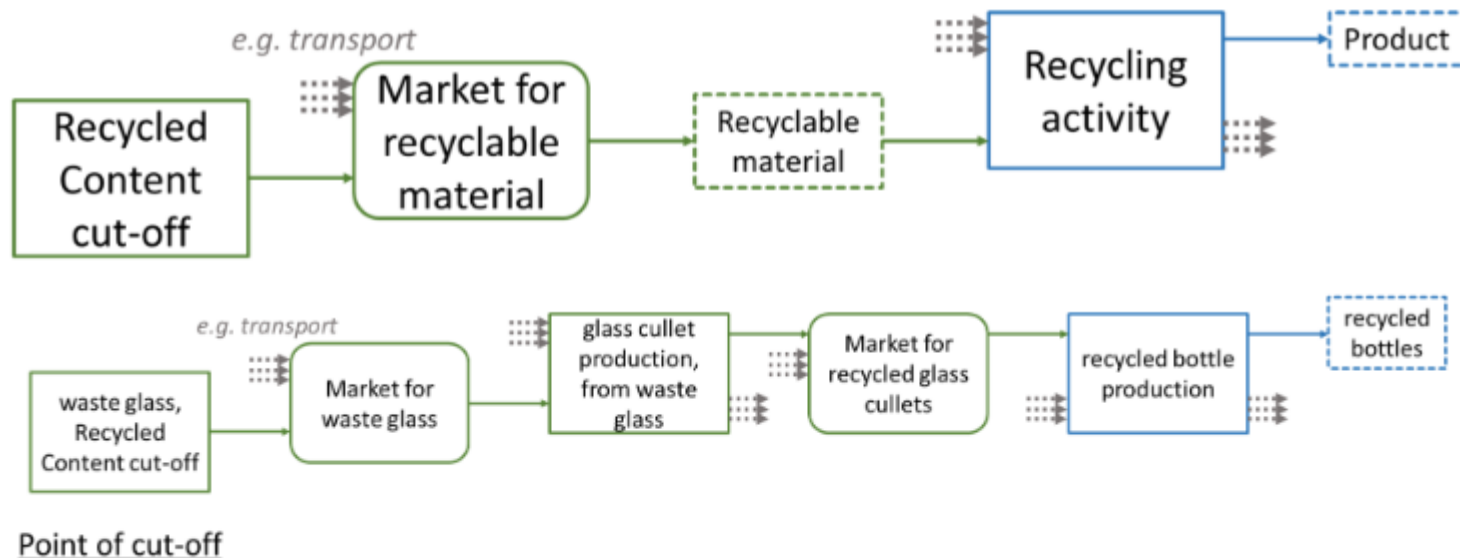
- Handling of recyclable materials: negative input (=output) of a dummy process recycled content cut-



http://www.ecoinvent.org/fileadmin/documents/en/System_Models/System_model_description_and_specification-Cutoff.pdf


Ecoinvent 3, cut-off model (VI)

- Handling of recyclable materials: when used in markets, markets get additional transport effort as



http://www.ecoinvent.org/fileadmin/documents/en/System_Models/System_model_description_and_specification-Cutoff.pdf

Ecoinvent 3, **new data**

- 
- (very few: some international data; water data)
 - Data updates
 - e.g. electricity mixes, transport

Ecoinvent 3, consequences for openLCA

- Much larger systems
 - Optimization of performance in product systems (open, create new): before 2 min, now 10s
 - Optimization of the calculation (Background: matrix inversion, memory use, speed)
- Modelling corrections (correct some links; uncertainty information)
- (openLCA structure adapts well already)

Feedback

- Did you learn in the training what you expected to learn?
- What do you like/dislike in openLCA?
- Which functions do you miss?

Thank you!

The GreenDelta logo consists of a solid green rectangular box. Inside the box, the word "GreenDelta" is written in a white, bold, sans-serif font. Below it, the words "sustainability consulting + software" are written in a smaller, white, lowercase sans-serif font. To the left of the green box is a vertical line with segments of blue, red, and green.

GreenDelta
sustainability consulting + software

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