openLCA PRACTICAL USER MANUAL

Step-by-step instructions, real-life examples, and exercises for independent work

Attribution and Disclaimer

This manual was prepared within the ECOThink project as a training and reference resource. Its content is based on and professionally adapted from the official documentation and training materials for the openLCA software. OpenLCA is an independent software tool; the openLCA developers are not responsible for the content of this manual.

The ECOThink project partners do not claim any ownership of the document. The ownership stays with the originator. The document has been created as no document existed so far that could be easily used by trainees. The manual was so far only available as a web version.

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Contents

1 INTRODUCTION

ECOThink is an Erasmus+ project designed to strengthen practical skills in sustainable design and life cycle thinking. It supports vocational education and training (VET) learners, trainers, and practitioners—especially in small and medium-sized enterprises (SMEs)—in better understanding, measuring, and reducing the environmental footprint of products and processes.

Within ECOThink, openLCA is used as the core hands-on software tool. This manual serves as a companion guide to the ECOThink training, explaining how to work with openLCA step by step using real-world examples and targeted exercises. This approach enables participants to apply what they learn immediately in their own context.

What this manual provides:

- Clear, practical instructions for key tasks in openLCA, from setting up a project to calculating results.
- Worked examples that translate sustainability concepts into concrete modelling steps.
- Exercises for independent practice, with suggested solutions and guidance on common pitfalls.
- Troubleshooting tips and recommended workflows to help you work efficiently and avoid typical errors.

How to use this manual:

- If you are new to openLCA, follow the chapters in order. Each section builds on the previous one.
- If you already have experience, use it as a reference: each topic is written to be usable on its own.
- Use the exercises to test your understanding and to build confidence before applying openLCA to your own case studies.

To get the most out of the manual, you should have openLCA installed and access to at least one life cycle inventory dataset (a database of background data) and an impact assessment method (a set of indicators used to interpret the results). No advanced programming knowledge is required.

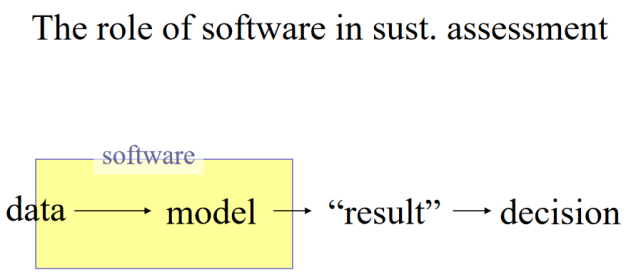
Finally, remember that software is only one part of a good assessment. The quality of results depends on clear questions, transparent assumptions, and careful interpretation. ECOThink encourages you to use openLCA not only to calculate numbers, but also to support better decisions and continuous improvement.

1.1 WHY WAS OPENLCA STARTED?

We started developing openLCA in 2007; a super-long German startup incubation project preparation in the end led to nothing (we needed to specify the number of trainings we will have five years after the project start, per quarter, etc., and were then offered half a million € but only as a loan, to the same conditions as if obtained from a bank, which we declined). However, we also submitted an abstract to the Ecobalance conference in Japan, where we presented the idea and mentioned that we are seeking funding to initiate the project. To our surprise, after the presentation, the CEOs of PRé

and of ecoinvent came and asked how much we need. We did not ask for much, but this funding enabled us to start, initially with a format converter, but then also with an LCA software.

Why we started openLCA is contained in this early presentation, and is still valid today:



Slide 4 of the presentation.

Every sustainability ("sust.") life cycle assessment decision is based on results obtained from a model, which in turn uses data. Software is responsible for taking data, feeding it to a model, and producing a result from the model.

So, software is fundamental for decision support.

Software has an influence on:

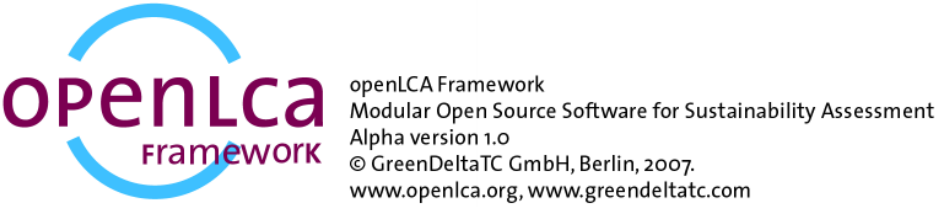
- What models can be built?
- How models can be built;
- Which methods can be applied (for calculation; impact assessment; data quality assessment; uncertainty assessment; interpretation; …);
- Which results are easily and not so easily accessible, and on
- How results are presented

Having written other Life Cycle Assessment (LCA) software before, we thought that writing a new LCA software was something we could do. It should not be a cheap and simplified software, however, but a high-performance, flexible software that can model any LCA, not limited to one sector or product type. And it should be open source, for one, to offer something different, but also to overcome a true bottleneck of LCA: with specialised software being really expensive, apart from promotional licenses for universities, many could not afford to use dedicated LCA software, and many thus could not apply LCA.

The first release of the format converter was in 2007, and the first release of the openLCA LCA software was in 2008. The Open Source license was Mozilla, so relatively soft and non-aggressive. Andreas Ciroth designed the logo and icons, and Michael Srocka led the software development.

The first format converter logo and splash screen looked like this:

The first openLCA LCA software ("openLCA framework") looked like this:



1.2 OPENLCA NOW

Since its inception, openLCA has undergone numerous modifications, extensions, and revisions. In May 2023, following approximately 15 previous releases, we decided to name the new version "2.0" due to its significant improvements, numerous new features, and changes to usability and design.

openLCA today is a best-in-class LCA software, still open source, and the most widely used worldwide. The format conversion feature, initially a separate tool, has been integrated into the openLCA import and export functionality, which now supports a wide variety of import and export formats. For LCA modelling, openLCA offers all the features a sophisticated LCA model will need, whether it is large or small. Economic and social assessments over the life cycle are also possible, making openLCA a suitable software for Life Cycle Sustainability Assessment.

An API with extensive documentation allows connection with and integration into other IT systems. openLCA supports in-application scripts, as SQL or Python, for automating modelling and data routines. Validation procedures in the software verify the accuracy of data and models.

Furthermore, openLCA today encompasses not only the desktop application but also the LCA Collaboration Server, which supports collaboration within teams using openLCA, as well as the server version, enabling deployment in cloud systems. All three work nicely together.

Some things remain the same from the beginning, and the biggest constant is probably the idea of an independent, aware user who does not need to be patronised. openLCA is flexible. Unlike SimaPro, for example, we do not have hardwired top categories; we do not require users to always (pretend to) have complete supply chains; we allow the use of different reference flow nomenclatures; and we also allow importing incomplete and imperfect data. The openLCA desktop version is a powerful tool, and not a "press a button" software for half-informed users.

With scripts, it is possible to change data.

However, in recent versions, especially version 2, extensive validation routines alert users to potential issues in the data, and further, entire databases and models can be converted into read-only libraries. Additionally, to round off openLCA's use cases, the server version with the web tool offers the possibility of a "click a button" software for semi-informed users, with a preconfigured openLCA model.

There are only a few aspects that openLCA requires. openLCA always requires that a flow that connects two processes in a life cycle is identical, meaning that you cannot, as is possible, e.g. in the software fka GaBi, connect apples with oranges. openLCA also requires a quantitative reference for each process.

One thing, however, developed differently than planned; we had thought that a community of software developers would emerge "around" openLCA. While there have been some attempts, our own development has been more focused and faster than other contributions so far. We also did not spend a lot of effort on community hackathons – the focus is on developing and maintaining superior software. Here, our friends from Brightway have followed a slightly different approach. We are very open to good contributions from others; however, if you are interested.

1.3 WHAT YOU CAN DO WITH OPENLCA

In a nutshell, openLCA is a tool for modelling and assessing life cycles, performing Life Cycle Assessments (LCAs). This involves modelling the life cycle in a narrow sense, by visually connecting processes or using tables, assessing them in terms of environmental, economic, or social impacts, and analysing these results to identify hotspots. Additionally, comparisons of products are possible, as well as assessments and comparisons of organisations.

Many different "variants" of life cycle models are possible in openLCA, for example:

- Carbon footprints according to the GHG protocol, or ISO 14067
- LCA studies according to ISO 14040
- LCA studies in line with the Environmental Footprint approach of the European Commission
- Environmental Product Declarations (EPDs) in line with EN15804
- Screening LCIA studies
- Organisational LCA studies
- Life Cycle Costing studies
- Social LCA studies

And so on.

Linked to this core use of openLCA, you can also import and export data, create and modify life cycle impact assessment (LCIA) methods, collaborate within a team, and many more things.

The purpose of this manual is to provide a precise description and guide users through various use cases and applications.

1.4 GREENDELTA GMBH – ABOUT THE DEVELOPER

GreenDelta has been the developer of openLCA since its inception. Apart from developing openLCA, GreenDelta is involved in sustainability research, consultancy services, case studies, database development and the development of various other tools.

Visit www.greendelta.com

GreenDeLTa

1.5 OPENLCA 2 – NEW FEATURES

In our latest release, openLCA 2, we gave openLCA a fresh visual and technical update. Explore a variety of new features, including:

- Improved model graph: The improved model graph allows direct modelling within the graph interface, offering greater flexibility and user-friendliness. Moreover, users can customise the graph's appearance using various preset and editable themes.
- Updated Design & Dark Mode: The application's design has been refreshed and now also includes a dark mode, providing a visually appealing interface that reduces eye strain in low-light environments. Our dark mode seamlessly follows the mode set for your entire system.
- Improved Calculation Speed: We optimised openLCA calculations, resulting in faster processing and improved overall performance. You'll experience shorter waiting times to obtain results.
- Accelerated Calculations with Data Libraries: The system utilises data libraries to enhance calculation speed, enabling even quicker and more efficient analyses.
- Direct Work with Environmental Product Declarations (EPDs): Users can now import and create EPDs directly within the system, streamlining the workflow and eliminating the need for extra tools or manual processes.
- LCIA Methods: The structure of the LCIA methods has been enhanced, notably by separating impact categories into independent entities.
- Enhanced Results Visualisation: We improved the visualisation options, including a Sankey diagram and the possibility to view, edit and compose a product system on a schematic platform. Users can also export a contribution tree with a chosen number of levels for detailed analysis.
- Improved and Faster Regionalised Calculations: Regionalised calculations have been significantly enhanced, resulting in a significantly faster process for calculating environmental impacts for specific regions.
- LCA Collaboration Server 2.0: The collaboration server has been upgraded to version 2.0, offering enhanced features for smooth collaboration, data sharing, and project management among multiple users.
- Parameters: It is now possible to create parameter sets in product systems to perform scenario modelling. Is it also possible to update uncertainty values in the

global parameter table and redefine parameters across the database by modifying the global parameter values, among other available options?

- Enhanced Script Writing: The system's API has new utility functions accessible via an internal Python editor, making it easier to write scripts and customise the application more efficiently.
- Script storage: It is now possible to store scripts as global scripts or exclusively within the database.
- Waste flow impact direction: A new functionality enables users to specify the impact direction as either "Input" or "Output" for each available impact category.
- Additional Information through "Tags": Users can now add extra information to different system components using tags, making it easier to organise and retrieve specific data or analysis.

EXTRA FEATURES TO ENHANCE YOUR EXPERIENCE:

- Experimental theming support for product systems
- Project result page now mirrors that of product systems
- Improved calculation setup and options for projects
- An experimental feature to prefer links within the exact location
- Uncertainty distribution parameters in the global parameter table
- Monte Carlo simulations for the direct calculations
- ecoinvent geographies added directly to the reference data
- Total requirements section of a product
- Export and import of libraries
- Management of default mapping via navigation

FEATURES FOR IMPROVED PERFORMANCE:

- Improved import/export functionalities
- Faster and extended database validations
- Updating links in the product system
- Calculation of upstream trees via olca-ipc.py

TECHNICAL FEATURES:

- CSS theming for the graphical editor
- Availability of more gRPC functions
- Inclusion of a Java 16 runtime environment

2 HOW TO GET openLCA RUNNING

The fastest way to get openLCA is to download the archive (zip, dmg, or tar.gz) or the installer (Windows). The installation process for openLCA differs slightly depending on whether you are using Windows, Mac, or Linux.

In this section, you'll discover system requirements, installation instructions, and initial setup steps for running openLCA on your system.

2.1 HARDWARE REQUIREMENTS

The hardware requirements for openLCA vary depending on the complexity of the LCA model. For optimal performance, a faster processor and more RAM are recommended. Here are the minimum system requirements:

WINDOWS

- CPU with 2 GHz or higher
- 6-20 GB RAM, depending on the background database and model size (6 GB for ecoinvent 2, 20 GB for PSILCA)
- 500 MB free hard disk space + space for databases (e.g. ecoinvent 3 requires ~250MB)

LINUX

- CPU with 2 GHz or higher
- 5-15 GB RAM, depending on the background database and model size (6 GB for ecoinvent 2, 20 GB for PSILCA)500 MB free hard disk space + space for databases (e.g. ecoinvent 3 requires ~250MB)

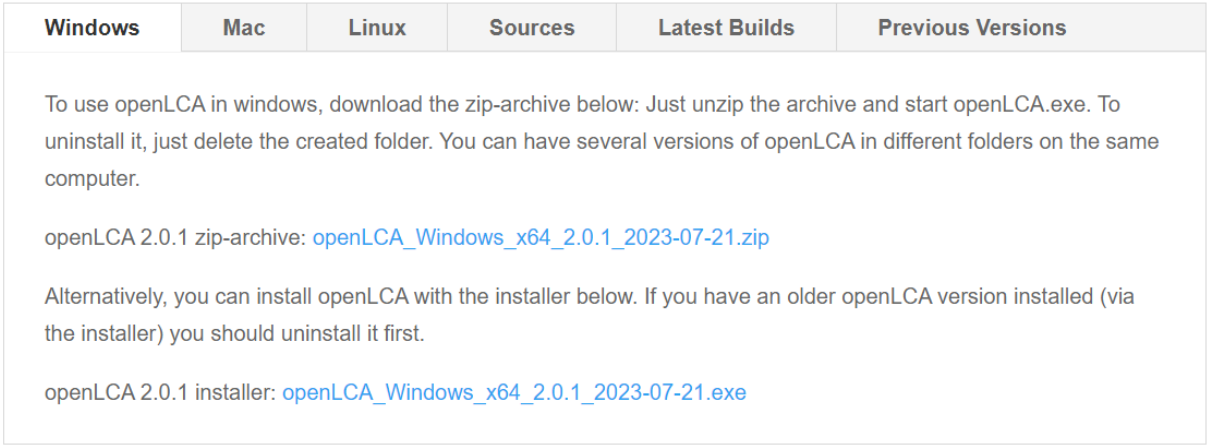
macOS

- CPU with 2 GHz or higher
- 5-15 GB RAM, depending on the background database and model size (5 GB for ecoinvent 2, 15 GB for PSILCA)500 MB free hard disk space + space for databases (e.g. ecoinvent 3 requires ~250MB)

2.2 DOWNLOAD AND INSTALLATION

openLCA natively runs on Linux, macOS, and Windows. For all operating systems, you can download the respective archive (zip, dmg, or tar.gz). For Windows, there is also an installer. Using the zip archive in Windows is typically more convenient than the classic installation in Windows. It is quick and easy, and the least "intrusive" method, helping you maintain a clean system.

To get openLCA running, the first step is to download openLCA from the download page (via openLCA.org). The installation process then differs slightly depending on your operating system: Windows, Mac, or Linux. Below are instructions for setting up openLCA on your specific platform.



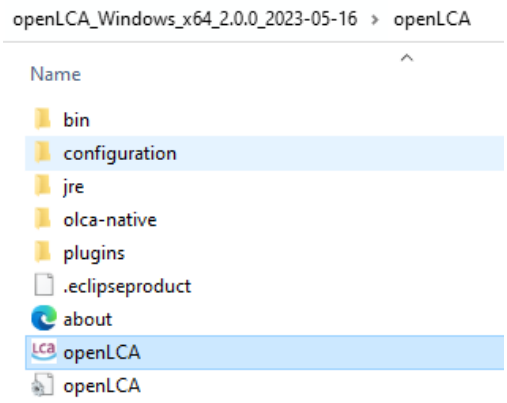
openLCA'download#installation'options³Zip]extraction'and'direct'execution'or'full' installation

Regardless of the installation approach you choose, there will be no difference in the program's performance.

LAUNCHING OPENLCA FROM AN ARCHIVE (ZIP, TAR.GZ, DMG)

Windows

Once you have downloaded the zip archive, simply extract the content, launch the openLCA.exe, and the program will start running.



A'decompressed'ZIP'file

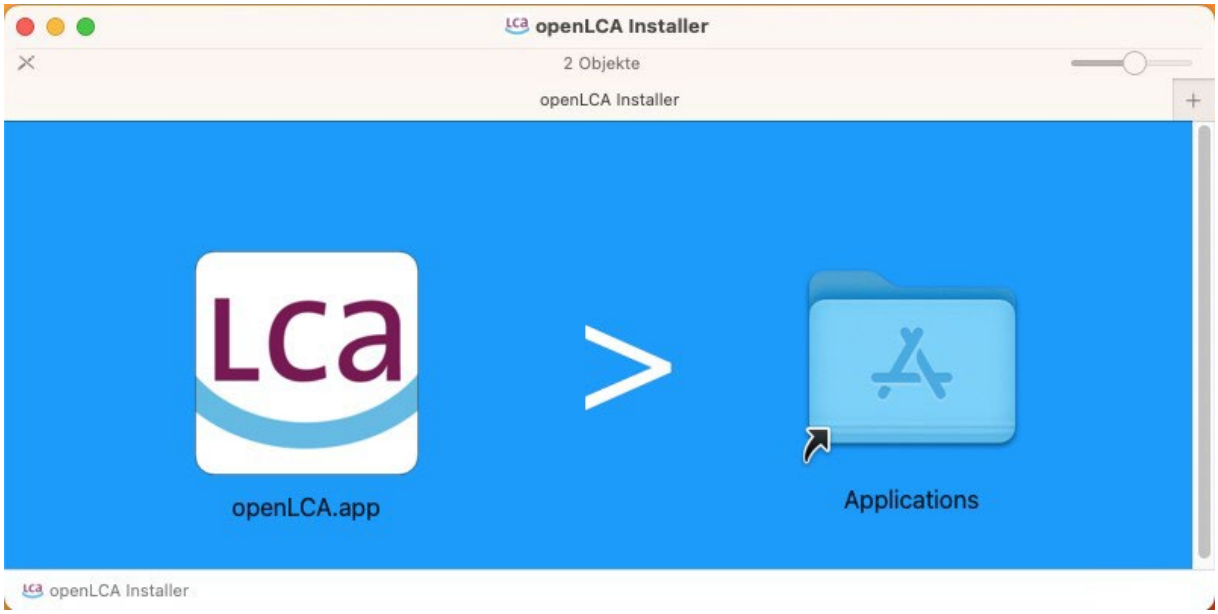
If you have enabled SmartScreen on a newer Windows system, a warning will pop up stating that Microsoft does not recognise the organisation issuing the software. You can safely click "Install Anyway" and proceed.

If you are not an administrator on your computer, extract the zip file to a folder where you have write access, such as your user directory.

With the zip installation, you can have multiple openLCA installations and versions that coexist without conflicts on your computer. This also allows you to run multiple versions of openLCA simultaneously. However, be mindful of the storage space requirements. Uninstalling, by the way, simply means deleting the respective folder and its subfolders that you created from the zip archive.

MAC OS

To install openLCA on your macOS system, double-click the downloaded DMG image. This action will open a window where you can conveniently drag and drop the openLCA2 application (the .app file located on the left side) into the Applications folder of your macOS system (located on the right side). Once the app is successfully installed, you can launch it either by using the Launchpad or by navigating to the "Applications" folder using the Finder.



Installation for Mac OS

Linux

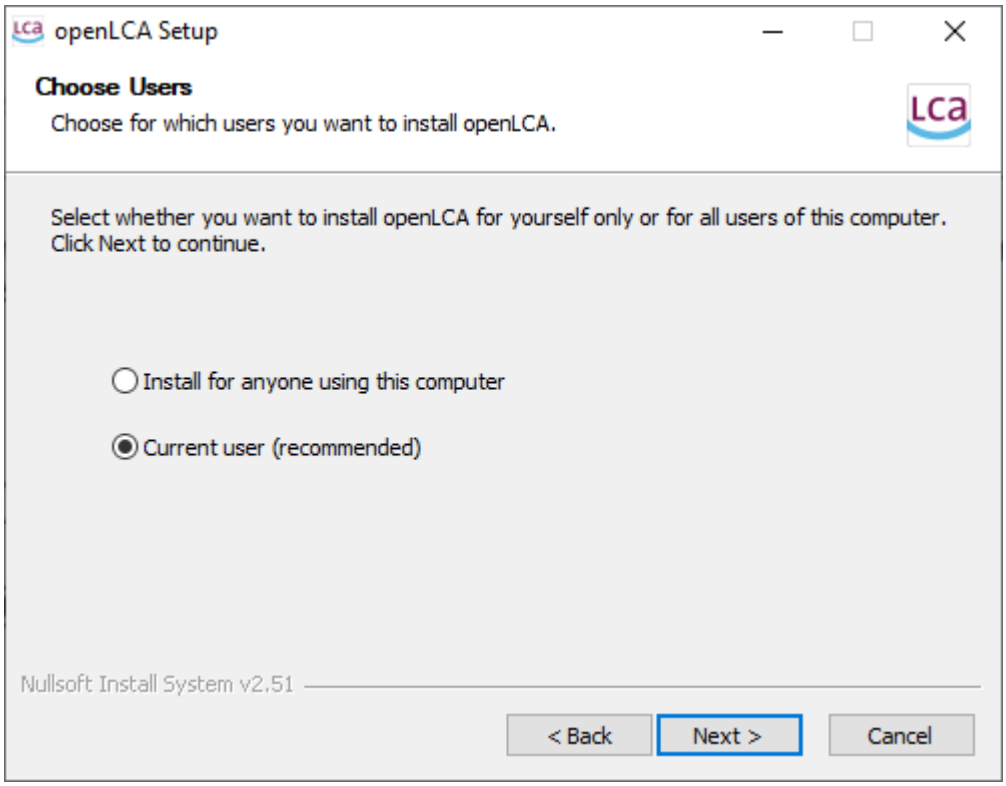
Extract the tar.gz into your home folder and double-click on the executable to run openLCA.

RUNNING openLCA WITH INSTALLATION (ONLY WINDOWS)

WINDOWS: Download the installer file from the download page of the openLCA website and run it. You can choose whether openLCA will be available only to the user who installs it or to anyone working on the computer. For the installation, you will need admin rights. The folder where openLCA stores its databases will be created for the user who is running the installation.

It is therefore not a good idea to ask an admin to install openLCA via the installer when you are not the admin yourself, since you will not have access to the database folder afterwards, and also not to the folder where openLCA stores the configuration file, which means you will not be able to change the settings after the installation.

Note: You must first uninstall previous versions of openLCA.



Setup screen for installation in Windows

Follow the installation steps to completion, and you can then begin working with openLCA.

Note: If you encounter any issue with Windows Defender preventing you from installing openLCA, please have a look here (https://support.bemopro.com/hc/en-us/articles/11450999280531-Microsoft-Defender-SmartScreen-blocking-program-installation).

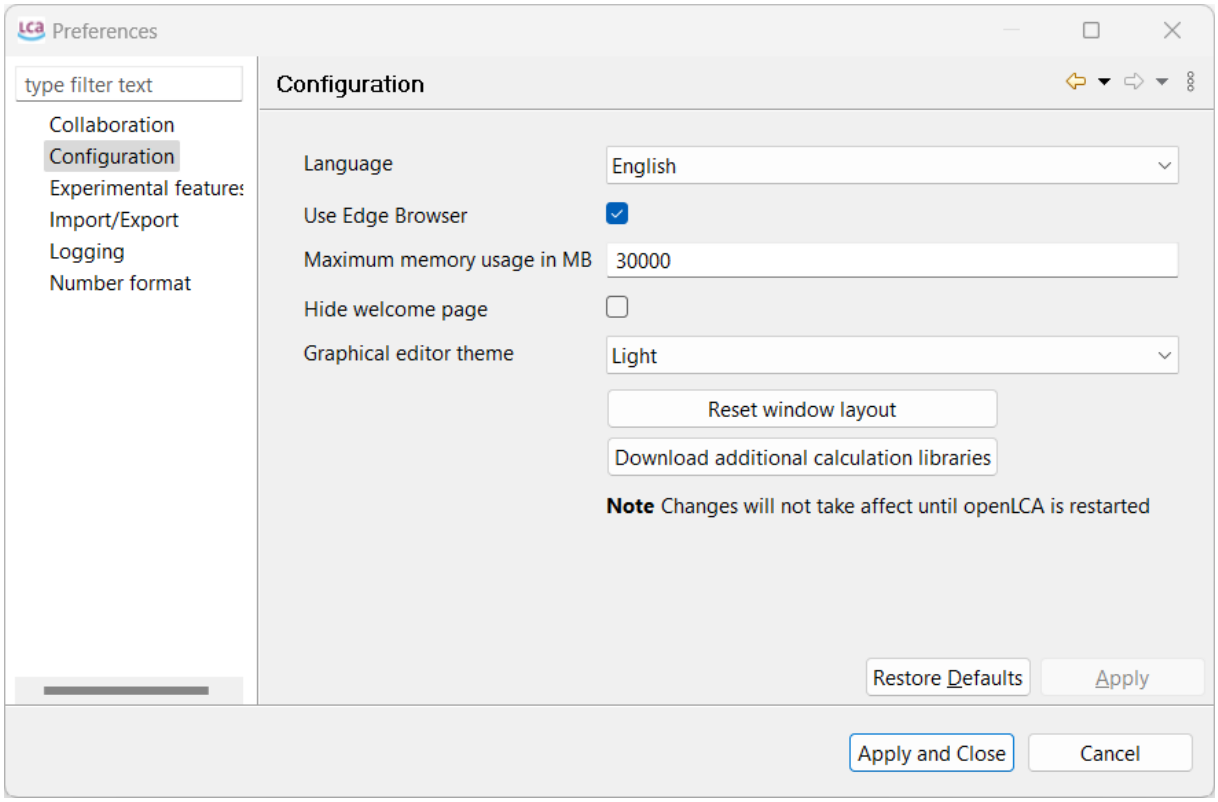
2.3 ADJUST MEMORY

After installation, openLCA can utilise a relatively moderate amount of memory (RAM) on your computer, allowing for use on many computers, including those with weaker specifications. It is typically useful, however, to expand the memory, especially if you plan to use modern, larger background databases such as ecoinvent 3. The approach for expanding the memory is slightly different in Windows and Apple systems. Please check the minimum requirements for allocated memory here (#link); as a general rule, 16GB of RAM is sufficient.

Note: You cannot allocate more memory than what is installed on your computer. You need to leave some memory for the operating system and other software as well. To view the available memory, check, for example, the task manager in Windows.

EXPANDING MEMORY UNDER WINDOWS

To increase memory allocation on Windows, open "File", then "Preferences", and select the "Configuration" tab. Here you can select the maximum memory usage. It is recommended to increase this value for calculating very complex product systems. In the picture below, we illustrate how to allocate 30 GB to openLCA on a system with 64 GB of available memory.



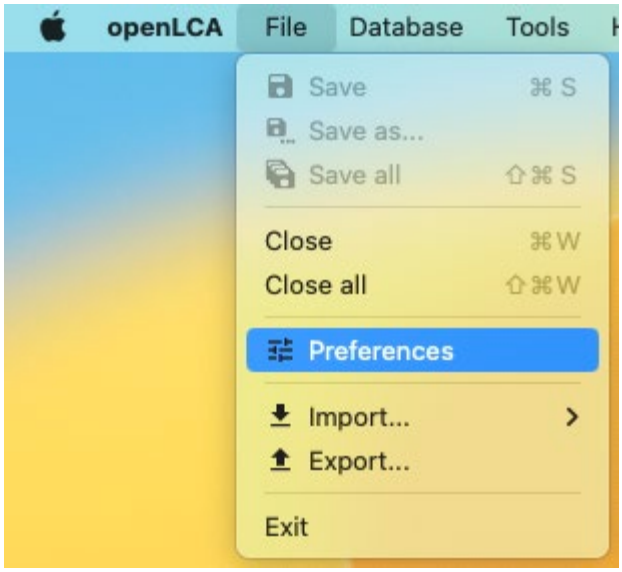
Preferences' Configuration

Note: Any changes made to the configuration settings will require to restart openLCA in order to apply.

EXPANDING MEMORY UNDER MACOS

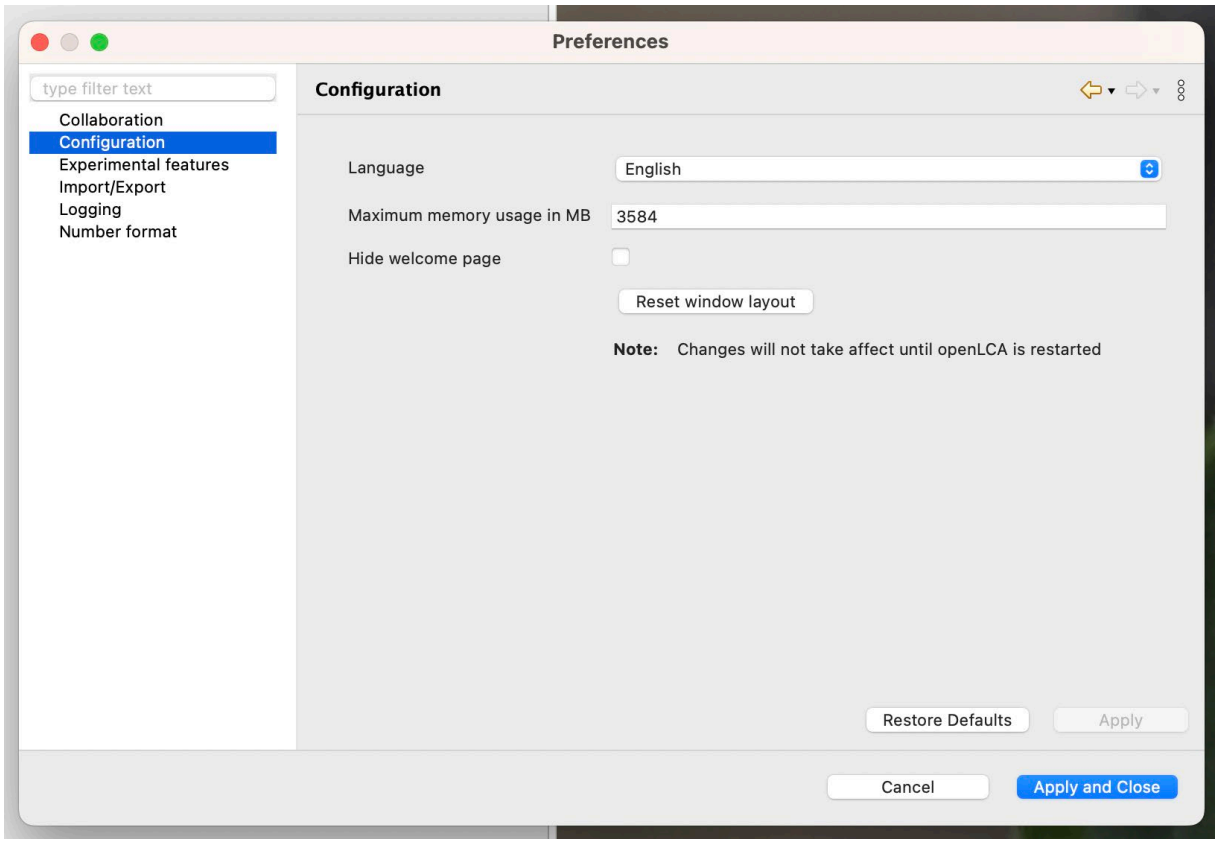
Note: This procedure is new with openLCA 2 (old version below)!

To increase the memory allocation on a Mac, start by launching openLCA. Then, after clicking on "File", open "Preferences".



How to access the „Preferences…" in openLCA under macOS

Note: is NOT under "openLCA" and "Settings"! And then the tab "Configuration":



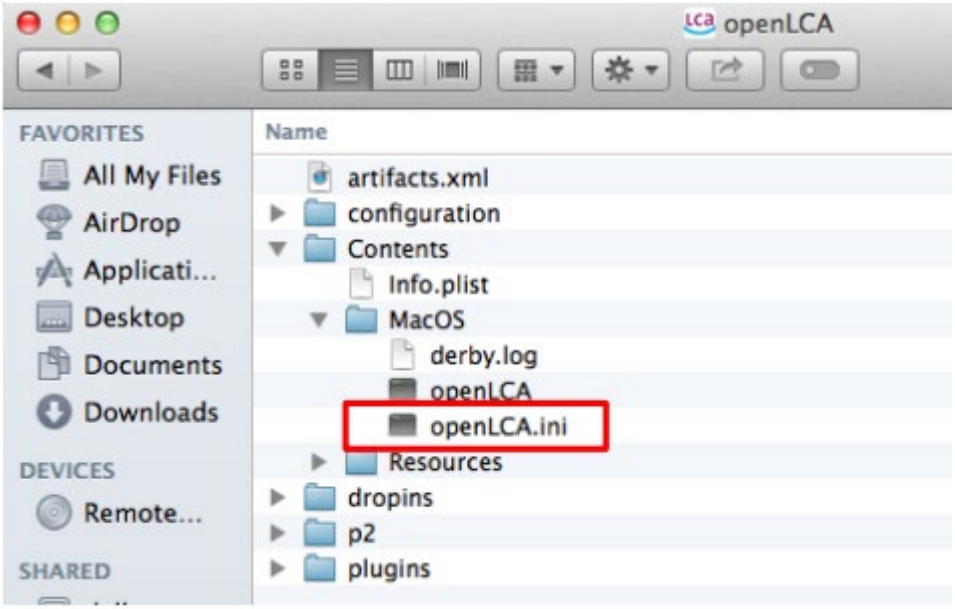
Preferences Configuration

Adjust your memory accordingly!

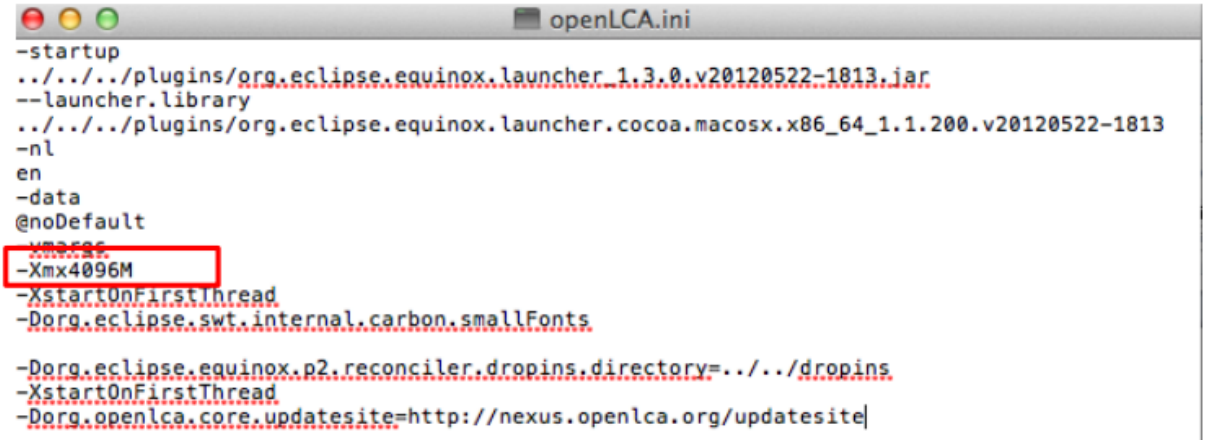
MACOS (OLD PROCEDURE)

Launch the "Finder" and navigate to the "Applications" folder. Locate openLCA in the Applications folder. Next, right-click on openLCA and select the "Show package contents" option. Once you have accessed the "Show package contents" option, navigate further by opening the "Contents" file. Within the "Contents" file, locate and open the "MacOS" file. You can do this by double-clicking on the file named "openLCA.ini". If the text editor does not open automatically, you can manually select the "Text Edit" program to open it.

Within the text editor, you can manually modify the memory allocation by changing the value. For instance, you can set it to 4096M. After making the desired changes, save the file, close all windows, and proceed to restart openLCA.



Expanding the memory on macOS



Expanding the memory on macOS

2.4 DOWNLOAD FAST LIBRARIES

FOR OPENLCA 2.0.2 OR EARLIER

openLCA uses fast numerical libraries (UMFPACK, openBLAS, etc., for the nerds). However, these are publicly available under an open-source license that prevents us from distributing them with openLCA. To bring these into openLCA, you will need to install them yourself. To do so, simply click on the "make the calculation in openLCA faster" banner on the welcome page in openLCA.

How'to'access'fast'libraries

This will download and install the libraries in the openLCA database folder. You need to restart openLCA afterwards, and the banner will disappear.

In the openLCA log file, accessible via help / Open log file in openLCA, you will find an entry such as:

16:15:31	INFO	org.openlca.app.App	loaded native libraries; with UMFPACK=true

Confirming a successful installation. These libraries make openLCA 5-10 times faster than the default Java libraries.

Having completed these steps, you are good to work with openLCA.

FOR OPENLCA 2.0.3 AND LATER RELEASES

Since openLCA 2.0.3, we're thrilled to announce a significant improvement in the user experience. Through the incorporation of the Intel Math Kernel Library (MKL), we have eliminated the need to download the supplementary UMFPACK library for accelerated calculations. MKL stands as an optimised and efficient library for mathematical and scientific computations.

Please note that openLCA 2.0.3, which uses the previous math libraries, can still be downloaded from openLCA.org.

3 RESOURCES

Stay updated on the latest developments by visiting our openLCA blog, where we share insights on new releases, bug fixes, and other relevant topics.

Explore also our LinkedIn page, LinkedIn group, YouTube account, and Twitter account , where you'll find updates and a wide range of tutorials.

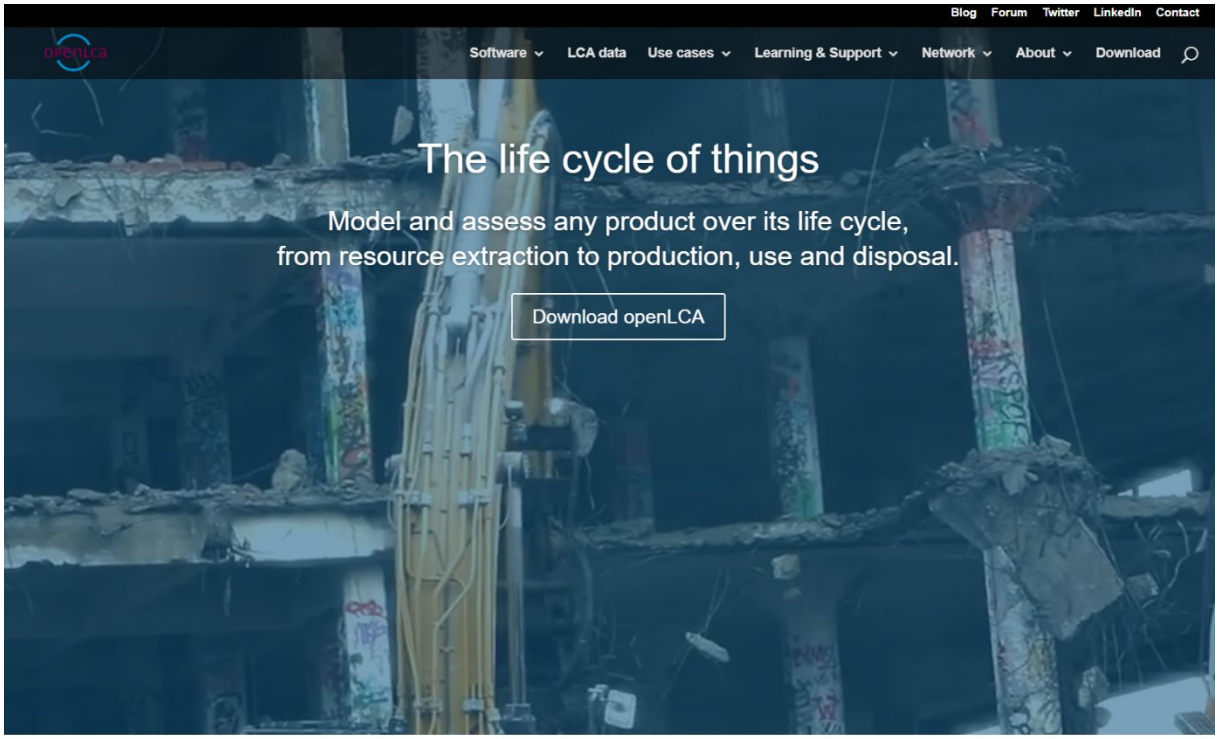
For manual-related inquiries, you can reach us at manual-feedback@greendelta.com.

In this section of the manual, you'll find further information about:

- openLCA.org
- openLCA Nexus
- ask.openLCA

3.1 OPENLCA.ORG

Our website offers a range of services for both new and existing openLCA users. you can find download links for the software, source code, openLCA LCIA Method Pack, case studies, user manuals, and links to instructional videos. Please visit the Learning & Support section.



The world's leading, high performance, open source Life Cycle Assessment software

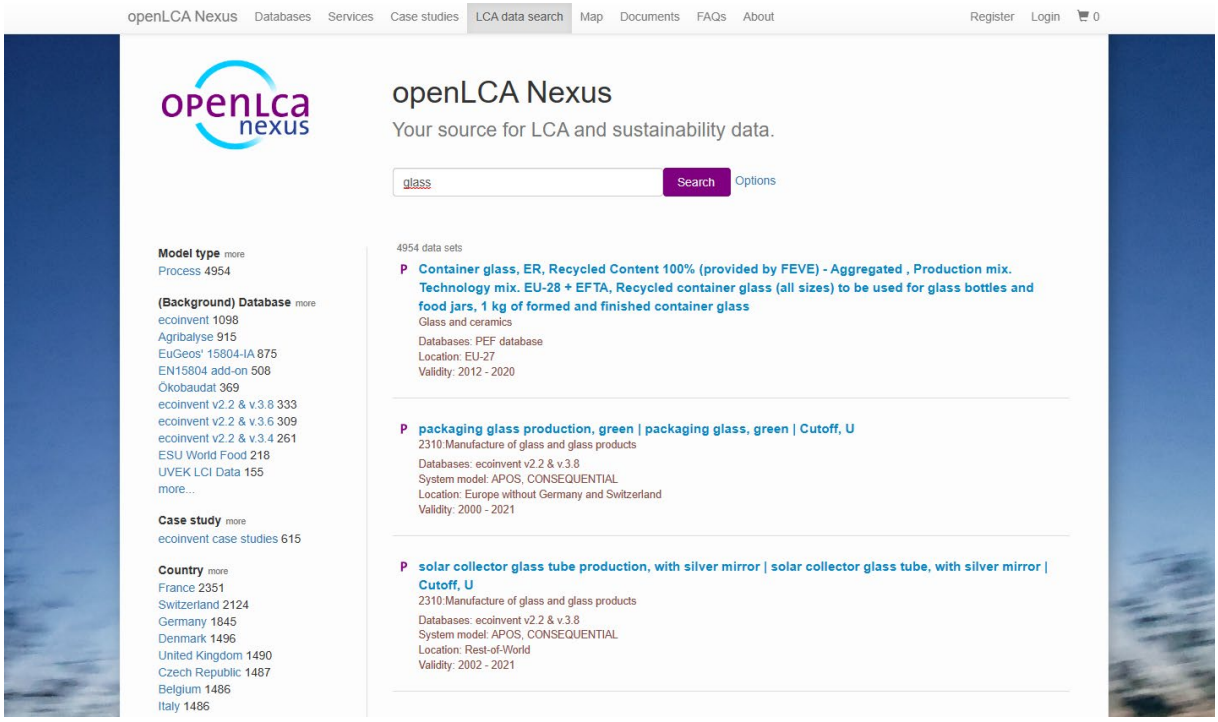
openLCA is an open source and free software for Sustainability and Life Cycle Assessment, with the following features:

- Fast and reliable calculation of your Sustainability Assessment and/or Life Cycle Assessment
- Very detailed insights into calculation and analysis results; identify main drivers throughout the life cycle, by process, flow or impact category, visualize results and locate them on a map

3.2 OPENLCA NEXUS

openLCA is a free and open source software. However, many LCA databases are not for free. GreenDelta has created openLCA Nexus, an online repository for making LCA data available to users. It contains free and "for purchase" data. Some are shown in the image below.

Moreover, the Nexus website enables you to search for datasets in Nexus. It is also possible to filter data sets by the data provider, location, category, price and year of validity.



openLCA'Nexus'homepage'search'function

DATABASES

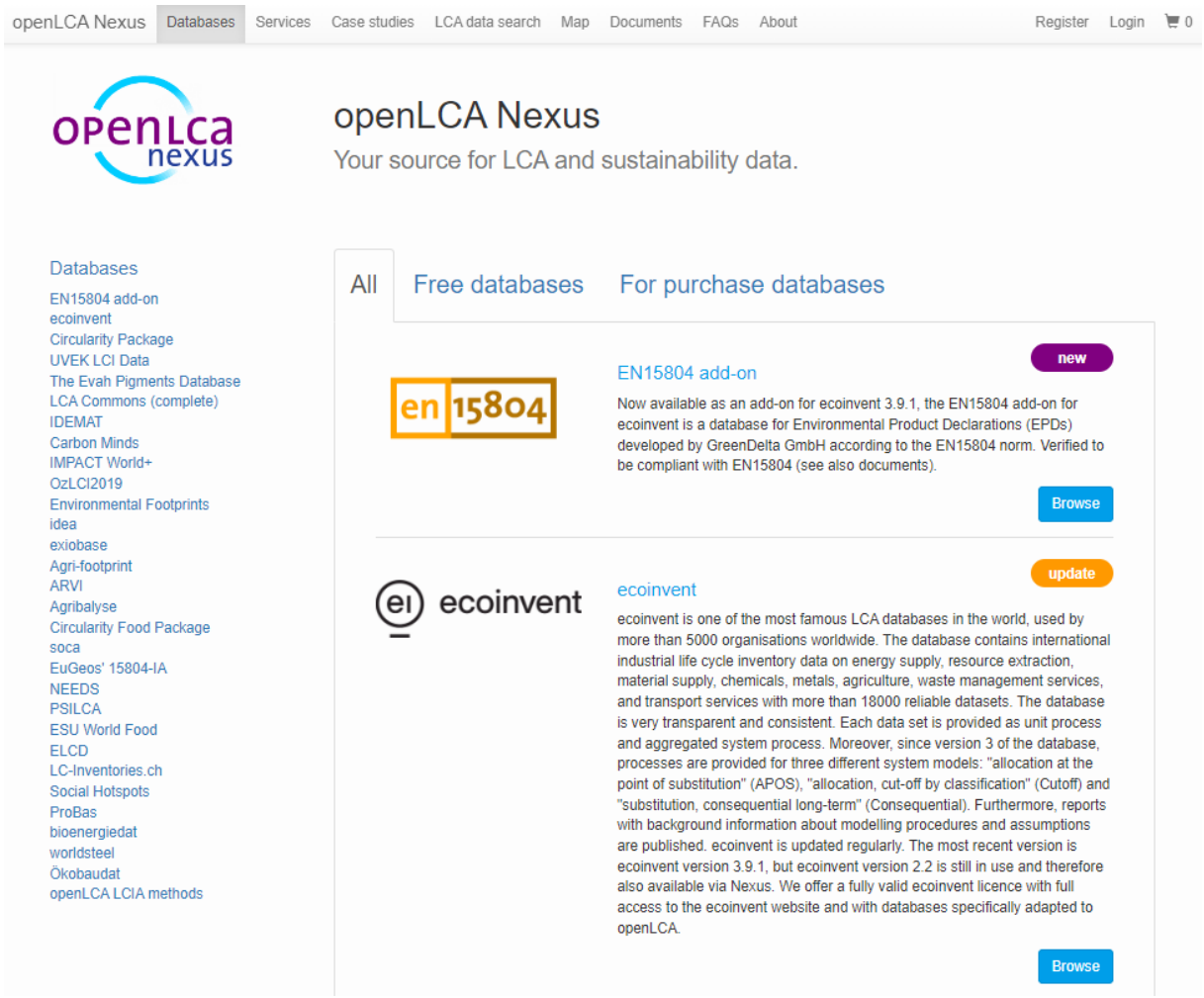
openLCA offers the largest collection of datasets and databases worldwide for LCA software, some of which are available for purchase and others for free. Altogether, around 300,000 different data sets are available on Nexus.

Extract of available databases on openLCA's platform Nexus

Most databases support the same reference flows and impact assessment methods. Some databases are separate and do not mix with the others. An example is Input/Output databases such as PSILCA, the SHDB, or Exiobase.

ACCESSING DATABASES FROM OPENLCA NEXUS

On Nexus, you can use the search engine and the "Map" feature to explore the content of the available databases.

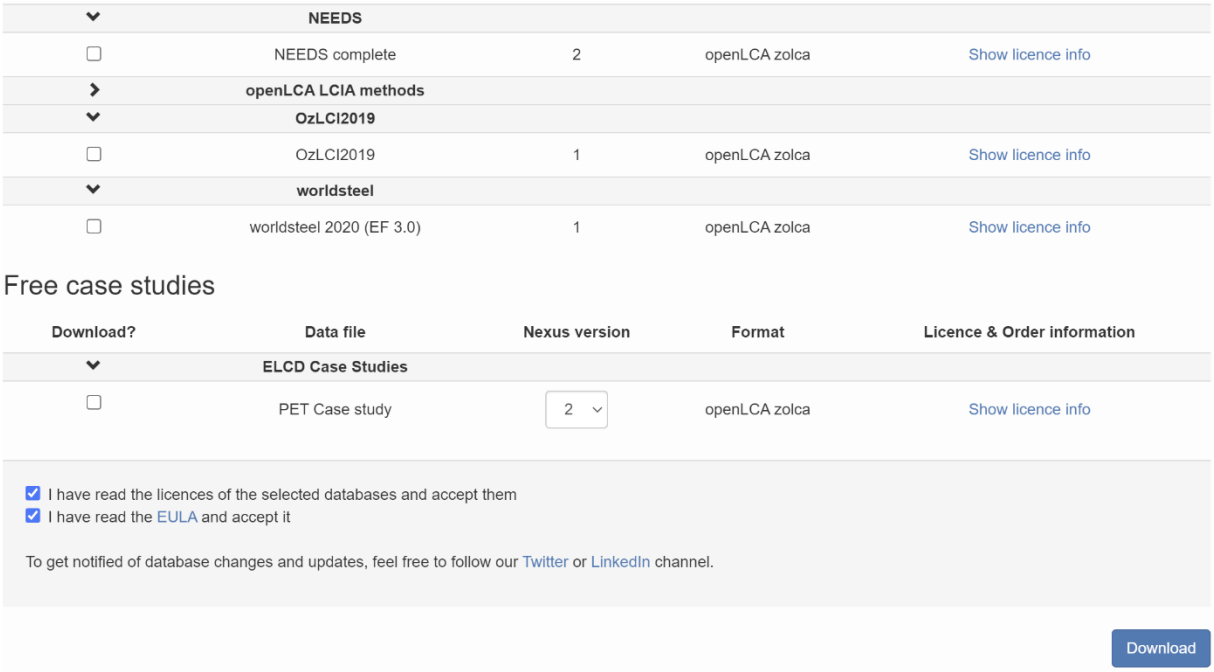


openLCA 'Nexus' website

To order and download a database from the openLCA Nexus site, please follow these steps:

1. Register an account at Nexus and log in: We are committed to stringent data protection principles to ensure the security of your privacy.
2. Select the desired license and add it to the cart: Navigate the "Databases" section, explore the available licenses, and select the one that aligns with your requirements or preferences. Please note that some databases are available for free, while others require a payment.
3. Place an order: Once you have added the license to your cart, proceed to place an order. You can check the openLCA Nexus website's FAQs for more information about database licenses.
4. Approval and database download: After your order is approved, go to the "Downloads" section on the Nexus website. This section is located in the upper right-hand corner of the page when you are logged in. Here, you will find a list of data files available for download.
5. Select files and format: Select the files you wish to download from the available options and choose the format you prefer (if applicable).

6. Review and accept licenses: Before downloading the file, carefully read and agree to the licenses and the End User License Agreement (EULA) by checking the two boxes at the bottom.
7. Download: Click on the "Download" button to start the download process.



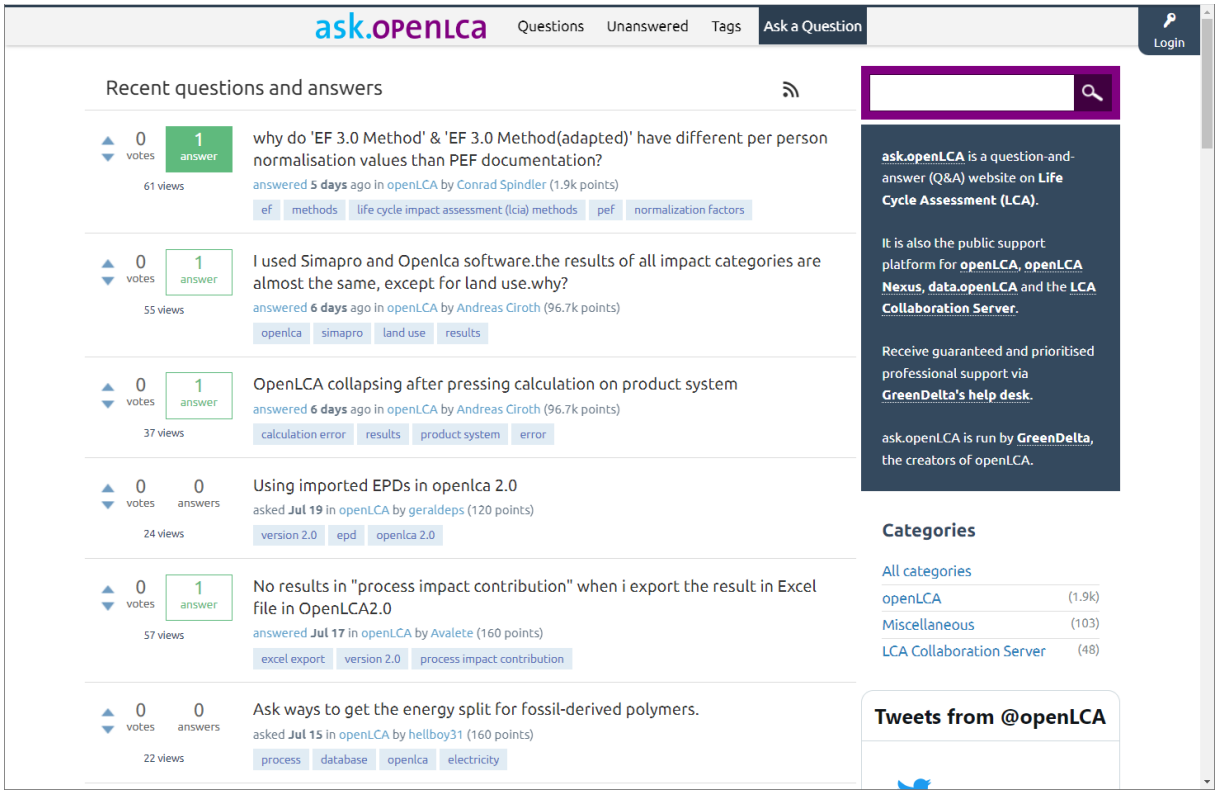
Downloading a database from Nexus

NOTE FOR MACOS USERS: If you are using Safari, the browser will automatically unzip your downloaded zip files. However, you need the zipped file for import into openLCA (e.g., when you want to import JSON-LD, method packages, or ILCD). You can solve this issue in two ways:

1. Use another browser for downloads, where zip files are not automatically unpacked after a successful download.
2. Zip the archives again using a third-party tool, as the built-in archive tool from Apple may add additional resources to the zip file that can cause issues when importing the file into openLCA.

3.3 ASK.OPENLCA

ask.openLCA is a public support platform, operating as a hub where users can ask questions and receive answers, facilitating access to assistance and information.



ask.openLCA' website

WELCOME TO openLCA!

4 LCA CASE STUDY

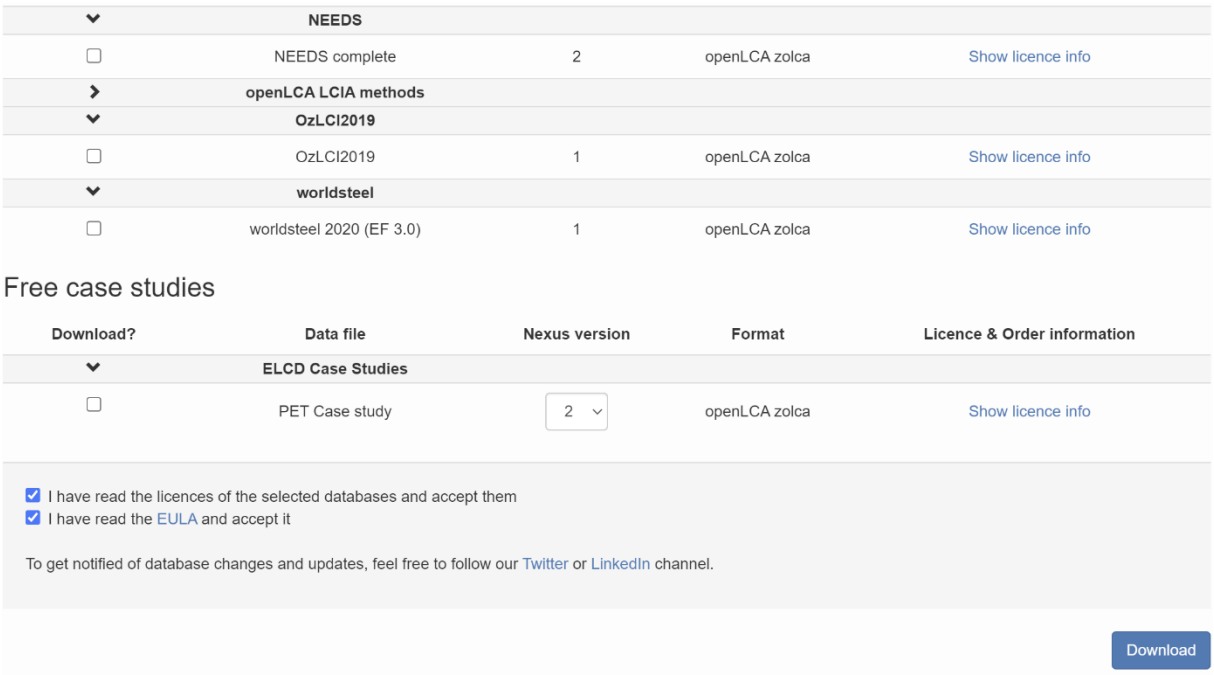
In this section, we provide an overview of openLCA's key features by demonstrating a typical LCA modelling approach. These key elements include selecting a background database, creating processes and products, connecting them to a life cycle, choosing an impact assessment method, performing life cycle calculations, and reviewing the results. Detailed instructions for using the software will be provided in subsequent sections of this manual.

Let's get started!

GETTING A DATABASE

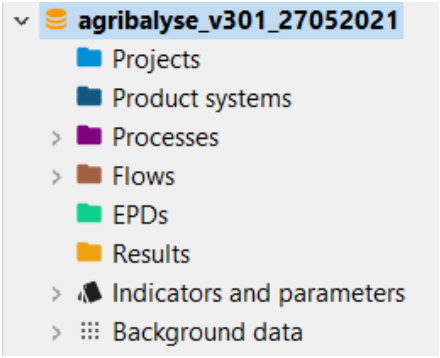
The essential first step in LCA modelling using openLCA is the selection of a background database. In the software context, a "database" serves as a repository for the components required for conducting LCAs; therefore, you need to create or import one to work with openLCA. Moreover, it's uncommon to model the entire life cycle from scratch. Instead, you will get standard processes from an existing database (these "common" processes typically include electricity production, transport, construction, waste treatment, and so on). You will typically model yourself as the core, foreground processes specific to the product or service you want to analyse.

In this case study, we'll model the life cycle of a pack of oat milk compared to the life cycle of a pack of cow milk, using core processes from the Agribalyse database, which is freely available on Nexus for users with an ecoinvent license. Check the "Accessing databases from openLCA Nexus" to learn how to download a database.



Downloading a 'database' from 'Nexus

Once you have your database, you can check the "Databases" section to learn more about its properties.

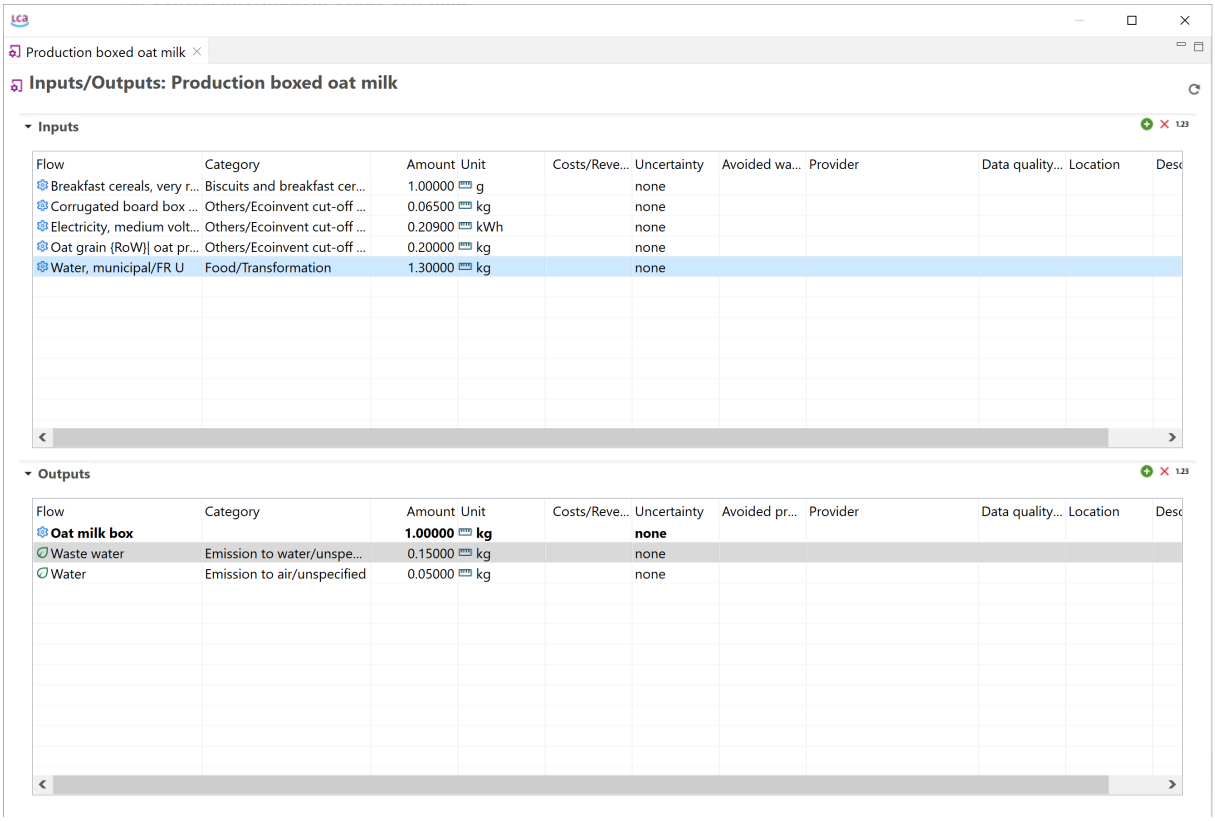


Agribalyse as an active database in openLCA

CREATING A PROCESS

Now, we can design the life cycle phases, or processes, of our product (in this case, packed oat milk). As you will see, a process is a set of activities that transform inputs into outputs. They are characterised by a quantitative reference, which is the product that the process produces, or, for waste treatment processes, the waste it treats. In the context of this case study, we will skip the raw material extraction phase and proceed directly to modelling the manufacturing processes.

Below, you can see the process that models the production phase of an oat milk pack, with its input and output flows.



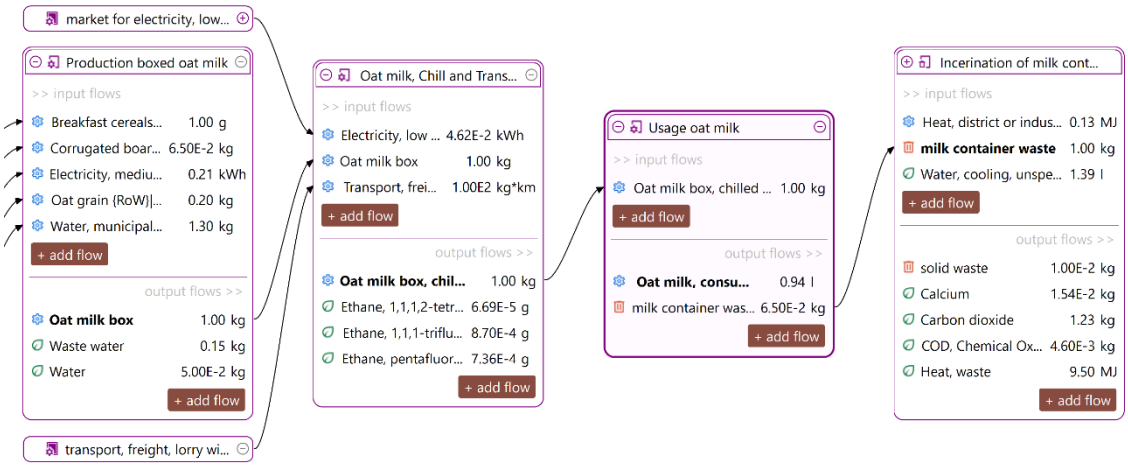
Process representing the production of an oat milk pack with its input and output

To model the entire life cycle of this product, we'll also create the distribution phase, use phase, and end-of-life processes (you can find details about end-of-life modelling in this section).

Check the "Flows" and "Processes" sections to learn more.

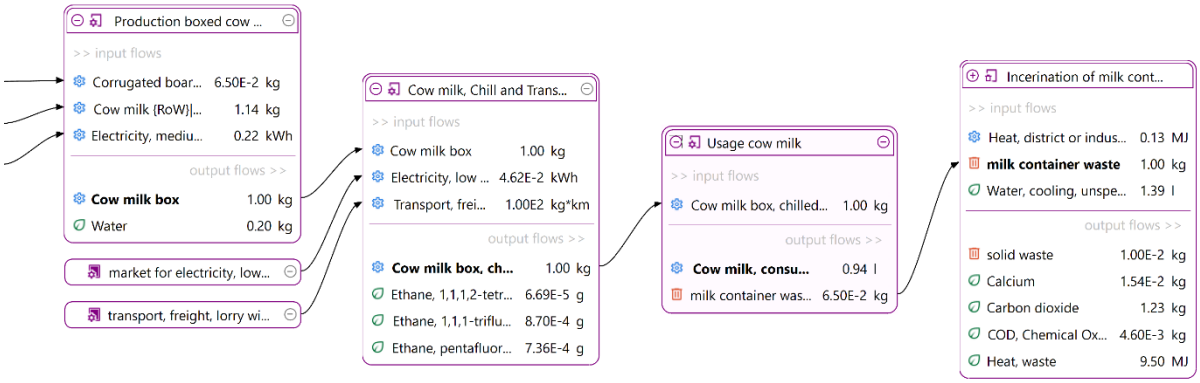
CREATING A PRODUCT SYSTEM

We will integrate all the processes we just created into a life cycle model by creating a product system from the process with the respective reference flow (oat milk, consumed). openLCA will connect the supply chain for you.



Life cycle model of an oat milk pack with all its interconnected processes

Following the same steps, we'll also create the product system of a cow milk pack. This way, we can compare them and draw some conclusions about their different environmental impact.



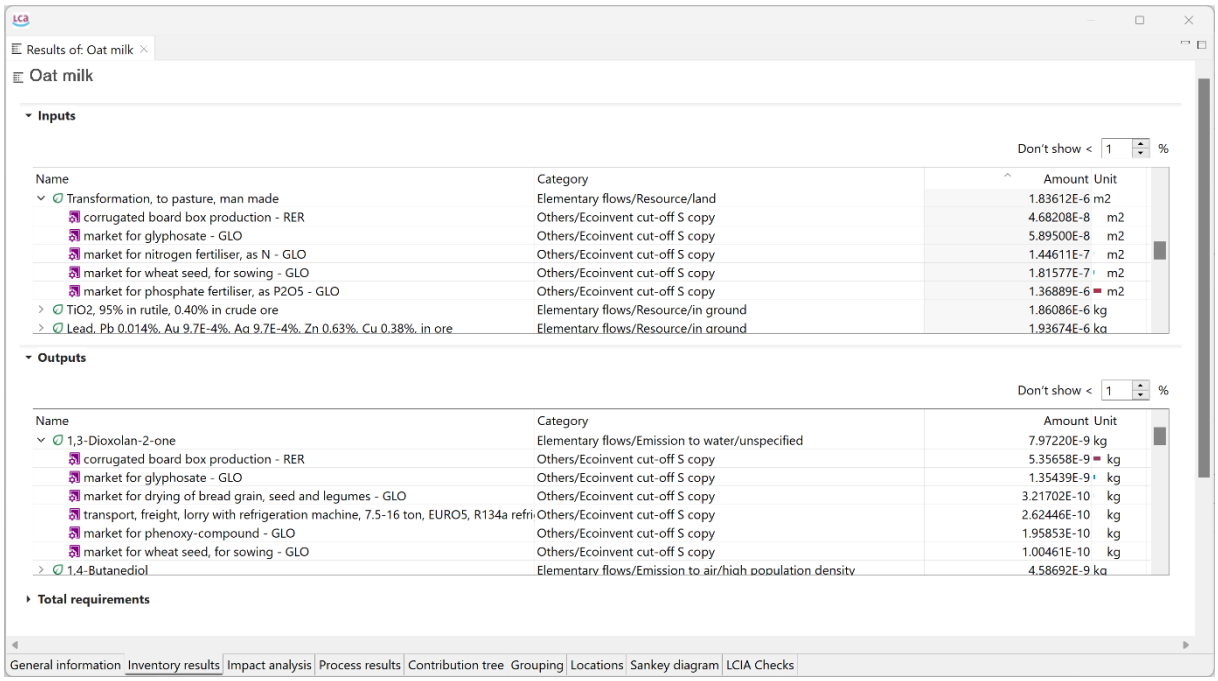
Life cycle model of a cow milk pack with all its interconnected processes

Check the "Product system" section to learn more.

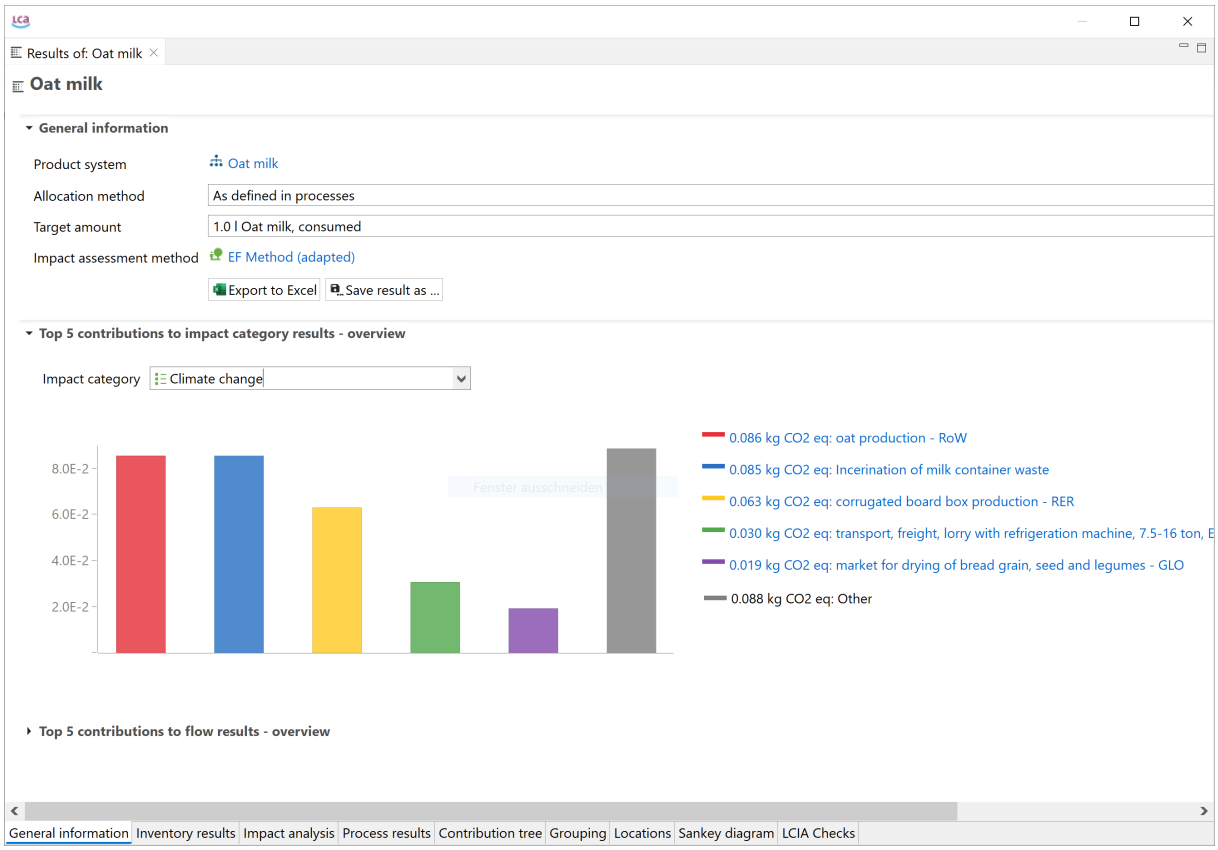
CALCULATING THE LIFE CYCLE INVENTORY (LCI) AND LIFE CYCLE IMPACT ASSESSMENT (LCIA)

With your life cycle model ready, it's time to calculate the inventory of your product. This provides insights into the materials and resources utilised and emitted throughout the life cycle of your product. This is the Life Cycle Inventory (LCI), and in openLCA, it can be obtained by clicking on "Calculate" in your product system window.

The "Inventory Results" tab will open, displaying a table that shows the input and output flows of the product system, including amounts and units for each.



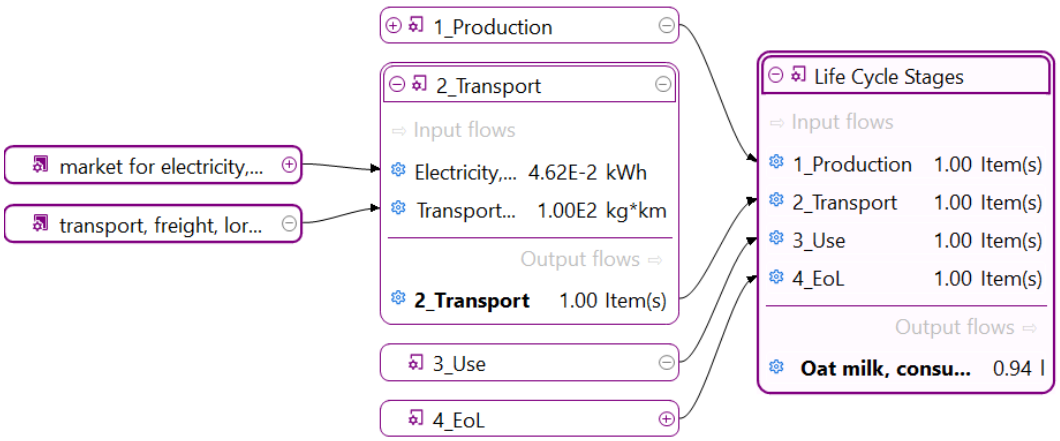
To generate the Life Cycle Impact Assessment (LCIA), you need to add an LCIA method to the calculation. After clicking "Calculate" in the product system window, select an "Impact assessment method" from the drop-down menu to calculate the environmental impact based on the life cycle inventory.

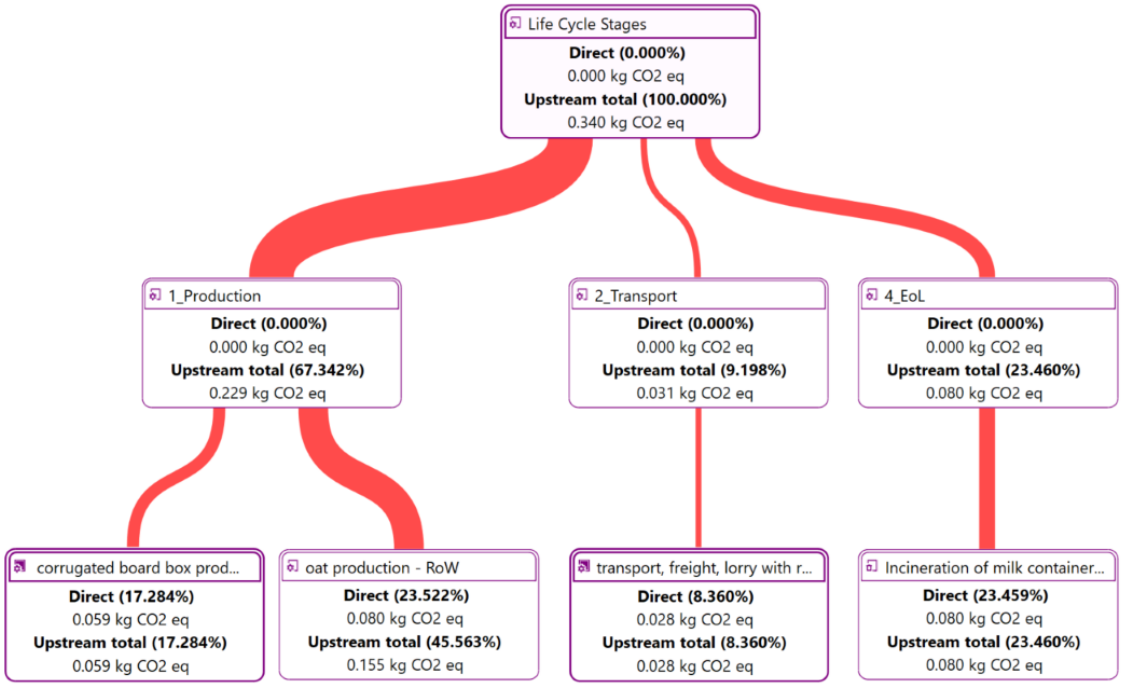


Calculation 'results' window

Check the "LCIA methods and categories" and "Calculation and Results Analysis" sections to learn more.

If you are interested in displaying impacts per life cycle stage:





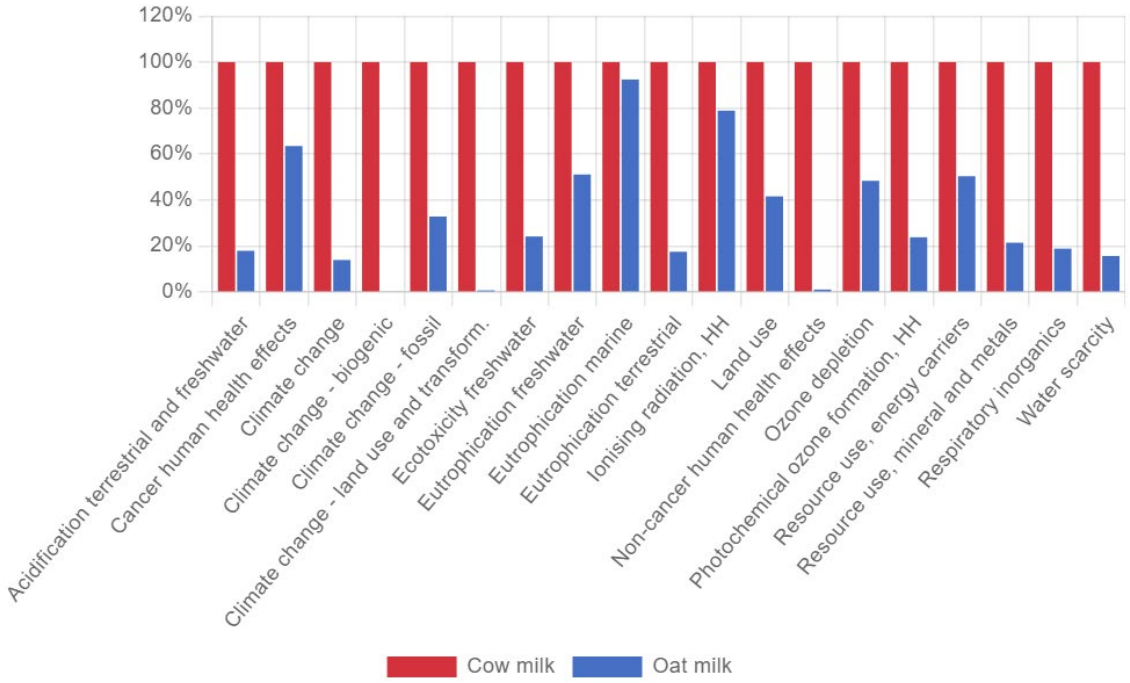
Impact category: Climate change

Contribution	Process	Required amount	Total result [kg C...	Direct contributi...
100.00%	Life Cycle Stages	0.00094 m3	0.34025	
67.34%	1_Production	1.00000 Item(s)	0.22913	
45.56%	oat production - RoW	0.20000 kg	0.15503	0.08003
17.28%	corrugated board box production - RER	0.06500 kg	0.05881	0.05881
03.48%	market for electricity, medium voltage - FR	0.75240 MJ	0.01183	0.01183
00.88%	Breakfast cereals, very rich in fibre, fortified with ...	0.00100 kg	0.00299	
00.14%	Water, municipal - FR	1.30000 kg	0.00047	
23.46%	4_EoL	1.00000 Item(s)	0.07982	
09.20%	2_Transport	1.00000 Item(s)	0.03130	
00.00%	3_Use	1.00000 Item(s)	0.00000	

COMPARING LIFE CYCLE MODELS USING PROJECTS

Comparing life cycle model results, i.e. product systems, can provide valuable insights into their relative environmental performance. In openLCA, this is done via projects.

When you create a project, you can add the product systems you want to compare and generate insights and graphs for both of them.



Relative impact results of one pack of oat milk vs one pack of cow milk obtained using EF Method

Check the "Project" section to learn more.

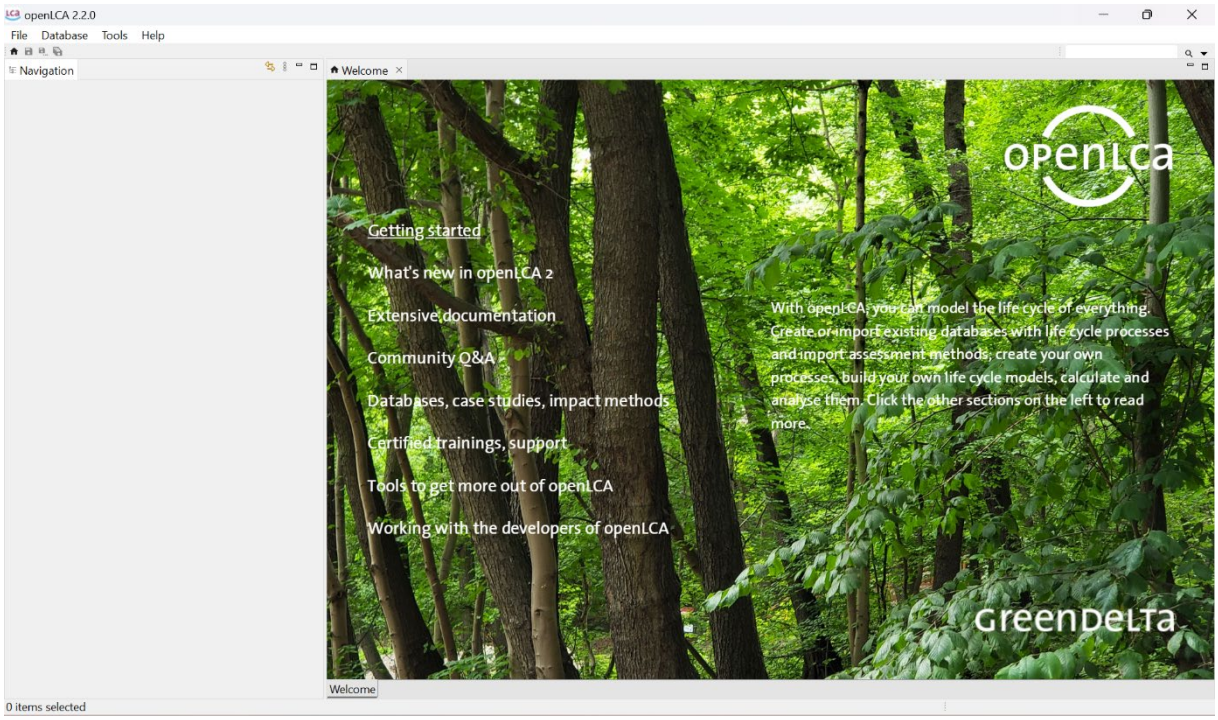
CONGRATULATIONS! You have successfully gone through the key steps in openLCA. With this knowledge, you can now start making informed decisions to improve the environmental performance of your products and processes. Happy analysing!

Next, we will go systematically through the features of openLCA.

THE BASICS FOR openLCA

5 RUNNING openLCA FOR THE FIRST TIME

When you launch openLCA for the first time, it does not contain any data. On the left side, you see an empty Navigation field. On the right, you see the Welcome page.

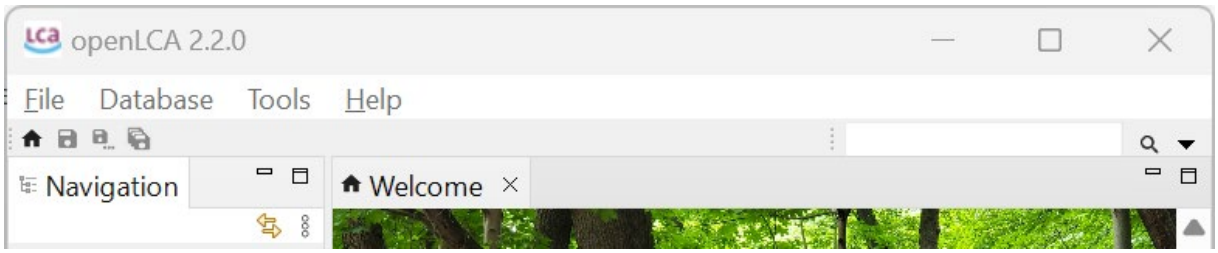


openLCA 'Welcome' page

The Welcome page provides quick links to openLCA Nexus, instructional videos, case studies, this user manual, the openLCA download page, where you can download the latest version of the software, and LCIA methods. Additionally, a link to more information on the openLCA network and its users will be available.

In the next sub-chapters, you can explore:

- The functionalities of the toolbar:



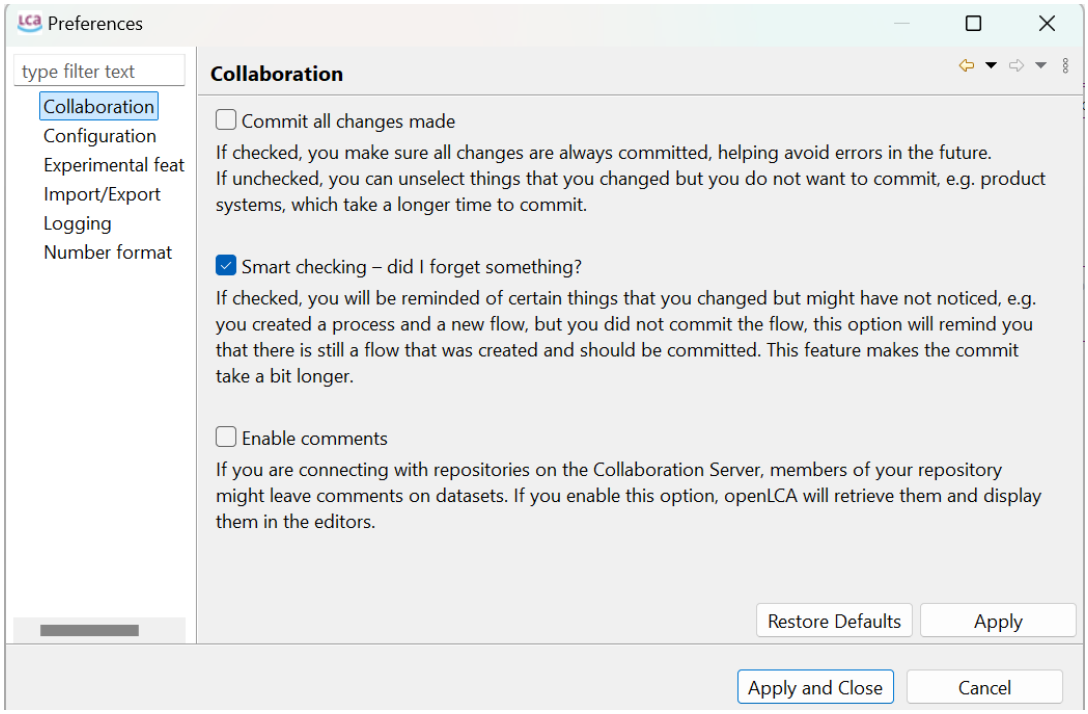
  - File
  - Database
  - Tools

- Help
- The basic features of openLCA:
  - openLCA search function
  - Using the editor function
  - Working with tabs

5.1 TOOLBAR: FILE

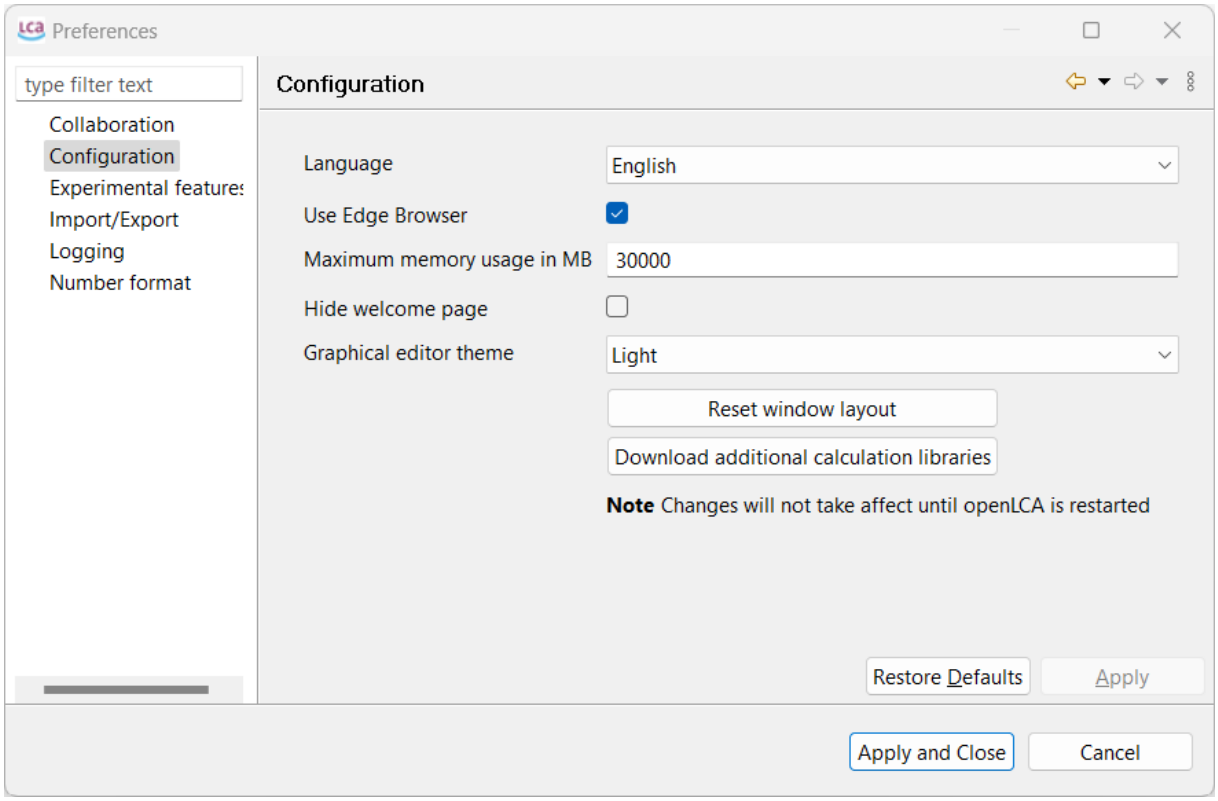
The following options are available under File:

- Save / Save As... / Save All: This option saves the work that is currently open in the editor tabs. Unsaved tabs will not be included in the calculations that will be performed.
- Close / Close All: This option closes the current/all windows opened in the editor.
- Preferences: Under preferences, you can customise openLCA to your needs. Here, you can find settings as memory allocation for openLCA and language selection.
  - Collaboration: Here, you can select your preferred configurations for working with the collaboration server. Each bullet point comes already with a description and is not further described here:
    - *Check 'referenced' changes*
    - *Smart 'checking*
    - *Enable 'comments*



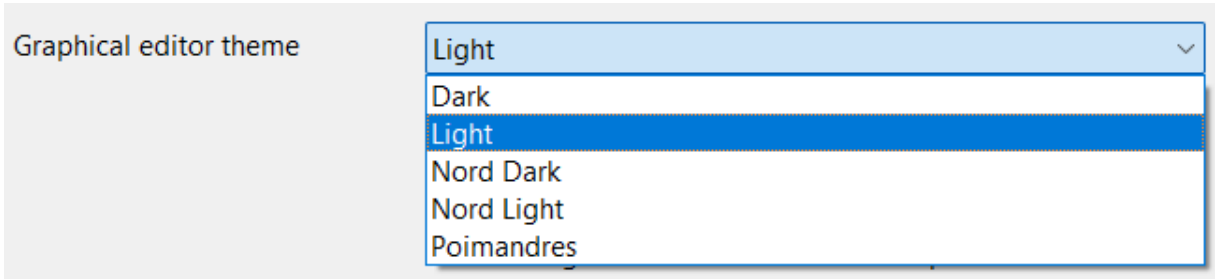
Preferences'Collaboration

- More information about the Collaboration Server can be found in the respective chapter.
- Configuration: Here, you can choose from eleven available languages (Arabic, Bulgarian, Catalan, Chinese, English, French, German, Italian, Portuguese, Spanish, or Turkish). You can also select the maximum memory usage (see chapter).



Preferences'Configuration

- Graphical editor theme: You can now change the theme for the model graph and Sankey diagram, namely: Dark, Light, Nord Dark, Nord Light, and Poimandres. However, to access the dark mode for the whole application, you need to select it on your operating system.

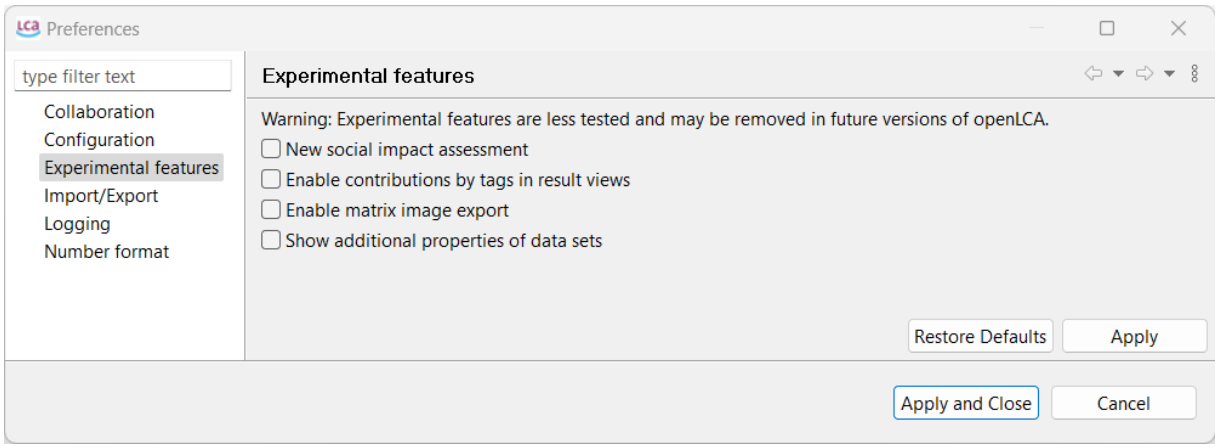


- Reset window layout: Furthermore, you can reset your window settings if you encounter a bug or if you find yourself lost with the number of open windows.

- Download calculation libraries: This option allows you to integrate fast calculation libraries for openLCA. This function is still being developed.

Note: You need to restart openLCA to activate configuration changes.

- Experimental features: These features are still in development, but you can already access them by checking this box. We welcome any feedback to further refine them. Here you can activate the novel social impact assessment feature.



Preferences'Experimental'Features

- Import/Export: Here, you can change the ILCD Network settings (currently under development).
- Logging: Here, you can set what information should be written in openLCA's log file. You can also keep the log file open permanently if you want.
- Number format: If you are not a fan of the six-decimal display format, you can modify it here. This setting will not affect calculation results, and it is just for your convenience, adjusting the format in the user interface.

If you made a mistake, "Restore Defaults" will always return you to the default settings.

- Import: See section "Importing and combining databases"
- Export: See section "Exporting data"
- Exit: This option closes openLCA, as well as clicking on the small cross in the right corner of openLCA.

5.2 TOOLBAR: DATABASE

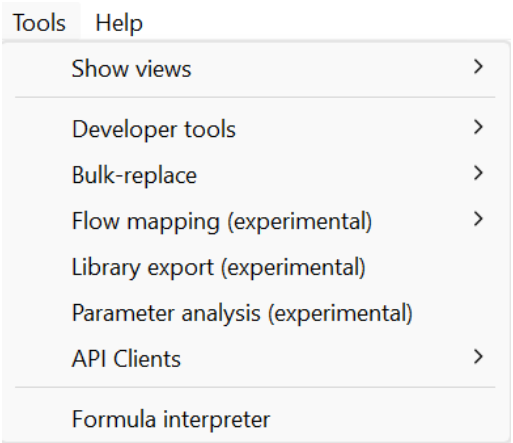
Note: Almost all the functions described here can also be accessed via right-click with the mouse on the active databases in the navigation panel.

The following options are available under "Database" when a database is opened:

- New Database: For creating a new database, either from scratch or by loading it from a file. Access the respective sections for details: Creating a new database from scratch, section "Creating a new database loading it from file" for details. It is also possible to activate both functions by right-clicking on the navigation window.
- Backup Database: Copy the database into an archive file to save it.
- Validate: Checks the database for inconsistencies and creates a validation report.
- Copy: Creates a copy of the active database.
- Rename: Renames the active database.
- Delete Database: Deletes the active database from openLCA. Please note that this action is irreversible.
- Close Database: Closes the active database. Alternatively, opening another database will automatically close the active one.
- Check linking properties: Performs a comprehensive provider check on the active database and displays the results in a table. It will indicate if processes lack a default provider, whether product or waste flows exist with multiple providers, which product flows have multiple providers, and identify provider linking options that are uncritical in the active database.
- Properties: Shows the database's location on the computer and the type of the database.
- Compress Database: This function removes deleted datasets from the active database, freeing up space.
- Contents: Under the two tabs, "*flows*" and "*processes*" are available. Clicking on them shows a list of all the flows or all the processes within the database. This option enables you to filter all flows by CAS number or chemical formula.

5.3 TOOLBAR: TOOLS

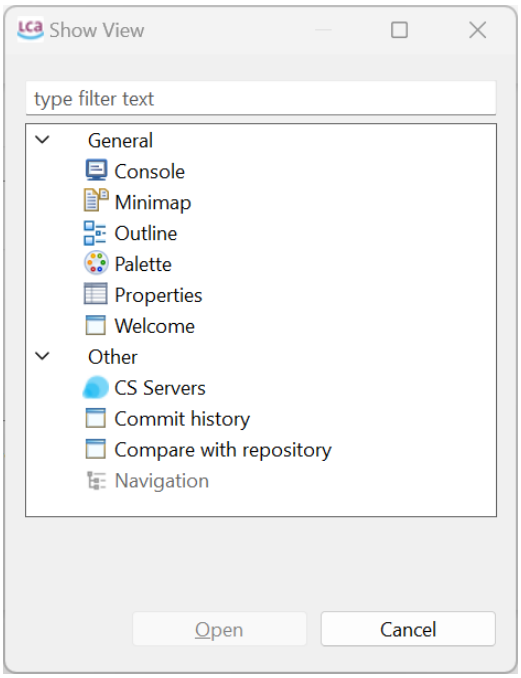
The following options are available under "Tools":



Options' under' Tools

- Show views

The following options are available after clicking on "Show views" and "Other...":



Options under Show views > Other...

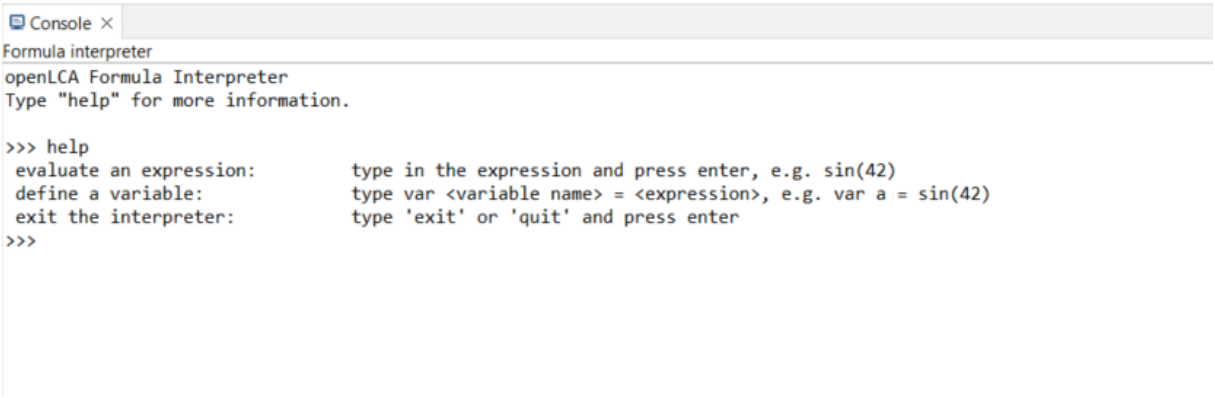
- General
  - *Console*: Displays the log file
  - *Minimap*: Not available, a relic from creating openLCA with Eclipse
  - *Outline*: Displays a list of all the processes of a product system, including all its background processes. It is only applicable after you've created a product system. Open the product system's Model Graph (tab) and choose the "Outline" option from "Views". The outline enables you to select the processes you wish to display or hide in the Model Graph.
  - *Palette*: Not available, a relic from creating openLCA with Eclipse (don't worry)
  - *Properties*: Not available, a relic from creating openLCA with Eclipse (don't worry)

- Other
  - *Commit History*: Shows the commit history of the synchronisation with the collaboration server, see section "Link with Collaboration Server".
  - *Compare with repository*: Shows the comparison with the collaboration server, see section "Link with Collaboration Server".
  - *Navigation*: The Navigation window displays the databases you have imported into openLCA, and all the data sets they include.

- Developer Tools:
    - *SQL*: A tool that can be used to carry out SQL queries in openLCA.
    - *Console*: The console tool provides a live feed of our program, featuring the same content as our log file.
    - *Python*: openLCA supports the execution of Python programs directly within openLCA. With this feature, you can automate calculations in openLCA, write your own data imports or exports, perform sensitivity analysis calculations by varying parameter values, and much more.
    - *IPC'Server*: Inter-Process Communication is a platform-independent data exchange interface via *HTTP*. *IPC* Server allows running openLCA services via Python's standard library

However, to run the scripts, use the respective button (green arrow) in the toolbar.

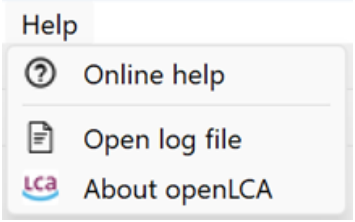
- Bulk-replace: It is a tool that allows the replacement of a flow or product provider with another flow or provider. For more details on bulk replacement, see the "Using mapping files in openLCA" chapter.
- Flow mapping (experimental): Still under development, but already available for you!
- Library export (experimental): Still under development, but already available for you!
- Parameter analysis (experimental): Still under development, but already available for you!
- soda4LCA: See soda4LCA chapter.
- CS Servers: See the collaboration server manual.
- Get EPDs from EC3: With openLCA 2, it is now possible to download EPDs from EC3 (Embodied Carbon in Construction Calculator) by Building Transparency. This requires access to the Building Transparency server. Also, an upload is possible.
- Formula interpreter: Use this interpreter to check if your formulas are correct. More information on the interpreter is accessible by opening the formula interpreter and typing "help" in the command line.



openLCA'Formula'Interpreter

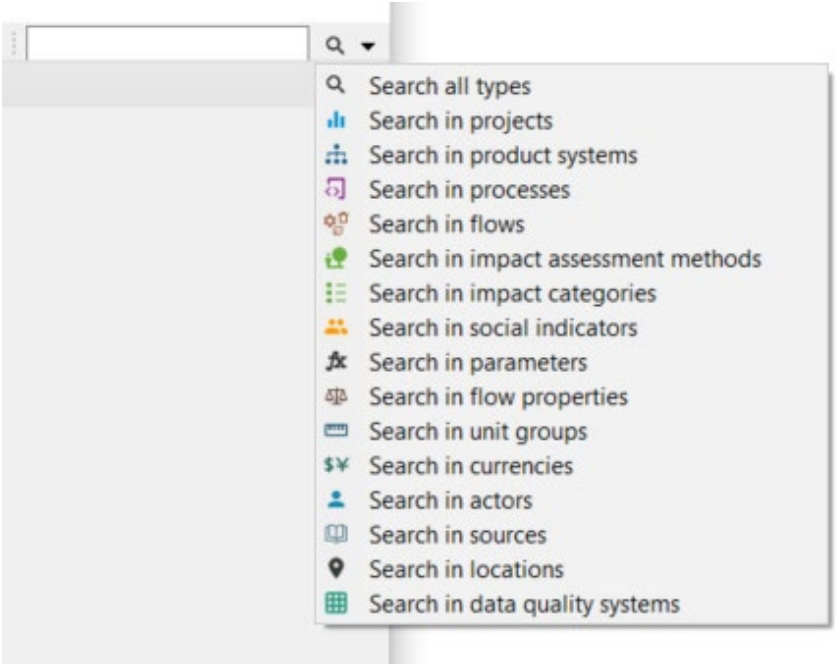
5.4 TOOLBAR: HELP

Under "Help" you can find information on the openLCA copyright and openLCA log file as well as a link to this user manual and other free resources.



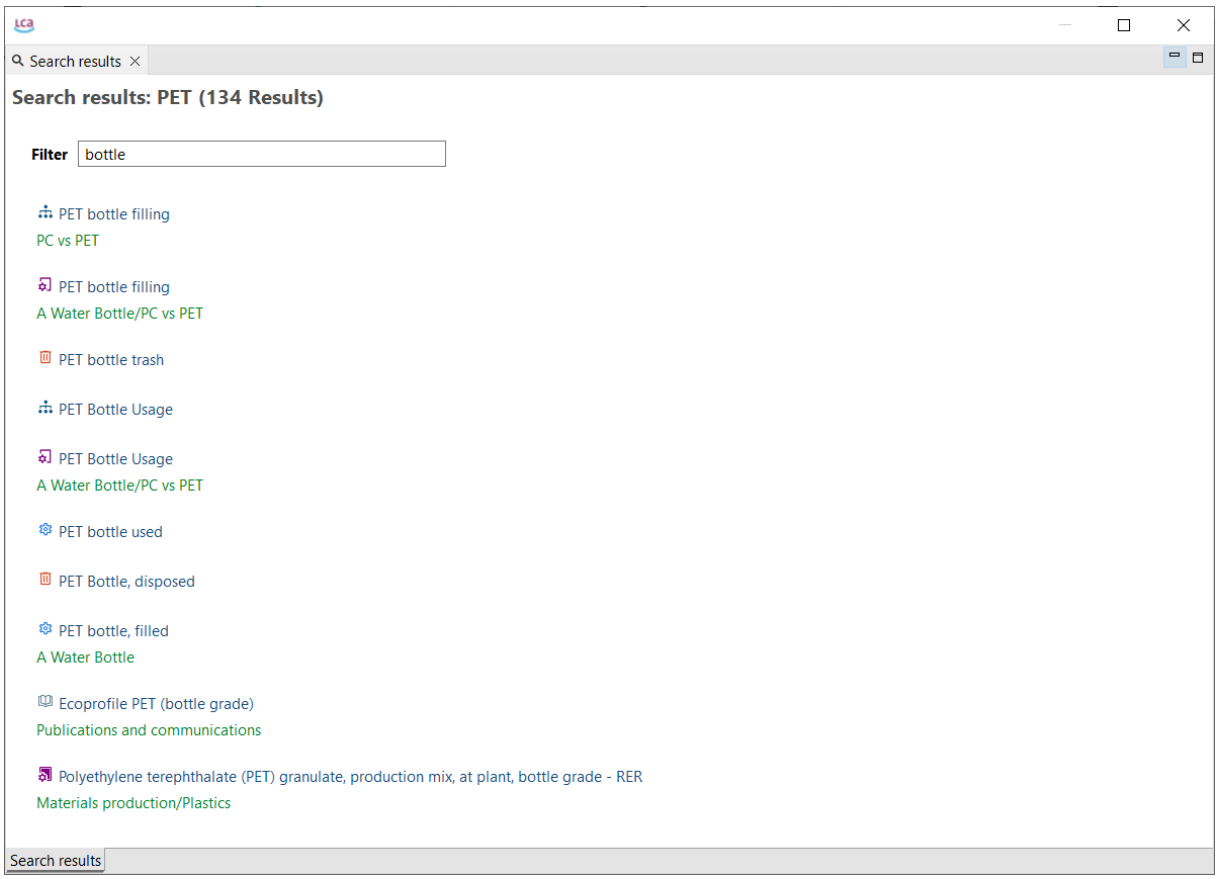
5.5 OPENLCA SEARCH FUNCTION

In the top-right corner of the page, the "Search" function enables you to search for keywords in openLCA (e.g., names of flows, processes, social indicators, currencies, etc.). You can search across all sections or specify specific areas. In openLCA 2, you can also search for datasets within accessible repositories on the collaboration server and import them into the local working database.



Search function in openLCA

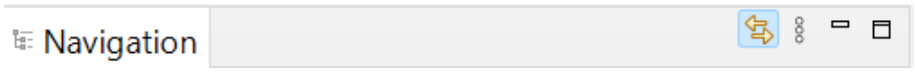
When you search for a term, you can even filter the results:



Filtering after using the search function in openLCA

5.6 USING THE EDITOR FUNCTION

As displayed, there is a small icon with two yellow arrows in the top-right corner of the navigation. This is the "Link with the editor" function, which can be active (displayed with a light blue highlight) or deactivated (without a highlight). If the option is activated, the flows/processes/product systems being opened in the main window of openLCA (editor) will be opened in the navigation panel. If it is deactivated, the currently opened flow/process/product system will not be opened in the navigation.



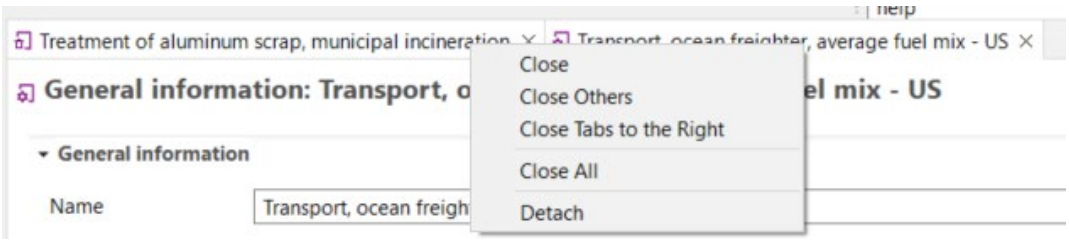
Activated „Link with Editor…" option

This option is helpful if you are looking for flows/processes/product systems in a database. With the option activated, it will automatically open the respective folder structure in the navigation panel. Once found, you can deactivate the option again.

Moreover, if you click on the three dots next to the editor, you will also find the "Refresh" function. It refreshes the "Navigator". For example, when creating data sets in a Python script or via the IPC server, they won't show up in the "Navigator" if you do not refresh it.

5.7 WORKING WITH TABS

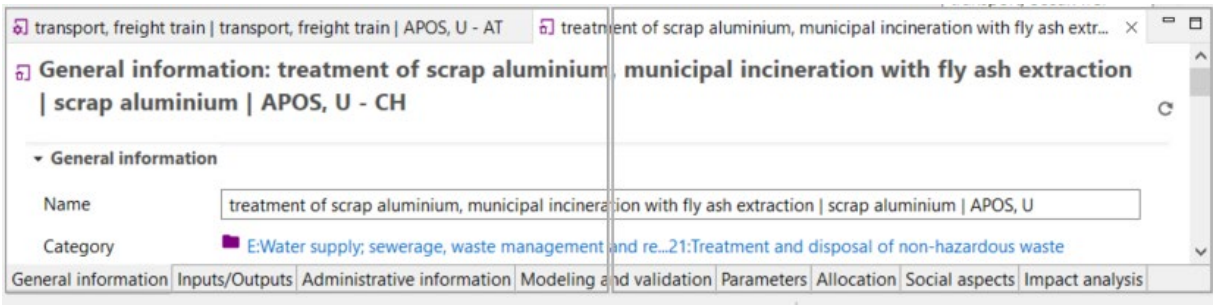
In openLCA 2, every new window is organised as a tab next to the welcome one within the main window. Right-clicking on a tab provides different management options, improving the user-friendliness of openLCA.



Right] clicking 'a 'tab

Tabs can be detached and moved around on the screen. By dragging and dropping a detached tab next to an existing tab in openLCA, you can reattach it. This feature allows you to run openLCA in single-window and multi-window modes, which is particularly beneficial when working with multiple screens.

To show two tabs either underneath or next to each other, drag one tab till a double line appears on your screen.



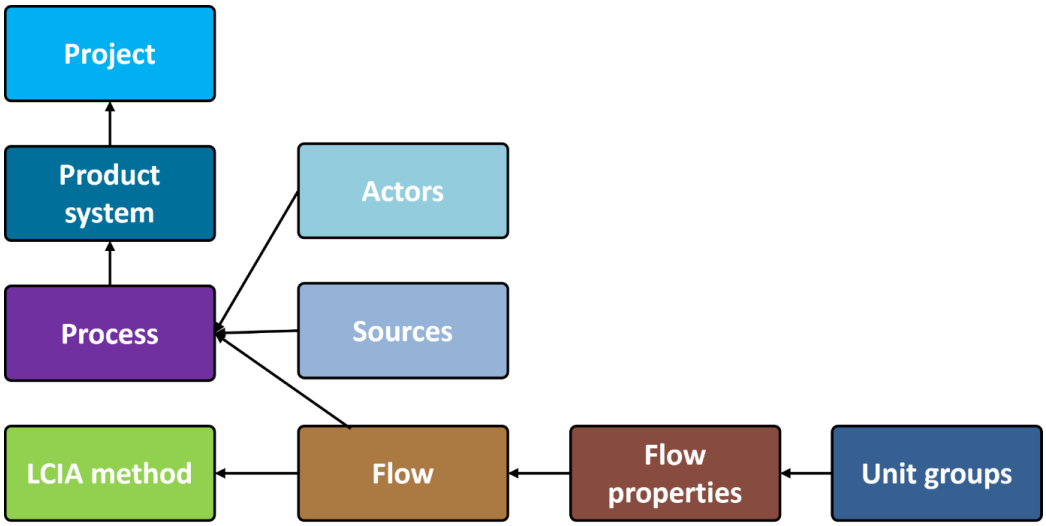
Placing 'tabs 'underneath 'or 'next 'to 'each 'other

Note An asterisk "*" in front of the tab's name indicates that the data of your tab is not saved, and therefore an older state of this tab will be included in any calculation.

Note If you are unhappy with your choice of tabs and windows, you can always reset them under File → Preferences → Configuration → Reset Window.

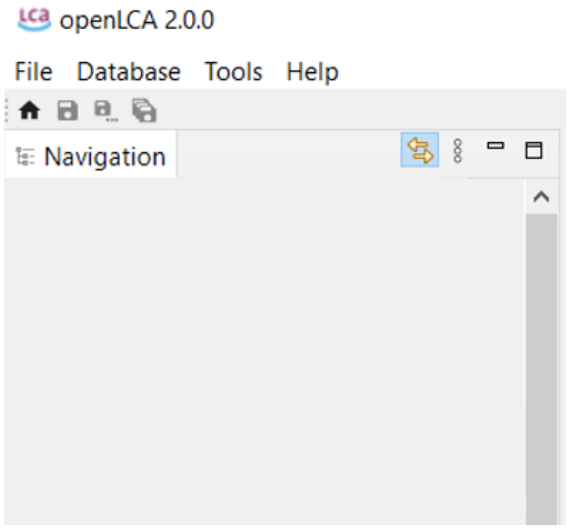
6 DATABASES

In openLCA, a "database" functions as a container that organises and stores interconnected elements needed by openLCA. It serves as a repository for projects, product systems, processes, flows, results, and other important components required for conducting LCAs. Key elements of an openLCA database are illustrated below, along with their relationships.



Database elements. The direction of the arrow represents the direction in which the information flows.

After launching openLCA for the first time, you will notice that the navigation section is empty. To start working with openLCA, you can either create a database from scratch or load one from an existing file (e.g. one you might have downloaded from openLCA Nexus; in this case, follow the instructions for "Accessing databases from openLCA Nexus" in the openLCA Nexus section). You can also load a database from a GitHub repository("New database" > "From repository...").



Empty Navigation window following openLCA installation

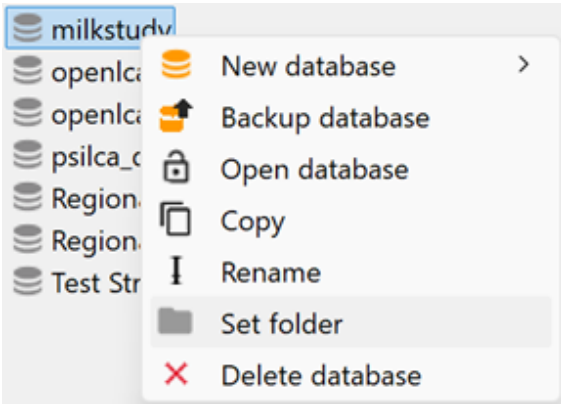
openLCA offers the flexibility to have multiple databases imported into the software. Each database functions independently and only one database can be "active" at a time, while the others remain "inactive". This allows you to separate different LCA studies or case studies for better organisation and management.

However, with openLCA, it is also possible to combine multiple databases by merging their content. This feature enables comprehensive analysis that incorporates various

datasets and LCA models. Refer to the "Importing and combining databases" section for details.

Note It is considered good practice to work with one database for each case study/LCA project performed in openLCA.

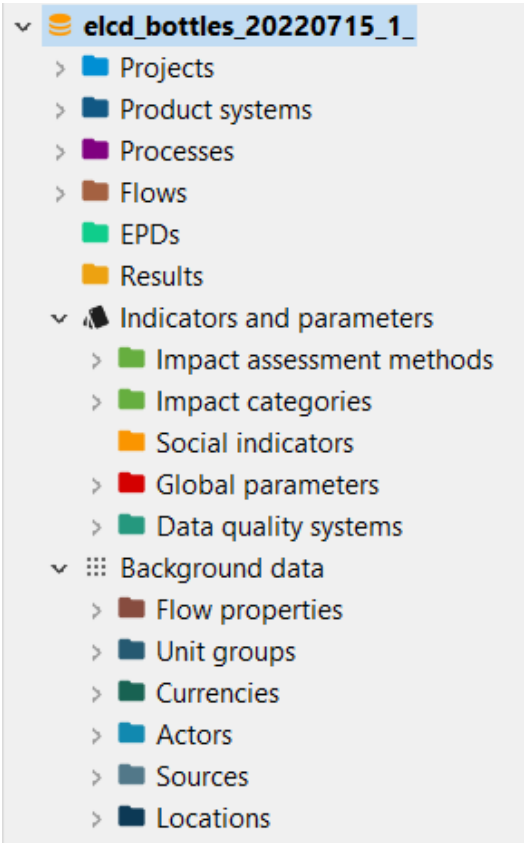
New* Now in openLCA 2, you are able to sort your databases in folders. Right-click on a database and then click on "Set folder", and create your new folder:



After your folder is created you can add also other databases in it just dragging and dropping them.

6.1 DATABASE ELEMENTS

Once you opened or created a database, you'll see these elements in the navigation panel:



- Projects: Projects serve as a platform to compare different product systems, allowing users to assess and evaluate various scenarios.
- Product Systems: Product Systems in openLCA are sets of interconnected processes, linked by flows, that model the life cycle of a product. They are essential for calculating inventory results and conducting impact assessments, as well as outlining the processes involved in producing or modifying products and materials.
- Processes: Processes are a set of interrelated or interacting activities that transform inputs into outputs within a product's life cycle. They outline the sequence of activities involved in producing or modifying products and materials, forming the core of a product system's structure.
- Flows: Flows represent products and materials in a life cycle, connected within the process network. They can be inputs, outputs, energy, and emissions.
- New* EPDs (Environmental Product Declarations): openLCA allows import and creation of Environmental Product Declarations, EPDs. EPDs provide verified, aggregated environmental performance information for specific products.
- New* Results: Results in openLCA are stored as impact assessment results obtained from calculating product systems.
- Indicators and Parameters: Indicators and parameters serve as flexible components that can replace plain input/output values, thereby enhancing the impact assessment method, product system, project, and database levels. They are key for a flexible model and ideal for scenario analyses where certain aspects of a model need to be modified to assess potential impacts on the calculation result.
    - Impact Assessment Methods: In openLCA, you can import different impact assessment methods. These methods provide the framework and algorithms to quantify and assess the environmental impacts associated with the product systems.
    - Impact Categories: Impact categories are classes representing environmental issues of concern to which life cycle inventory analysis results may be assigned (e.g. "global warming", "human toxicity").
    - Social Indicators: In openLCA, users can assess social impacts, incorporating social considerations into the life cycle assessment.
    - Global Parameters: Global parameters can be found and are valid on all levels in the database (processes, product systems, etc.). They can be used to modify formulas and amounts across processes, for example, or to set settings that should be valid throughout an entire database, which makes them extremely powerful.
    - Data Quality Systems: Data Quality Systems are matrices designed to evaluate and record the reliability of data across three key levels: overall data quality within a process, data quality for each individual data exchange within a process, and data quality of social aspects. Data quality can be calculated at the data exchange level within the process, and the

score is displayed in inventory results, LCIA results/impact analysis, and Sankey diagrams. Furthermore, uncertainty values can also be calculated from the matrices and can be used in the Monte Carlo simulation.

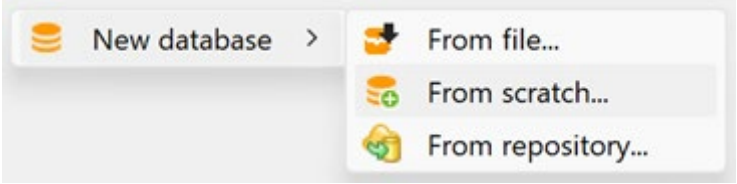
- Background Data: Background data summarises the elements that users typically don't engage with often, like units, locations and so on.
    - Flow Properties: Flow properties are characteristics or properties associated with flows, such as length, mass, volume, or other relevant attributes that help in quantifying and analysing the flows.
    - Unit Groups: Unit groups are collections of units for a given flow property. For instance, units of area, such as square meters (m^2), square feet (ft^2), and square yards (sq. yd), are part of the same unit group. A unit group always has one reference unit; other units in the same group can be converted from one type to another.
    - Currencies: In openLCA, you can assign costs to flows, which enables the calculation of the Life Cycle Costing of a product or service.
    - Actors: Actors represent individuals or entities. Actors can be researchers, experts, or stakeholders, such as data providers, reviewers, authors, and others.
    - Sources: Sources include references, citations, and other supporting information. OpenLCA allows the storage of the original PDF report and other supporting information for sources.
    - Locations: Locations are simply locations, and they can be a region, a country, or any other point on a map. They are important for localising the supply chain and for calculating regional impacts.

Note: openLCA utilises Universally Unique Identifiers (UUIDs) to identify and manage all entities, including processes, flows, product systems, projects, parameters, impact categories, and impact assessment methods. UUIDs are standardised identifiers that ensure uniqueness across systems or databases, even between users.

6.2 CREATING A NEW DATABASE FROM SCRATCH

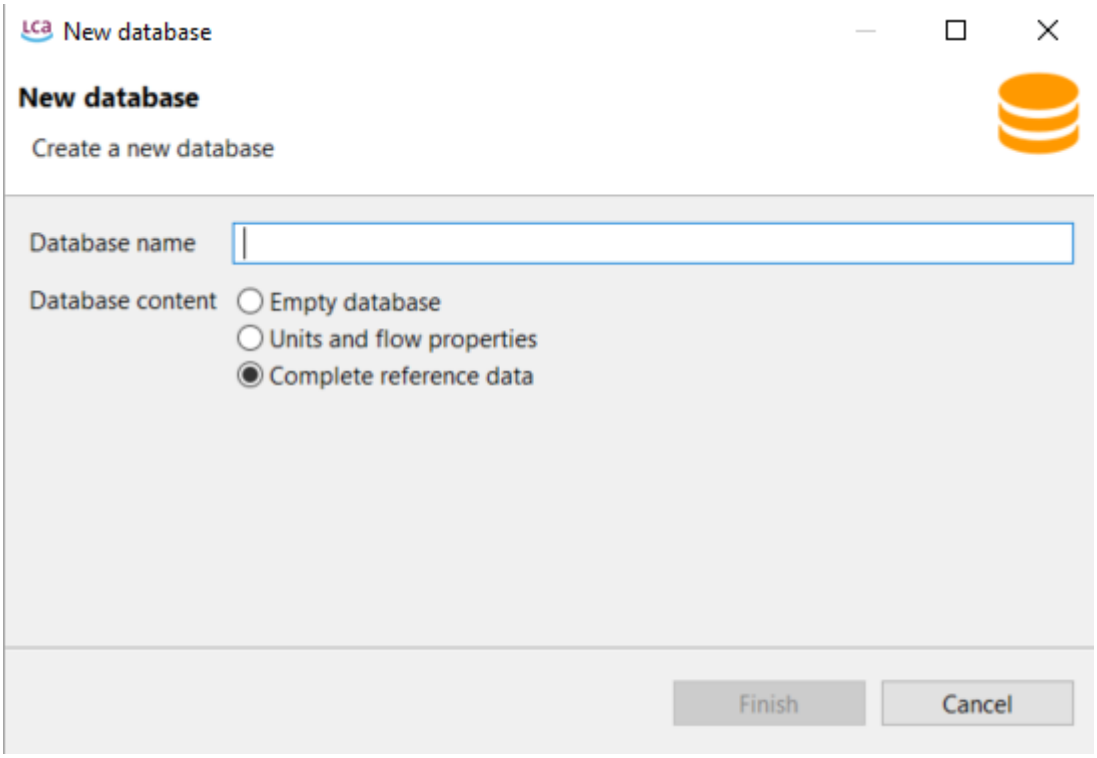
To create a new database in openLCA, follow these steps:

1. Right-click in the navigation window and select "New database" and then "From scratch...".



Step 1: Creating a new database

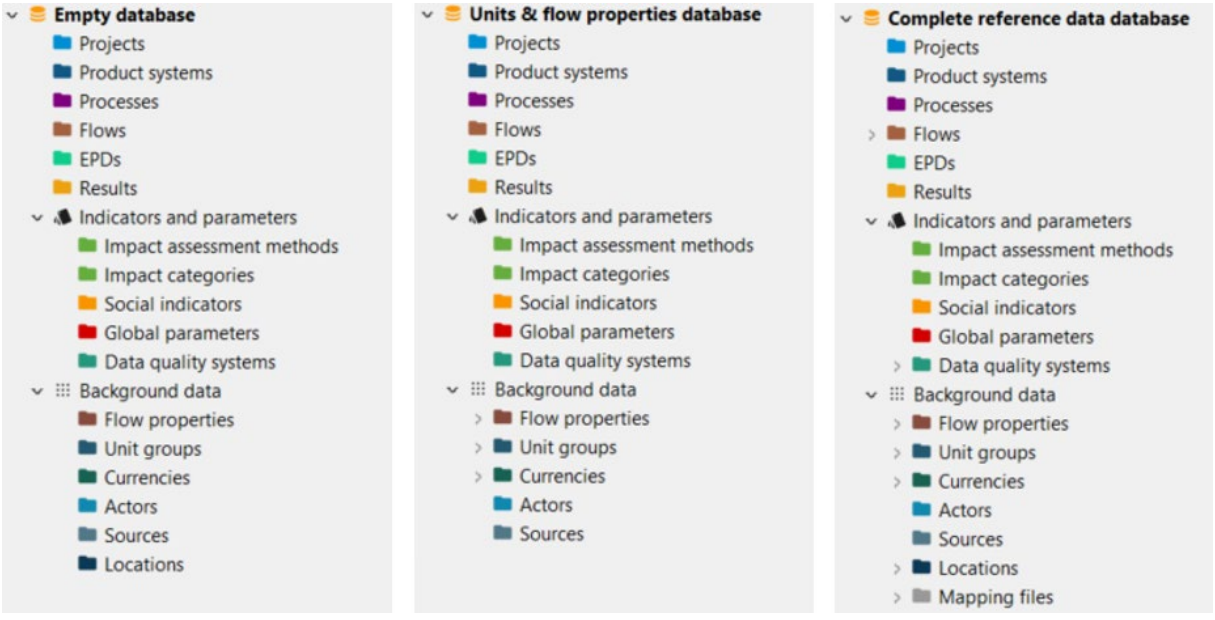
2. A wizard for creating a database will appear, asking you to name the new database.



Step 1 of 2: Data creation wizard

In the wizard, you can choose from the following "Database content" options:

- Empty database: Select this option if you want to create a blank database without any data. As you can see in the figure below, all folders are empty.
- Units and flow properties: This option includes flow properties, unit groups, and currencies in the "Background data" folder of the new database.
- Complete reference data: This option provides a more comprehensive setup, including elementary flows, flow properties, unit groups, currencies, locations, and mapping files in the "Background data" folder of the new database.



The difference between the three available new database types

Note Typically, you will create the database with the "complete reference data" setting, unless you are importing data sets from external sources with other flows than the openLCA reference flows. E.g., you can import an entire SimaPro database and just use all flows and LCIA methods from there. Units are causing fewer issues in different databases and LCA software systems (every LCA software has a unit "kg"), and you will need units, of course; thus, in an empty database, you will need to create everything yourself. Starting with a database that contains the most basic content, such as units, saves time.

New* The ecoinvent geographies, along with their respective geometries, are now directly added to the reference data. Hence, if you create a database using the "Complete reference data" template, it will include these geographies.

Once you've made your selections, simply click on "Finish" to finalise and create the new database!

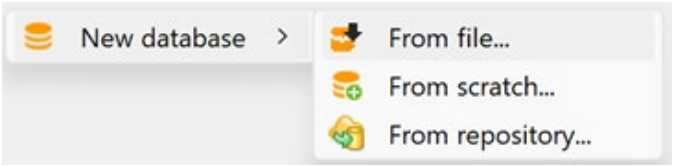
6.3 CREATING A NEW DATABASE, LOADING IT FROM A FILE

Loading a database allows you to import an entire openLCA database, with all elements, process datasets, models, etc., into the openLCA system you are currently working with. This is useful, for example, for restoring backups or migrating all LCA work from a project or colleague.

For loading a complete database, you need a zolca file from openLCA. For example, most files provided by openLCA Nexus are zolca files (see "openLCA Nexus" section in "Resource" for more details about downloading databases from our platform)

To restore a complete database, follow these steps:

1. Right-click on the navigation window and choose "New database" and then "From file...".



2. Select the zolca-format database file from you want to load.

Note The zolca file format was specifically developed by GreenDelta to compress and package openLCA databases, for backup and sharing purposes.

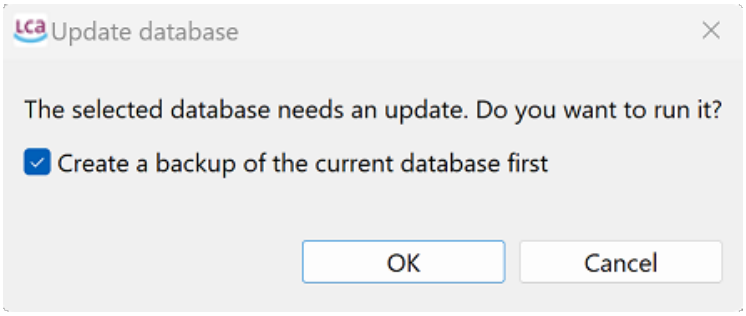
Note The program decompresses the files into a different directory (C:\Users\NAME\openLCA-data-1.4). As a result, the original zolca file remains compressed and won't be directly affected by changes made to the database within the software.

6.4 DATABASE UPDATE

openLCA has an internal database that stores all the different elements visible in the navigation tree (or, at least, most of them). With a new openLCA version, the structure of

the internal database, or database schema in IT terms, may change, for example, because new elements have been added in a new version.

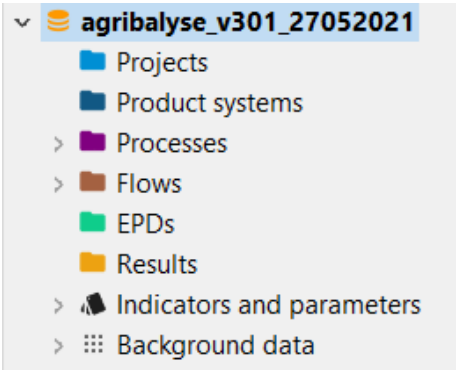
When you try to open a database in openLCA with an older database schema, the software will detect the differences and prompt you to update the database. After the update, your database will be compatible with the new version of openLCA.



Backing up a database before updating to a newer openLCA version

Note: Once the database has been updated, it will only be compatible with the newer version of openLCA. It cannot be reverted to be compatible with older versions of openLCA! It is recommended to create a database backup before updating it.

After completing these steps, the database will open and automatically become your active database (indicated by the yellow icon and bold text). You will see the navigation panel with various folders:



6.5 IMPORTING DATA AND COMBINING DATABASES

Previously, we have described the function "Creating a new database loading it from a file", which is specifically intended for zolca files. Working with data, particularly during the life cycle inventory data collection phase, is a complex process. Therefore, openLCA supports various data formats for use.

SUPPORTED IMPORT AND EXPORT FORMATS:

- EcoSpold1
- ILCD
- Excel

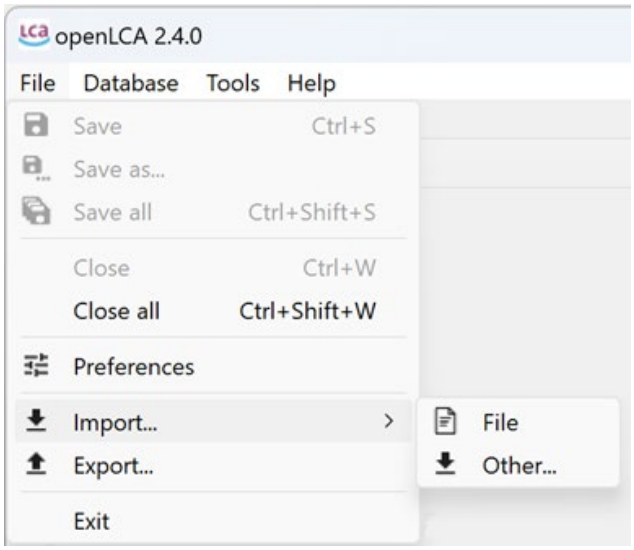
- SimaPro CSV
- Zolca
- JSON-LD

Note for macOS users: If you are using Safari, the browser will automatically unzip your downloaded zip files. However, you need the zipped file for import into openLCA (e.g., when you want to import JSON-LD, method packages, or ILCD). You can solve this issue in two ways:

1. Use another browser for downloads, where zip files are not automatically unpacked after a successful download.
2. Zip the archives again using a third-party tool, as the built-in archive tool from Apple may add additional resources to the zip file that can cause issues when importing the file into openLCA.

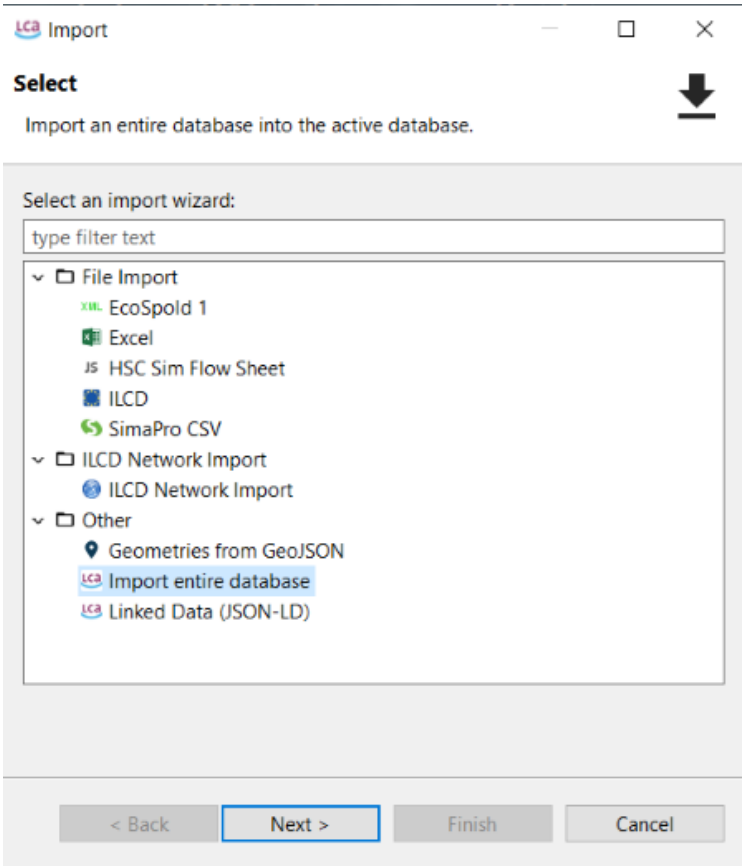
IMPORTING DATA

To import data into openLCA, click on "File" and then "Import", or right-click on an active database in the Navigation Window and choose "Import".



Under the "Import" section, you can find the following options:

- File: This option allows you to import data in various formats, including zolca, EcoSpold 1, Excel, HSC Sim Flow (experimental), ILCD, and SimaPro CSV. The import format is detected automatically.
- Other: This option allows you to manually specify the format of the import, in the picture below you can see the wizard.



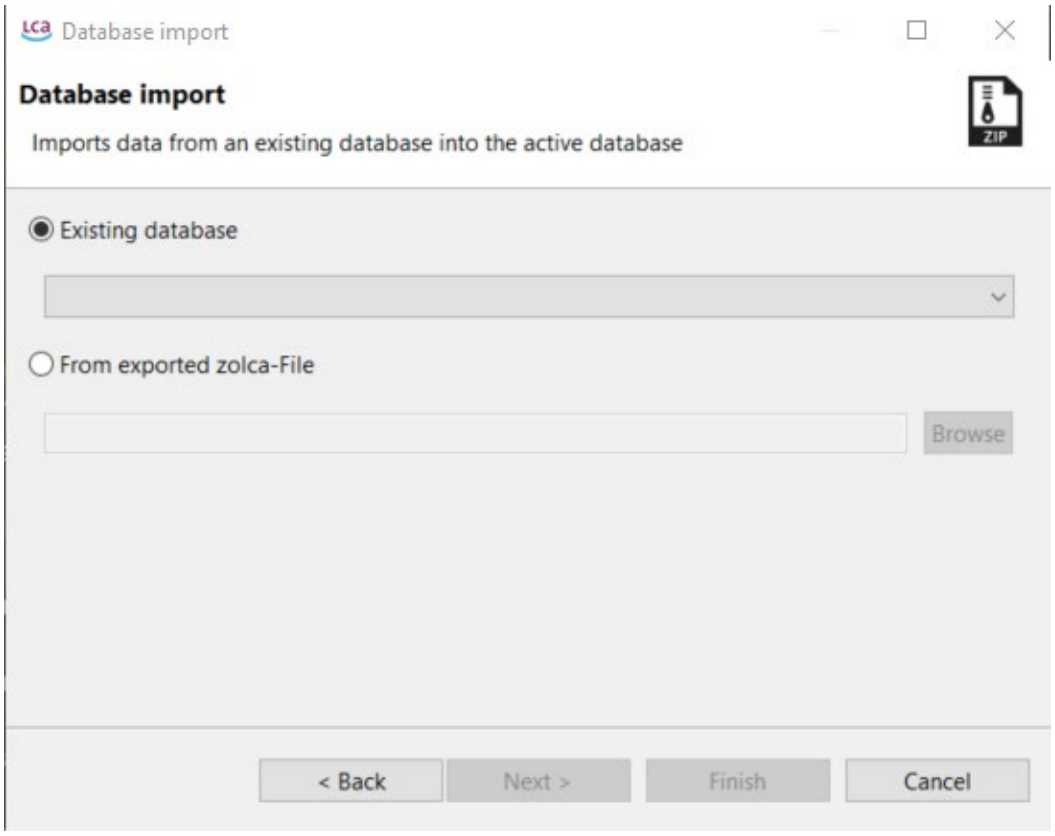
Import'Wizard

The details for each option are displayed below:

IMPORTING A DATABASE FROM AN EXPORTED ZOLCA FILE

The fastest way to open a zolca-format database in openLCA is outlined in the "Creating a new database loading it from file" section. Alternatively, you can use the "Import" function with the following steps:

1. Click on "File" and then "Import".
2. Select "Import entire database" and then click on "Next".
3. Choose the option "From exported zolca-File" in the import wizard.
4. Locate the desired zolca file in your file browser and select "Open". Then, click "Finish".



Import'from'exported'zolca]File

After importing it, the database will be "inactive". To activate it and gain access to its flows, processes, and other components, simply double-click on it.

Note: The program decompresses the files into a different directory (C:\Users\NAME\openLCA-data-1.4). As a result, the original zolca file remains compressed and won't be directly affected by changes made to the database within the software.

IMPORTING AN EXISTING DATABASE

In openLCA, an existing database refers to a database that has already been imported or created within the software. To import data from an existing database into the currently active database, you can follow these steps:

1. Start by following steps 1 to 2 as described above.
2. Select the option "Existing database".
3. Use the drop-down menu to choose the desired database from the available options.
4. Finally, click on "Finish" to complete the import process.

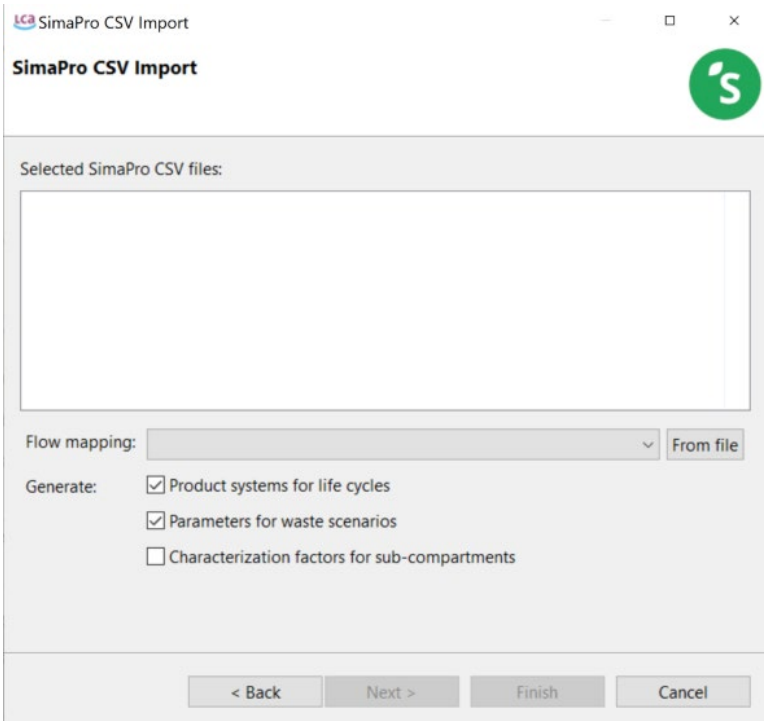
IMPORTING DATABASES AND DATA SETS AS ECOSPOLD, EXCEL, ILCD, SIMAPRO CSV, AND JSON-LD

By following these steps, you can import databases in various formats into existing openLCA databases, allowing you to expand and enhance your data resources:

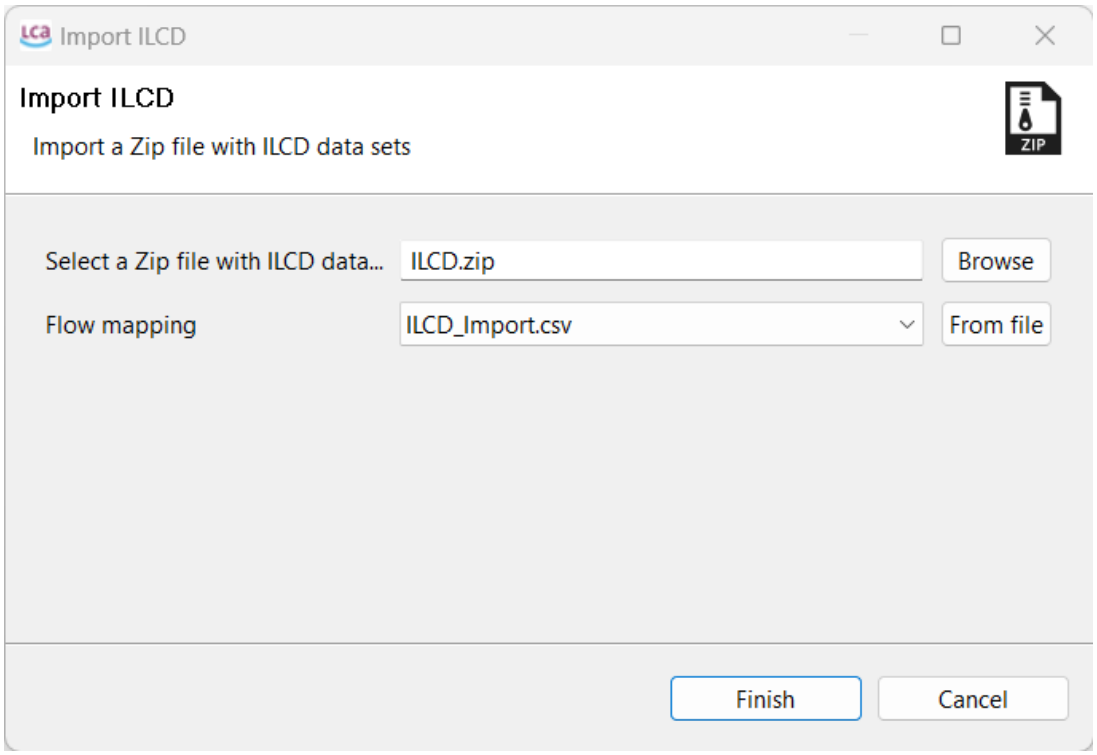
1. If needed, create a new empty database in openLCA to also import the respective reference system (elementary flows, units, etc.) from the database/data set.
2. Double-click on the target database to activate it before importing the data.
3. Navigate to the "File" menu and select "Import". Choose "Other" from the options.
4. Select the specific format of the database you want to import (e.g., Ecospold, Excel, ILCD, SimaPro CSV, or JSON-LD).

Here are some notes on specific formats. Be aware that this is not exhaustive guidance, but provides just some key aspects:

- For SimaPro CSV files, add a flow in the window and optionally select a flow mapping file. If you are importing multiple CSV files without a mapping file, import all the CSV files together to ensure correct mapping.

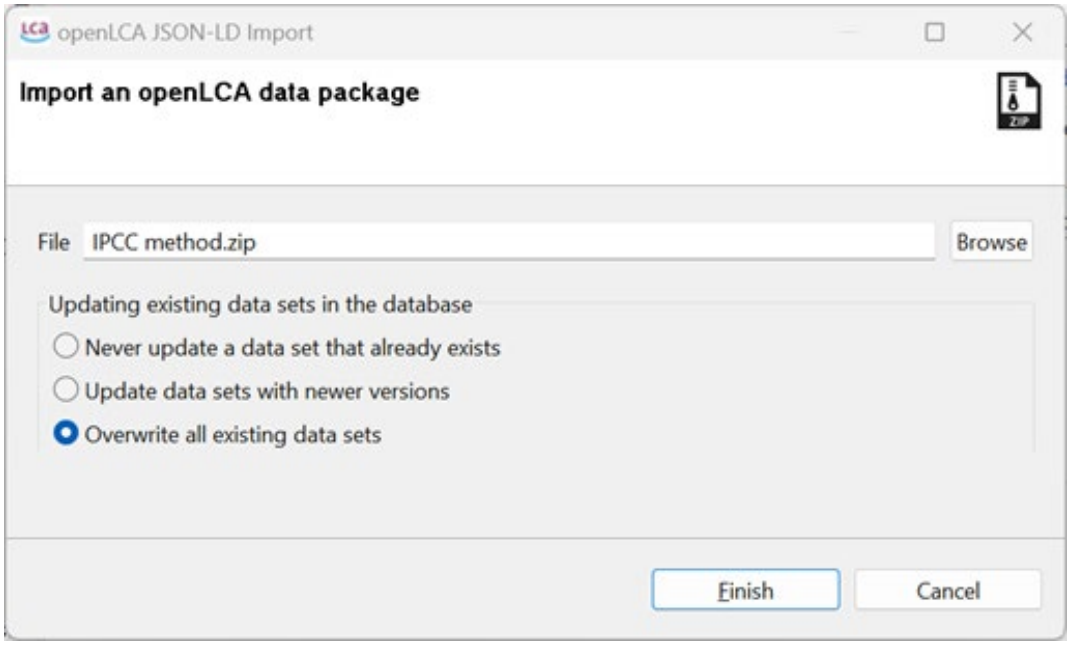


- For ILCD files, select the import file from the directory and optionally a flow mapping file. ILCD databases have to be in .zip format to be imported.



- For Ecospold1 files, ensure that units are checked and assigned using a flow mapping file.
- JSON-LD is the in-house format for openLCA. You can import entire databases, LCIA methods, or any other database element. JSON-LD data has to be in .zip format.

When importing JSON files, you have three options for the case of already existing datasets:



- Never update a data set that already exists: The system will check for matching UUIDs. If a match is found, the existing dataset will remain as it is.

- Update data sets with newer versions: If matching UUIDs are found, the system will update the existing datasets only if the imported version is newer (the version can be checked in the "General information" tab of every dataset).
- Overwrite all existing data sets: If matching UUIDs are found, the system automatically replaces the existing datasets with the imported ones, regardless of versioning.

Datasets with UUIDs that are not present in the current database will be imported anyway, regardless of the option you choose.

In the dedicated chapter, you can find more details about importing LCIA methods in JSON-LD format into openLCA, as the openLCA LCIA methods pack.

5. Click "Finish" to initiate the data import process. The duration of the import may vary depending on the size and complexity of the data.

IMPORTING GEOJSON FILES

In openLCA 2, we introduced a new feature that allows you to import GeoJSON files, enabling the incorporation of geographic information for existing locations in the database. The feature compares attributes like name, UUID, or code of the locations in the database with the features specified in the corresponding GeoJSON file. This helps to find and assign the appropriate location. For example, you can use this method to import the GeoJSON file of ecoinvent locations available at Geography ecoinvent .

Within the database, GeoJSON data is stored in a compressed binary format. This approach reduces storage requirements and ensures the rapid loading of data.

To import GeoJSON files, follow these steps:

1. Select "Geometries from GeoJSON" in the import wizard under "Other".
2. Choose the folder where the GeoJSON file is located.
3. Select the specific GeoJSON file you wish to import.

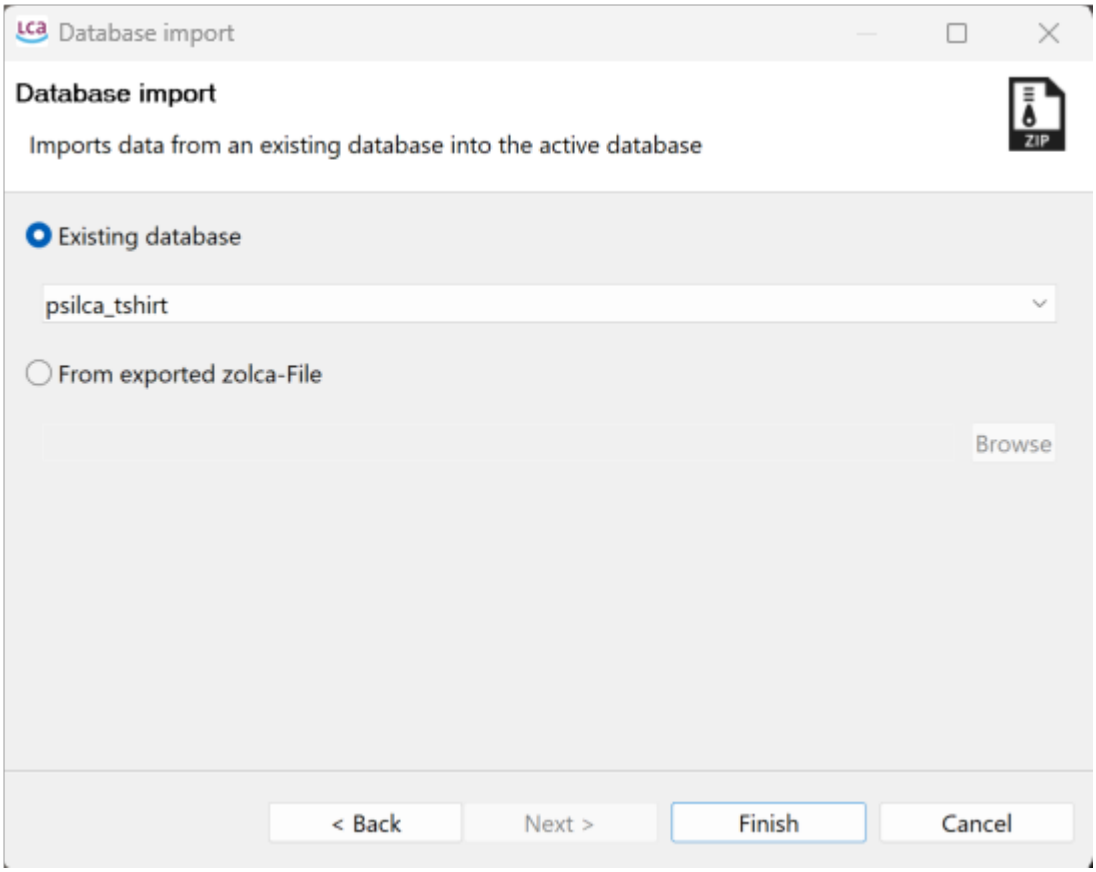
Note: If the GeoJSON file is in a zipped format within the selected folder, extract or unzip it before proceeding, as the import wizard can only add uncompressed GeoJSON files. The GeoJSON file may not be visible in the folder view, but it will be visible in the import wizard once the folder is selected.

COMBINING DATABASES

In openLCA, it is possible to merge multiple databases into a single one. The databases available in openLCA Nexus are carefully mapped to ensure that all elements within each database are accurately recognised and applied. This mapping prevents the creation of duplicate flows during import and guarantees the correct functioning of impact assessment methods.

To combine databases, follow these steps:

1. Begin by creating/importing the first database. It is recommended to import the largest database first to minimise compilation time.
2. Activate the imported database by double-clicking on it.
3. Now, you can proceed to import the remaining databases by right-clicking on the active database, choosing "Import", then "Other...".
4. Select "Import entire database", click on "Next", and eventually choose the database to import from databases that are already present in openLCA or from an exported zolca file (see picture below). Click on "Finish" to combine the databases.
5. The software will automatically combine the databases. The duration of this process may vary depending on the size of the databases involved. For visual guidance, you can refer to the instructional video on combining ecoinvent 3.1 databases.



You can decide to combine the active database with another database already present in openLCA or an exported database.

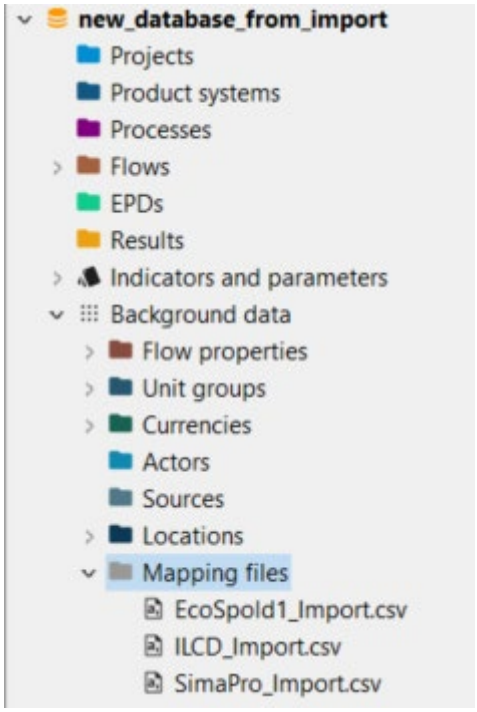
6.6 USING MAPPING FILES IN OPENLCA

When integrating databases from different LCA software that use different names for elementary flows, mapping files become essential for importing these databases into openLCA. These files describe the correspondence between flows in the source system and those in openLCA, facilitating the matching of elementary flow references. By using mapping files, you can align the elementary flow reference system of another data

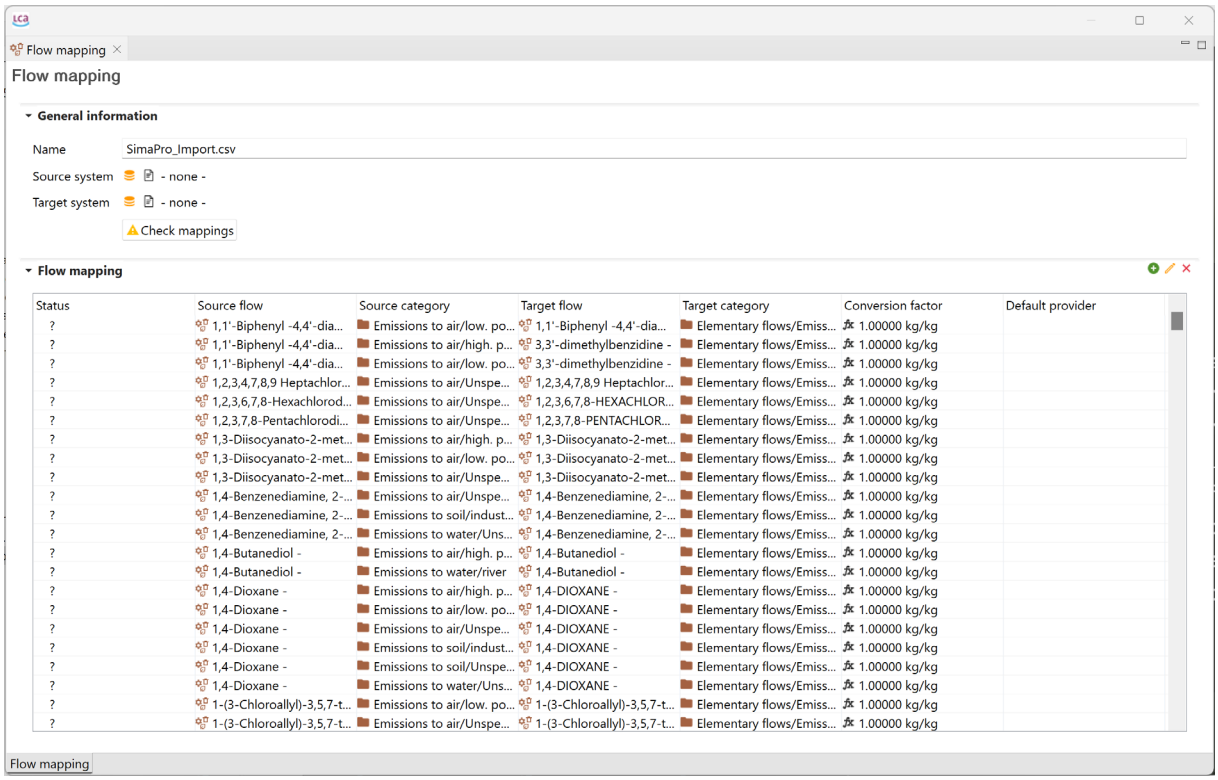
format with that of openLCA during the database import process. Mapping files are in .csv format, containing the necessary data for accurate mapping.

For your convenience, openLCA includes mapping files for the most common formats (ILCD, SimaPro, EcoSpold1) when creating a database with complete reference data, as described in the section "Creating a new empty database".

The database just created has a section "mapping files" under Background data, where you can find the mapping files for SimaPro, EcoSpold1 or ILCD:

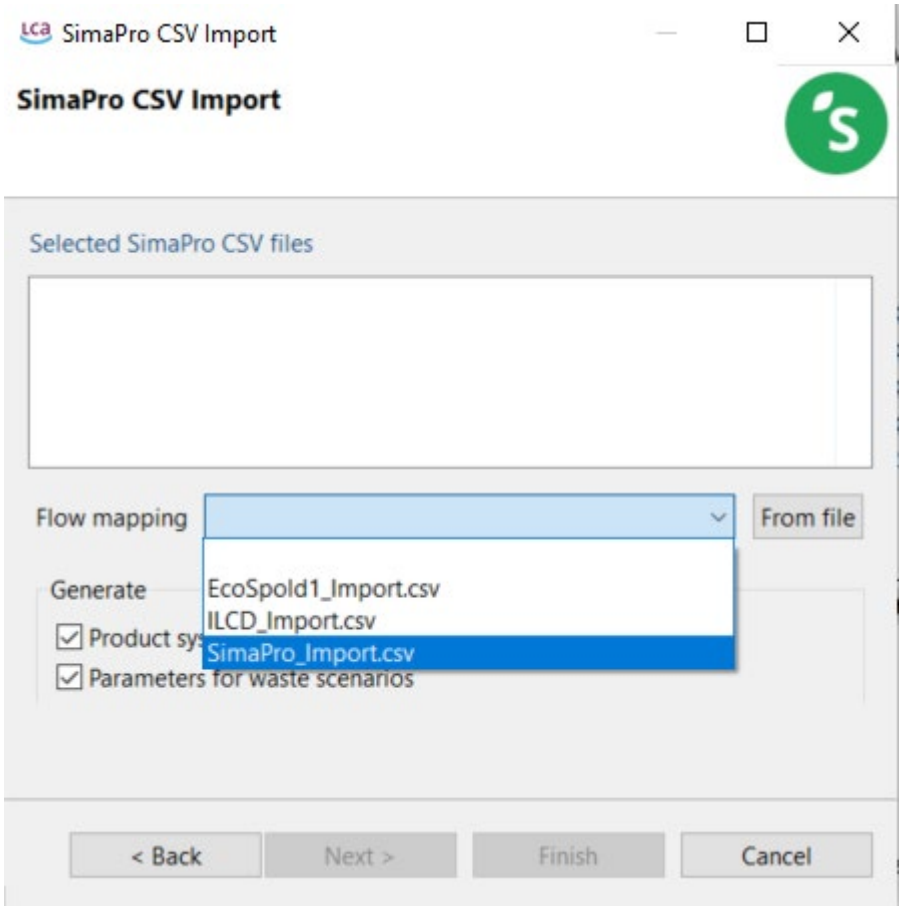


Location of mapping files in the navigation panel



Example of a 'mapping' file

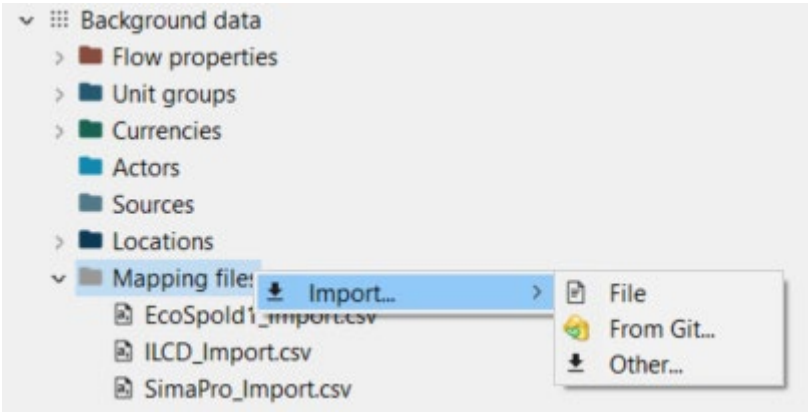
The mapping file is required while "importing a database" with different data formats, e.g. SimaPro, EcosPold1 or ILCD, see the figure below.



Importing a 'database' using a 'mapping' file

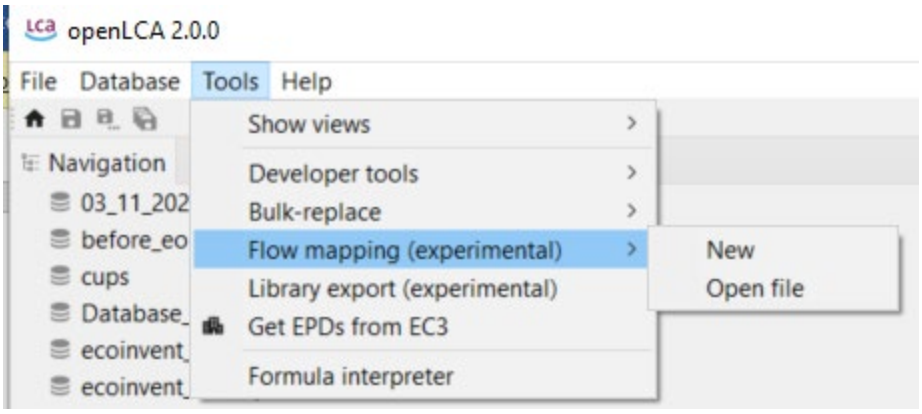
Always check how the mapping file fits your data, and remember that you can also create your own mapping file by following the column schema described in this link.

If you have a new mapping file, you can add it by right-clicking on "Mapping files" and then selecting "Import".



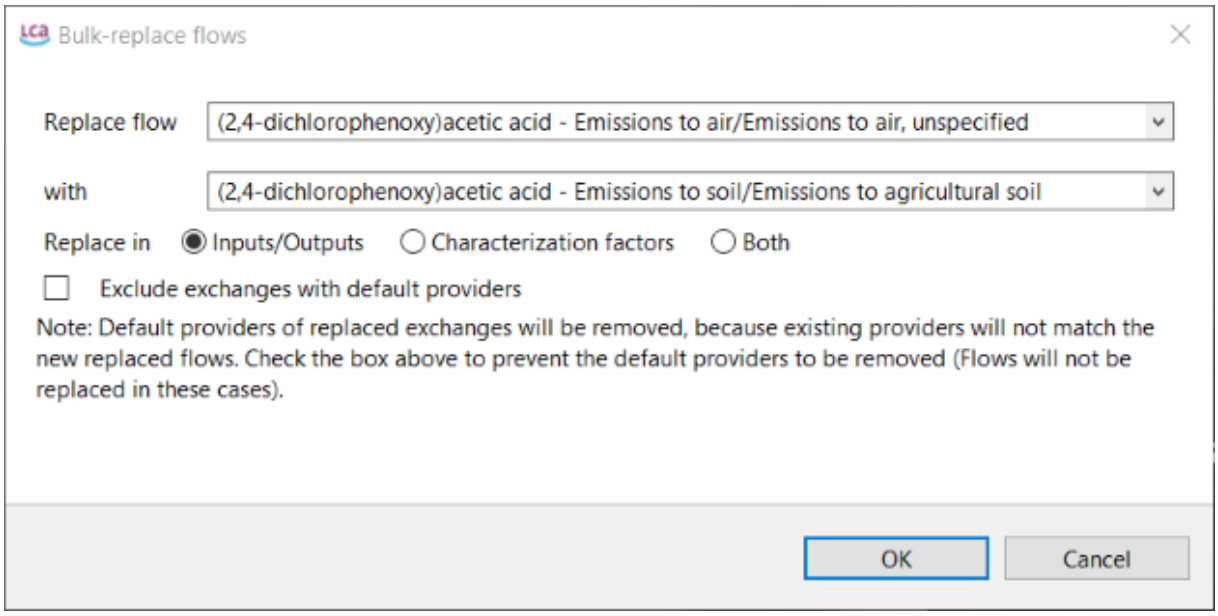
Importing a 'new' mapping' file

You can also access the mapping files through the main menu bar at the top under "Tools".



Importing a 'new' mapping' file

For the manual correction of elementary flows or providers, you can also use the "Bulk-replace" function under "Tools":



Using the bulk replace function for flows

Note: Please always make sure that your mapping was done correctly using the "Validation" (see below) or after a calculation, by having a look at the "LCIA checks" tab. Check out the "Results Analysis" chapter for details.

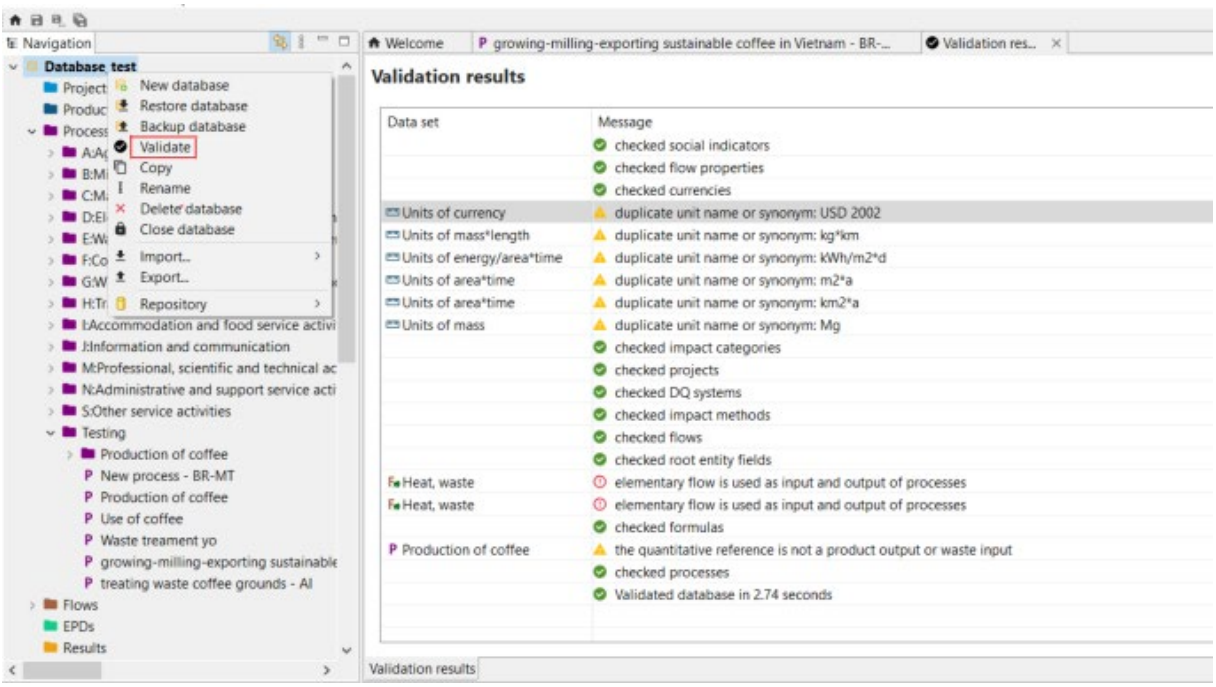
VALIDATION OF A DATABASE

The validation option serves to confirm the integrity of inter-linkages within a database following the import and mapping processes. It ensures that all connections within the database are functioning correctly and accurately. Validating a database is particularly helpful to confirm the accuracy of imported data from external sources and its integration into the existing database. To validate a database, right-click on it and click on "Validate".

In case the validation process encounters errors, it is crucial to address any missing links before proceeding with further modifications. If validation proves to be impossible, it is recommended to discard the recent changes, retrieve the repository again, and start over by committing the modifications.

Examples of validation messages:

- The presence of duplicates or synonyms for a unit
- The quantitative reference is a product input or waste output



Example of errors when validating an active database

In general, errors may arise when corrupt records are retrieved from the repository, or the flows of the database appear to be incompatible (it might be required to use a mapping file during the import).

6.7 EXPORTING DATABASES

Exporting databases in openLCA allows users to extract and save data in various formats for further analysis or sharing.

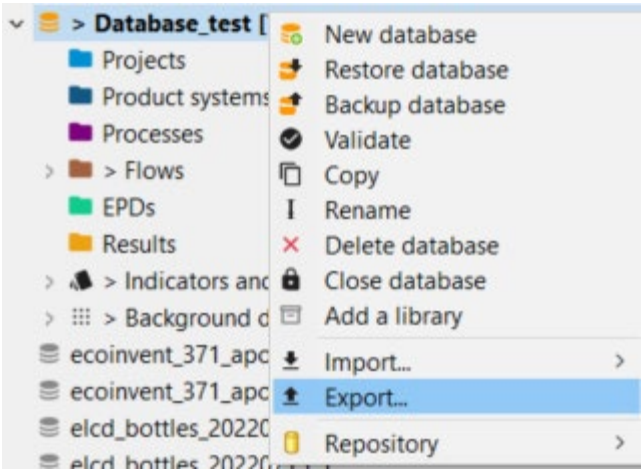
Note: The methodologies described in this chapter can be applied to the entire database in use, as well as to individual elements (such as flows, product systems, and results). You can right-click on the element you want to export and select "Export".

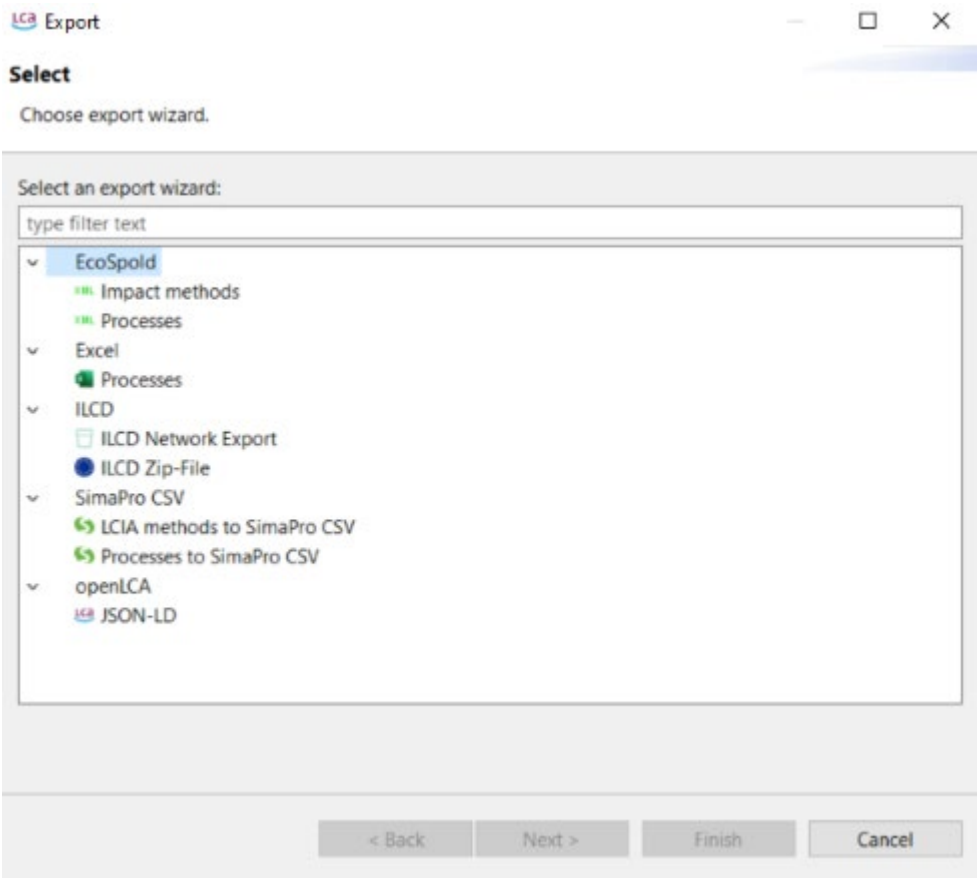
openLCA supports data export in many formats, offering adaptability to different needs:

- Ecospold: Allows exporting impact assessment methods and processes.
- Excel: Enables exporting processes, analysis results, Monte Carlo simulation results, and more.
- ILCD Network Export: Allows exporting data in the XML-based format adapted from the International Life Cycle Data System format.
- SimaPro CSV: Provides compatibility for exporting data in SimaPro CSV format.
- JSON-LD: Allows exporting databases in JSON-LD format, which is a standard for linked data encoding.

To export data from openLCA, follow these steps:

1. Activate the database you want to export from by double-clicking on it.
2. Click on "File" and select "Export" to open the export wizard.

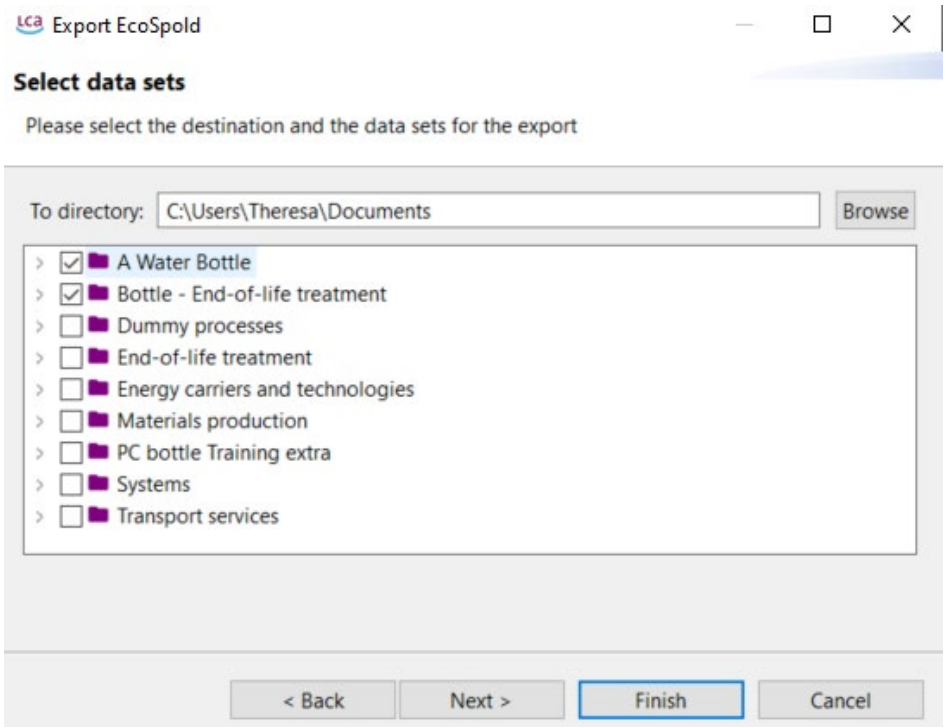




Exporting data from an active database

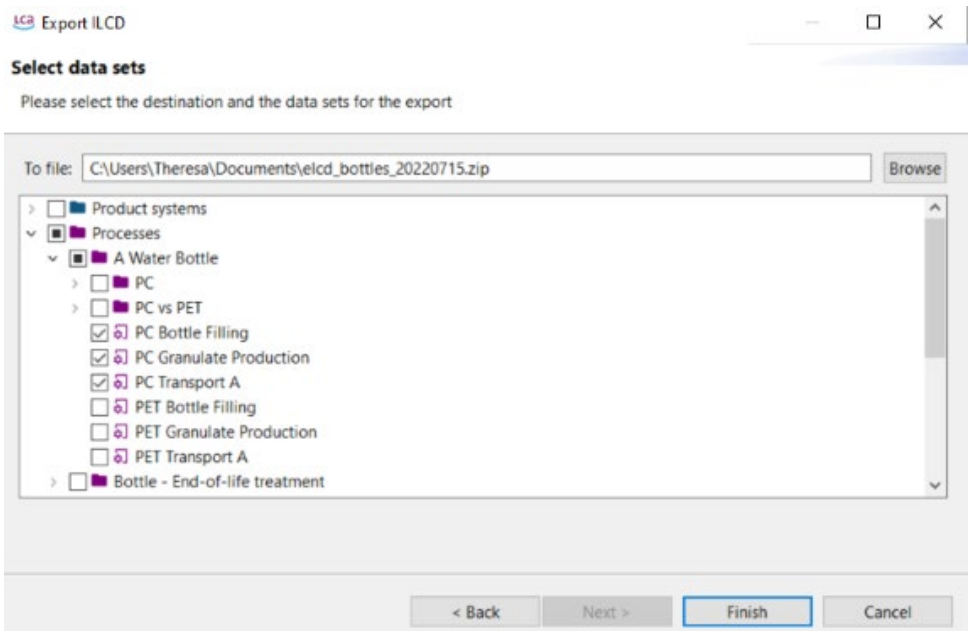
3. Here we provide specific instructions for exporting different data types:

- Ecospold: Choose either "Impact methods" or "Processes" after clicking on "EcoSpold". Select the destination directory and the datasets to export, then click "Finish".



Selecting'data#processes'to'be'exported

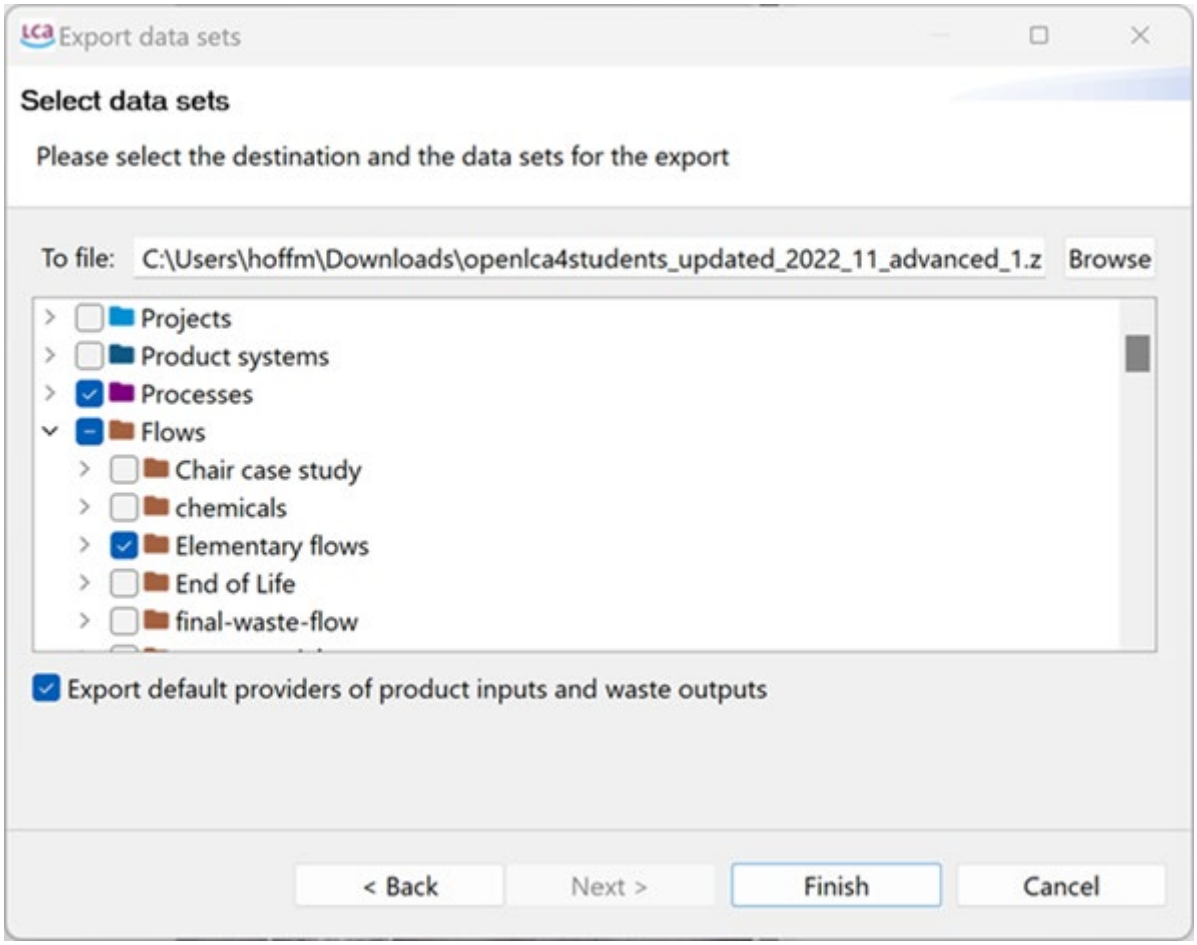
- Excel: To export processes as Excel files, select "Processes" after clicking on "Excel". Specify the export directory and the processes to export, then click "Finish". Each process will be saved as an individual Excel file.
- ILCD ZIP-file: Select "ILCD Zip-File" in the export wizard. Choose an export directory and the database elements to export in ILCD format. Click "Finish".



Selecting'the'destination'and'the'data'set'for'the'ILCD'export

- SimaPRo CSV: You can choose between exporting LCIA methods or processes in SimaPro CSV. Then, click on "Next" to select the elements you want to export, choose a recipient folder for the CSV, and finally click on "Finish".

- JSON-LD: openLCA allows you to export your database as JSON-LD. This allows you to efficiently export selected datasets (processes, product systems etc even on a folder level). Also, you can export the default provider for product inputs and waste outputs. For this, select "JSON-LD" in the export wizard. Choose an export directory and the database elements to export, then click "Finish".



Selecting the dataset#s and destination for the JSON-LD export

Note: The option "Export default providers of product inputs and waste outputs" will not only export the provider link but also the linked processes. This is important if you only export the processes but not the whole database.

For details about JSON-LD, click here.

COPY FUNCTION

openLCA enables users to easily copy information from any table and paste it into other applications, such as Excel or Notepad. Please check the "Importing and exporting data" section for details.

7 FLOWS

Flows represent products and materials that move throughout a life cycle, interconnected within the process network, and take the form of inputs, outputs, energy, or emissions. Flows can be substances, products, materials, energy carriers, emissions, or other types of inputs or outputs. Its name, flow type characterises a flow, and reference flow property (unit category in which the flow is expressed). Examples of flows include electricity, water, CO2 emissions, aluminium, and so on.

In general, openLCA distinguishes three flow types:

Icon	Description
	Elementary flow
	Product flow
	Waste flow

- Elementary flows: These flows represent material or energy entering the system that has been drawn from the environment without previous human transformation, or material or energy leaving the system and released into the environment without further human transformation. For example, crude oil is extracted from the ground, or emissions are released into the air.
- Product flows: These are all the flows that are not elementary or waste flows, and represent the materials or energy exchanged between processes within the product system.
- Waste flows: Waste flows are any substances or objects that the holder needs to dispose of, like by-products with no market value or those requiring more resources to recycle than their economic return.

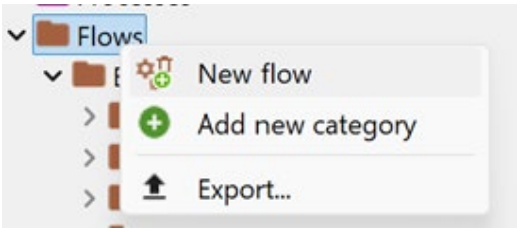
Each flow created in openLCA must be associated with a reference flow property, such as mass, volume, or area. Though it is also possible to have multiple flow properties for the same flow (e.g. uranium can be measured using both mass and radioactivity units, gases can be measured using both mass and volume units, etc.)

Note: Certain waste flows can also be modelled as product flows. In databases, this is usually stated in the name. Waste paper is a great example. As it can be used in the production of paper, waste paper isn't necessarily modelled as a waste flow but instead as a product flow.

7.1 CREATING A NEW FLOW

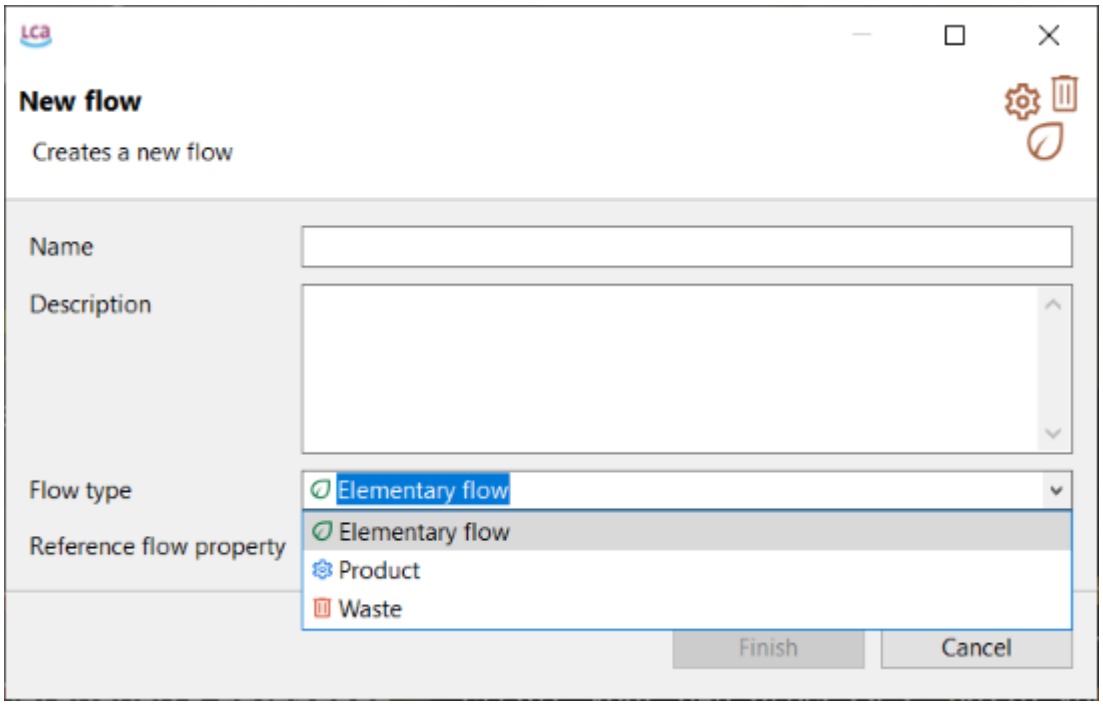
To create a new flow in openLCA, follow these steps:

1. Right-click on the "Flows" folder in your active database.
2. Select "New flow" from the context menu.



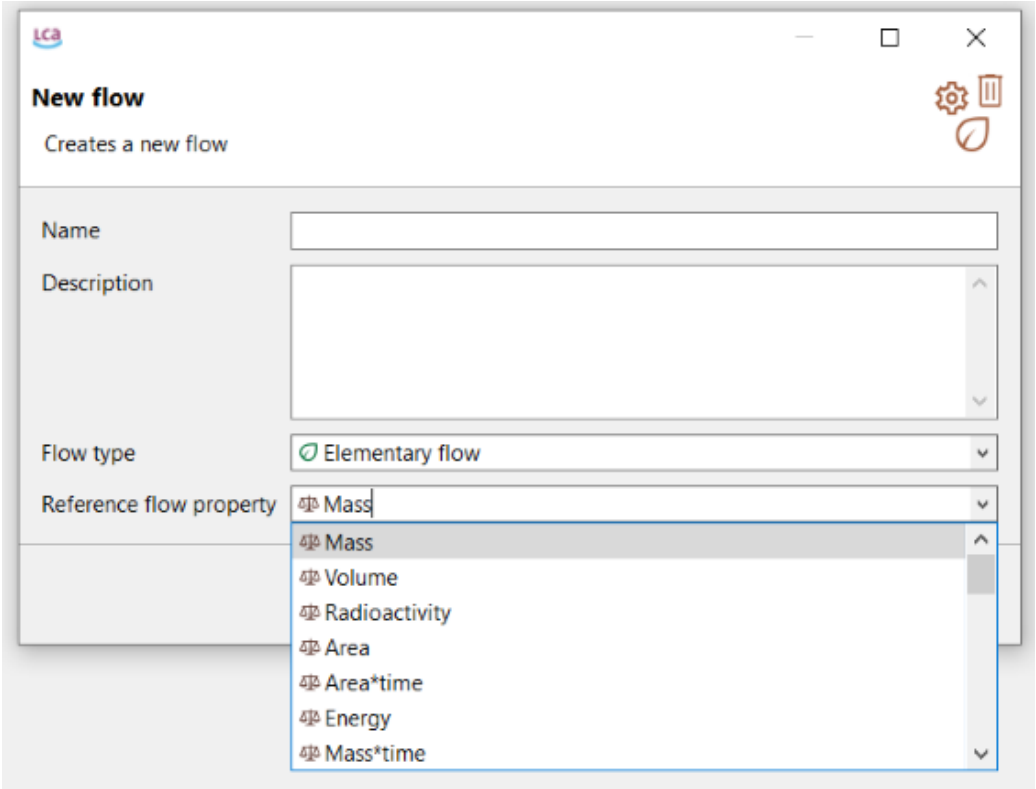
Creating a 'new' flow

The flow creation window will open automatically. Here you can provide a name for the flow, adapt the flow type as a product, elementary or waste flow:



Flow' creation' window

Moreover, choose the reference flow property:



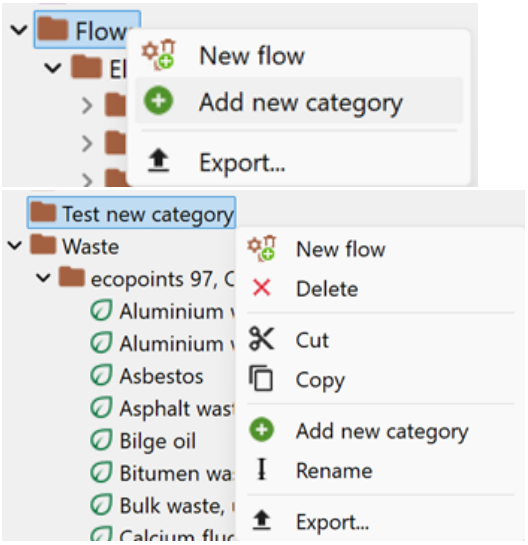
Flow'creation'window

It is mandatory to define a reference flow property to proceed. However, you can change it afterwards.

4. Click "Finish" to complete the flow creation process.

After clicking "Finish," a new flow window will open in the editor interface. Here, you can further specify and define the properties and attributes of the newly created flow according to your requirements.

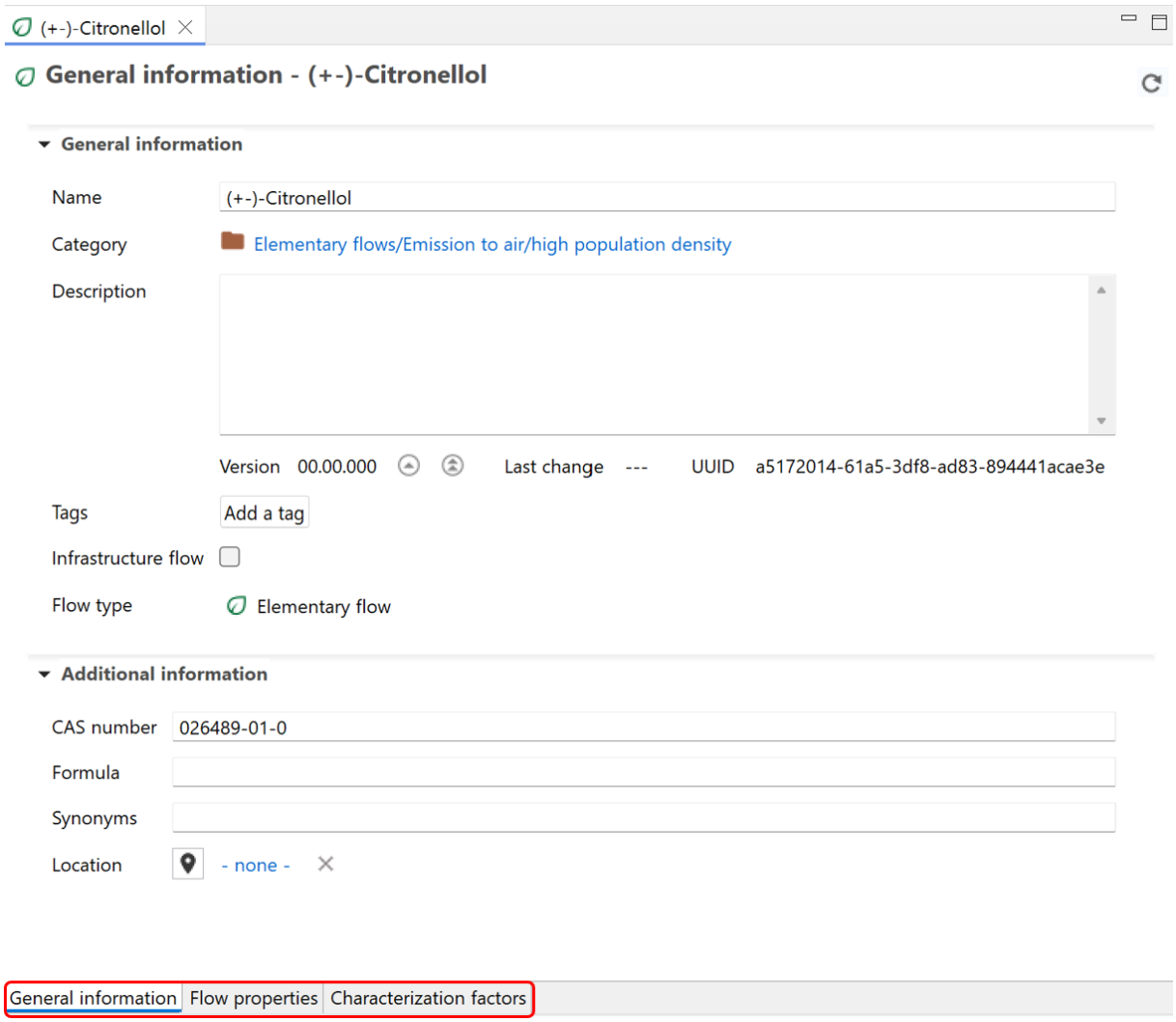
Note: If you want to organise flows into different categories, first choose to add a category (sub-category). This allows you to create a new category/folder under which you can then add flows to maintain organisation.



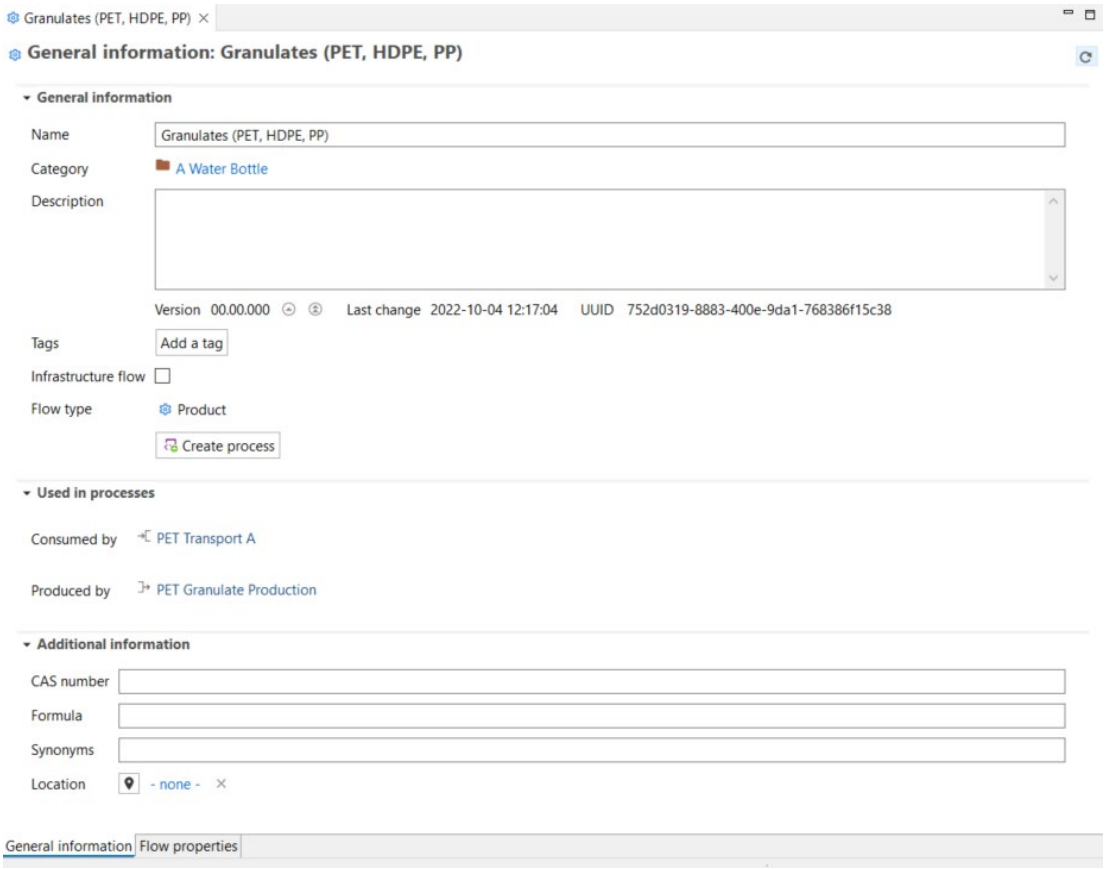
Creating'a'new'category

7.2 FLOW TAB CONTENT

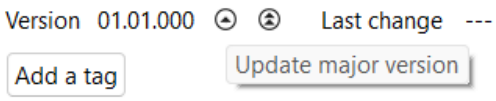
After opening a flow in openLCA, you will find tabs at the bottom of the window that provide access to different information and settings relevant to the flow. These tabs differ based on whether the flow is a product, waste, or elementary flow. Let's explore the contents of these tabs:



GENERAL INFORMATION



- General Information: Here, you can view and modify the flow's name, add a description, additional details, or tags, and create a process using the flow as a reference.



Note'on'..Version...openLCA performs versioning for you. Every time you save the flow, the version will be updated automatically. Additionally, you can also manually increase the version by clicking on either "Update major version" or "Update minor version". The version can't be reset or modified downwards within openLCA to keep track of changes.

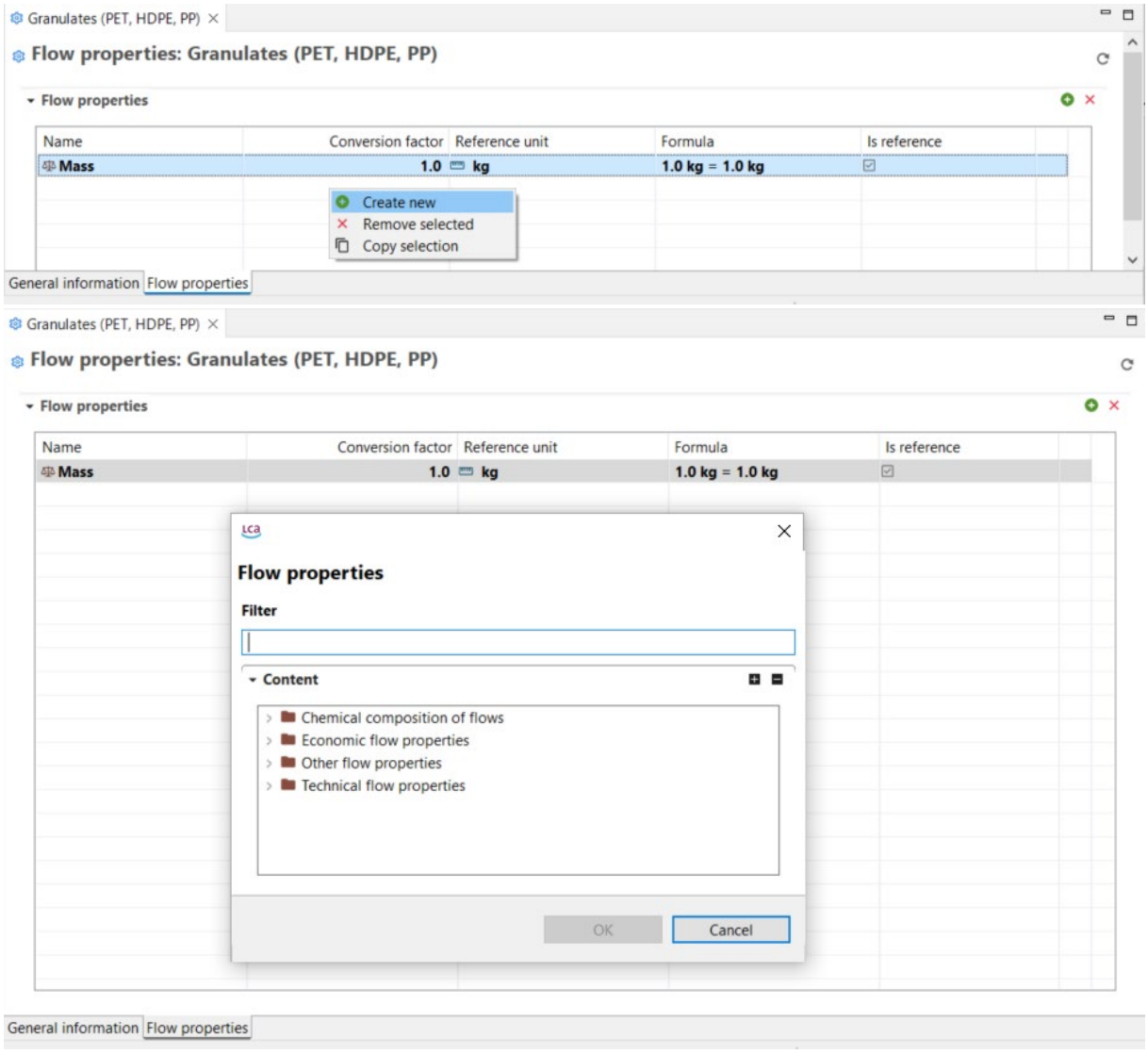
Note'on'..Infrastructure'flow...This checkbox serves to store whether a flow is an infrastructure flow or not (so, the flow is a product with a long lifetime and costly – a building, a machinery, ...). This is a mandatory field in the EcoSpold1 format and also used by SimaPro, e.g.. In openLCA, it has no practical effect.

- Used in Processes (for product and waste flows only): This section shows the processes that consume or produce the flow. Double-clicking on a process will open it in the editor for further exploration.

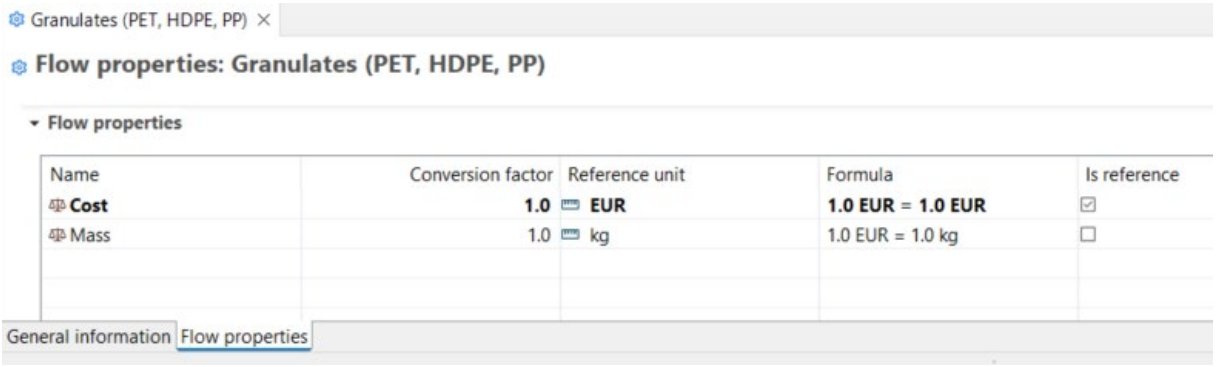
- Additional Information: You can use this section to include extra details like CAS number, chemical formula, location, and synonyms to facilitate search and identification of the flow.

FLOW PROPERTIES

Under the "Flow Properties" section, you can modify the reference property of the flow. Clicking on the green plus icon, you can also add any other properties relevant to the flow (e.g. economic properties, technical properties, etc.). Alternatively, you can add new properties by right-clicking on the property table and selecting "Create new". When you enter an additional flow property, you also need to enter a conversion factor to allow conversion between different properties.



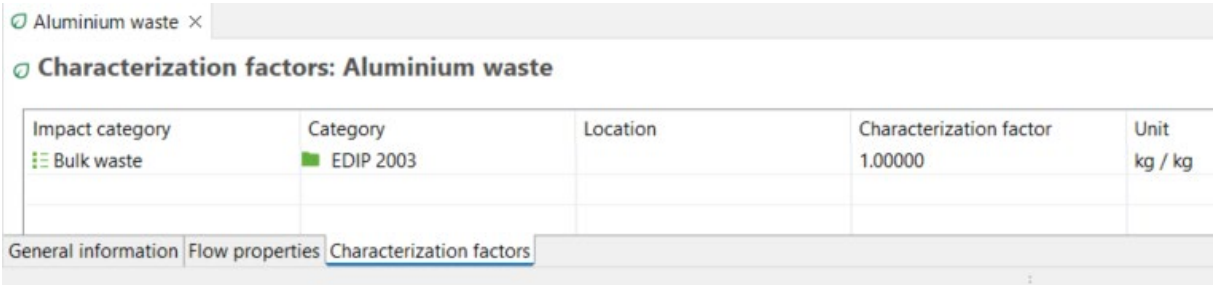
Add#edit'flow'properties



Conversion factors are given in the „Formula…" column

CHARACTERIZATION FACTORS (FOR ELEMENTARY FLOWS ONLY)

For elementary flows only, you have a third tab called "Characterisation Factors". Within this tab, you can view the impact category or categories in which the flow is involved (if any), the impact method associated with the category, the location associated with the flow (if any), the characterisation factor for each impact category, and the corresponding unit.



Elementary flow characterisation factors

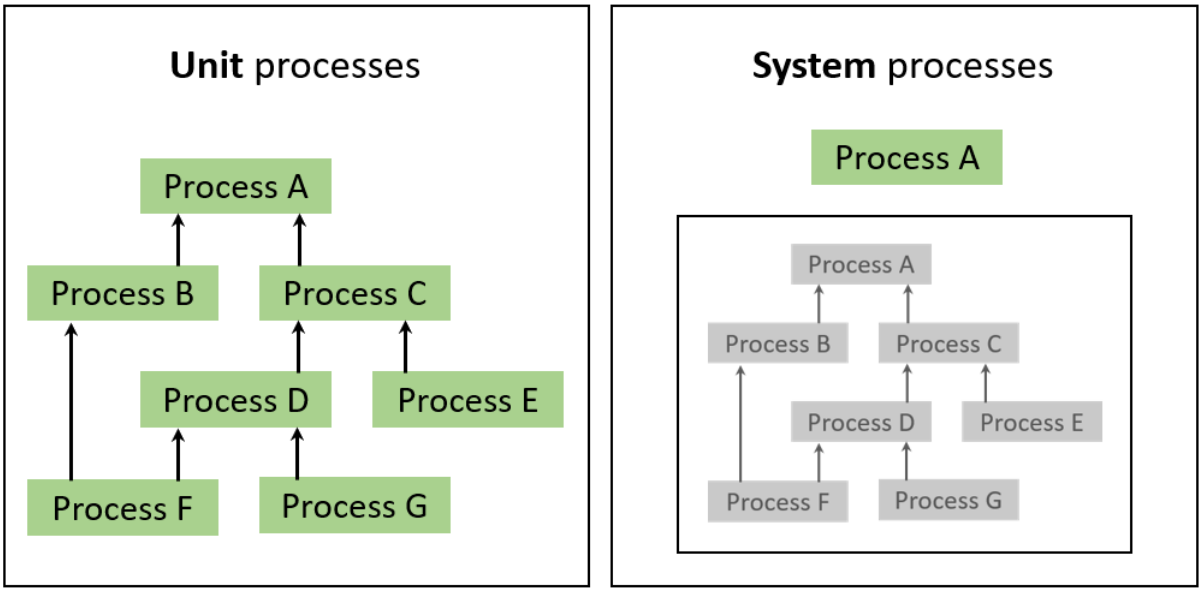
8 PROCESSES

A process is a set of interrelated activities that takes place within the life cycle of a product or system, and transforms inputs into outputs. A process can be a manufacturing process, a transportation activity, an energy generation process, or any other operation within the life cycle. Processes are defined by their quantitative reference, which represents the amount of product or service that the process provides. For example, a process could be defined as the set of all inputs and outputs that occur during the production of 1 kg of PET granulate.

openLCA distinguishes two types of processes:

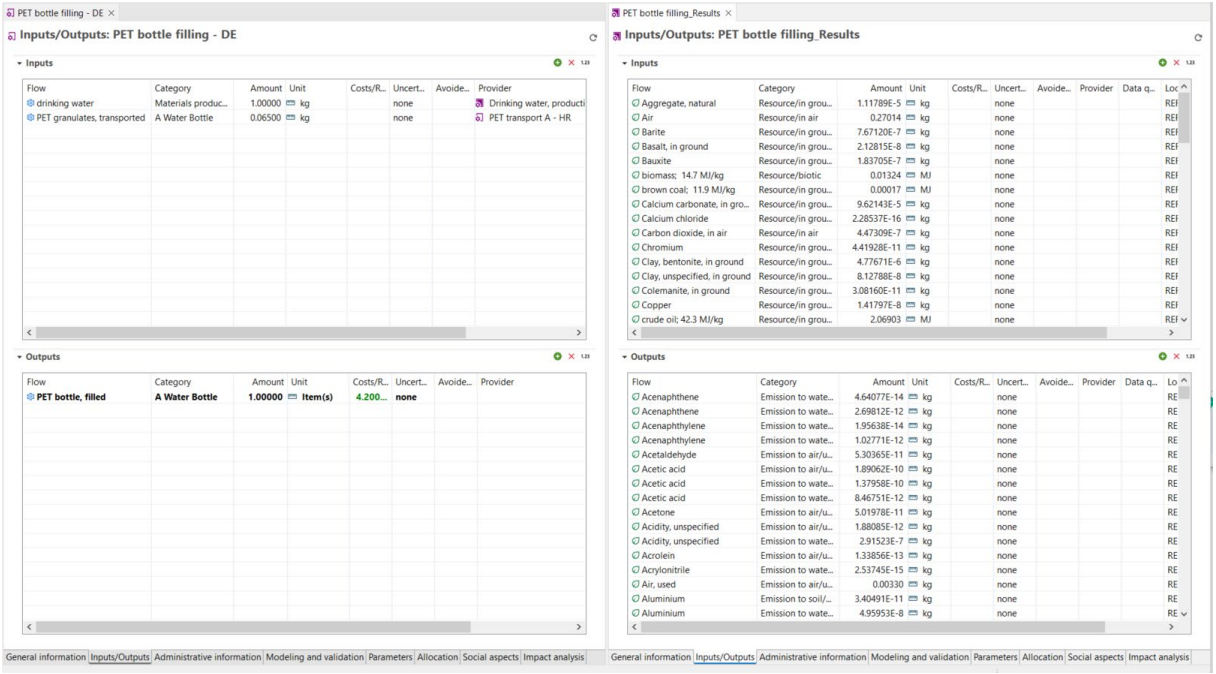
- Unit process: A unit process is the smallest (least aggregated) unit in a production system, for which input and output data are quantified. It can contain any flow type.
- System process: A system process is an aggregated life cycle result saved as a process.

The following picture shows the difference between a unit process (left) and a system process (right). In the left picture, each process from A to G is a unit process. In the right picture, an aggregated process (system process) is shown instead.



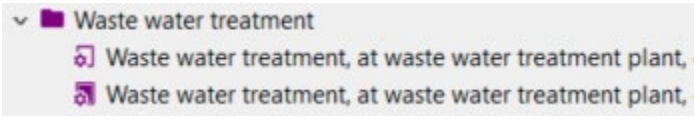
Difference between unit process and system process

The following picture shows the difference between a unit process (left) and a system process (right) in openLCA.



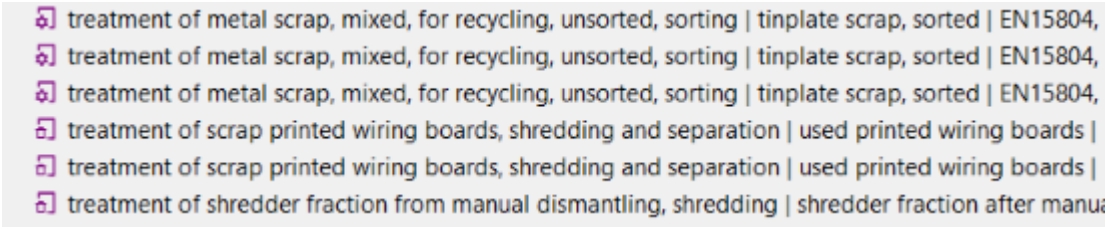
Difference between unit process (left) and system process (right) in openLCA

Unit processes and system processes are displayed with different icons in the navigation window as shown below.



Unit processes with purple font colour and empty background, and system processes with purple font colour and filled background.

Moreover, in openLCA, we differentiate the icons between processes with product flows (gear) and waste flows (bin) as a reference accordingly:

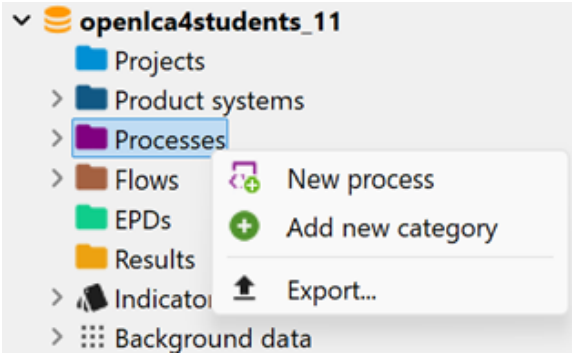


The top three processes are those with product flows as a reference, in contrast to the other three, which represent waste treatment.

8.1 CREATING A NEW PROCESS

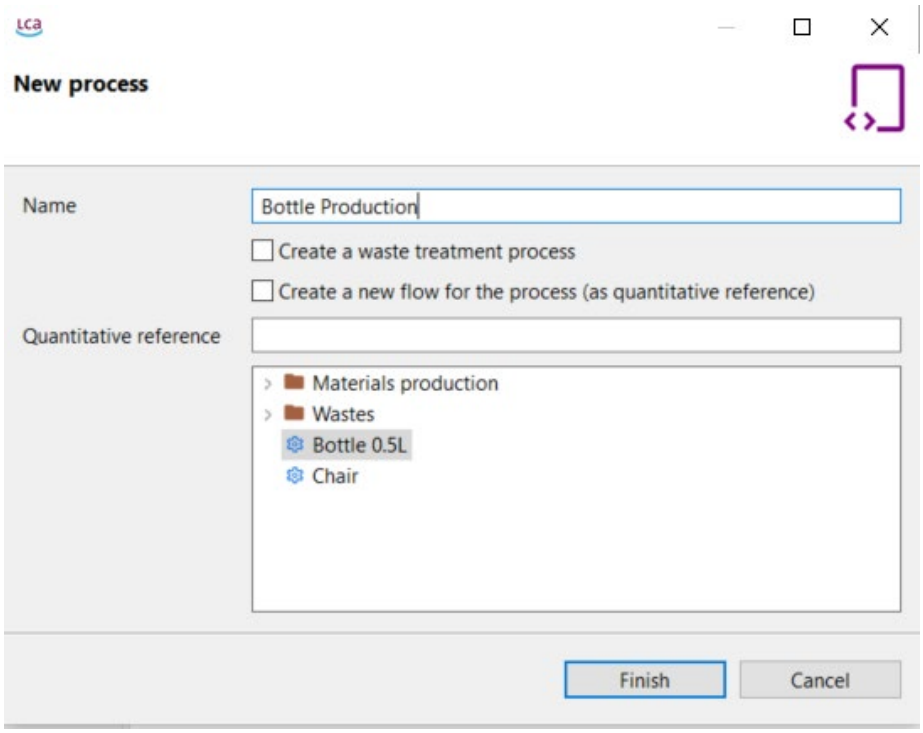
To create a new process, follow these steps:

1. Right-click on the "Processes" folder and select the option "New process" from the context menu.



Step 1: Creating a new process

2. Provide a name for the process and choose a quantitative reference for it by selecting an existing flow, or create a new flow by checking the corresponding box. If the flow is not named, it will automatically adopt the same name as the process.



Step 1/3: Selecting a quantitative reference while creating a new process

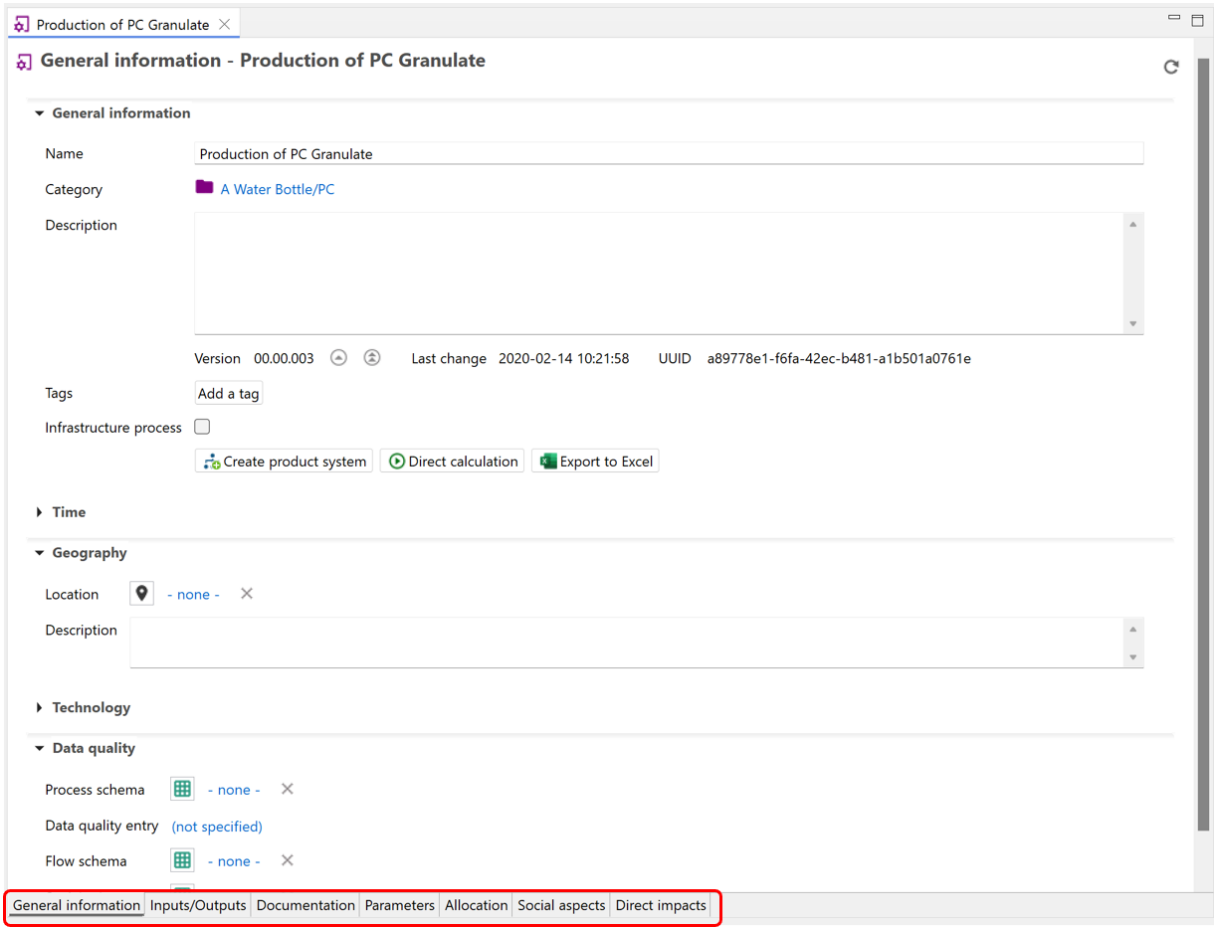
3. Click "Finish" to create the process, which will then open in the editor.

After creating a new process, the process window opens, allowing you to define and manage the process's properties.

It is also possible to create waste treatment processes. Check the "Waste modelling" section for details.

8.2 PROCESS TAB CONTENT

After opening a process in openLCA, you will find tabs at the bottom of the window that provide access to different information and settings relevant to the process.

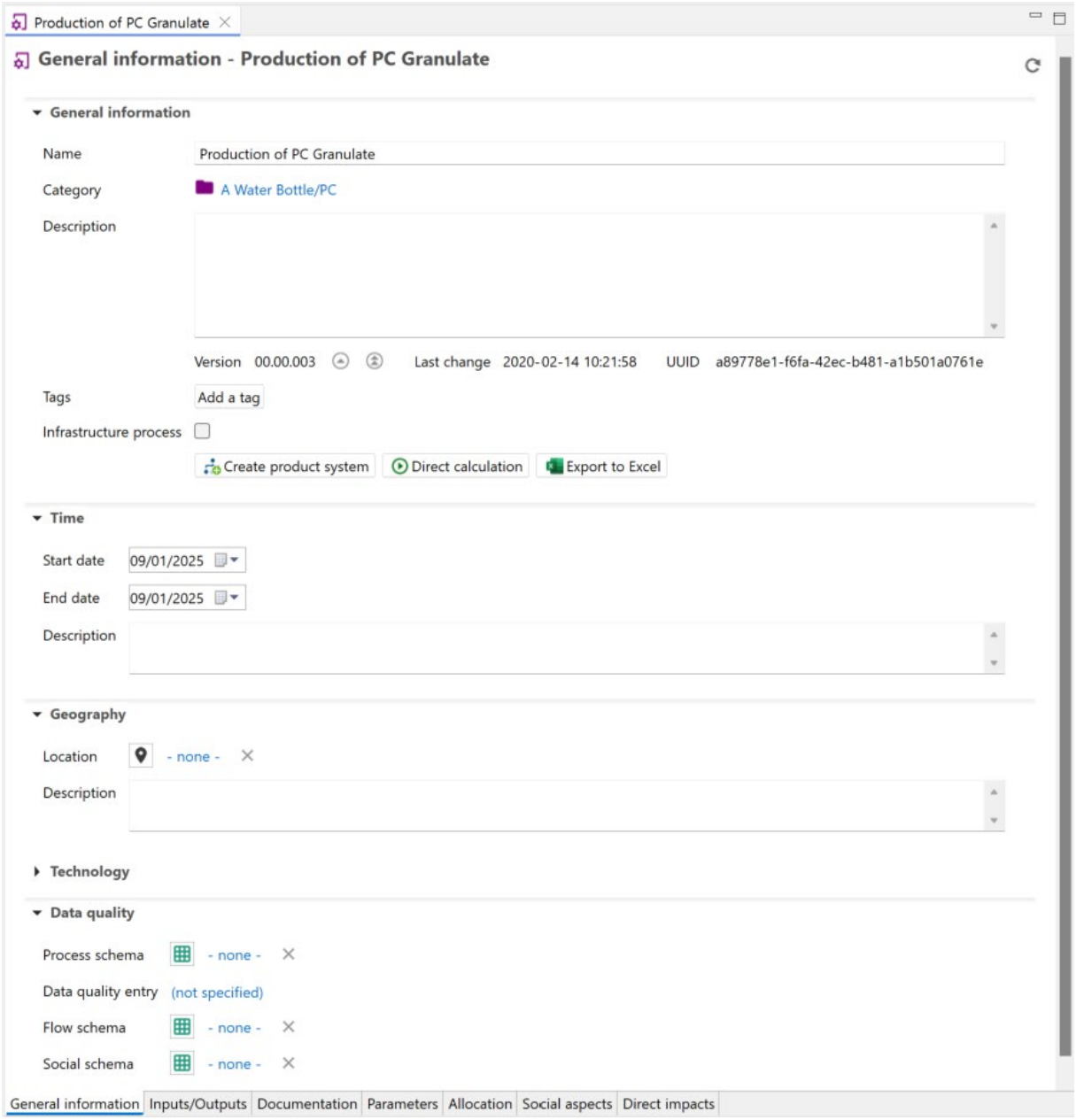


Tabs of the process window

In the sub-chapters that follow, we'll explore every tab in detail.

- General information
- Inputs/Outputs
- Documentation
- Parameters
- Allocation
- Social aspects
- Direct impacts

8.2.1 General information



General information tab of a process

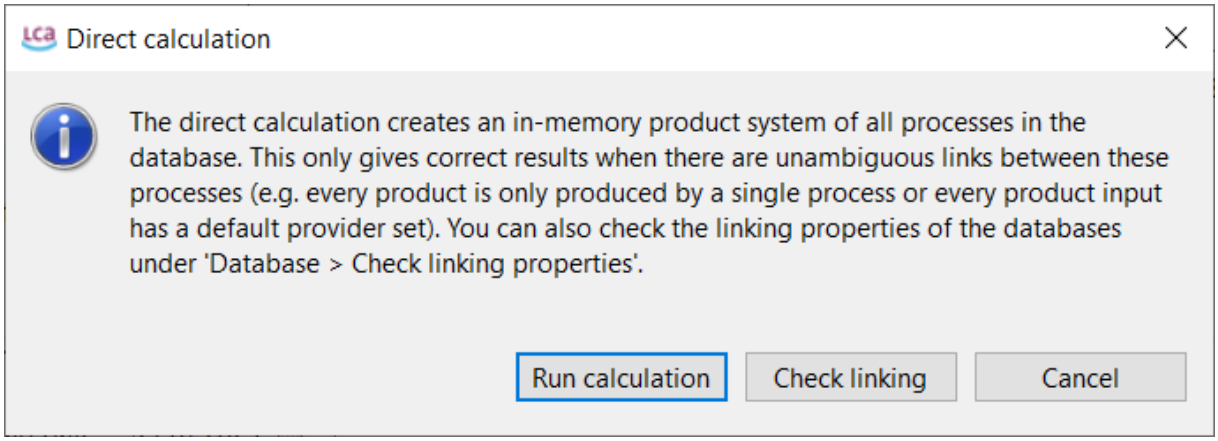
Here, you can view and modify the name of the flow, add a description, additional details, or tags, create a product system from the process, and export the process tabs to an Excel file. Additionally:

Note on „infrastructure process“: This checkbox serves to store whether a process is an infrastructure process or not (so, the process is a product with a long lifetime and costly – a building, a machinery, ...). This is a mandatory field in the EcoSpold1 format and also used by SimaPro, e.g.. In openLCA, it has no practical effect.

Direct calculation: The "Direct calculation" feature generates and then calculates an in-memory product system, connecting processes using default providers or the first found connection. Reproducible and correct results are only obtained if there are unambiguous connections between these processes, i.e., if either there is always only

one producing process for a product, or a default provider is set, making the connection to the providing process clear and unique.

If you are unsure about the connections, check the linking properties of a database, either via "Database → Check linking properties" or via the "Check linking" option in the pop-up window after selecting "Direct calculation":



Check the linking prior calculation.

The main advantage of "Direct calculation" is its lower memory usage. It bypasses the need to create a separate product system in advance. This is particularly practical when working with databases that create very large product systems, such as PSILCA and Exiobase.

TIME

In the time section, you can add and edit the start and end times of the process as well as provide any relevant descriptions.

GEOGRAPHY

In the Geography section, you can add and edit the location of the process. Clicking on the chosen location, you can also see it on a map.

Add a location to a process.

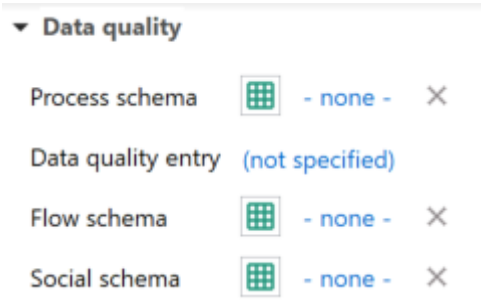
View a location on a map

TECHNOLOGY

In the Technology section, users have an add a description about the technology employed in the process.

DATA QUALITY

Here, you can define the data quality flow schema for your process at both process and flow levels.



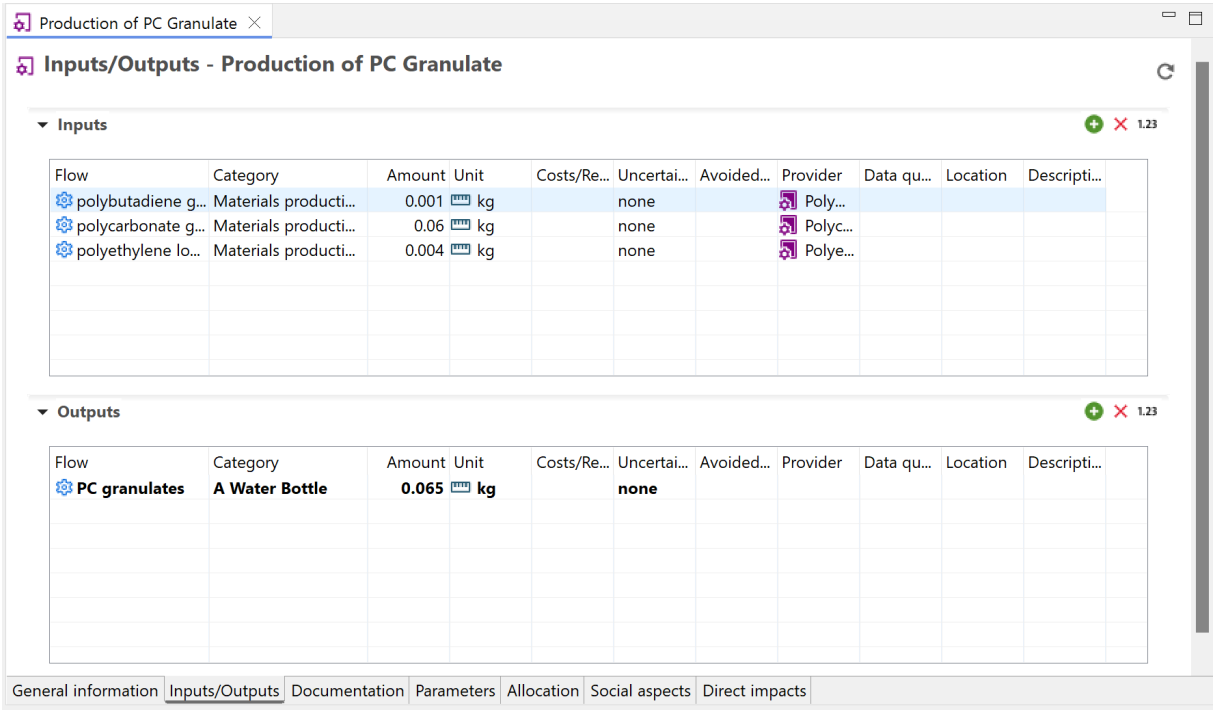
Options for data quality in a process

The process data quality will be entered in the "Data quality entry", whereas flow data quality will be entered at the Inputs/Outputs tab next to the respective flows. Check the Data Quality section for details. Further, a "Social schema" can be filled.

8.2.2 Inputs/Outputs

As we've seen, a process encompasses all the inputs and outputs associated with an operation. Let's examine the setup of an Input/Output table for a process in openLCA.

CHANGE IMAGE



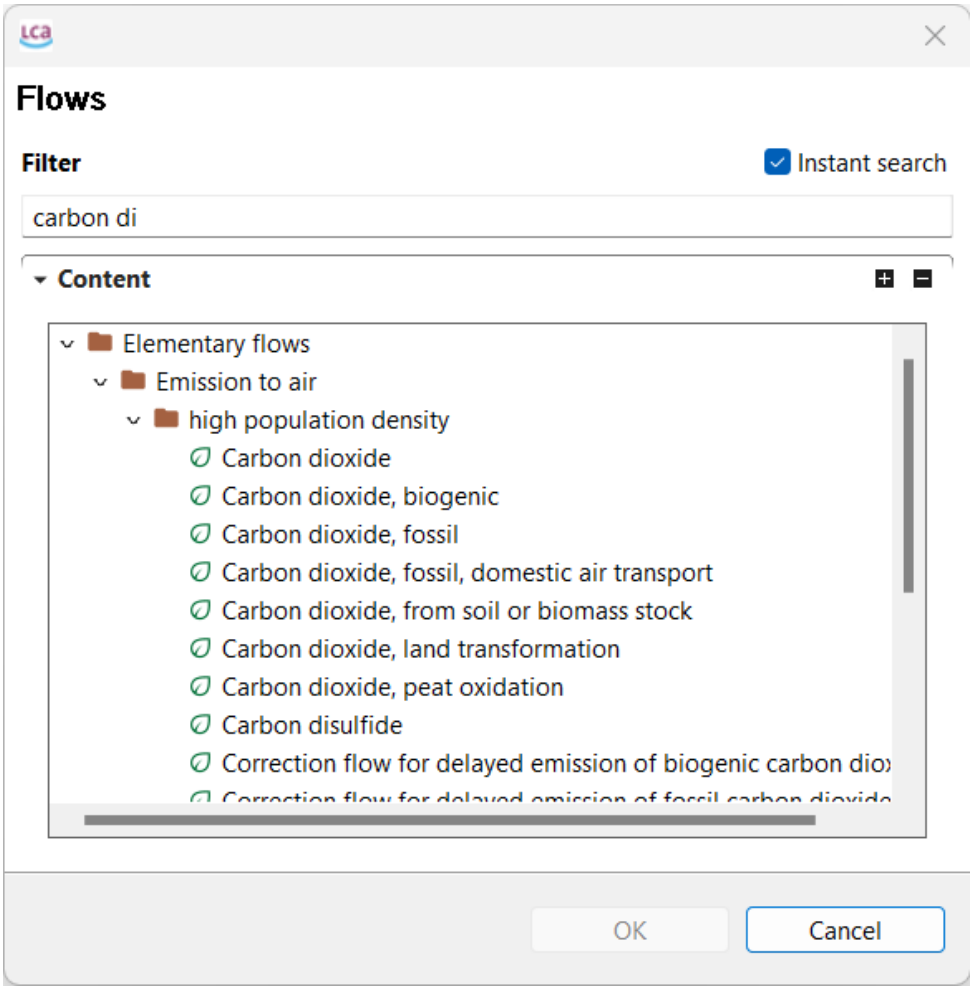
Inputs#outputs'tab'window'with'highlighting'on'the'tools'in'the'right'top'corner

In the top right corner, you will see several icons: "Refresh" (circled arrow), "Add Flows" (green plus), "Delete Flow" (red x), and a "123"/ "fx" icon you can use to switch between displaying the "Amount" as either a value or formula (when mathematical operations have been applied).

Note: A waste can also be designed as an input covering recycling approaches in openLCA. Then it is possible to select "avoid product" to define a supplier. Check the "Waste" section for details.

Flow

Product, elementary, and waste flows can be added as inputs or outputs to the process in several ways. You can drag and drop them from the navigation panel, double-click on an empty flow cell, or click on the green plus icon. A pop-up wizard will appear, allowing you to manually select the flows from the drop-down list or use the filter option to narrow down your choices. The option "instant search" allows you to select/deselect whether openLCA runs the search function directly while you type. You can deselect this option if the live search significantly slows down your operating system.



Moreover, you can also drag and drop processes into the input/output section. This will automatically add the respective reference flow to the table with the selected process as a provider.

Category

The "Category" column displays the child category of the flow, indicating its placement within the folder structure.

Amount

You can enter the amount of the flow as values, formulas, and/or parameters.

- To view the calculated value, click the "123" icon located in the top-right corner.
- To see the original formula/parameters, click on the icon again, which will change to the "*fx*" icon.

Note⅜

- When a formula and/or parameter are typed in the "Amount" field, the software will automatically calculate the value for the amount.
- Complex formulas must adhere to a specific format (e.g., Tan(a), trunc(c), etc.). Have a look at the 'Constants, operators and functions for formulas in openLCA' chapter.

- You can use the formula interpreter, accessible under "Tools" → "Formula Interpreter", to identify errors within your formulas.

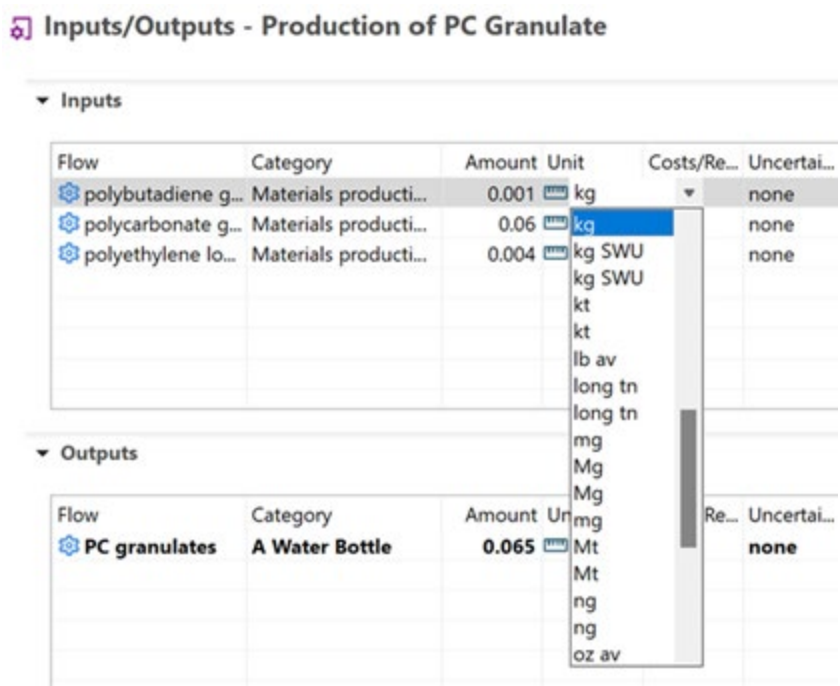
Unit

openLCA supports a wide range of measurement unit types to represent different physical quantities. Some common types of units available in openLCA include:

- Mass: Kilograms (kg), grams (g), tons (t), etc.
- Volume: Cubic meters (m^3), litres (L), gallons (gal), etc.
- Energy: Joules (J), kilowatt-hours (kWh), megajoules (MJ), etc.
- Length: Meters (m), kilometres (km), miles (mi), etc.
- Time: Seconds (s), minutes (min), hours (h), days (d), etc.
- Money: Currency units such as USD, EUR, GBP, etc.
- Area: Square meters (m^2), square kilometres (km^2), hectares (ha), etc.
- Pressure: Pascals (Pa), bar, psi, etc.
- Temperature: Celsius (°C), Fahrenheit (°F), Kelvin (K), etc.
- Electric Current: Amperes (A), milliamperes (mA), etc.

Units are assigned to the flows based on the flow property defined in the "Flow properties tab" You have the flexibility to change units by clicking on the unit cell and choosing a different unit from the provided list. If a conversion factor is available, the amount will be automatically converted to the newly selected unit.

Note: openLCA allows users to create custom/new units. This can also be done in the "Flow properties tab".



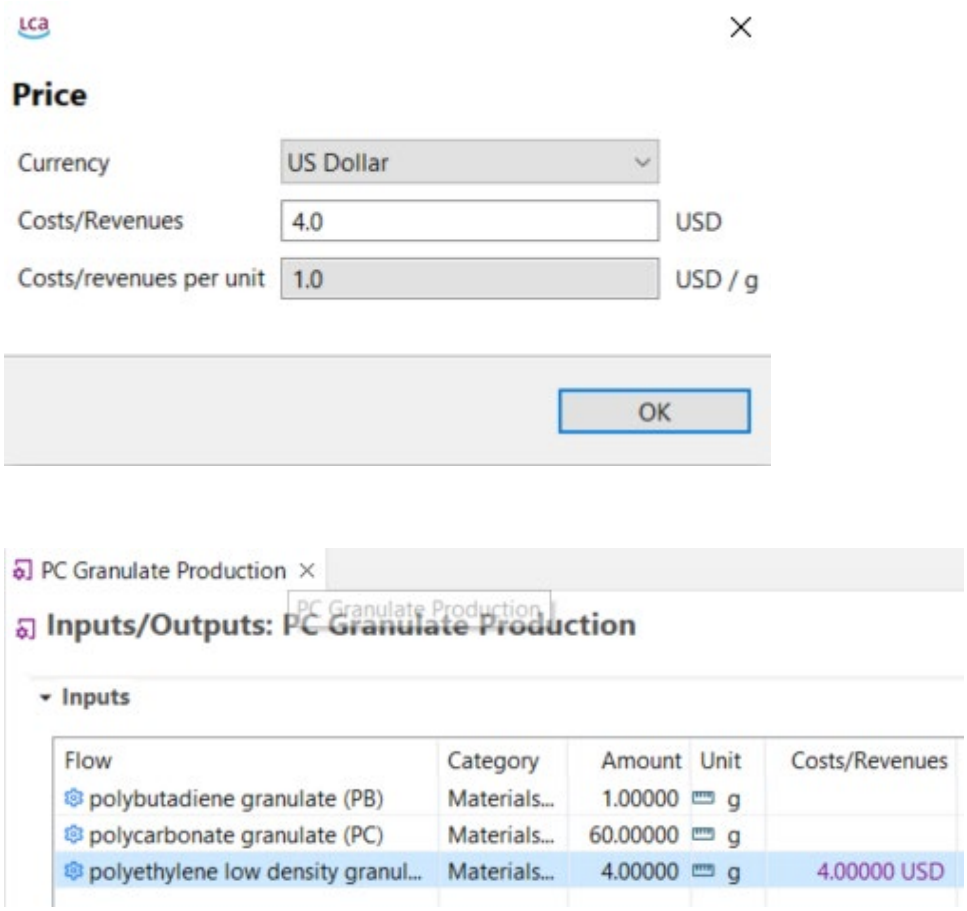
Changing 'flow' units 'within' a 'process' editor

Cost/Revenue

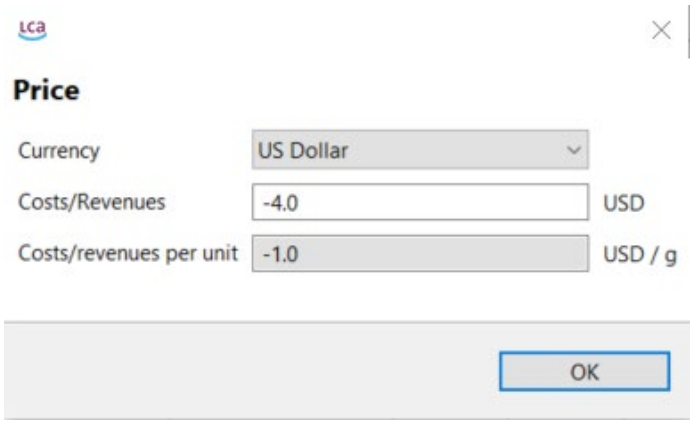
openLCA has the capability to assign costs and revenues to processes, enabling the conduct of Life Cycle Costing studies.

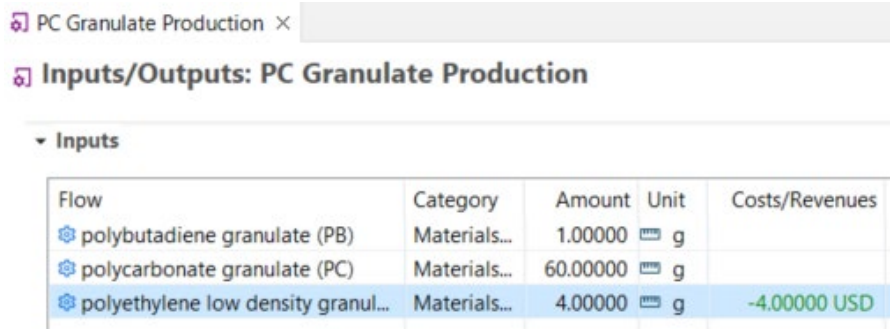
To add or modify a cost/revenue value, follow these steps:

- Select a cell in the "Costs/Revenues" column, click on it and select "Edit".
- Specify your desired currency and enter the overall costs or revenues for the corresponding flow in the pop-up window.
- The software automatically calculates the price per unit based on the value in the "Amount" column.
- Revenues are displayed in green, while costs/expenses are shown in violet.



Adding costs to flows





Adding 'revenues' to 'flows

Note: openLCA allows you to create custom/new currencies. It can be done in the "Currencies" folder in the "Background data" section of the Navigation panel.

Creating 'a 'new' currency

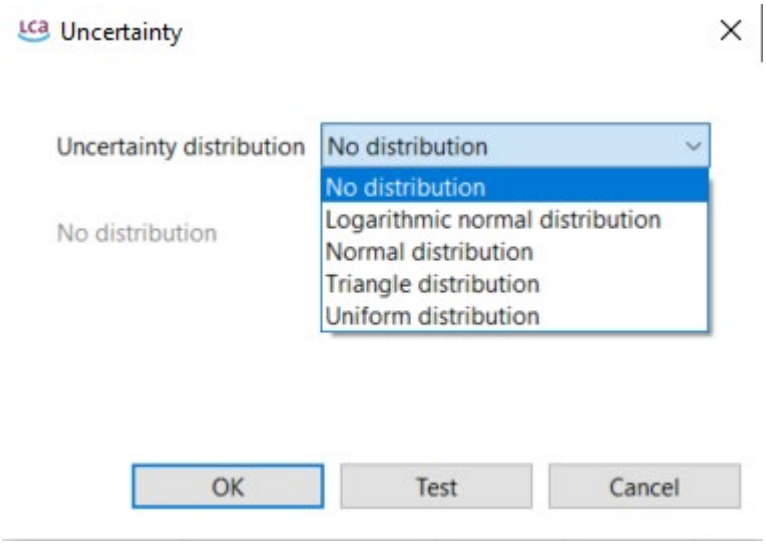
Uncertainty

Users have the option to associate uncertainties to data in their LCA studies. Otherwise, this cell is set to 'none' in a user-created process..

To add uncertainty data to flows, follow these steps:

- Click on the uncertainty cell corresponding to the flow and select "Edit".
- Choose the desired uncertainty distribution, such as logarithmic normal, normal, triangle, or uniform and fill in the required data.

Adding uncertainty information step 1



Adding uncertainty information step 2

Note: Uncertainty data can also be defined for parameters and LCIA characterisation factors in a similar manner.

Avoided waste

Avoided waste occurs in a situation where the waste from one process is converted into a resource for another process. System expansion is a technique used to account for avoided waste. Learn more about the concept of avoided waste in the "Waste modelling" section, and explore the concept of system expansion in the "Allocation" section.

Provider

In openLCA, a "provider" refers to the process that supplies a specific flow (the source or origin of a particular input or output flow). Output "providers" are waste treatment processes that take the waste generated in a process. You see that the name does not perfectly fit here, but we did not set up a new name. The provider information helps establish the relationships and dependencies between different processes and flows within the LCA model, making the input/output unique. It can be overwritten in a product system, allowing you to select a different connecting process within the system.

To choose a provider for a flow, follow these steps:

1. Click on the provider cell corresponding to the flow and choose "Edit".

2. From the drop-down list, select the specific provider for the flow (in cases where multiple providers exist for the same product flow).

Note that many processes from databases, such as ecoinvent, have predefined default providers. To access detailed information about the provider, simply right-click on a flow and select "Open provider".

Note When creating a product system in openLCA, the software can automatically handle flows with multiple providers. It offers several options for auto-linking processes, which are explained in detail in the "Creating a new product system/Settings for a product system" section.

Data quality

Check out the "Data quality" section.

Location

By default, the location of the inputs and outputs is automatically set to match the location of the process. However, you have the option to customise the location for each individual flow.

To modify the location:

- Click on the location cell associated with the flow you want to change and select "Edit."
- A pop-up window will appear, allowing you to choose a location from the available options. You can also apply filters to find the desired location.

Gain more insight into the use of locations in the "Regionalised LCA" section.

Description

Add a description or additional details about the process.

9 PRODUCT SYSTEMS

After creating flows and processes, it is time to create product systems. They are life cycle models used to calculate inventory results and assess their impact.

A "product system" is described by ISO 14040 as a "collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product." In openLCA, a product system is a set of processes connected by flows that perform one or more defined functions and model the life cycle of a product. A product system has a reference process with a defined amount of the product (referred to as the functional unit), which serves as the basis for calculating impacts for all connected processes within the system.

9.1 CREATING A NEW PRODUCT SYSTEM

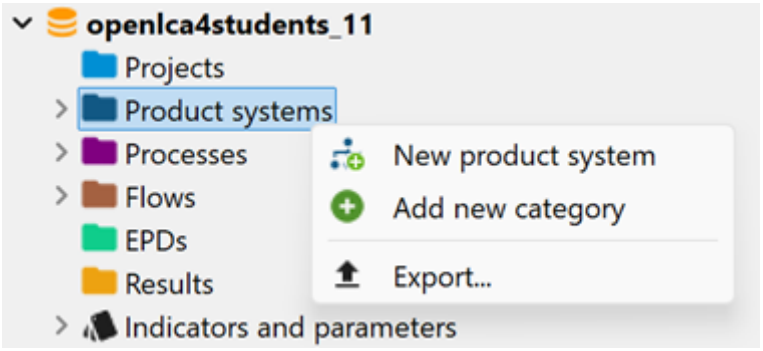
In this section, you can learn how to create a product system and specify its settings:

There are two ways to create a new product system in openLCA. You can use the navigation panel and then manually add the reference process, or you can create it directly from an open process, which will automatically be selected as the reference process for the new product system. Both can also be used in combination, i.e. manually creating a part of the system and having the software then autocomplete the remaining supply chains.

Autoconnecting processes enable you to create large systems, comprising several thousand interconnected processes, efficiently. It is beneficial if the connections are clear from the database, either because there is only one possible connection (the provider process) for each product, or because default providers are set for the processes. Manual connection provides full control over the connection and is necessary for databases like GaBi or EF, where connections can be ambiguous.

CREATING A PRODUCT SYSTEM IN THE NAVIGATION PANEL

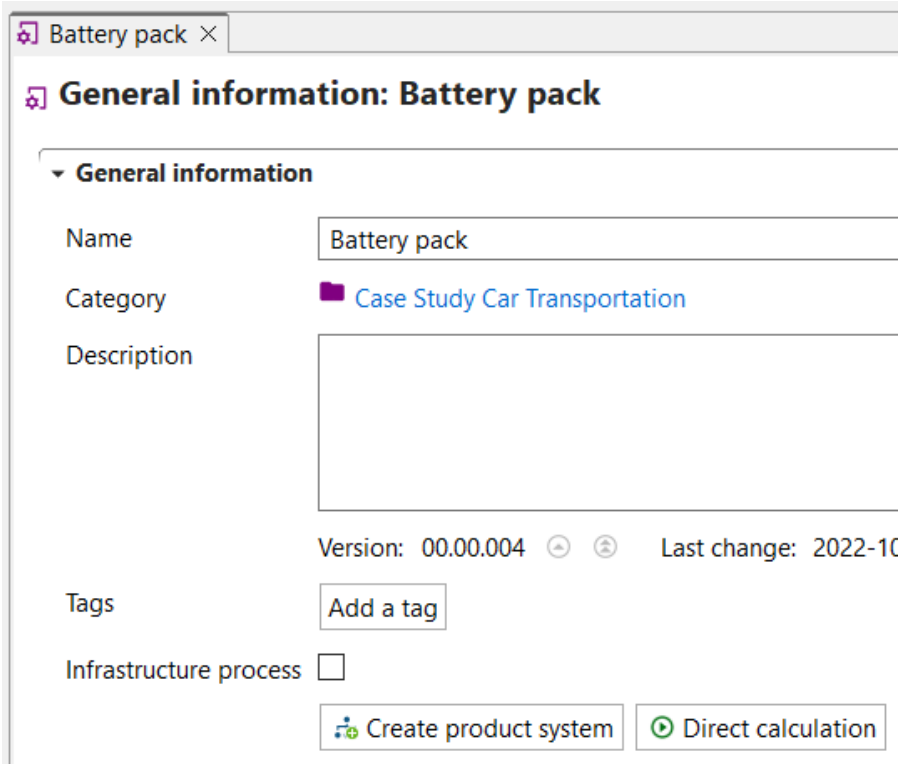
To create a product system from the navigation panel, right-click on the "Product systems" folder and select "New product system":



New'product'system

CREATING A PRODUCT SYSTEM FROM A PROCESS

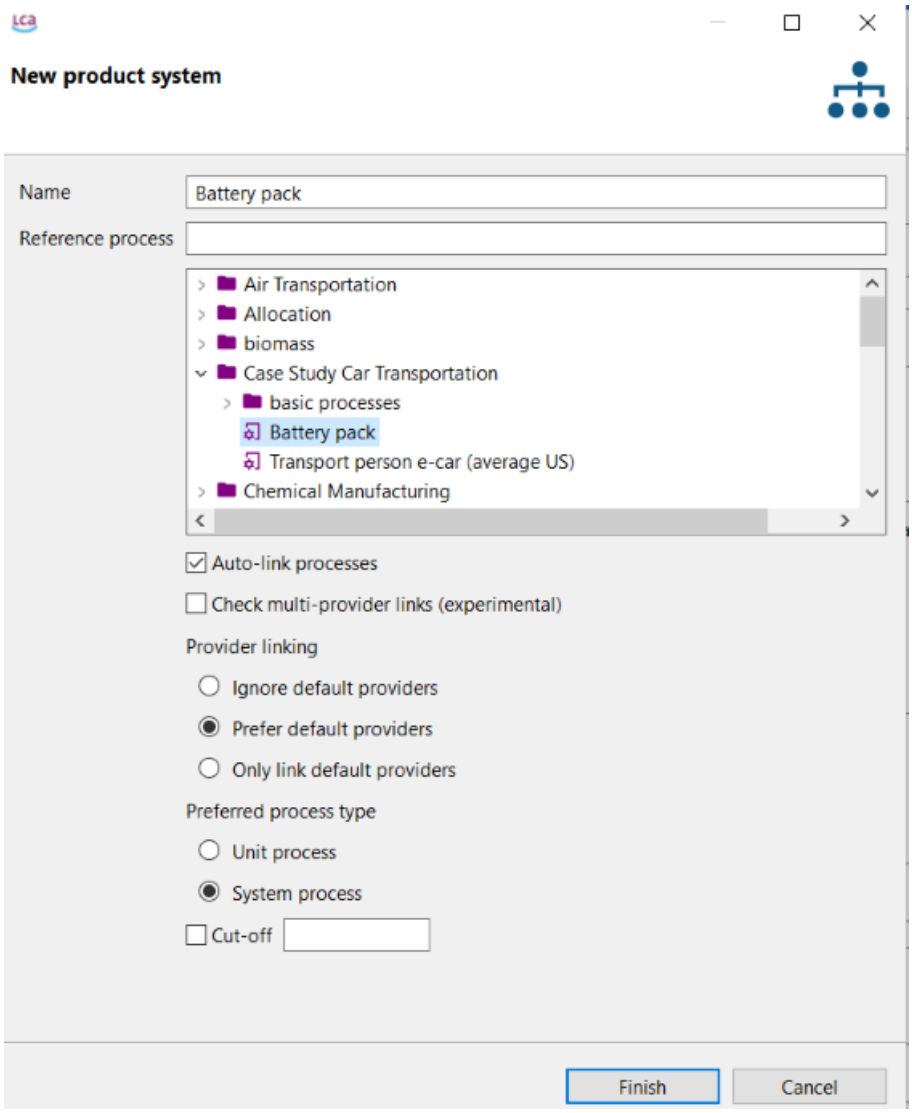
To create a product system directly from a selected process, go to the "General Information" tab of the process and select "Create product system":



Create'product'system

PRODUCT SYSTEM SETTINGS

The "New product system" pop-up window will appear, allowing you to define the name of the product system, select the reference process, provider linking, preferred process type, and preferred cut-off option.



Product'system'creation'window

- Reference process: The reference process is the process that models the last step of your supply chain, or the last step of a specific chain. For example, the production of a battery pack may represent either the entire supply chain of interest or an intermediate stage within the production model of an electric car. If you want to assess the potential impacts of the battery pack, the corresponding process "battery pack" is chosen as the reference flow. To add the reference process to a new product system that you are creating from the Navigation panel, you can type the name of the process into the "Reference process" field or navigate through the process folders. If you are creating the product system directly from a process, that process will automatically be selected as the reference process.
- Auto-linking: To automatically have all upstream processes linked to the reference process, select "auto-link processes". Hereby, the auto-linking function connects input and output flows between processes. Using the auto-linking feature, you can save time and effort by avoiding the need for manual linking processes within an LCA model. It helps ensure that the material and energy flows within your model are properly accounted for. If you don't select this option, no upstream processes will be taken into account!

The following options are available upon selecting the "auto-linking" option:

- Check multi-provider links (experimental): This option has been added for your convenience and allows you to also check for linkages to various providers (please refer to the "Model graph" tab later on).
- Provider linking: When creating a product system, openLCA can automatically check for flows with multiple providers. However, many processes from databases such as ecoinvent have preselected providers, which are called "default providers". If openLCA detects a flow with multiple providers in a product system, you can choose how openLCA should handle this situation, choosing from three default provider options.

Details on default providers

- Only link default providers: openLCA will exclusively create links between processes that share input and output flows from the default providers.
- Prefer default providers: openLCA will give priority to creating connections using data from the default providers. However, if no default providers are set, openLCA will consider other providers to establish connections.
- Ignore default providers: openLCA completely disregards the default providers during the auto-linking process. The first suitable process connection found will be used, and then it will be used in each case.

After creating a product system, you can add and delete connections in the "Model graph" tab.

- Unit process or System process: The next step is to choose whether to connect to a unit process or a system process if no provider is selected in the process. This setting only has an effect if default providers are not used or not specified, since the default provider is always one specific process, which is then already a unit or system process. The difference between a system and a unit process is described in the section "Processes".
- Cut-off threshold: It is possible to set a cut-off threshold for the auto-connection to reduce the complexity of your product system. Providers that contribute less than the threshold to the inventory are not connected (i.e., they are numerically cut off). This is applied throughout the whole (connected) supply chain! Elementary flows of the reference process are not affected! The function can be handy for databases with extensive process networks that have minimal individual process contributions and consistent units, such as multi-regional input-output databases, e.g., PSILCA. Be aware that the cut-off is applied irrespective of the unit used and focuses solely on the numbers. For this reason, it works best for databases where all products have the same unit, such as, again, multi-regional I/O databases (PSILCA).

To finally create the product system, click "Finish"!

9.2. PRODUCT SYSTEM TABS CONTENTS

In the following, we will describe each tab of a product system in openLCA:

GENERAL INFORMATION

The General Information tab is divided into "General information" and "Reference".

Product system] General information tab

- General Information: Here you can change the name of the product system and optionally add a description. Below the "Add a tag" button, the "Calculate" button initiates the impact calculations (you can also achieve this by clicking the green "Calculate results" icon above the navigation panel). The "Update" button (represented by a circular arrow) in the top-right corner allows you to reset the connections between processes. This is helpful if you have performed any changes to the processes involved in the product system. You can also do this in the model graph.
- Reference: Here, you can see the reference process of the product system and editing the reference product, the flow property, the unit, and the target amount. The target amount should be chosen in accordance with your functional unit.

PARAMETERS

At the product system level, you can add "Parameters" by selecting the green "+" button at the end of the "Parameters" bar. It is not possible to create new parameters on the product system level, but you can add parameters that are already defined in processes. You can customise the parameters you add by selecting one and then changing the amount, uncertainty, or description. To select multiple parameters at once, use your keyboard's "Shift" button. The amounts saved in a product system will override those saved in a process for the given product system. However, the values saved in the process will not change.

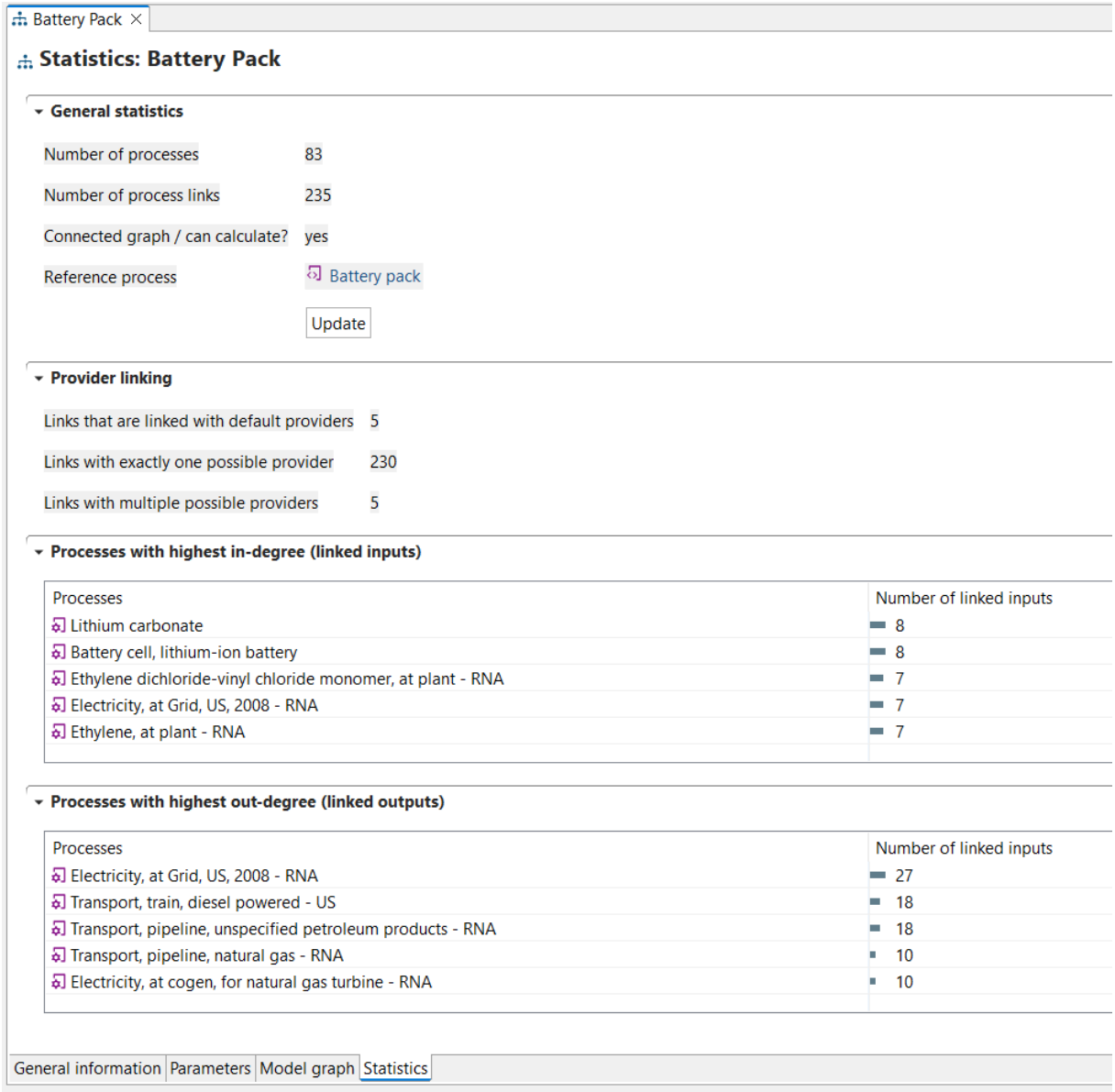
MODEL GRAPH

The model graph is a tool for visualising and modifying the product system, including all its processes and the connections between them. Check the "Model graph" section for details.

STATISTICS

The Statistics section gives you some basic numbers and facts about the product system, like the number of processes that compose it, links, whether the graph is connected, and the name of the reference process. If the graph is not connected, there is at least one section that is not linked to the reference process; such a non-connected section cannot be scaled in relation to the reference process, evidently, and thus cannot be calculated. The statistics sheet also provides information about provider linking and processes with the highest in-degree and out-degree. The in-degree counts how many

connected input flows a process has. The out-degree shows how many times a process is linked to other processes in the product system.



Product system's statistics

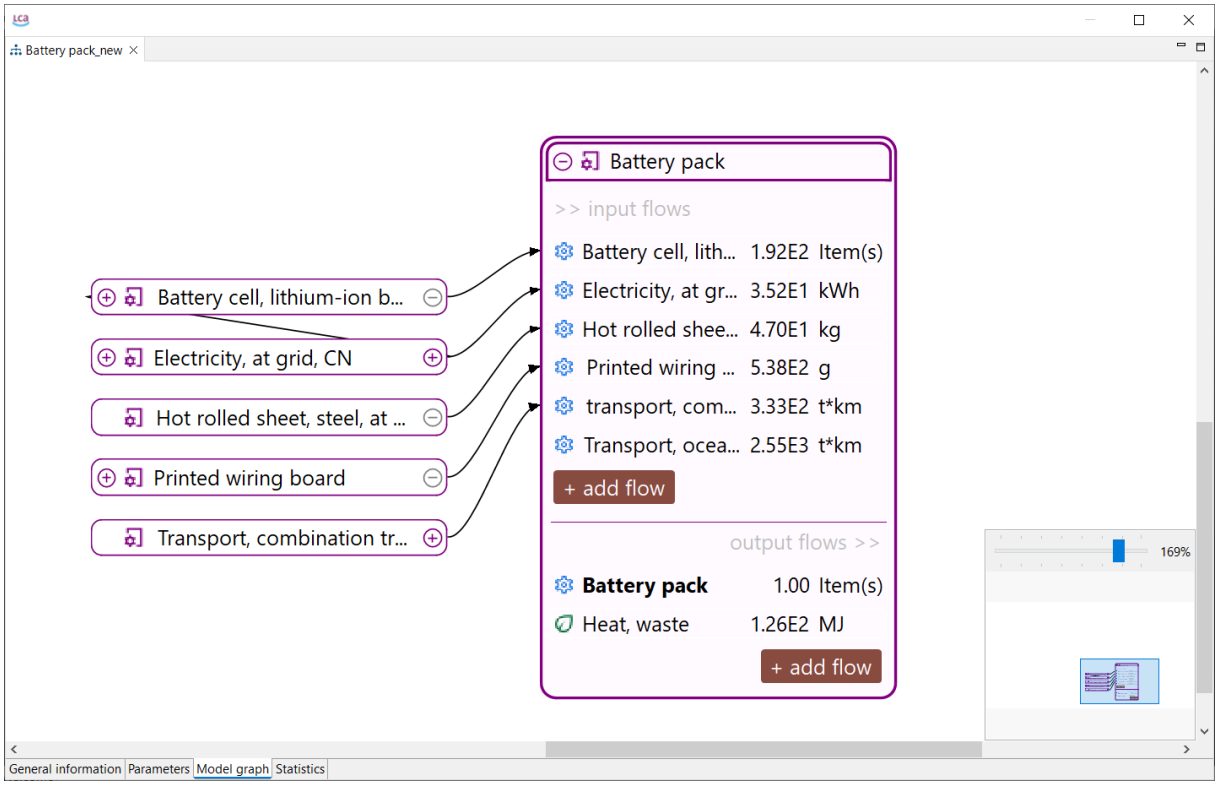
9.2 MODEL GRAPH

The model graph in openLCA is a powerful tool for the visual representation of the product system, including its supply chain (linkages to processes). It illustrates the interconnections of the product system's processes and flows, highlighting the supply chain (both upstream and downstream) of a product. Here we will describe its functionality in detail.

Quick start

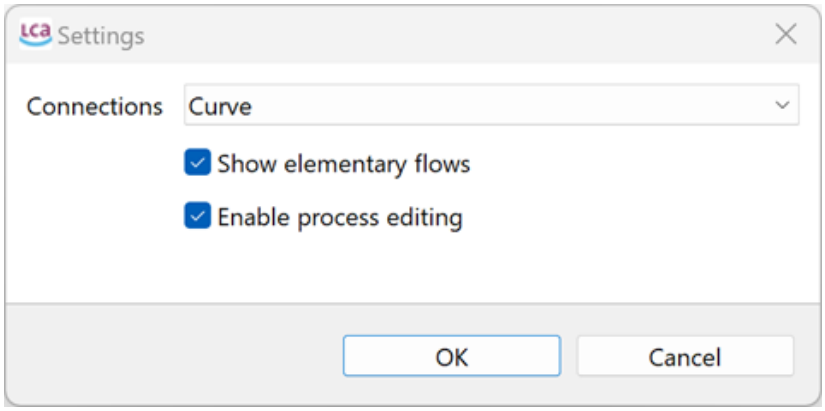
If you open the model graph tab, you will see the reference process of the product system. Double-clicking on a process within the graph will display the flows on its input and output sides. You can expand the visible supply chain by clicking the "+" symbol next

to the process names. To hide/collapse it, click on the "-" symbol. You can also freely reposition processes without disconnecting them by dragging them around the window.



The model graph with expanded first tier and still collapsed processes. As visualised, we activated the options „Show elementary flows…" and „Enable process editing…" under the right-click „Settings…".

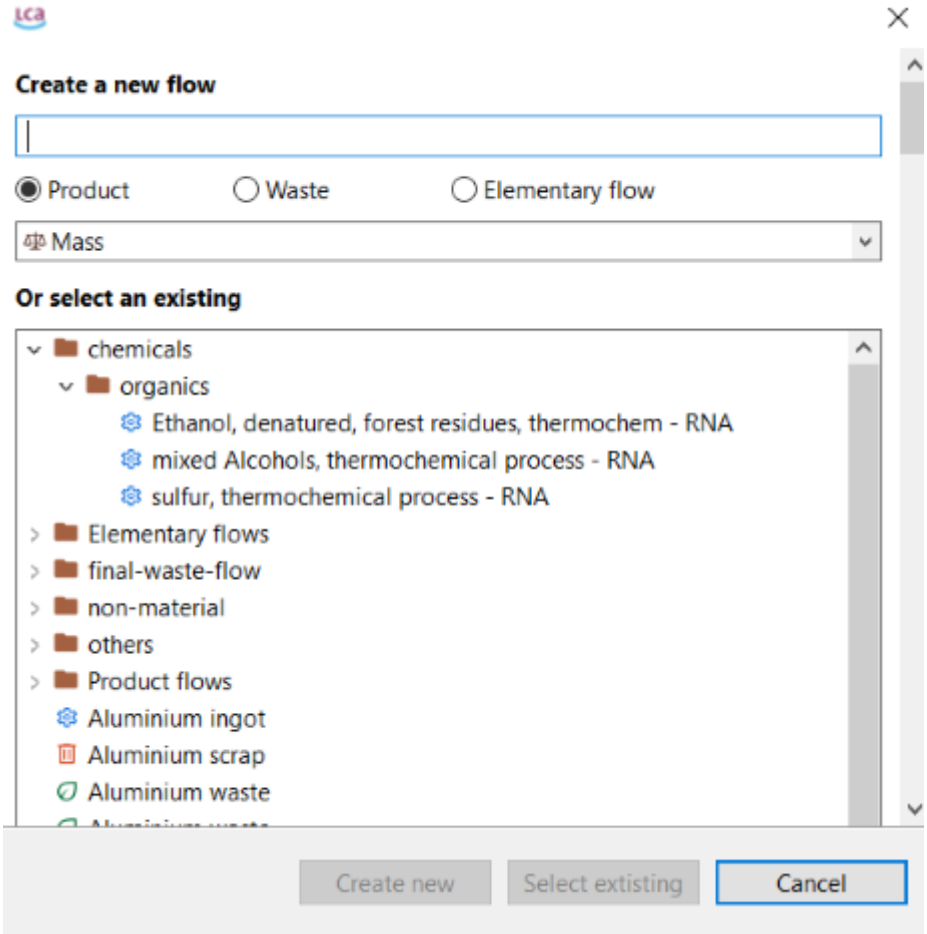
To show elementary flows and add or remove flows directly within the graph, right-click on the graph, click on "Settings" and then check "Show elementary flows" and "Enable process editing".



Activated settings in the model graph.

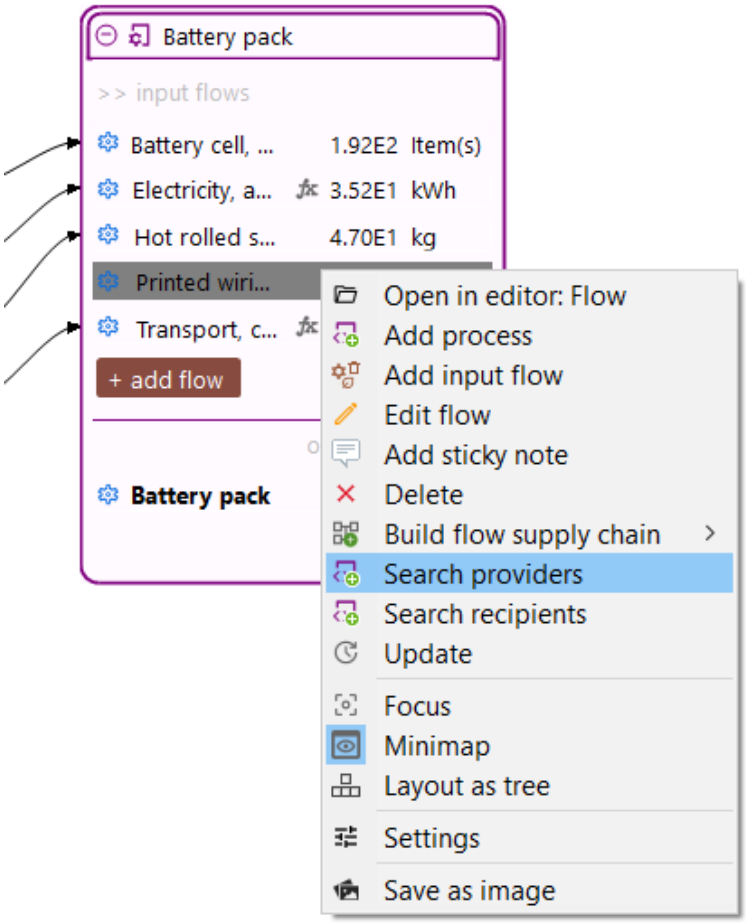
Connections between processes are visualised as lines. Those connections or the processes themselves can be deleted. Note that alterations to the model have an impact on the entire product system, and only connected processes contribute to the calculation of the product system.

With this new feature, you can use the brown "+ add flow" button to modify processes by adding new input or output flows. A pop-up window will appear, allowing you to add or create the new flow.



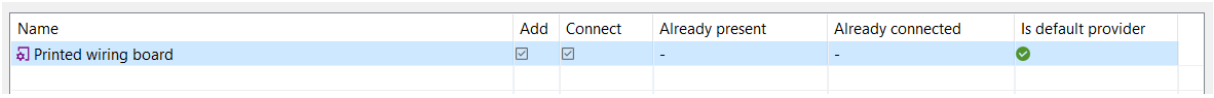
Model'graph']· 'Process'editing']· 'Add#Create'new'flow

This allows you to model the product system directly within the model graph. After adding a new flow to a process, you need to add its provider. This can be done by right-clicking on the flow, then "Search providers".



Model'graph'] 'Search'providers

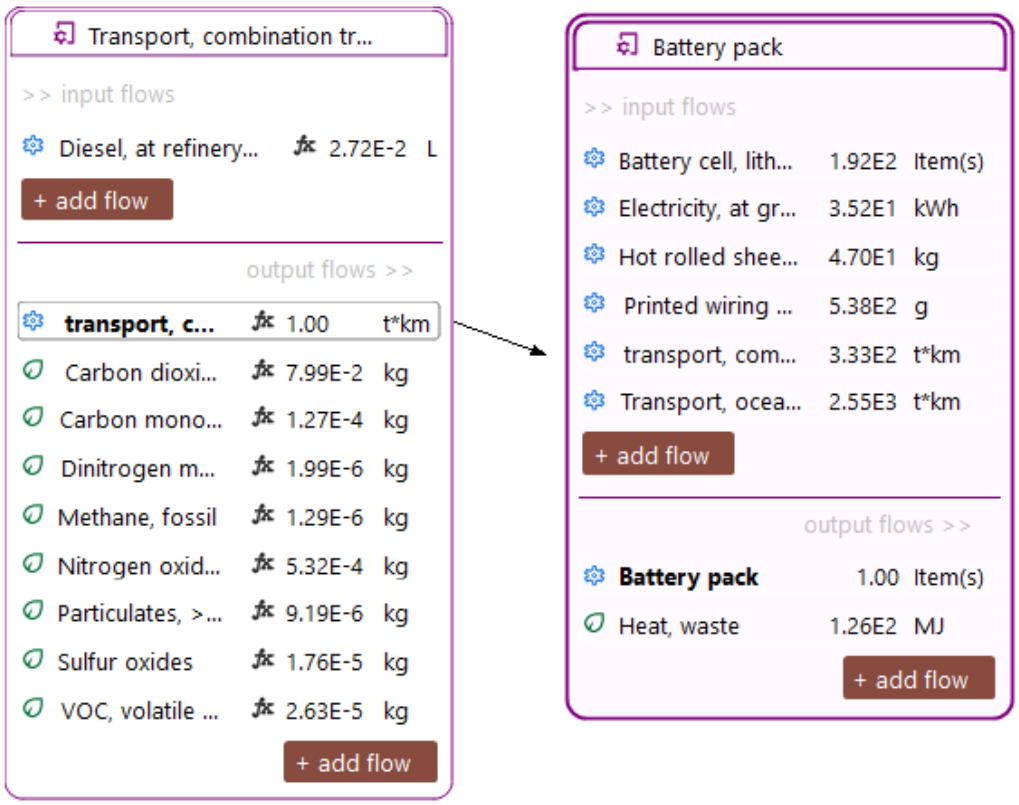
A pop-up window will appear with a list of all possible providers for that flow. You can select the right one and check the box "Connect" to add the provider and connect the flow to the process at the same time. Likewise, it is possible to search for recipients for specific outputs.



Model'graph'] 'Search'providers'] 'Connect

Note: If you add processes with this function, the full supply chain will be NOT added. You have to manually add it afterwards, using the "Build flow supply chain" function (see below).

Moreover, if you want to create/edit the product system graphically, you can drag and drop processes from the navigation panel into the model graph void area. Then you can drag a flow to the corresponding one in the provider/receiver process to create the connections between the flows. To connect the newly added process to its supply chain, right-click on it and then select "Build supply chain".



Model graph] After a drag and drop of a process the flows are connected manually

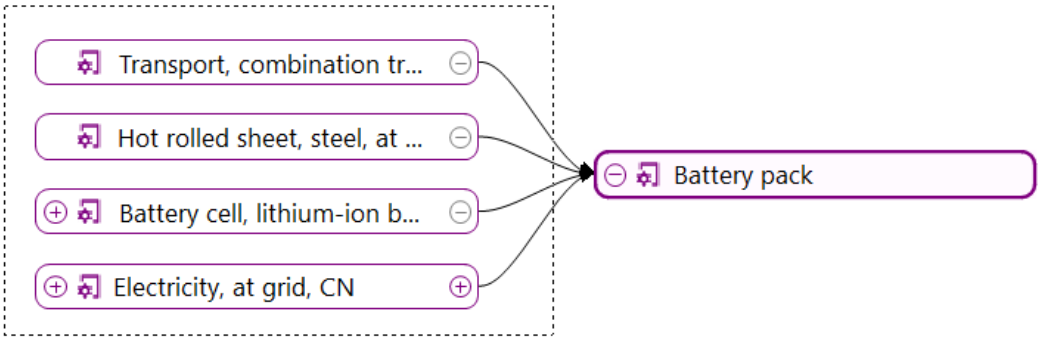
You can also remove a connection by right-clicking on a process and choosing "Remove connections" or by clicking on a connection and then selecting "Delete". The software will ask you if you also want to delete or hide the supply chain. Choose "No" to remove the connection only. The result is shown below:

ZOOM BAR (NEW)

A new feature in openLCA 2 is the zoom bar on the bottom right, which allows you to adjust the reading size and display section by zooming in and out. You can either use the zoom bar directly or scroll with the mouse to zoom in and out. Holding the space bar while scrolling allows for vertical movements, and pressing Alt + Shift while scrolling enables horizontal movements. In addition, you can reposition the graph by clicking and dragging it on the screen. Holding the space bar while clicking and dragging a process will cause the entire graph to move.

SELECTING PROCESSES

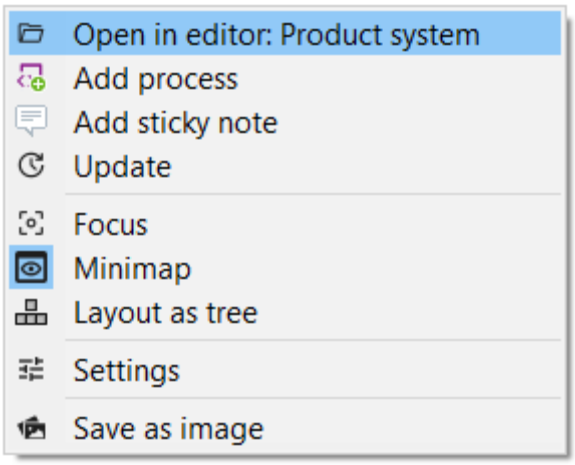
Several processes can be selected at the same time by pressing the Ctrl keyboard (Control), clicking on the void area and dragging the selection outline over the processes you want to select.



Model'graph'] 'Multiple'process'selection

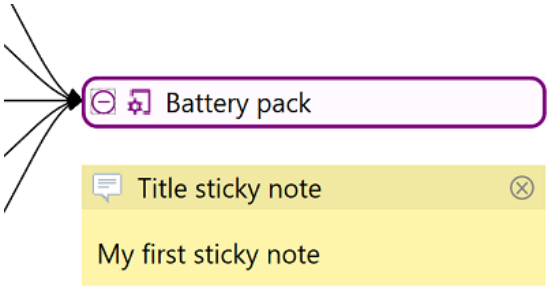
RIGHT-CLICK IN THE MODEL GRAPH

By right-clicking on the background in the model graph, the following options will appear:



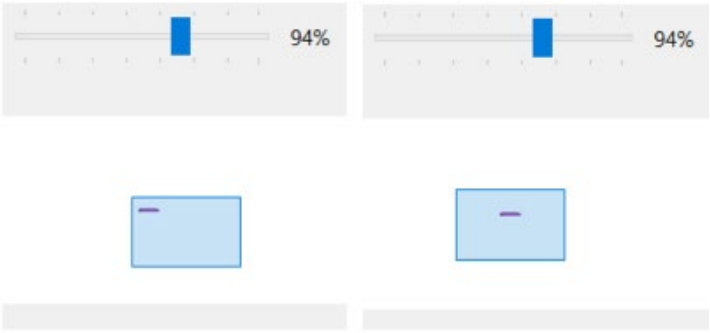
*Model'graph'] 'Options'/background_*

- Open in editor: Product system: Brings you to the "General information" tab of your product system.
- Add process: Adds a process to the model graph without connecting it.
- Add a sticky note: You can add sticky notes to your graph. They will be stored locally in the openLCA-data-1.4 folder, rather than in the database itself.



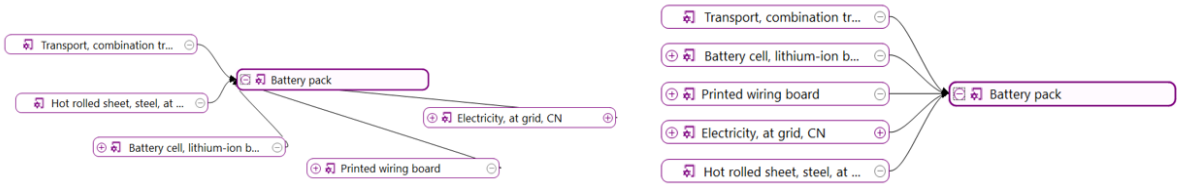
Model'graph'] 'Sticky'note

- Update: With "Update", you can reset the connections between processes. In the pop-up window, you have the option to choose between the same "provider selection" and "preferred process type" options that are available when calculating a product system. Additionally, you can select "Keep all existing links" and "Prefer links within the same location."
- Focus: Positions the reference process in the middle of the view window.



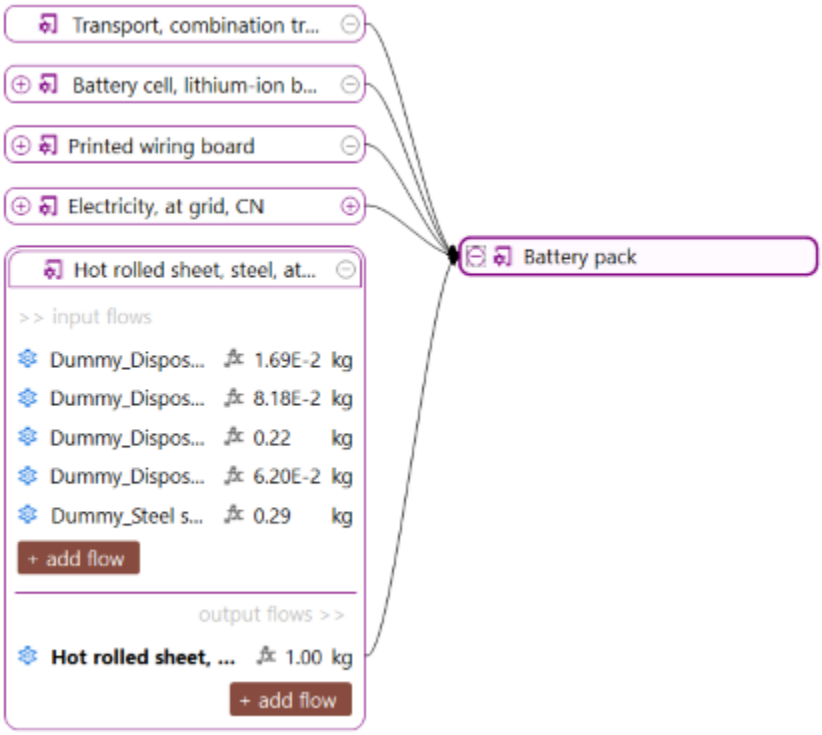
Model'graph'] 'Focus

- Mini-map: Displays a miniature view with a zoom bar. This helps you navigate complex model graphs. The blue area represents the current view.
- Layout as tree: Arranges the processes in the model graph so that those at the end of a supply/value chain are positioned on the right side of the graph.
-



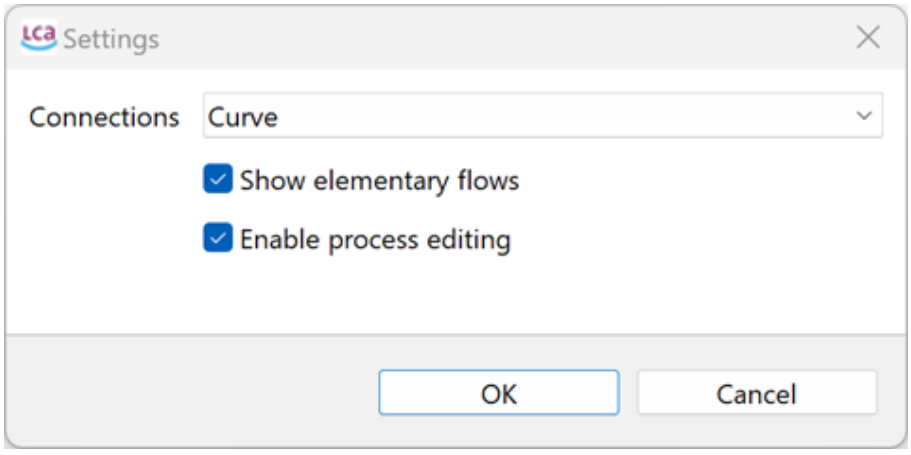
*Model'graph'] 'Tree'layout'Xeft'before³⁄₄ight'after_*

- Maximise or Minimise: Maximise allows us to see the input and output flows, the corresponding amount and unit. The quantitative reference is in bold. Minimise will collapse the information beside the process name. A double-click on the process name either maximises or minimises it.



Model'graph'] 'Maximise

- Settings: In the settings pop-up window, you can adjust the shape of connection lines, enable the display of elementary flows, and activate in-graph process editing.

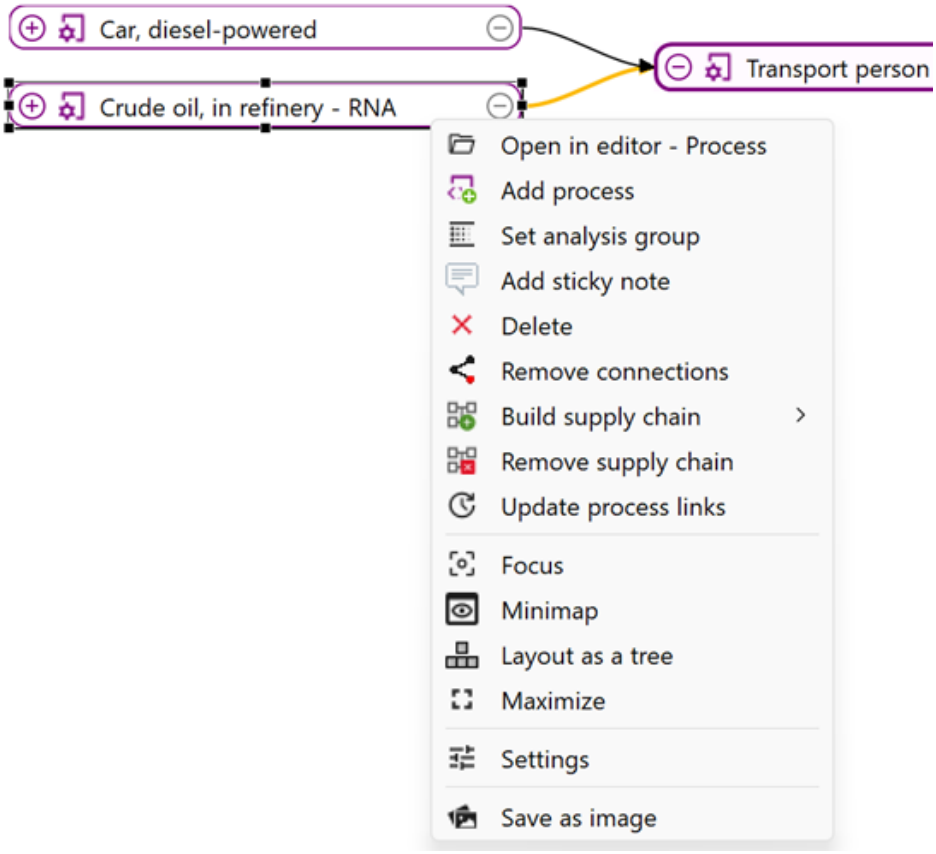


Note: Themes can be modified under "Graphical editor theme" on File > Preferences > Configuration (check out Toolbar: File), and also by editing the .css files under /openLCAdata-1.4/graph-themes. To reset the themes to the original one, simply delete (or rename) this folder before launching openLCA. In addition, the colours of the model graph elements marked with #model (note that #sankey refers to the Sankey diagram) can be modified by changing the hexadecimal colour codes (using Google colour selector, for example). It is very important to keep the same syntax of the document (no changes can be made outside of the bracket {}).

- Save as image: Saves an image of the model graph as a .png file

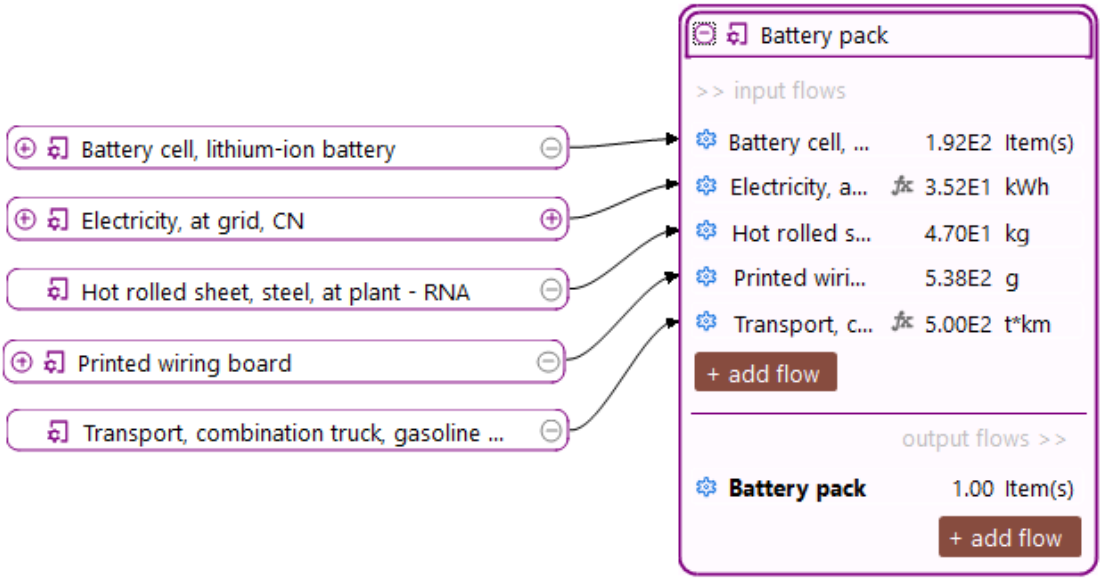
RIGHT-CLICK ON A PROCESS IN THE MODEL GRAPH

By right-clicking on a process in the model graph, you find the following additional options:

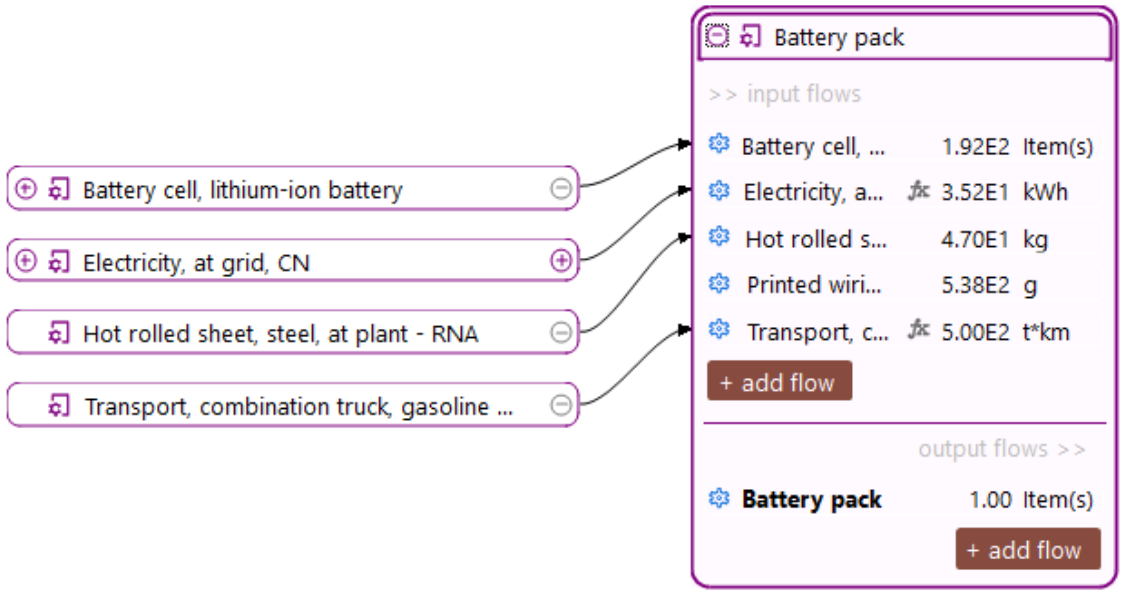


Model'graph'] 'Options

- Open in editor: Process: This option will lead you to the general information tab of the selected process.
- New* Set analysis group: This new function of openLCA 2.4 allows you to conveniently categorise your LCA product system results into various categories, such as the EN15804+A2 modules. Instead of setting up specific processes, you can easily group results. Check the dedicated section for details.
- Delete: Removes not only the selected process but all the processes that are linked only to it. Here is an example of deleting the process "Printed wiring board".

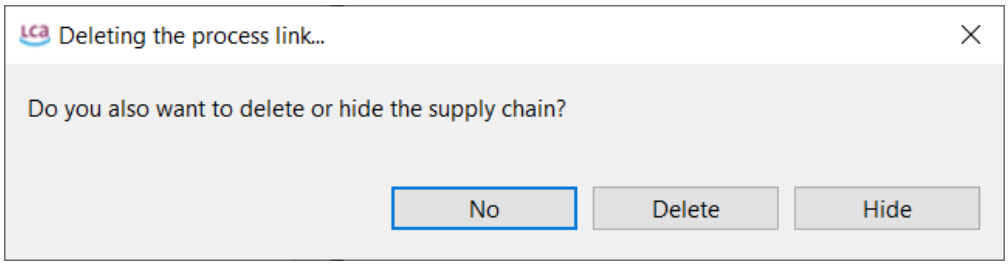


*Model'graph'] 'Example'of'deleting'a 'process'./before_*



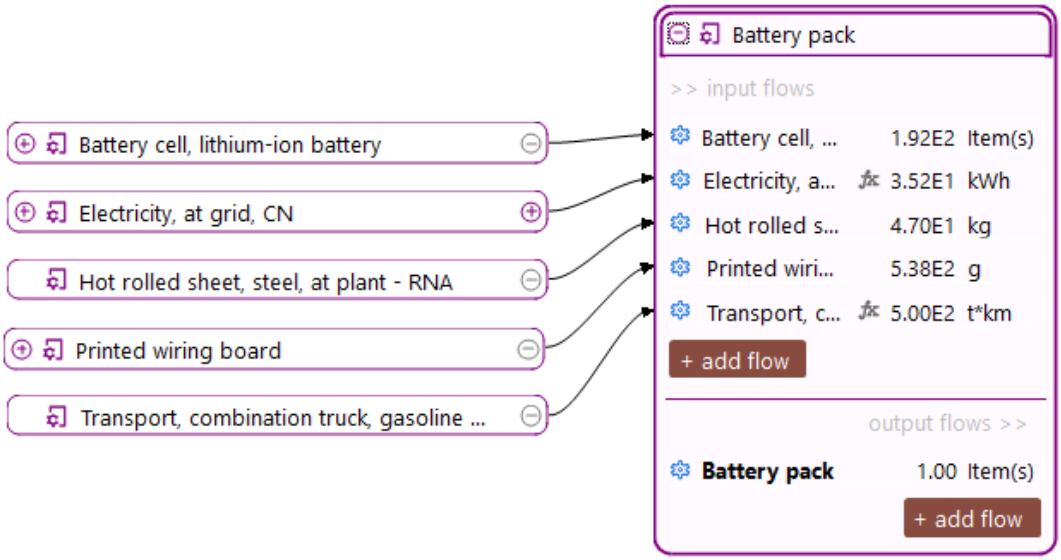
*Model'graph'] 'Example'of'deleting'a 'process'./after_*

- Remove connections: The same can be achieved by right-clicking on a connection and selecting delete. When removing a connection, the software will also ask you if you also want to delete or hide the supply chain.

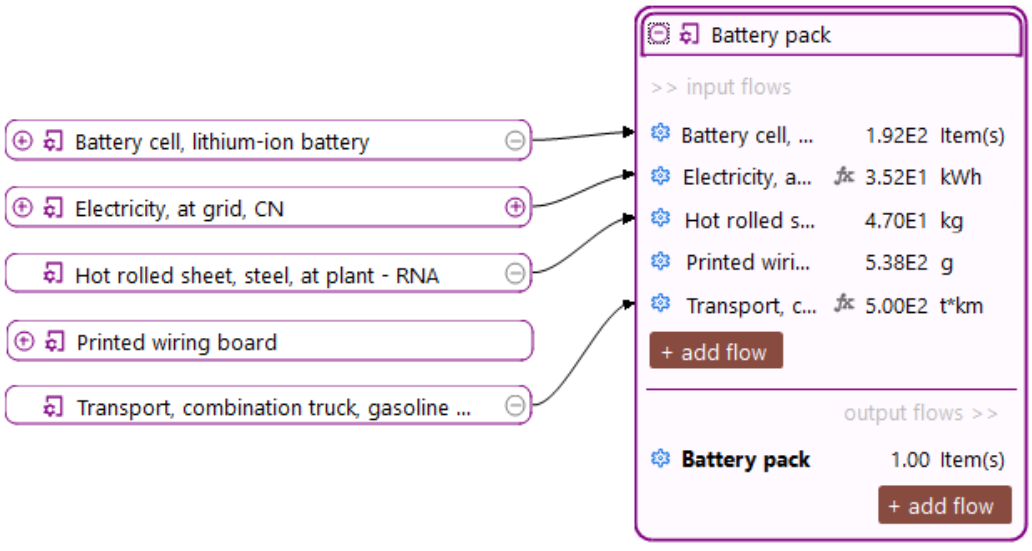


Deleting'or'hiding'the'supply'chain

Note Deleting the supply chain when removing the connection of a process removes it from the product system entirely. The "Hide" option, otherwise, lets you retain the supply chain. This is important when your supply chain has multiple connections within your product system. For instance, if you delete the link to "Electricity, at grid, CN," it will also disappear from other processes using the same electricity source. Therefore, we recommend using "hide" if you're unsure about the supply chain within the whole system (otherwise, check with Usage).

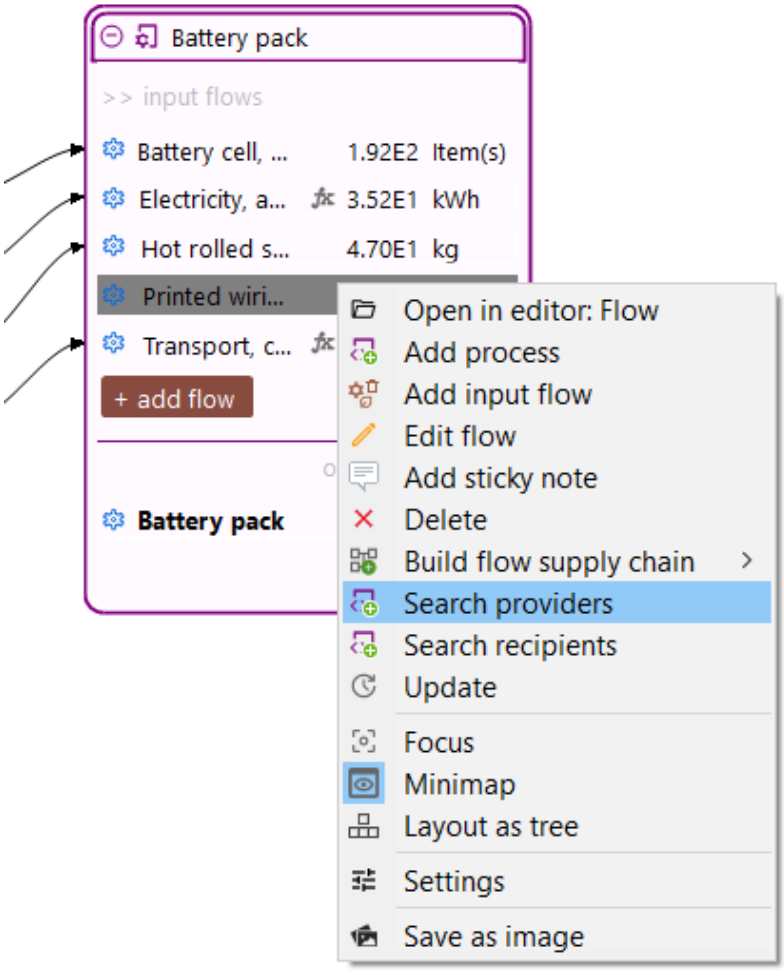


*Model'graph'] 'Example'of'removing'a 'connection' /before_*



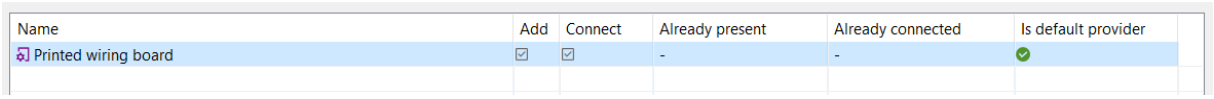
*Model'graph'] 'Example'of'removing'a 'connection' /after_*

To add a provider to a flow that is missing one, right-click on the respective flow and select "Search providers".



Model'graph'] 'Search'providers

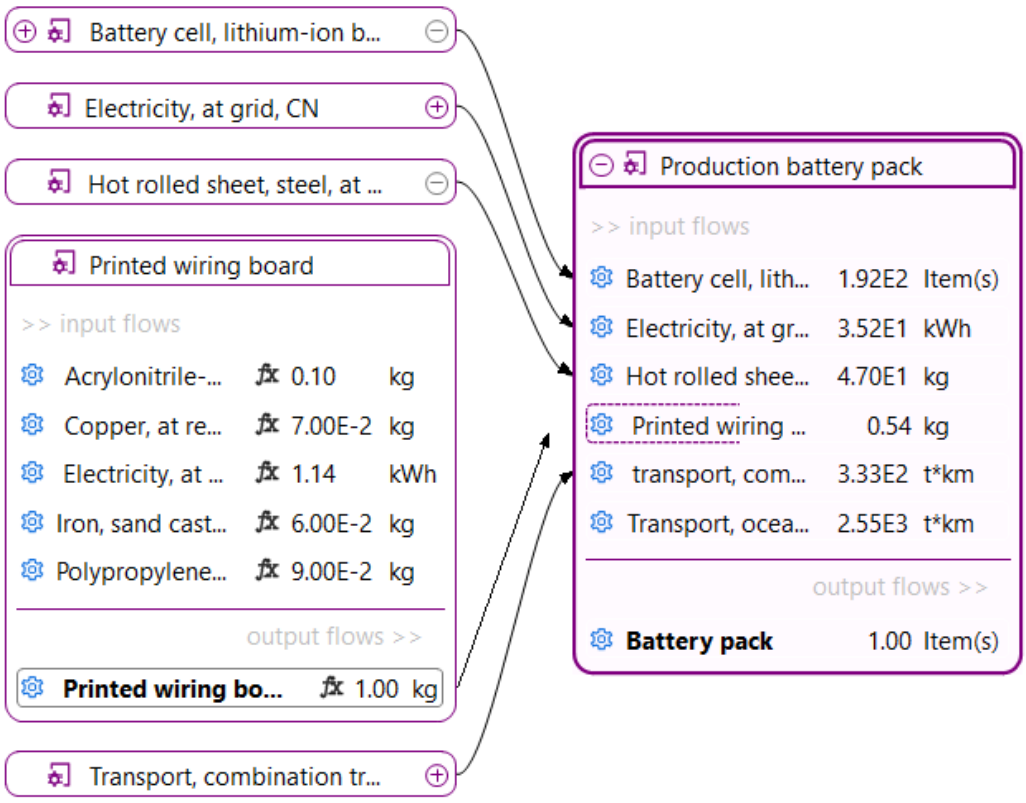
A pop-up window will appear with a list of all possible providers for that flow. You can select the provider you would like to add to the model graph in the table and check "Connect" to automatically connect the process to the flow. Likewise, it is possible to search for recipients for specific outputs.



Model'graph'] 'Search'providers'] 'Connect•

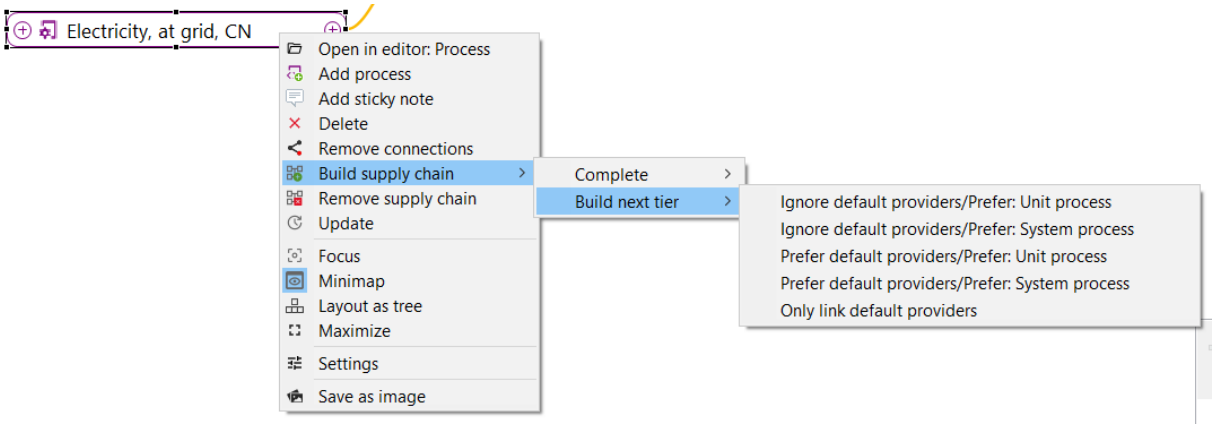
Note: If you add processes with this function, the full supply chain will NOT be added. You must manually add it afterwards using the "Build flow supply chain" function (see below).

Otherwise, you can also draw connections by dragging from one flow to another flow! To do that, you need to have the respective processes expanded, then click on the provider flow and drag it to the receiver flow:



Manually connect flows

- Build supply chain: Allows you to connect processes in the model graph. You can then select whether to build the complete supply chain for the process or just the next tier. The next tier means adding one provider without its supply chain.



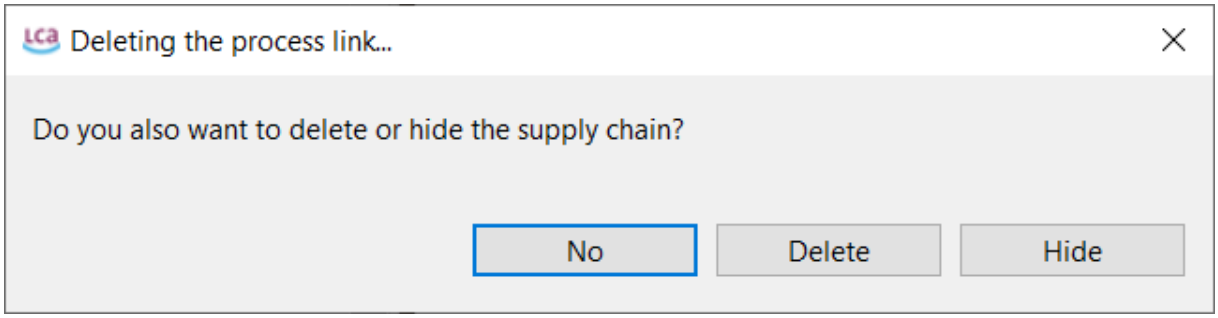
Model graph] Build next tier

- Remove Supply Chain: This option will remove all processes and their respective connections prior to the selected process. The option does not ask if you are sure to do this. If you click on it by accident, close the product system on the tab and do not save the changes made.

RIGHT-CLICK ON A CONNECTION IN THE MODEL GRAPH

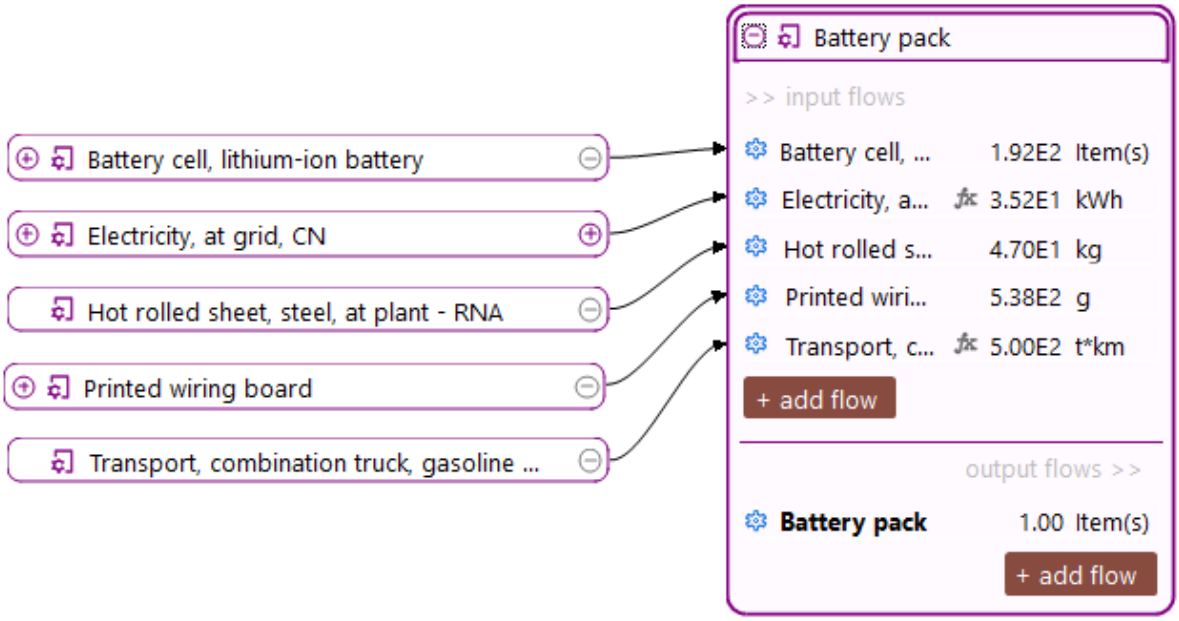
By right-clicking on a connection in the model graph, the following additional options will appear:

- Delete: Removes only the selected process!

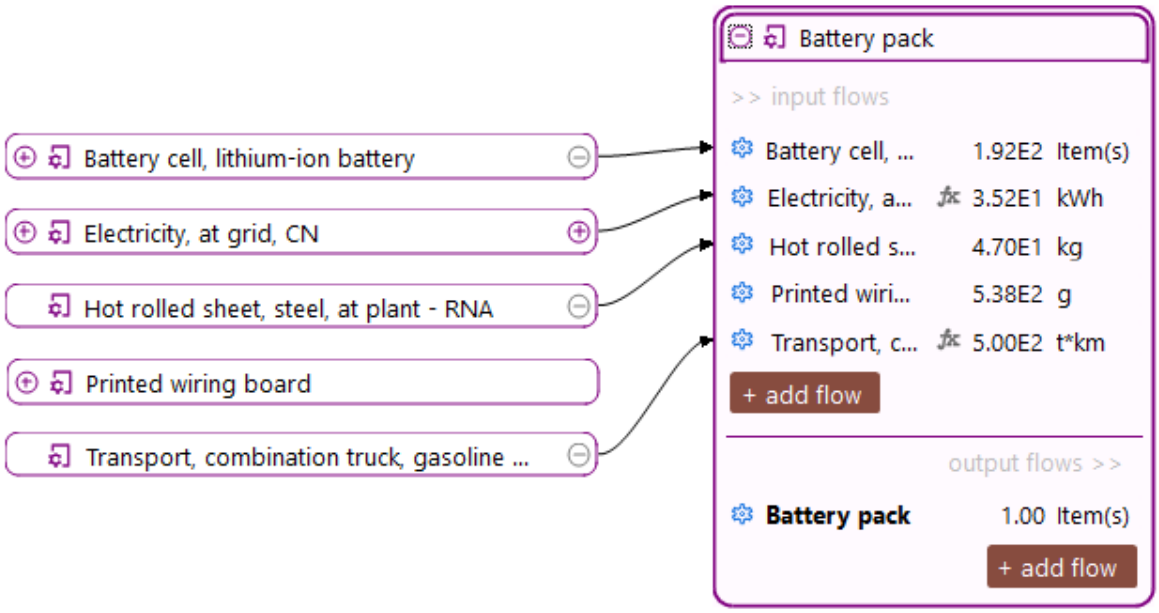


Deleting or hiding the supply chain

Note: Deleting the supply chain when removing the connection of a process removes it from the product system entirely. The "Hide" option, otherwise, lets you retain the supply chain. This is important when your supply chain has multiple connections within your product system. For instance, if you delete the link to "Electricity, at grid, CN," it will also disappear from other processes using the same electricity source. Therefore, we recommend using "hide" if you're unsure about the supply chain within the whole system (otherwise, check with Usage).

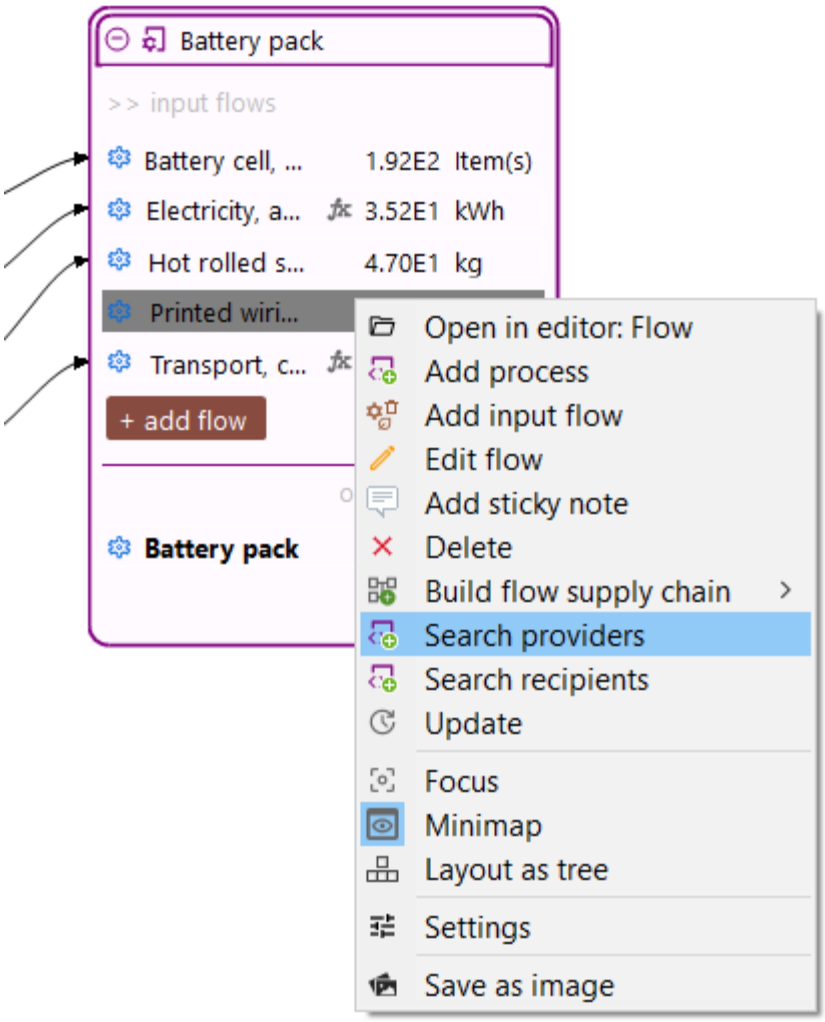


Model graph] Example of removing a connection (before



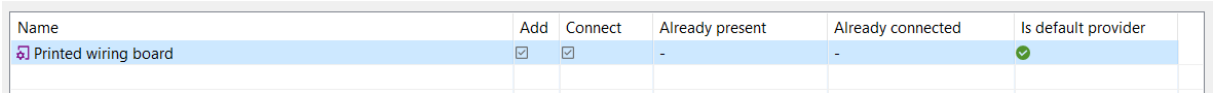
*Model'graph'] 'Example'of'removing'a 'connection' after_*

To add a provider to a flow that is missing one, right-click on the respective flow and select "Search providers".



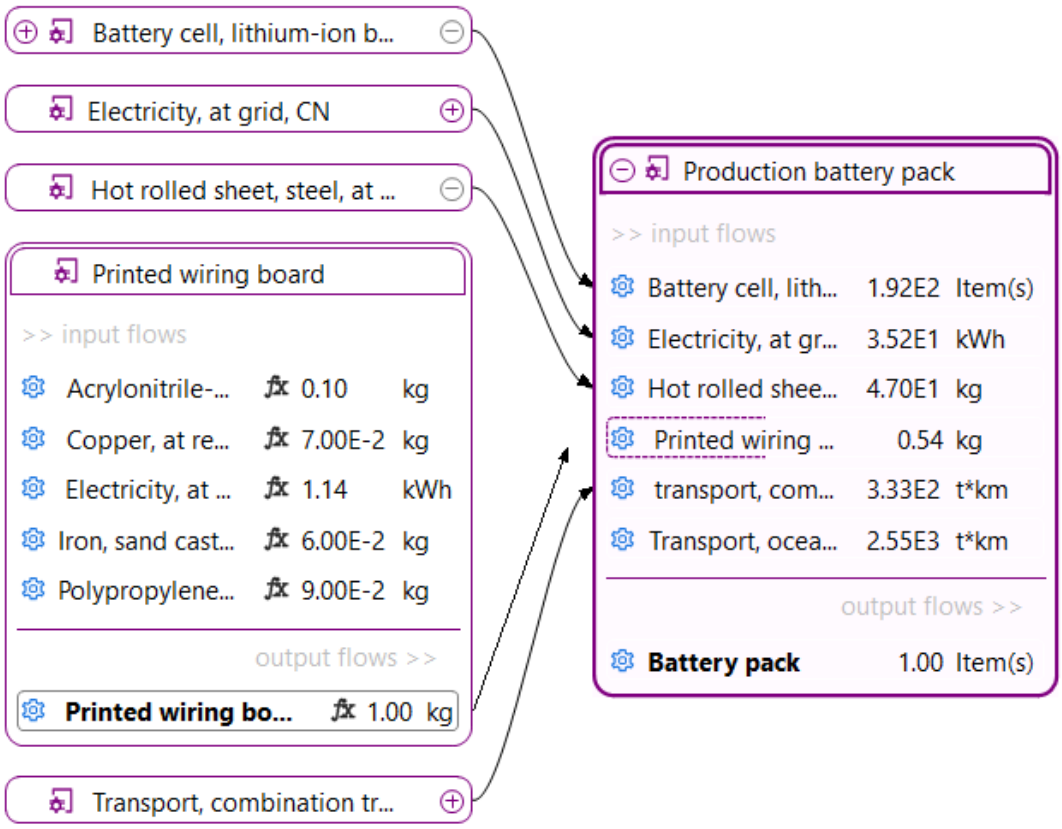
Model'graph'] 'Search'providers

A pop-up window will appear with a list of all possible providers for that flow. You can select the provider you would like to add to the model graph in the table and check "Connect" to automatically connect the process to the flow. Likewise, it is possible to search for recipients for specific outputs.



Model'graph'] 'Search'providers'] 'Connect•

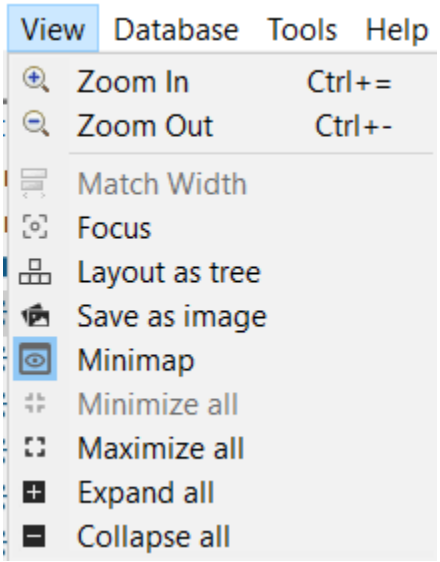
Otherwise, you can also draw connections by dragging from one flow to another flow! To do that, you need to have the respective processes expanded, then click on the provider flow and drag it to the receiver flow:



Manually connect the flows

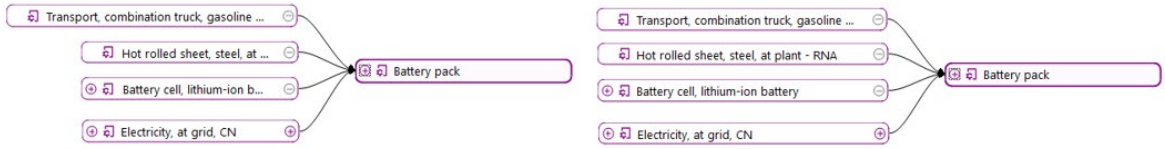
VIEW TAB IN THE TOOL BAR

The "View" tab allows access to some of the options described above, as well as some additional ones:



Model graph | View

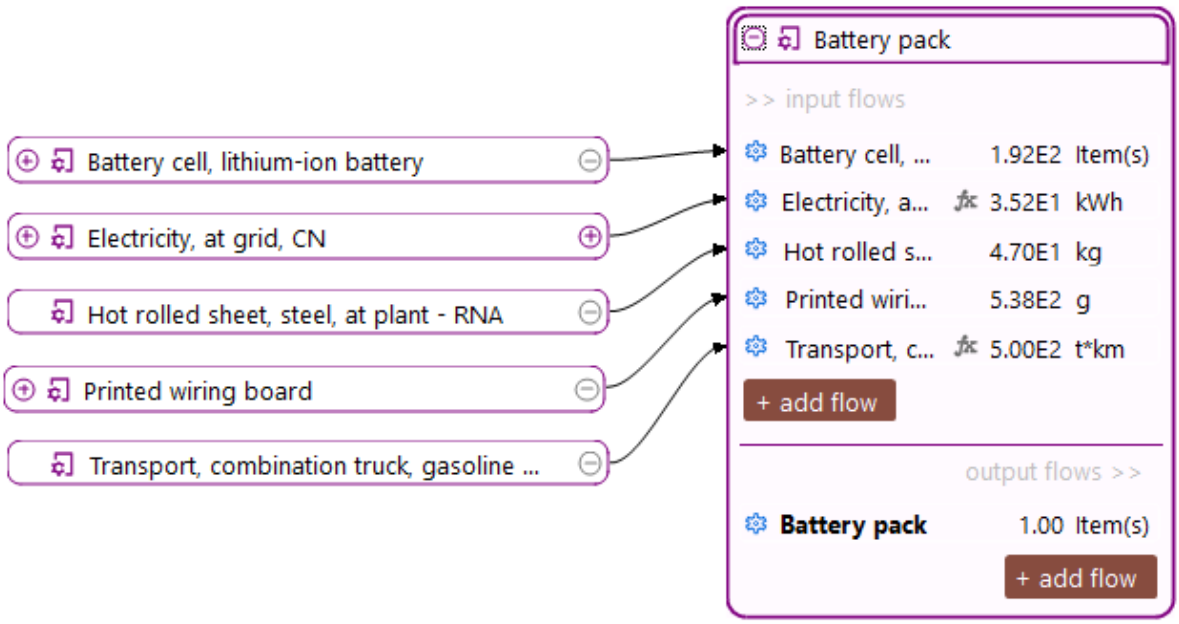
- Expand all: Expands the model graph to show all connected processes.
- Collapse all: Minimises connected processes to show only the first and second tiers.
- Match with: To match the length of a process with another one, first click on the process you want to change; press Ctrl and click on the process which has the desired length. Then use the "Match with" option.



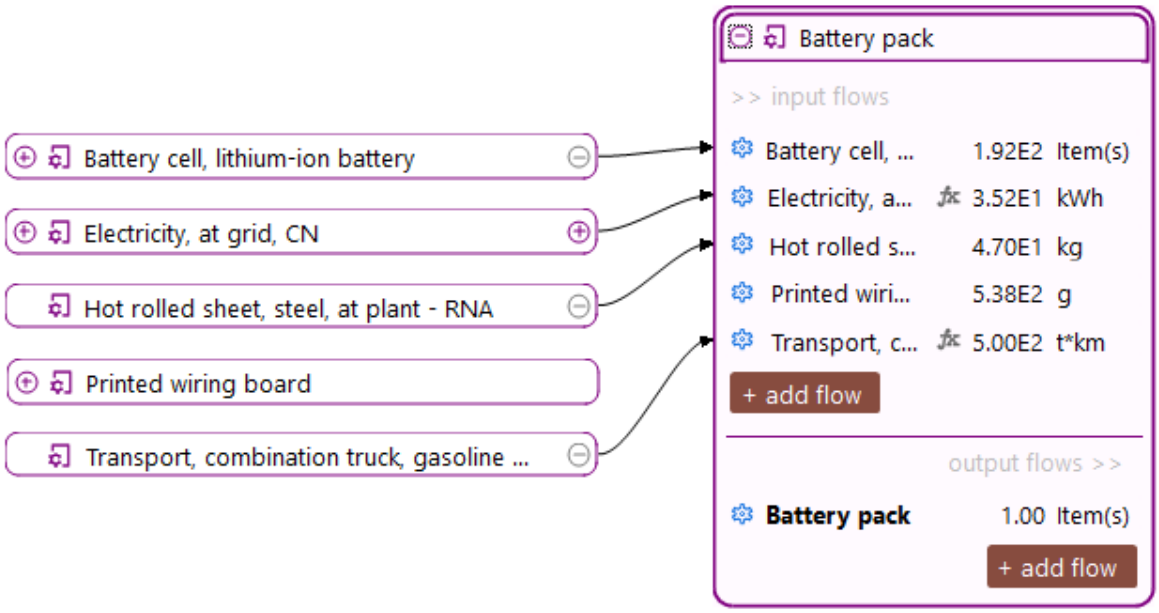
Model graph - Match with - left: before; right: after.

DRAG AND DROP RESULTS INTO THE MODEL GRAPH

In openLCA 2, it is now possible to drag and drop results into the model graph. Check in this section for details.



Model graph - Example of removing a connection - before.



*Model graph] Example of removing a connection Äfter_*

Removing a connection can be useful when you want to assess the impact of your product system without a particular process, such as "printing wiring board" in the example, or more broadly, without considering a specific phase, like the "use phase" of a product.

This was a glimpse of how you can use the model graph. See below for more details:

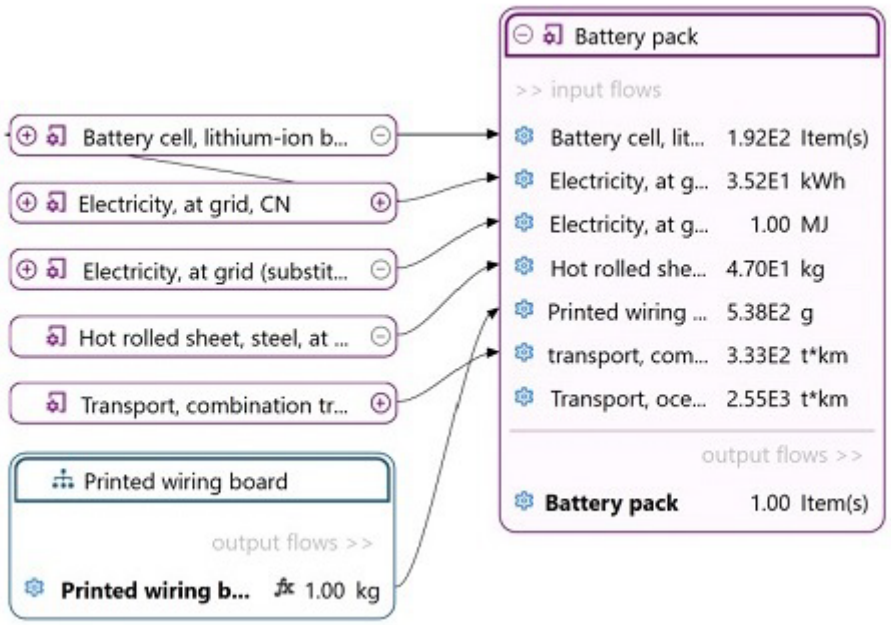
Zoom bar (new)

Selecting processes: Right-click in the model graph, right-click on a process in the model graph, right-click on a connection in the model graph, or view tab in the toolbar. Drag and drop results into the model graph.

9.3 ADVANCED PRODUCT SYSTEMS FEATURES

NESTED PRODUCT SYSTEMS

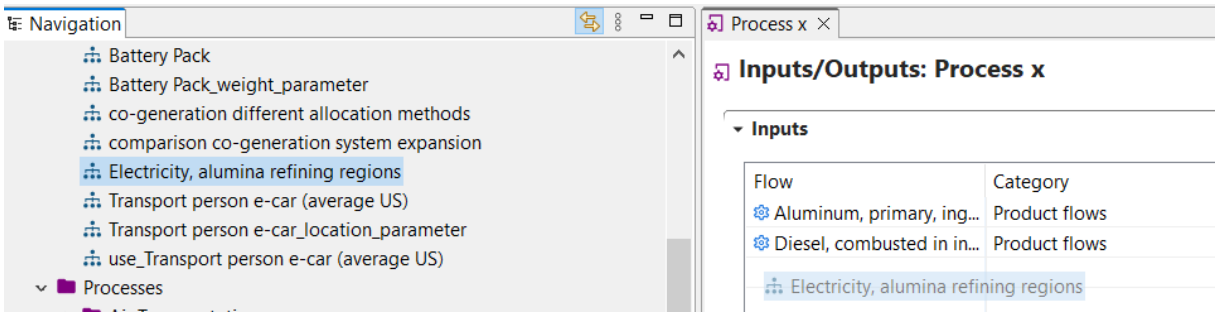
A product system can serve as a provider to another product system, resulting in a "nested" product system. To do this, drag and drop a product system into the model graph of a different product system and connect it to one of the input flows via "Search Recipients for".



Nested 'product' systems

You will see the contributions of the sub-product system to the overall results, e.g. in the impact analysis and contribution tree results.

A product system can also be used as an input flow for a process. The quantitative reference flow of the product system will be added to the process.



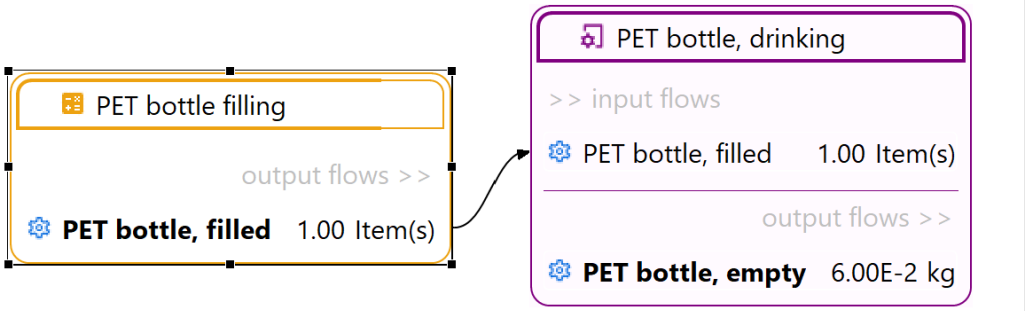
Drag and drop 'of a 'product' system 'into 'the 'input' flows 'of a 'process

This is particularly helpful when working with EPDs. Check the "Using results of EPDs in the supply chain" section for more details.

Details about nested product systems can be found at this link.

USING RESULTS IN PRODUCT SYSTEMS

As you will see (check the "Save and export results chapter" section for details), you can now save your results and use them in different ways. Among them, once saved, you can drag results into a product system:

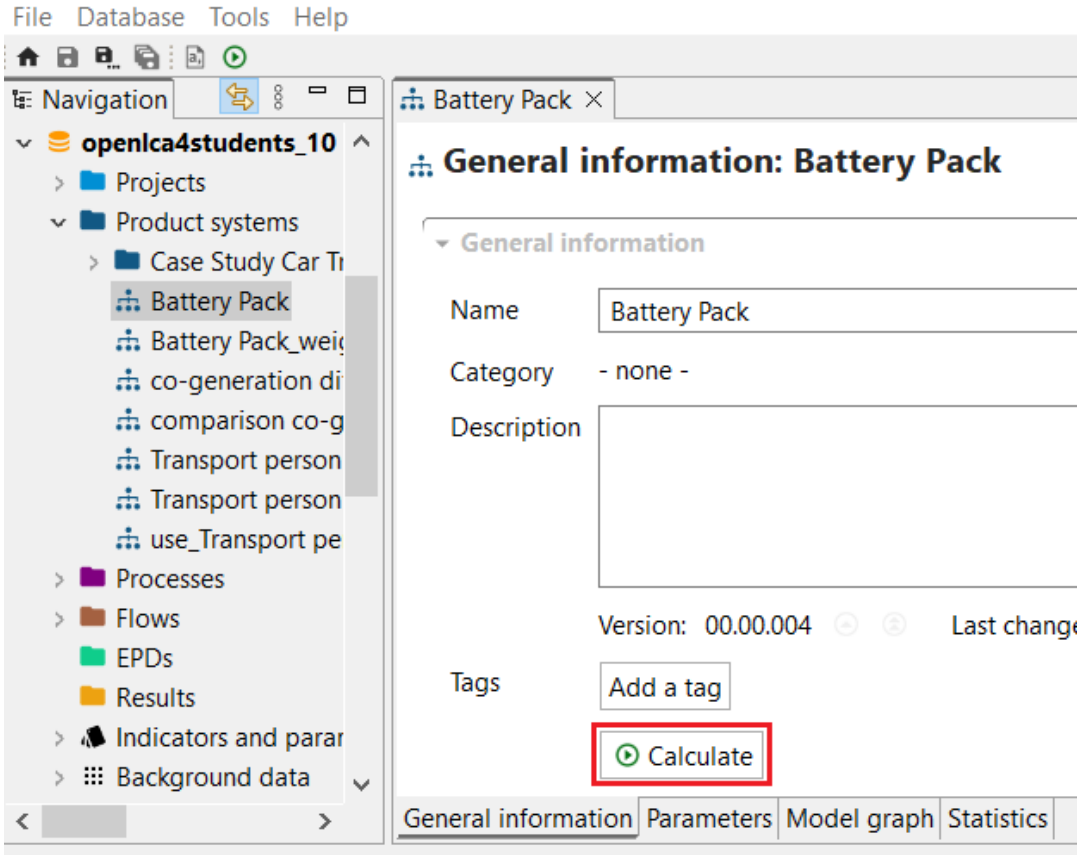


Result' dragged'in'a'product'system

You can use this feature to complete the supply chain when the inventory is unknown, provided the method used is the same. It is also particularly helpful when working with EPDs (check "Using results of EPDs in the supply chain" section for more details).

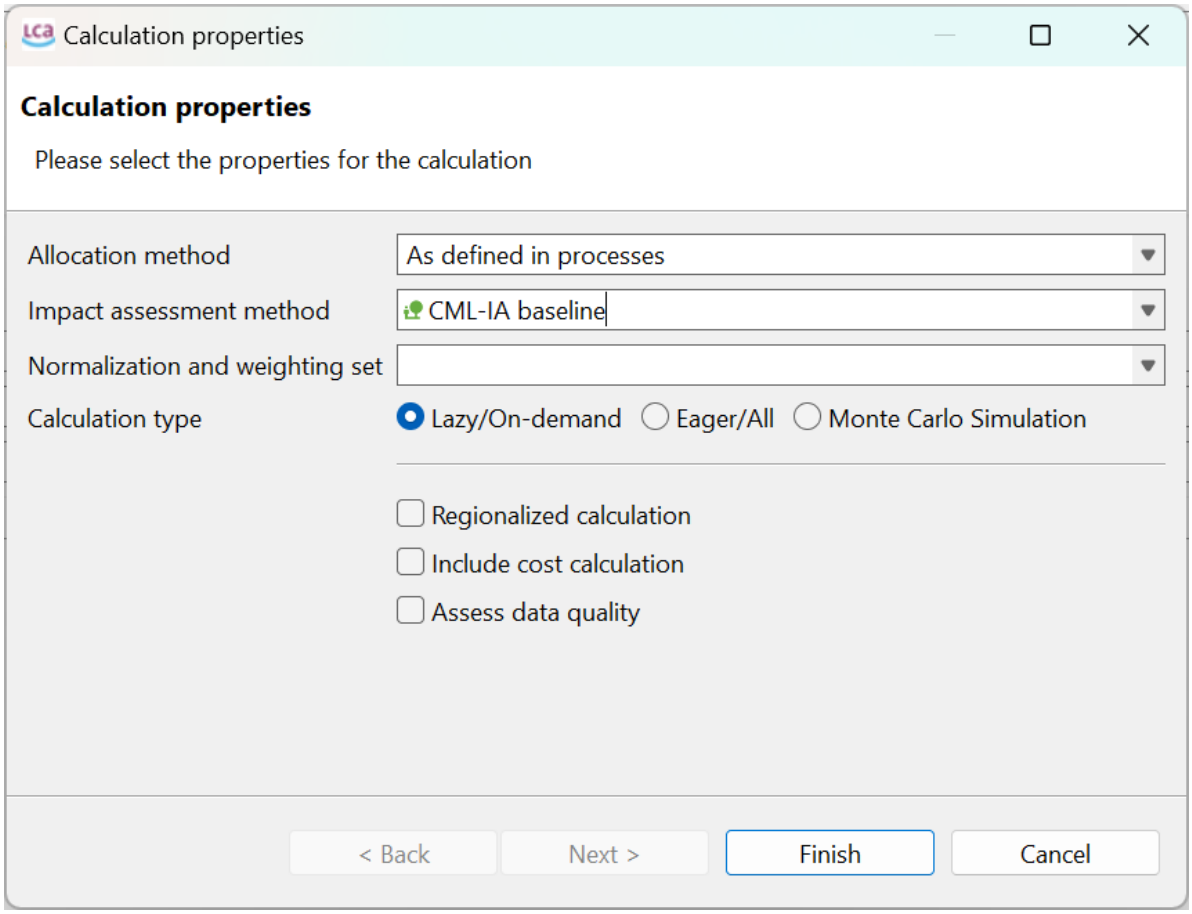
9.4 CALCULATING A PRODUCT SYSTEM

There are three ways to access the calculations of a product's impact assessment. You can right-click on a product system in the navigation panel and select "Calculate", click on the "Calculate" button in the "General information" tab of the product system, or click on the green "Calculate results" icon above the navigation panel.



Calculating'a'product'system

Either way, a pop-up window will open and you can choose the calculation properties.



Calculation' properties

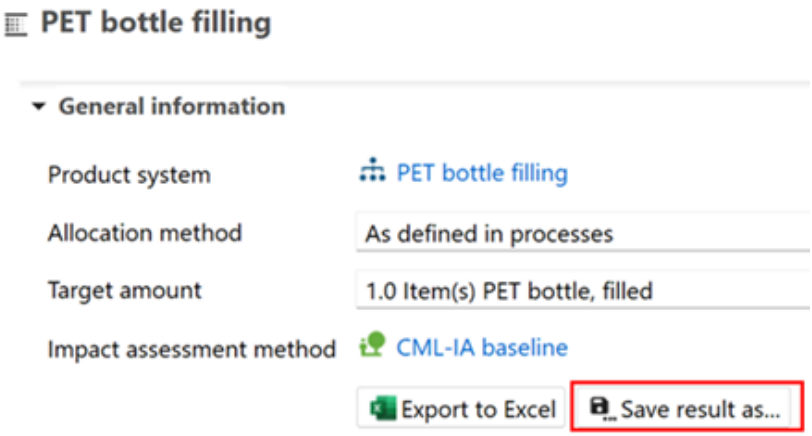
The details on the calculation setup and the result analysis are described in the section Calculation and Result Analysis.

9.5 EXPORTING/SAVING PRODUCT SYSTEMS

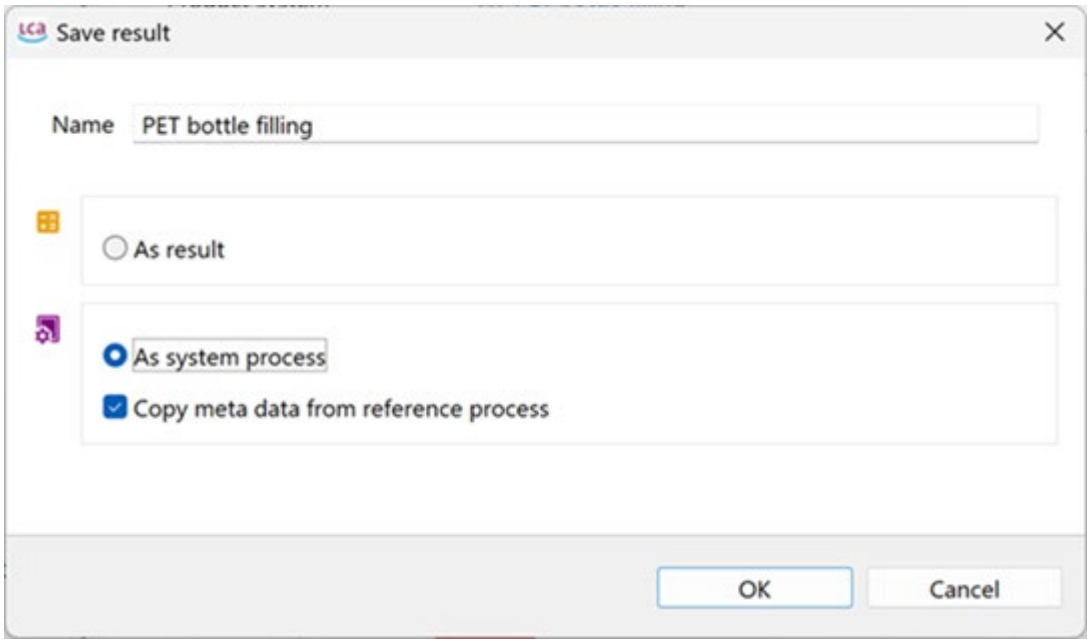
In openLCA, you can export your product system in various ways, tailored to your specific needs.

SAVING A PRODUCT SYSTEM AS A SYSTEM PROCESS

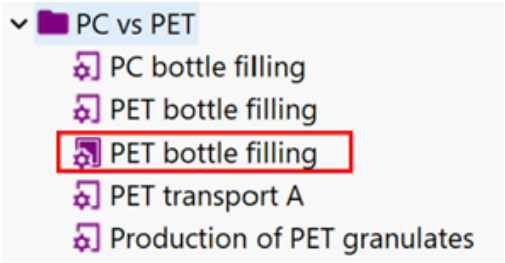
The first method for saving a product system is to calculate its Life Cycle Inventory and then save the results as a System Process.



Save 'results' as…



Save 'results' as 'a 'system' process



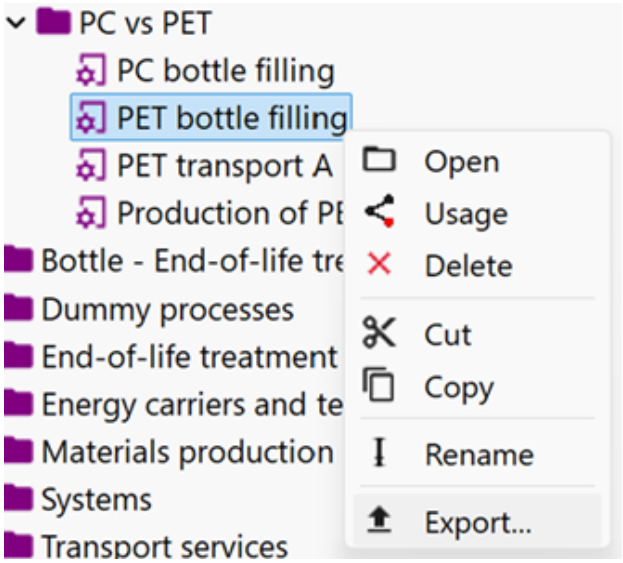
LCI 'results' saved' as 'a 'system' process

You can check the details in the "Save results" section.

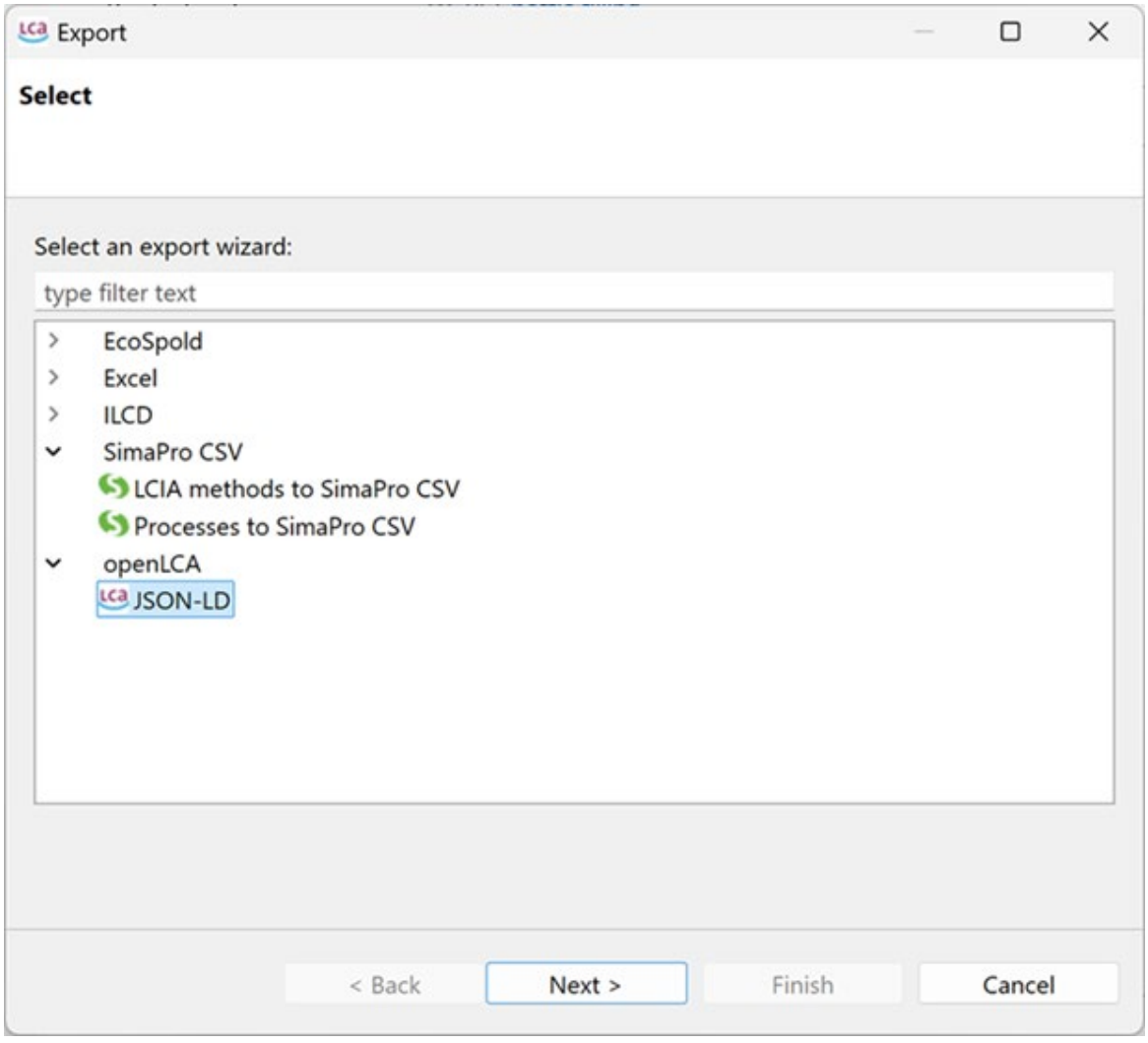
EXPORT IN JSON-LD FORMAT

Another option, very convenient for data exchange, is it to export the product system as a JSON-LD file. This feature is available for every elements of the database.

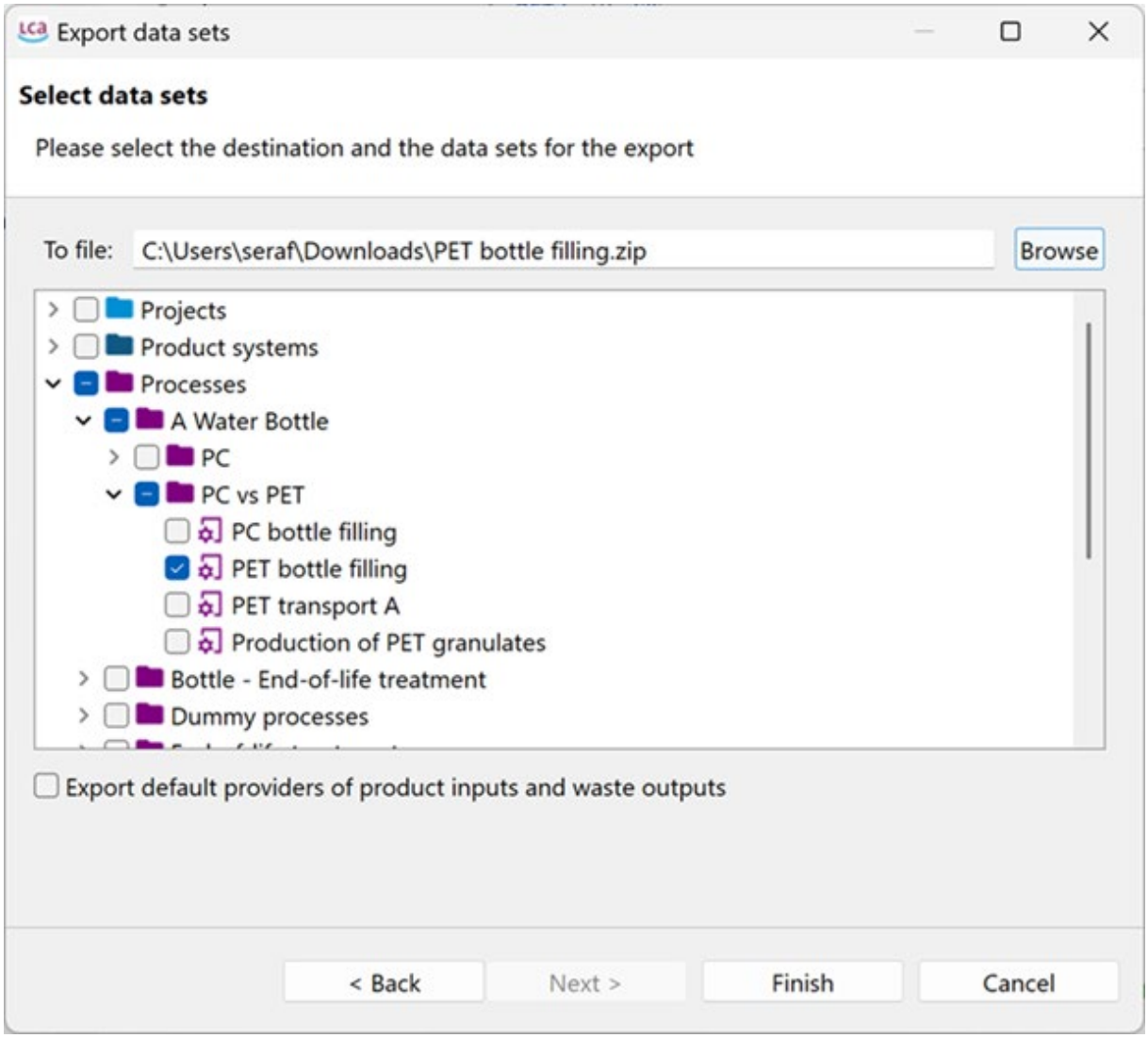
You can right-click on the product system you want to export and select "export":



On the window that will pop up, select "JSON-LD".



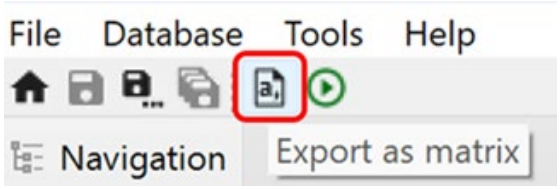
Afterwords, you can decide the name of your .zip file and where in your computer it's going to be saved. In the same window, you can check the elements that are going to be saved, adding or excluding some of them. When you're satisfied, click on "Finish".



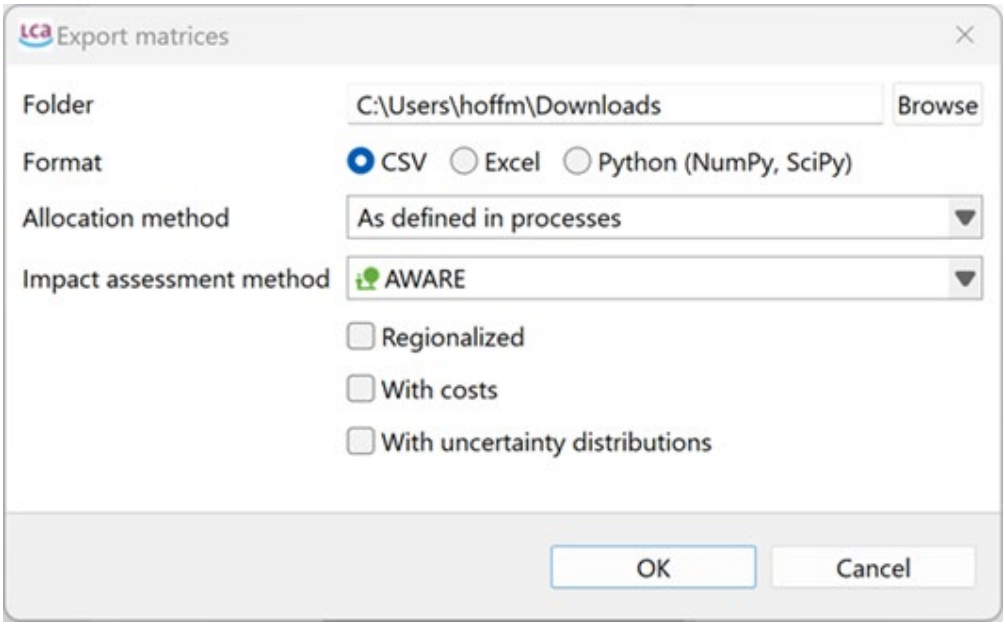
You can now import the elements you exported from another database in openLCA by right-clicking on them and selecting "Import".

EXPORT AS MATRIX

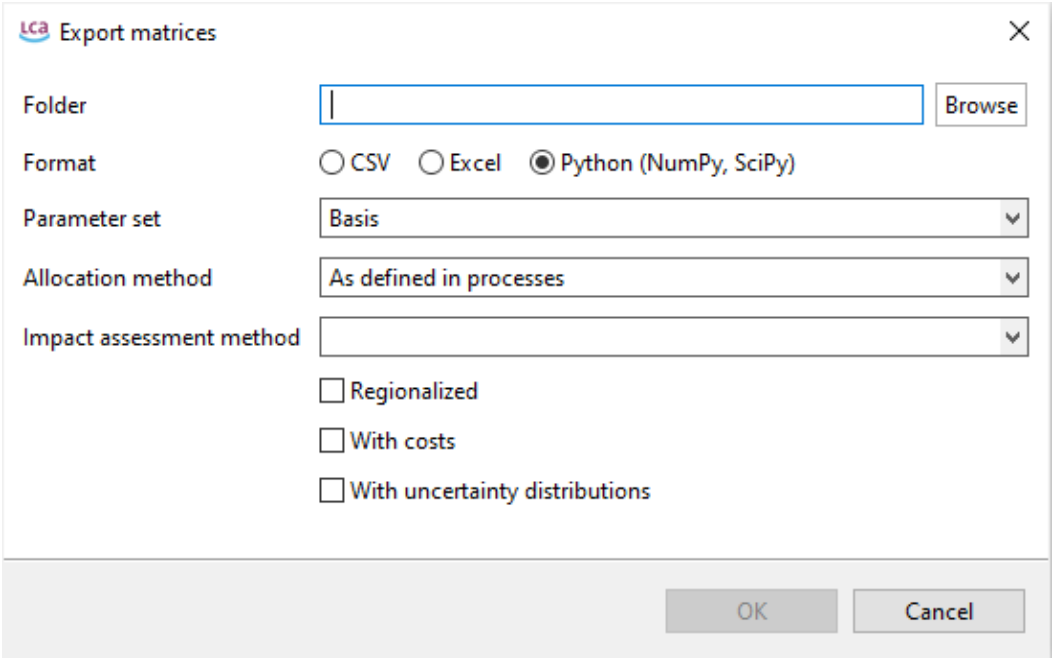
Eventually, you can export the product system as a matrix by left-clicking on 'Export as matrix' on the toolbar.



This will show the following window:



From here, you can choose the folder where the product system is exported, the format you want it exported in (CSV, Excel, Python), the allocation method used, the respective impact assessment method (present in the database), regionalisation, cost calculation, and uncertainty distribution. If you have created parameter sets for your product system, these can be selected using the drop-down menu, as in the picture below.



Esporting as a matrix a product system with parameter sets

10 LCIA METHODS

Impact assessment methods are essential components of life cycle assessment. They quantify the potential environmental impacts associated with products, processes, or services. These methods analyse the data from the inventory phase and translate it into meaningful indicators. LCIA methods encompass a wide range of impact categories,

such as global warming potential, acidification, eutrophication, and human toxicity, typically provided to encourage businesses and individuals to make informed, sustainability-driven decisions that promote a greener and more responsible future.

Note: If you use the databases provided by openLCA Nexus, they often do not contain LCIA methods (called "impact assessment methods" in the software). This enables us to update databases and LCIA methods more quickly. Hence, the LCIA methods need to be imported/created by you in each database in openLCA to carry out life cycle impact assessment. See below for details.

10.1 CATEGORY TABS

10.1.1 new! Impact assessment category tab contents

In openLCA 2, LCIA categories are now standalone entities that are stored separately from an LCIA method. A single LCIA category can be used in several LCIA methods, and an update of such an LCIA category will update it in all LCIA methods where it is used. The database update moves the LCIA categories to the new category "Environmental indicators" in the navigation.

Note: As LCIA categories in different LCIA methods often have the same name, there are also LCIA categories with the same name in this folder. This can be easily changed by assigning more descriptive names to these LCIA categories.

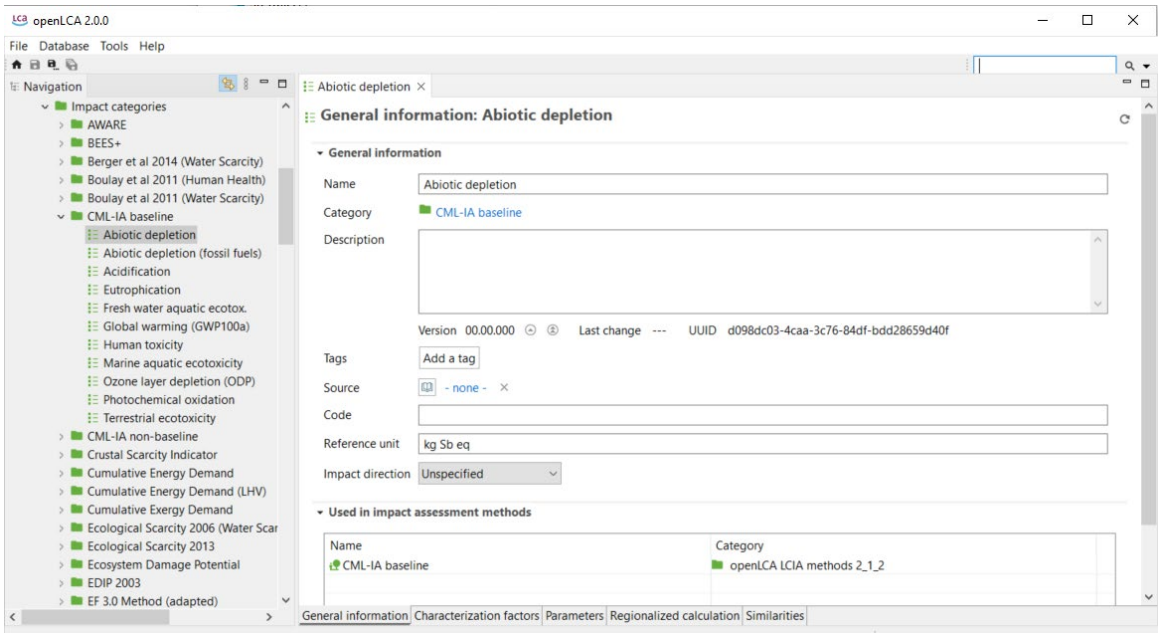
The contents of the impact categories window will be explained below.

GENERAL INFORMATION

Here you can view and modify the name of the category, add a description, a reference unit, additional details or tags, as well as:

- Adding a source in the database (see "database elements")
- Adding a code (i.e., a short name for the category, useful in result views)
- Choosing an impact direction

The image below shows an example of the General Information tab for the CML-IA baseline methodology from ecoinvent:



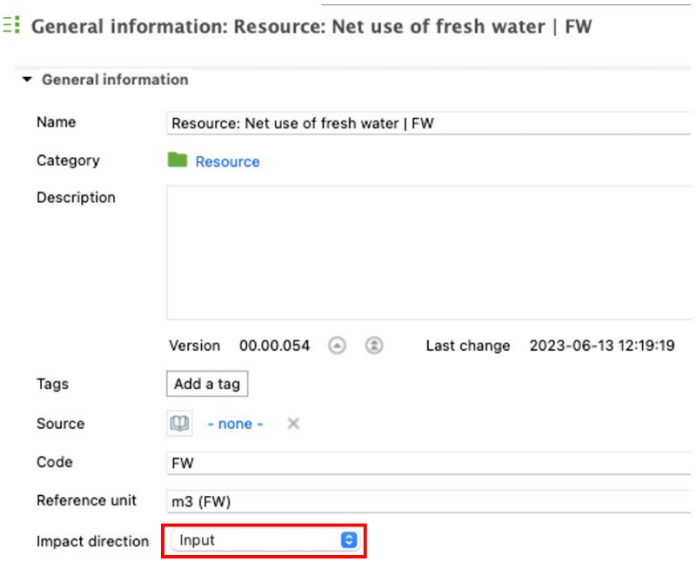
LCIA 'category'] 'General' information' tab

USED IN IMPACT ASSESSMENT METHODS

In this helpful tab, you can view the impact assessment methods that utilise this impact category and the category in which each method can be found.

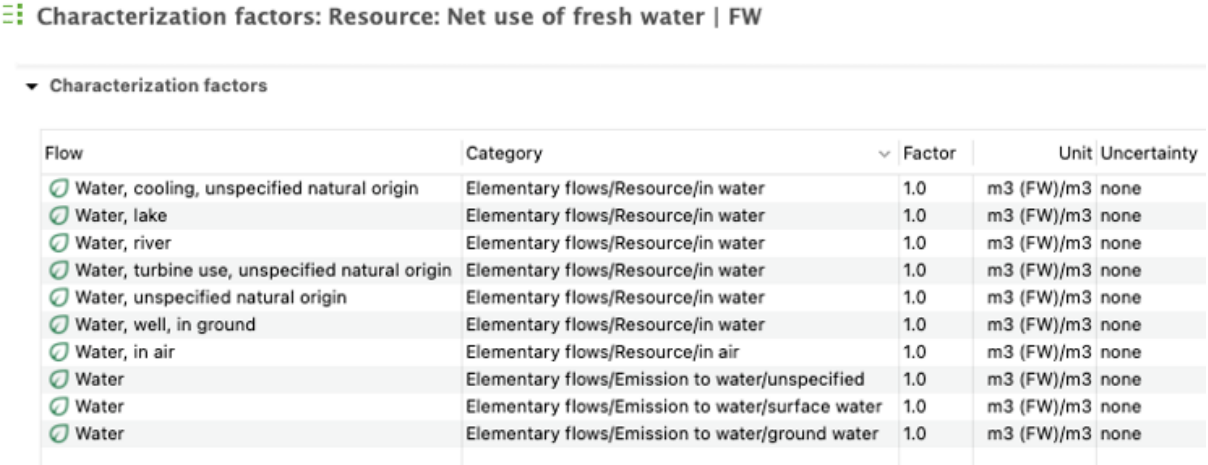
IMPACT DIRECTION

New: In openLCA 2, a new feature allows you to specify the impact direction for each impact category as either "Input" or "Output" (as shown in the figure below). Essentially, resource use categories are inputs, while emission-related categories are outputs. The default setting, when no specific impact direction is chosen, is "Unspecified". With the option "Unspecified", all characterisation factors and their signs (plus or minus) will be taken into account for the calculation as they are listed in the factors table of the methods.



General'information'window'of'an'impact'category'with'the'setting'for'..Impact'direction...' set'to'..Input..:

When you choose "Input" or "Output" as the impact direction, openLCA automatically handles the sign of factors, depending on whether the flow is an input (resource) into a process or an output from a process (emission). This way, the sign of the characterisation factors is set during the calculation and displayed in the results. Taking water as an example. In the figure below, an impact method is illustrated to calculate the net use of freshwater, meaning that all water used as an input is summed up, and all water lost as an output is subtracted. If the resulting total impact value is positive, more water is used as an input resource than water is emitted in the output of processes and vice versa. When no impact direction is specified as "Unspecified", the factors for water must be negative for all flows within the emission compartments and are (correctly) modelled as an output of processes. When the impact direction is set from "Unspecified" to "Input", the factors for water can remain positive for all flows (see the figure below). During the impact calculation in this example, openLCA will automatically invert the sign of the water flows in the output of processes. On the other hand, if the impact direction "Output" is chosen, the water flows in the input of processes will be inverted. The inverted value will also appear in the impact analysis window on the results page, allowing users to directly see which flows contribute with a positive sign and which ones with a negative sign.



Flow	Category	Factor	Unit	Uncertainty
Water, cooling, unspecified natural origin	Elementary flows/Resource/in water	1.0	m3 (FW)/m3	none
Water, lake	Elementary flows/Resource/in water	1.0	m3 (FW)/m3	none
Water, river	Elementary flows/Resource/in water	1.0	m3 (FW)/m3	none
Water, turbine use, unspecified natural origin	Elementary flows/Resource/in water	1.0	m3 (FW)/m3	none
Water, unspecified natural origin	Elementary flows/Resource/in water	1.0	m3 (FW)/m3	none
Water, well, in ground	Elementary flows/Resource/in water	1.0	m3 (FW)/m3	none
Water, in air	Elementary flows/Resource/in air	1.0	m3 (FW)/m3	none
Water	Elementary flows/Emission to water/unspecified	1.0	m3 (FW)/m3	none
Water	Elementary flows/Emission to water/surface water	1.0	m3 (FW)/m3	none
Water	Elementary flows/Emission to water/ground water	1.0	m3 (FW)/m3	none

Water elementary flows and characterisation factors / all positive_ inside an impact method to calculate the net use of fresh water % with the impact direction set to ..Input...

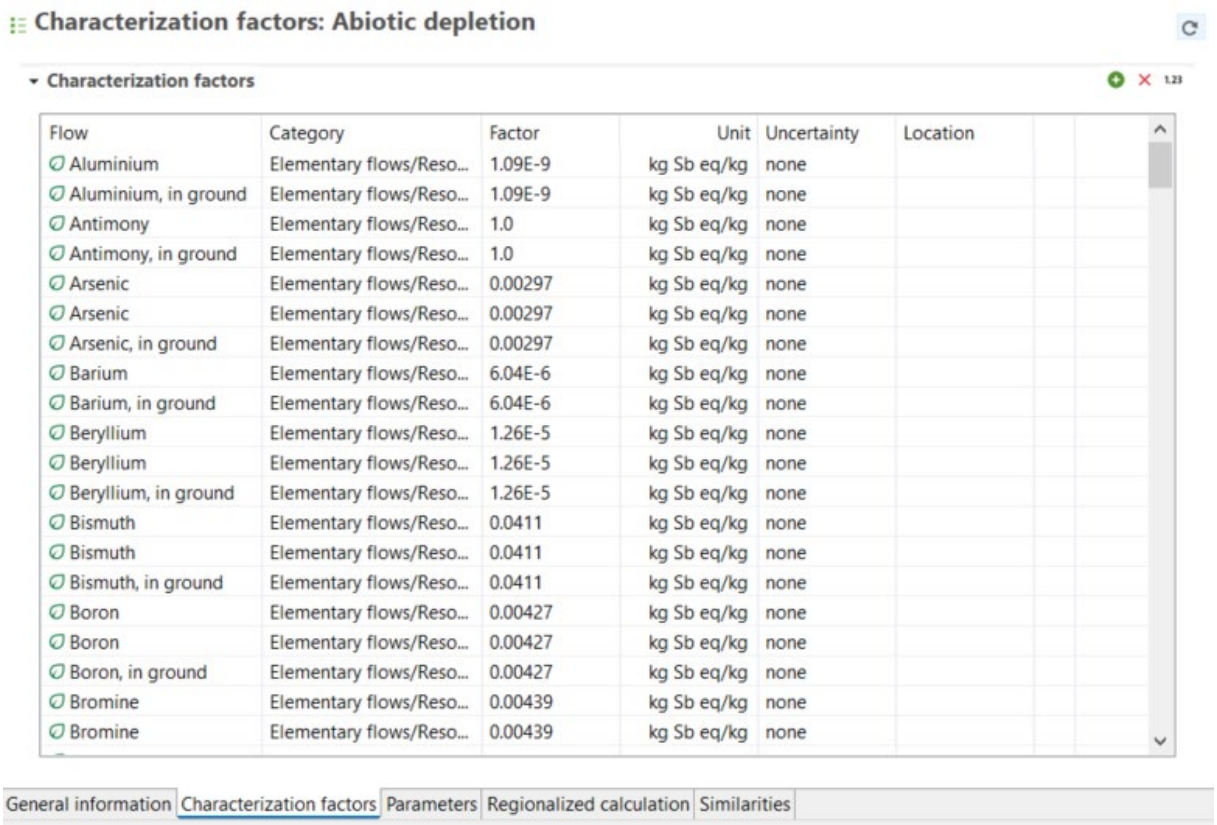
The advantage is that all flows, which are modelled in a "correct" way for resources in the input and emissions in the output of processes, can keep their positive factor for the characterisation. For example, carbon dioxide emissions to the air have a characterisation factor of 1.0 for their global warming potential. The flow for carbon dioxide removal from air (utilising it as a resource) can also maintain a positive value of 1.0, as it is essentially (but not technically) the same elementary flow. Another advantage of setting the impact direction is that negative values for the factors within the methods (which are, of course, still possible) will directly indicate to the user which flows are modelled on the "wrong" opposite side of a process. With the example from above, the water output (emissions compartment) can also be modelled as an input with the opposite sign for the factors inside the method. It will be on the "wrong" side, but the impact direction is set to "Input", and the calculation result will be the same. The input is not inverted, and the water factors would remain negative, contributing as an output.

Note To correctly respect impact directions, users should use the new method packages to obtain correct results: Version 2.0.3 onwards. For more details, please refer to our blog post on the topic.

CHARACTERIZATION FACTORS

In this window, you can:

- Add/edit flows that are included in the category
- View the emission category to which the impact category belongs
- Edit the corresponding impact factor, units, and uncertainty data
- Add/edit location



„Characterisation'factors...'tab

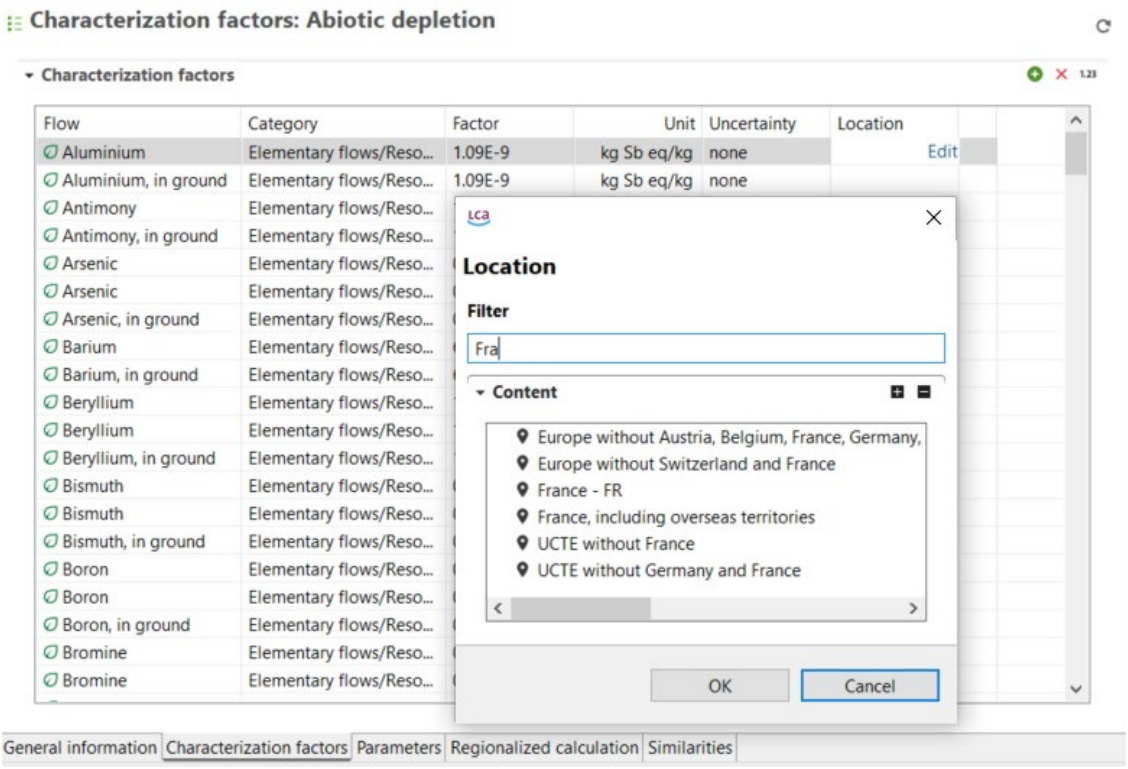
PARAMETERS

Parameters can be used in the same way for LCIA categories as for processes, see the section "Parameters".

REGIONALIZED CALCULATION

In openLCA, you can now assign locations to characterisation factors and process inputs/outputs. These locations are then used in the new calculation and shown in the results. By default, the process location is used for inputs and outputs, but you can specify a different location at the flow or even exchange level if needed.

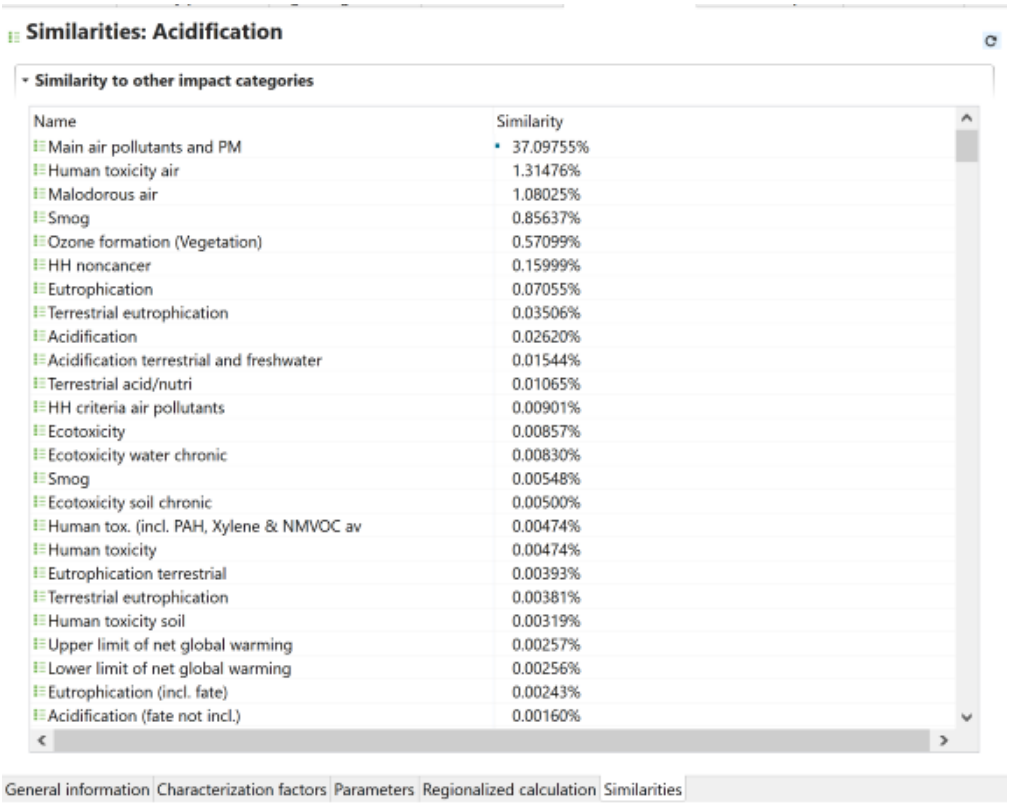
More on regionalised calculation can be found in the "regionalised LCA" section.



Adding 'locations' for 'flows' in 'impact' categories' and 'using' filters

SIMILARITIES

In openLCA 2, a similarity check for LCIA categories is available as a separate tab within the Impact Category Editor. This feature can be useful for finding duplicate impact categories.



Similarity check for LCIA categories

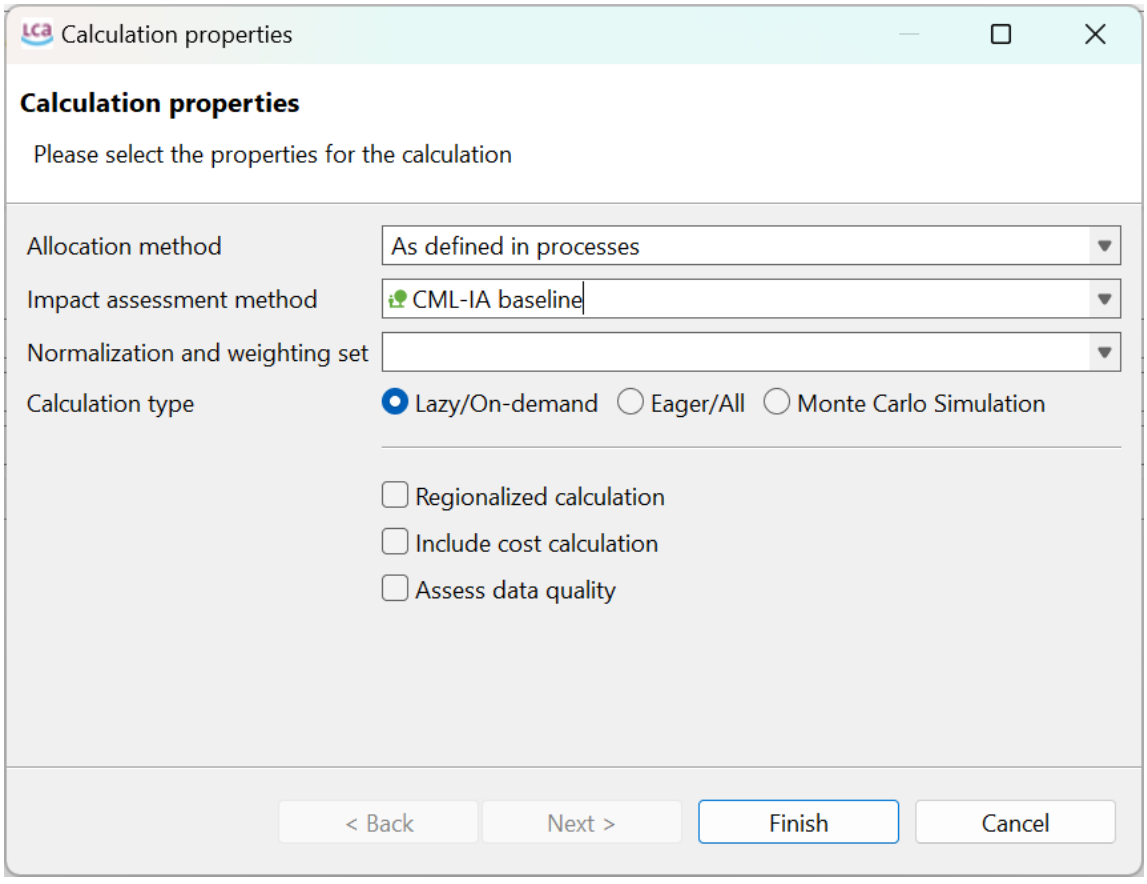
10.2 IMPACT ASSESSMENT METHODS OVERVIEW

Various scientific LCIA methods exist to perform the impact assessment. Depending on the goal and scope of your study, as well as other factors, specific methods are employed. Here we provide a small overview of the most common methods and the impacts they cover:

As displayed above, some impact methods only cover one specific impact category, but also represent the foundation of other methods; for example, the IPCC is used in the Environmental Footprint method.

11 CALCULATION AND RESULT ANALYSIS

After you've completed the modelling of your processes, created your life cycle model (product system), or finished constructing your project report, it's time to move on to the calculation.



Calculation properties

To start the calculation for a product system, have the product system open, and then press on the "Calculate" green botton. In the upcoming screen, you can customize the calculations according to your requirements. You can choose the allocation method, the impact assessment method, normalisation and weighting set, the calculation type (lazy,

eager, or Monte Carlo simulation), or whether to include regionalised calculations, cost calculations, or data quality. In detail:

- Allocation method: Here, you can choose the allocation method applied in the calculation throughout the product system. Options are none, casual, physical, economic, or "as defined in process". "None" is the default setting. "As defined in process" means that the allocation is performed as defined in each process (you may have different allocation methods in different processes). However, the chosen option will overwrite predefined allocation methods in the individual processes. See the Allocation section for more details.
- Impact assessment method: Here, you can choose the Impact assessment method from the list of methods available in your activated database. If no methods are listed, you need to first import a method pack into the database or create a new method.
- Normalisation and weighting: In this section, you can select a normalisation or weighting set for your values. This set must be included in the impact assessment method. If the chosen method doesn't have any sets, you need to add them to the impact assessment method first.
- Eager/all & Lazy/On-demand: You can choose to perform the calculations in "Eager/All" or "Lazy/On-demand" mode. Eager calculation provides complete results upfront, while lazy calculation offers faster navigation and on-demand calculation of impacts. For more details, see the section Lazy vs Eager calculation.
- Monte Carlo Simulation: You can perform uncertainty calculations using a Monte Carlo simulation. This method considers all uncertainty distributions defined in flows, parameters, and characterisation factors, with the exception of the one associated with the reference product of the system. Check the Monte Carlo simulation section for details.
- Regionalised: Check this box if you want to calculate the results in dependence on regions using geoJSON files. Check the Regionalised Calculation section below for details.
- Include cost calculation: This option additionally performs cost calculation. Check the Life Cycle Cost Calculation section for details.
- Access data quality: If you've included data quality information in your processes, this option will calculate the data quality for your results. Be sure to define the details of the data quality assessment by clicking "next" before proceeding with the calculation. Especially, the data quality system specified here must be referenced by the processes. Check the Data Quality section for details.

11.1 LAZY VS EAGER CALCULATION

When calculating impact results, you can choose between eager and lazy calculation modes:

- Eager/all: This mode will calculate the entire LCA model, including all contributions of flows and processes to the result upfront, regardless of whether the results are immediately needed in the visible editor. While this mode offers

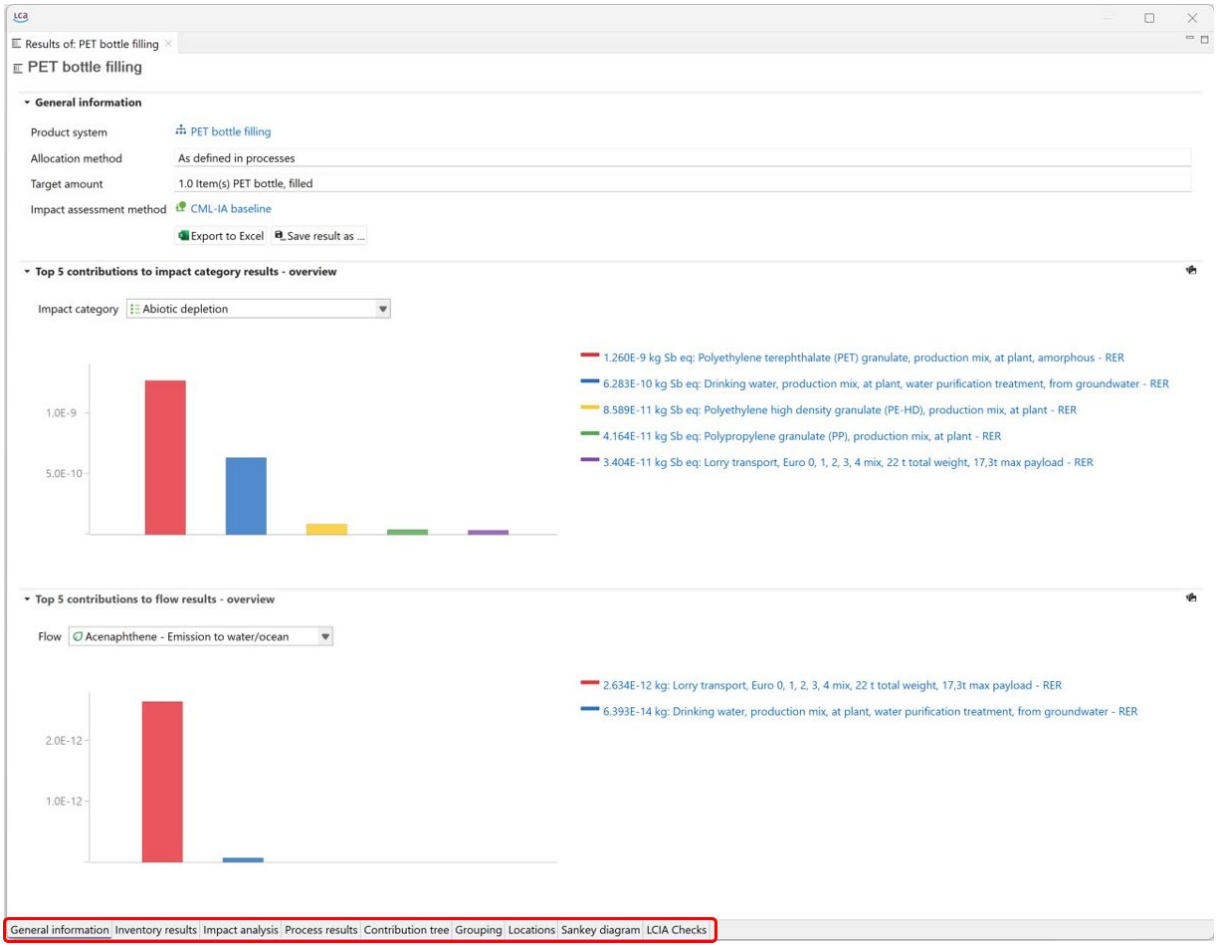
the advantage of providing comprehensive results immediately, it requires more computational resources and time, especially for large and complex models.

- Lazy/On-demand: This mode will postpone the calculation of contribution results until they are specifically requested. Lazy calculation has the advantage of reducing computational load and speeding up initial model loading and navigation. It calculates and displays results as needed; more complex calculations, such as those in the contribution tree and Sankey diagram, are only performed once the Sankey diagram or contribution tree is requested. After an initial calculation, the results are cached until the result is closed.

Whether you choose "Eager" or "Lazy", the calculation results will be the same!

11.2 RESULT ANALYSIS

Once the calculation is done, the window with the results will appear in the editor.



In the following chapters, we'll explore every tab in detail.

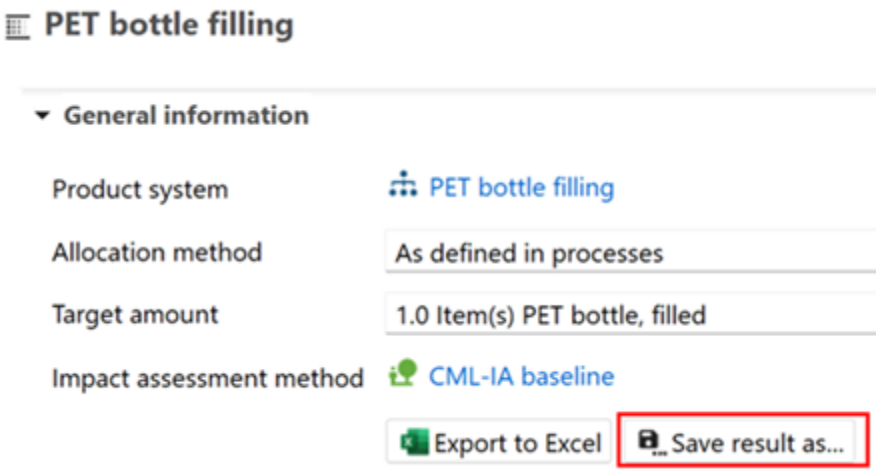
- General information
- Inventory result
- Impact analysis
- Process results

- Contribution tree
- Grouping
- Locations
- Sankey diagram
- Analysis groups
- LCIA checks

11.3 SAVE AND EXPORT RESULTS

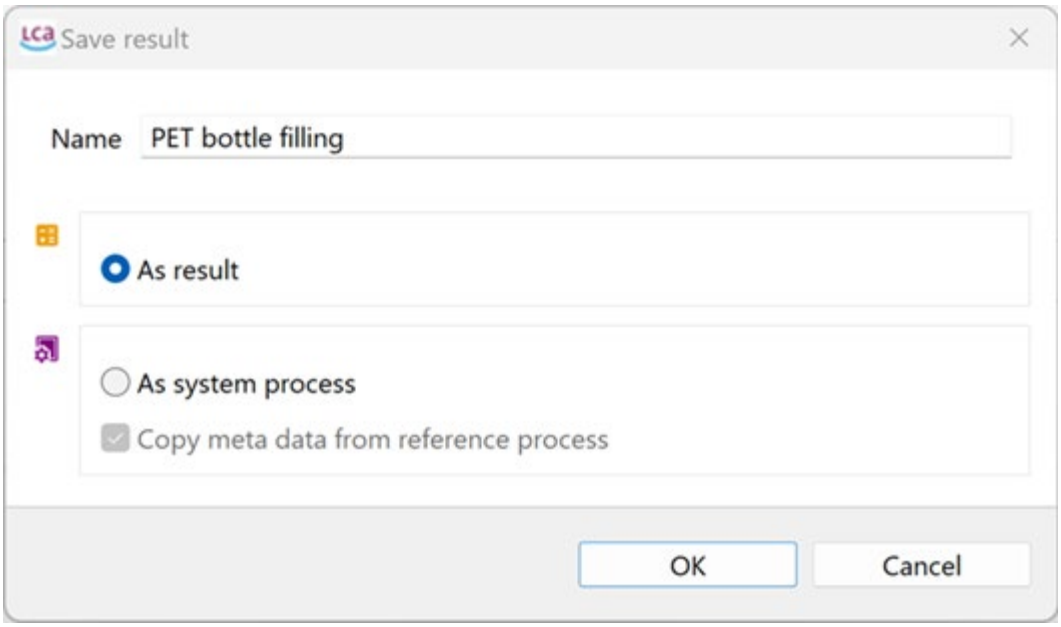
NEW! SAVE RESULTS

By clicking the "Save results as..." button in the General information tab of a product system results window. Alternatively, you can select "File" → "Save" above the navigation panel, and you can save your results as either a "result" or as a system process.



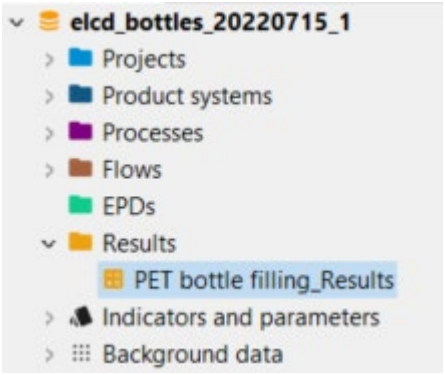
In openLCA 1.7 you can save results or even create a system process based on the results

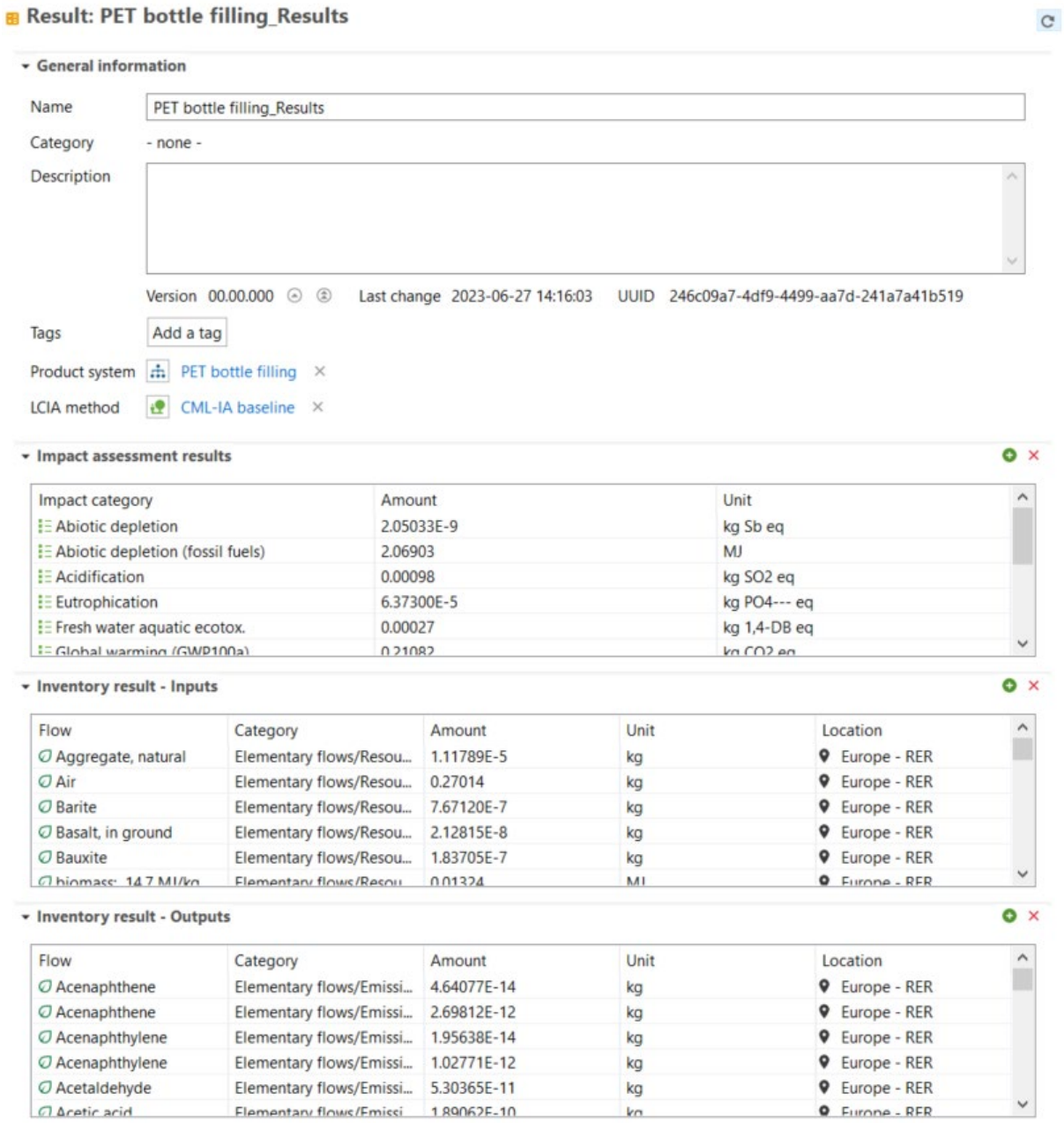
SAVE AS RESULT:



This option creates a "Results" folder in the navigation panel. The "Results" tab displays general information, Impact assessment results, and Inventory results (inputs and outputs).

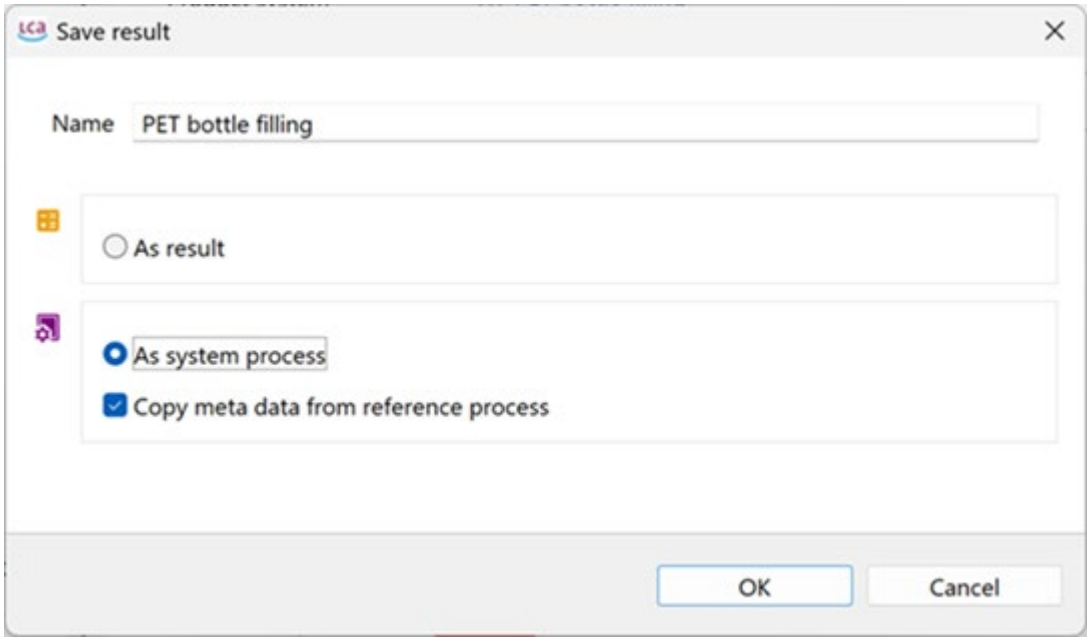
Saving your results as a "result" allows you to easily access them without needing to recalculate. Additionally, it can serve as a convenient way to compare calculations, such as changes in the LCIA method. They can also be directly used in product systems (see next paragraph).



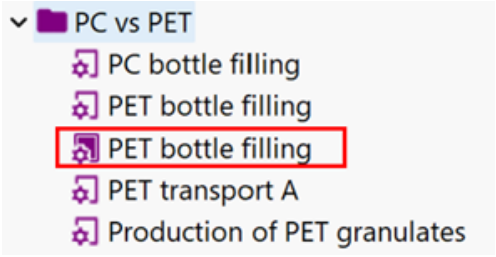


Saving 'results' as 'a' result

SAVE AS SYSTEM PROCESS:



This option creates a system process which is helpful if you want to use your results in another product system. This option also supports to hide detailed information on your product system.



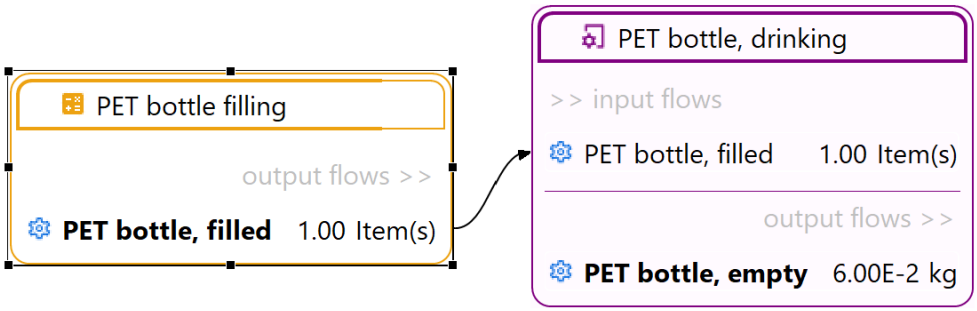
LCI results saved as system process

DRAG AND DROP OF RESULTS IN THE MODEL GRAPH

With openLCA 2 you are now able to add saved results by drag and drop the results into the model graph:

Drag and drop of a result into the input flows of a process

Then, the reference flow of the result can be directly linked to other processes in the model graph.

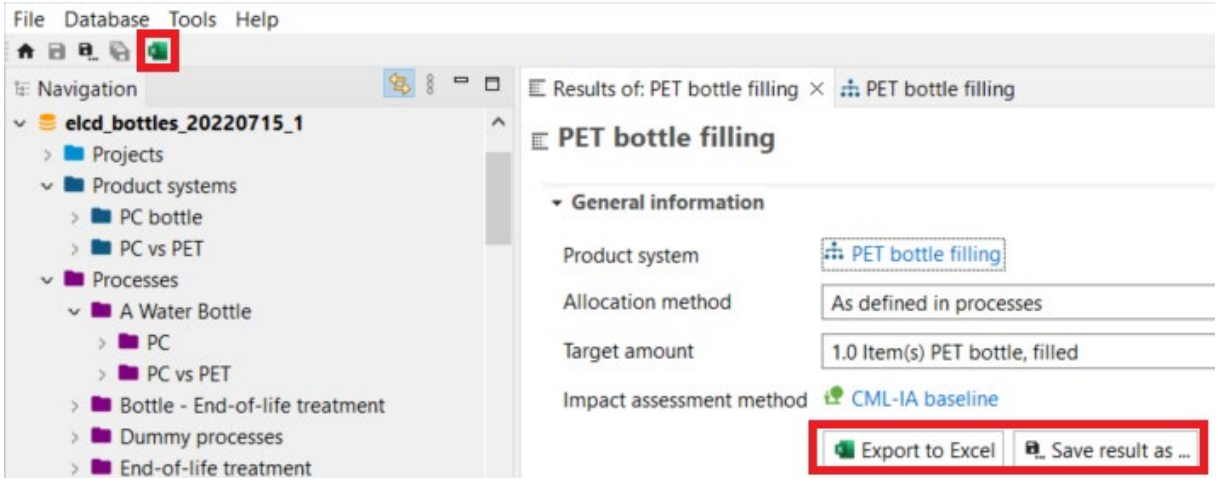


In the model graph, the reference flow can be linked to the same flow of another process

This option is particularly helpful when working with EPDs. Check the "Using results of EPDs in the supply chain" section for more details.

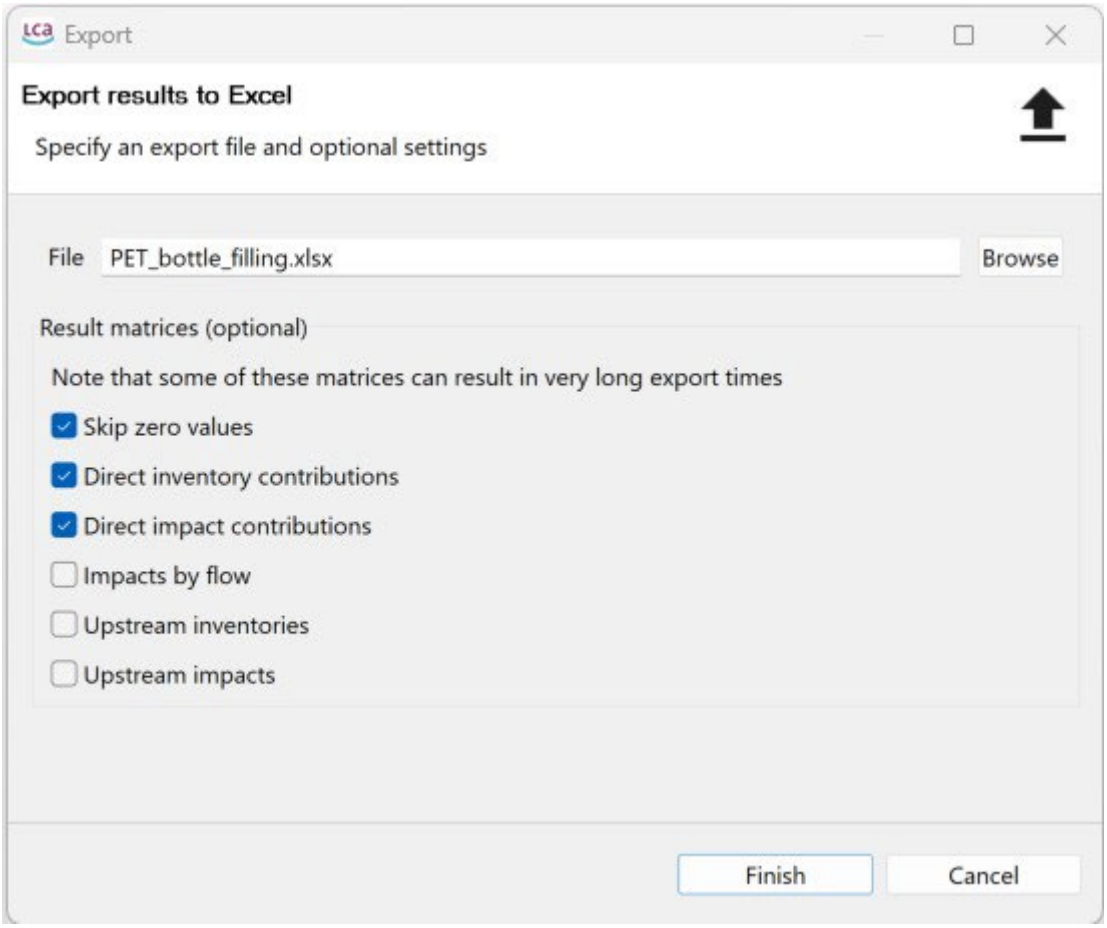
EXPORT RESULTS

The "Export to Excel" option in the "General information" tab or the "Excel" icon above the navigation panel enables you to export your results as an .xlsx file.



Saving and exporting results

You can then choose the export configuration that best suits your needs:

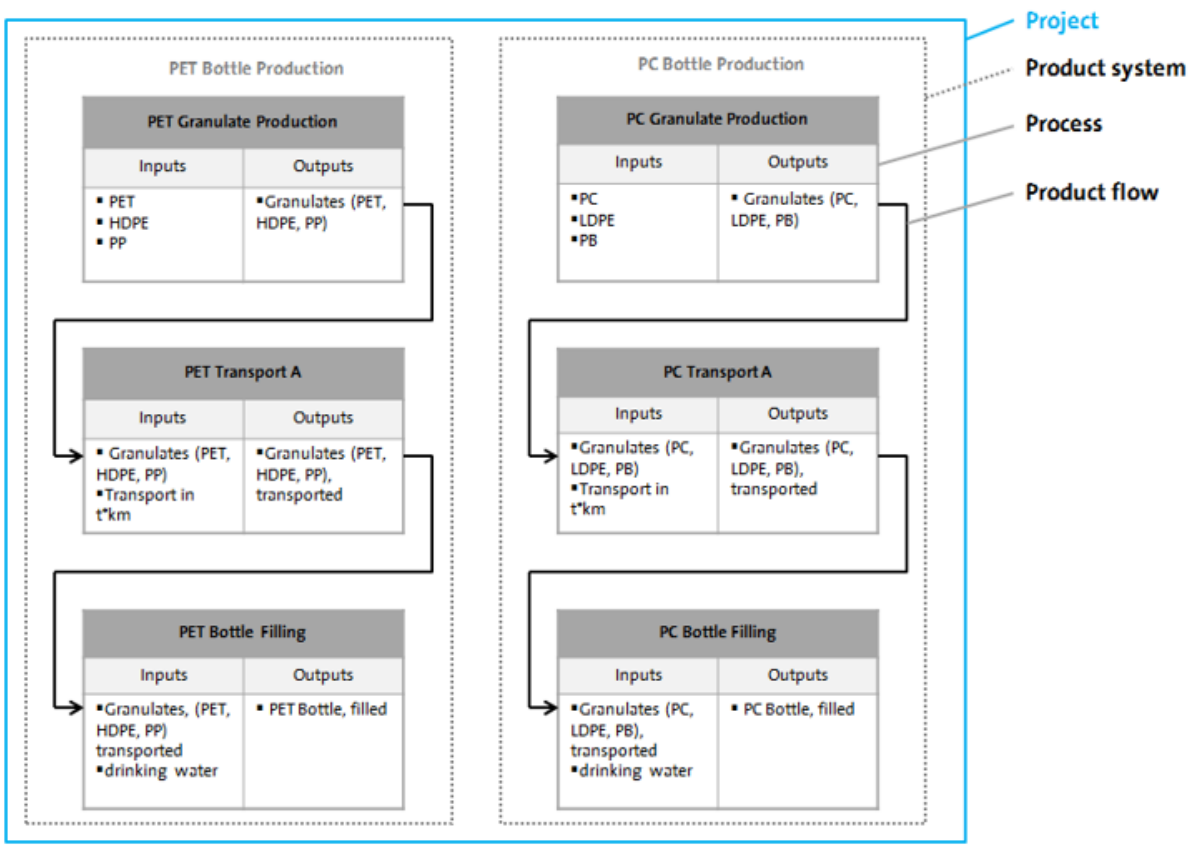


Note: At the current state, the results cannot be exported as ILCD data, but openLCA allows exporting the results as JSON-LD data.

12 PROJECTS

In openLCA, projects are used to compare multiple product systems. You can also use parameters to benchmark various options within the same product system. The resulting report is a powerful tool to communicate the results of your comparative study.

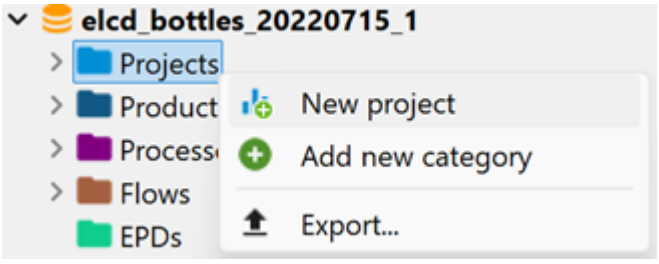
For instance, you can compare the production of polycarbonate (PC) and polyethylene terephthalate (PET) bottles using a project in openLCA (you can access this bottle case study for free). This comparison involves evaluating two or more product systems with a comparable functional unit:



Within a project, you can also vary the parameters used in your product system. This allows you to compare different versions of the same product system, which is an essential part of conducting a "Sensitivity Analysis" in a comprehensive LCA study.

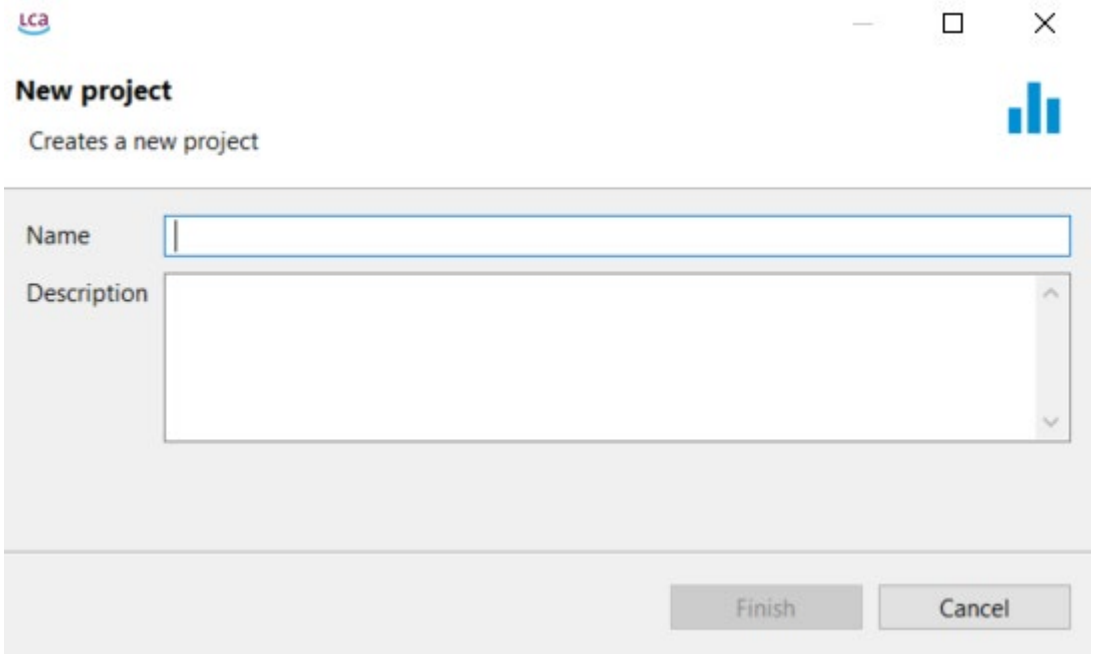
12.1 CREATING A NEW PROJECT

After you have finished modelling one or multiple product systems, you can create a "Project" to compare them. It is essential to note that for a valid comparison, both processes should utilize the same functional unit. To create a new project, right-click on the "Projects" folder and select "New project".



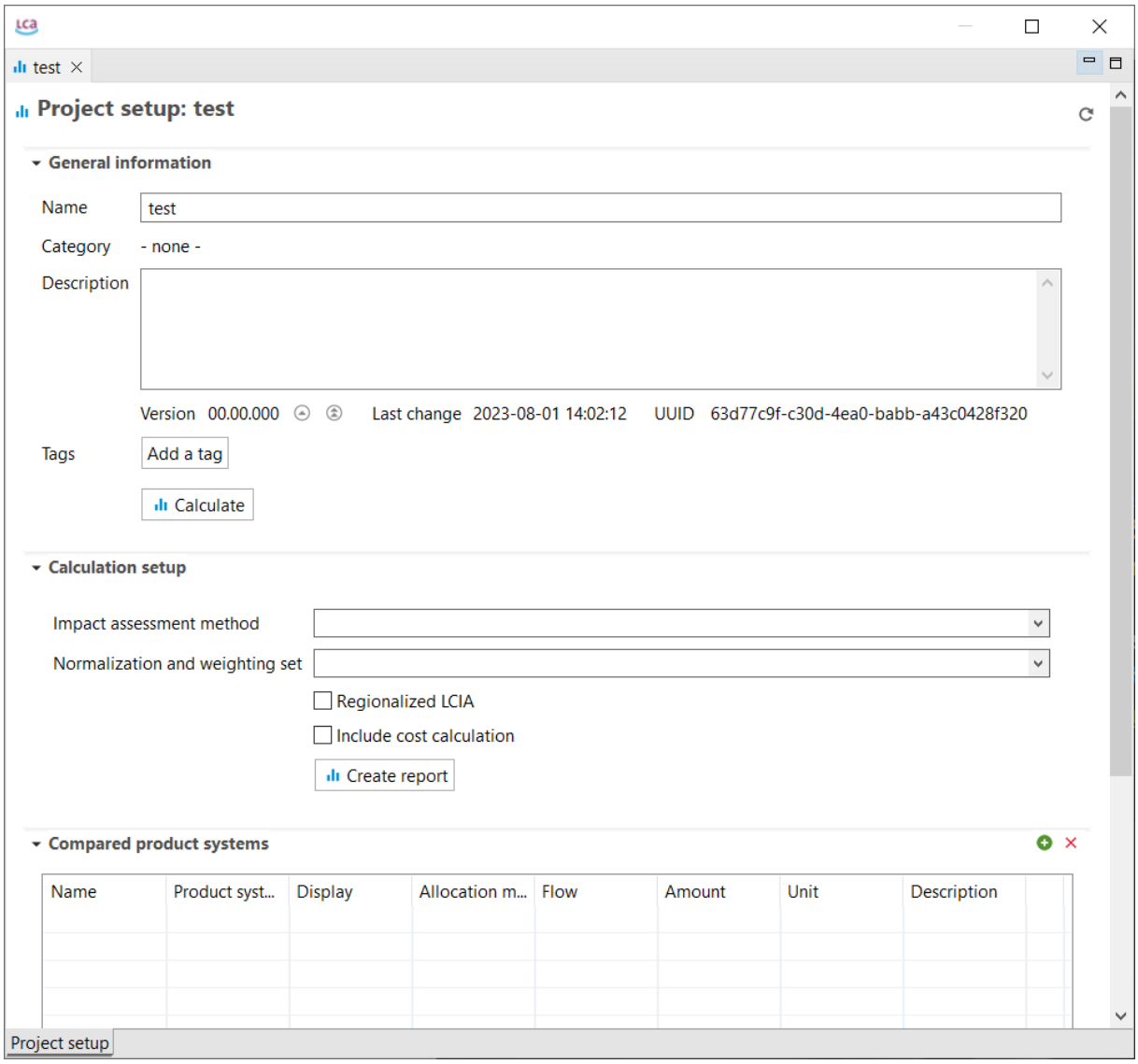
Step 1: Creating a new project

Name the new project and provide a description (optional):



Step 14: Creating a new project

The new project will open in the Editor (check below for details):



Project' window

GENERAL INFORMATION

In the "General information" section, you can edit the name of the project and optionally add a description. Moreover, you can add a tag and run the calculation.

Note: We recommend creating a report before running the calculation. Click on "Create report" in the calculation setup section and then configure it in the new "Report" tab. Check the Report Template section for details.

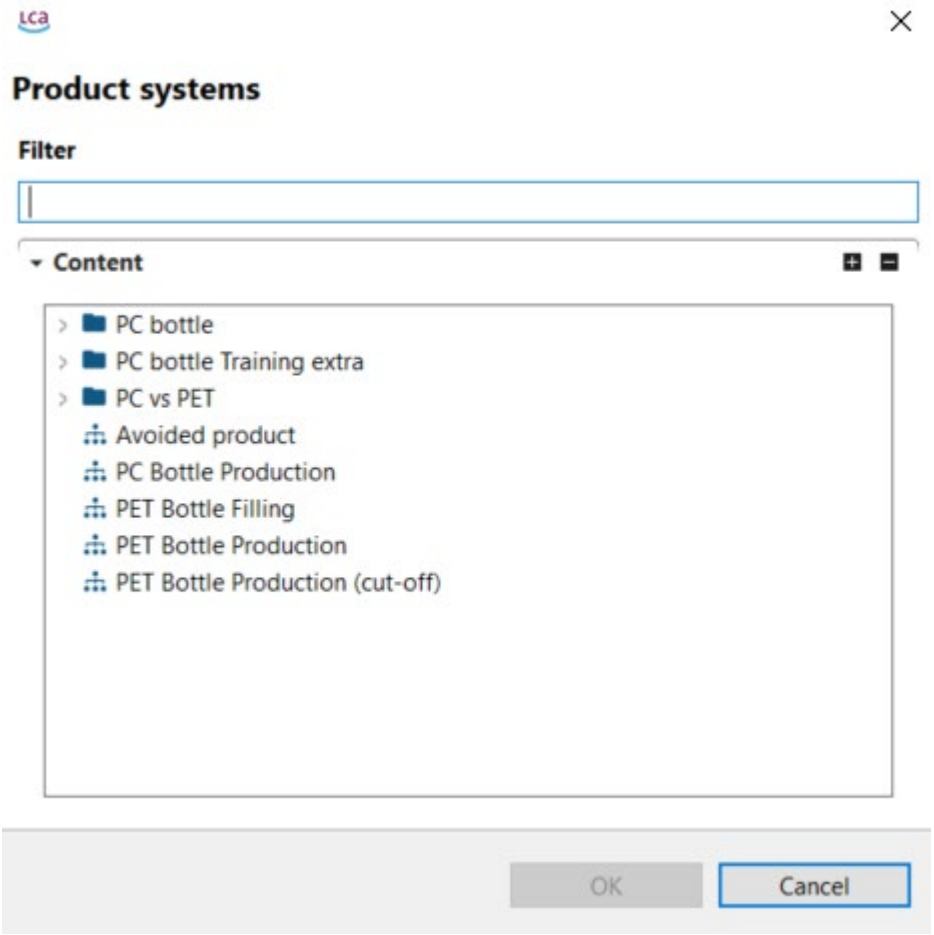
CALCULATION SETUP

In the "Calculation setup" section, you can select the impact assessment method for the calculation, as well as the normalisation and weighting set, if applicable (you can select a set from the methods you've imported in the database, but only if the method you chose includes one or you've created it yourself). You also have the option to select "Regionalised LCIA" and "Include cost calculation".

Project'setup³Calculation'setup

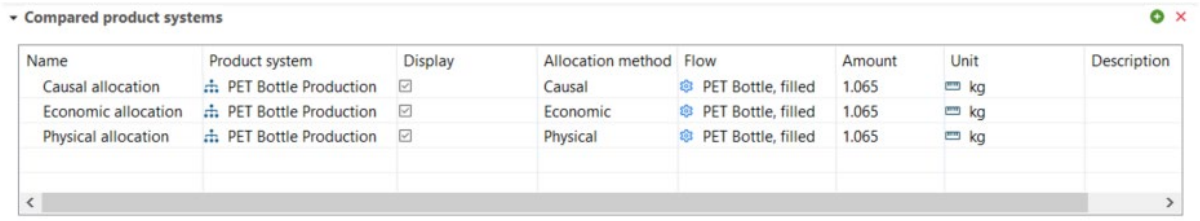
COMPARE PRODUCT SYSTEMS

In the "Compare product systems" section, click on the green "+" icon on the right to add the product systems you want to compare. Additionally, the drag-and-drop function is also supported.



Adding'product'systems'to'a'project

Each selected product system acts as a "variant" for the calculation. You can select the same product system multiple times and/or different product systems. For each variant, you can then provide a new name, a different allocation method and amount. For example, to compare three different allocation methods applied to the same product system, select that product system three times and then select a different allocation method for each. You can also decide which product systems to display in the results.

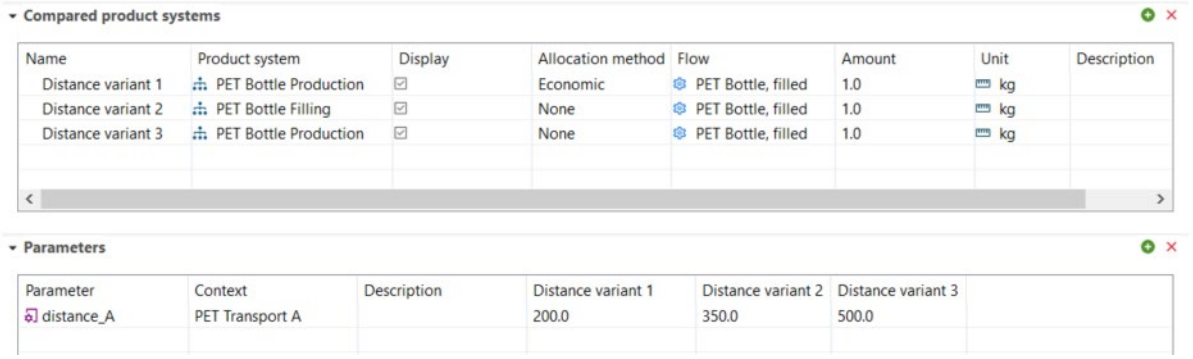


Project setup – Variants

PARAMETERS

In the "Parameters" section, you can modify parameter values for variants. For example, we can compare the impacts of PET bottle production based on the transportation distance of the PET Granules: 200, 350, and 500 km. In the "Compare product systems" section, you can select a product system three times for the PET Bottle, which contains a parameter for the transport distance ('distance_A').

Then, rename each variant and add the parameter 'distance_A' to the "Parameters" section by clicking the green "+" button on the right and selecting it from the available options. Eventually, a new parameter value will be entered for each variant.

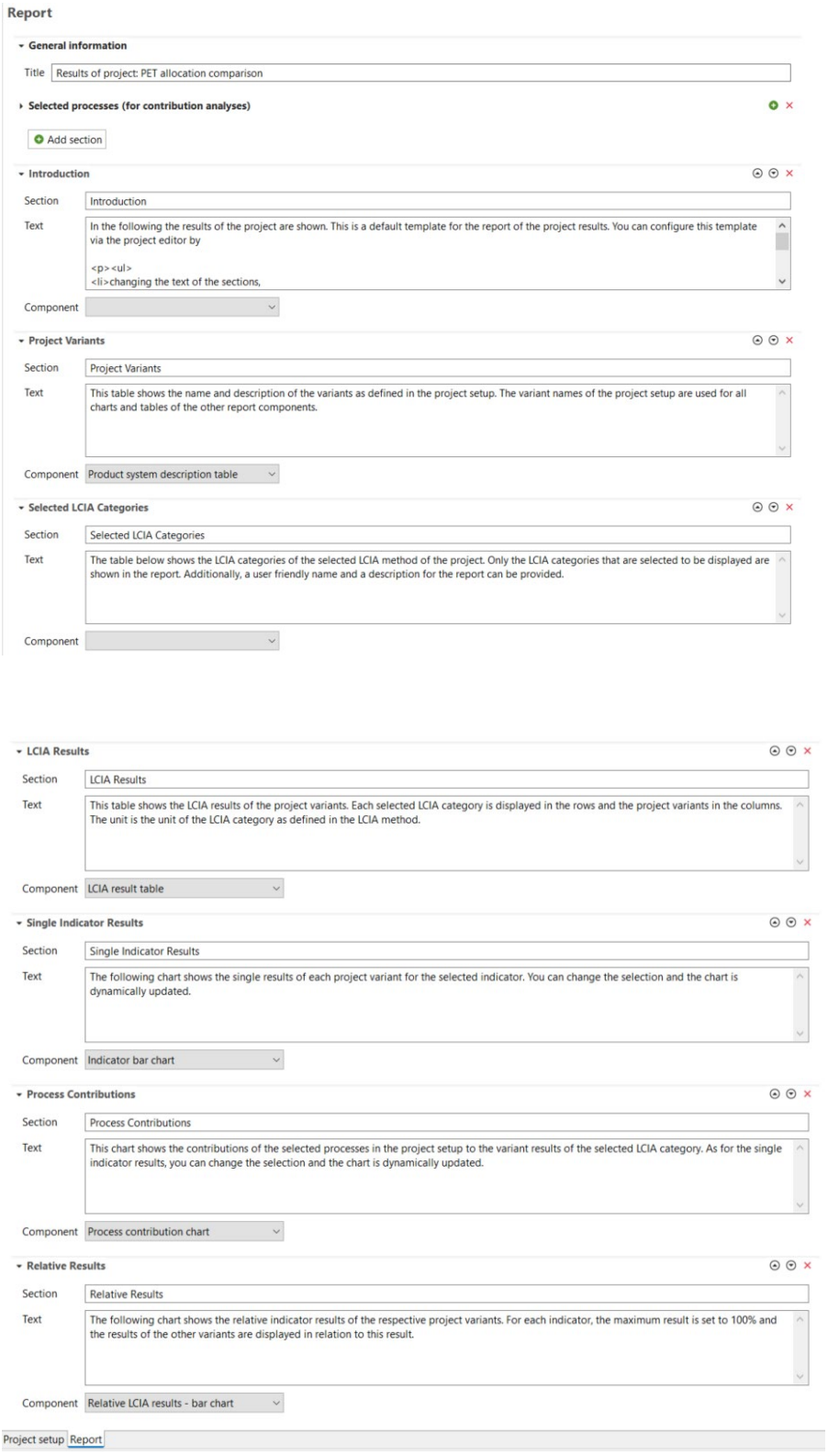


Project setup – Parameters

Once you have configured your project in the "Project setup" click on "Create a report" to configure the report.

12.2 REPORT TEMPLATE

After clicking on "Create report" in the calculation setup section, you can configure it in the new "Report" tab. This report is generated along with calculations when you click the "Calculate" icon in the "Project setup" tab. By default, a report contains the sections "Introduction", "Project Variants", "Selected LCIA Categories", "LCIA Results", "Single Indicator Results", "Process contributions", and "Relative Results. In the "Report" tab, you can name the report, add or remove sections, rename sections, edit their descriptions, delete sections with the red "X" icon on the right, and change their order using the up/down icons. Additionally, you can select a "Component" for each section. For example, which type of chart or table should be displayed? After configuring all the sections, remember to save the project before generating the report.

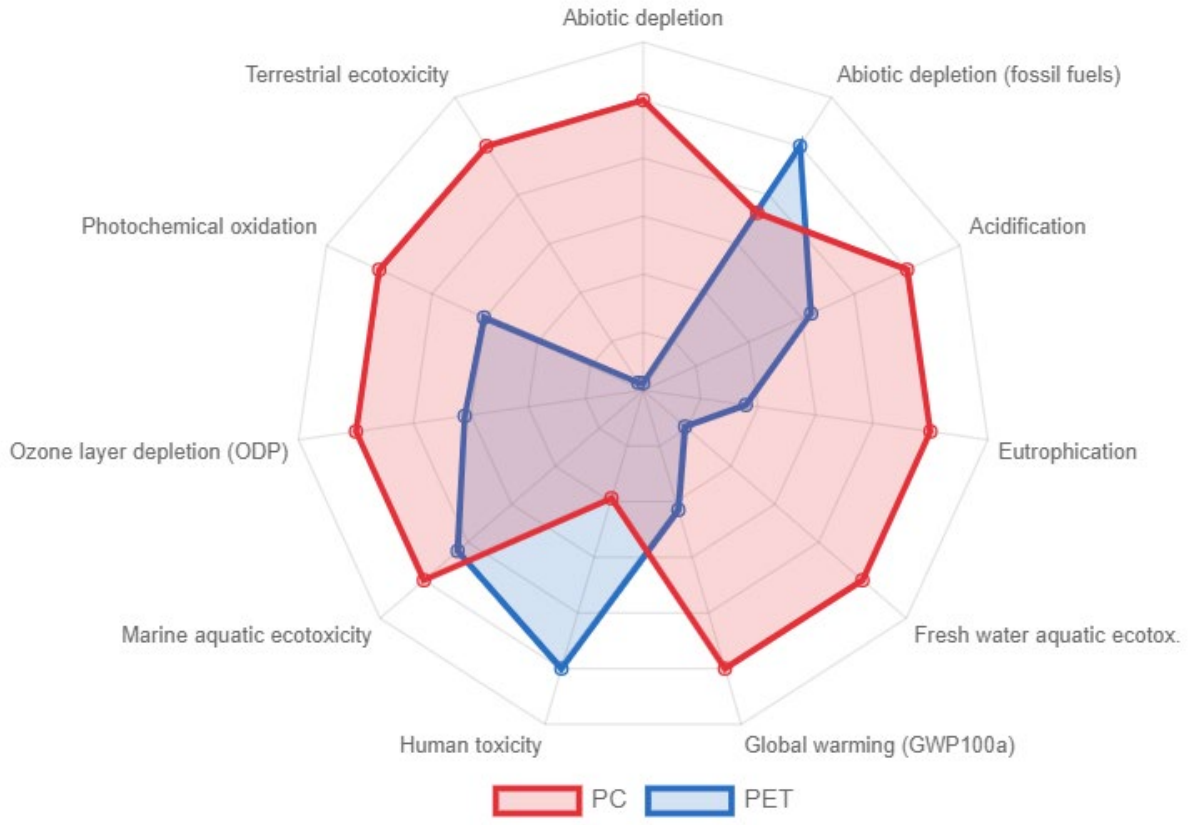


Project 'Report' tab

We want to emphasise our high variety of graphs for the communication of your results, e.g.:

- Indicator bar chart
- Relative LCIA results - bar chart

- Normalisation bar chart
- Relative LCIA results - radar chart
- Normalisation radar chart
- Single score bar chart
- Process contribution chart

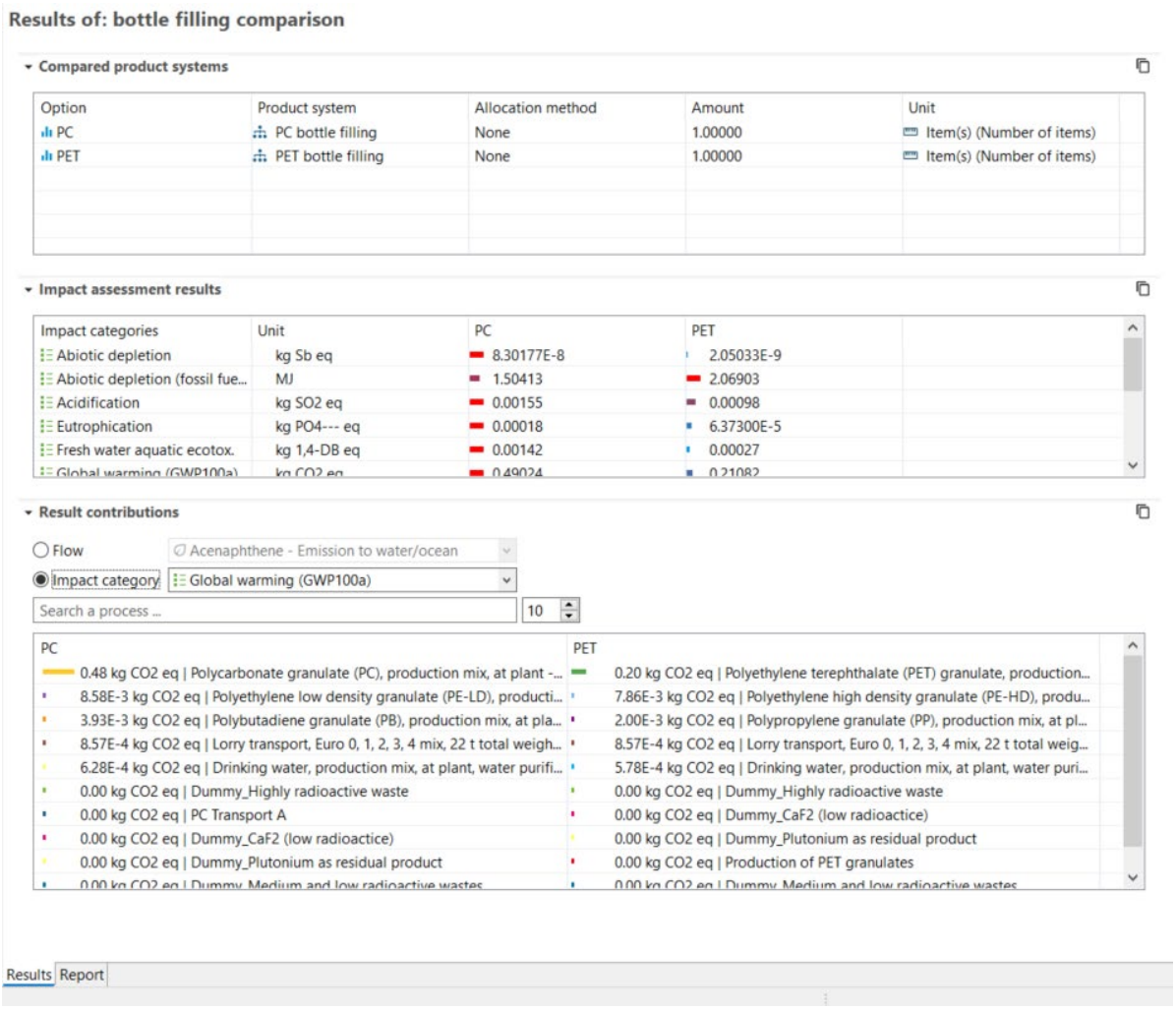


Relative LCIA results - Radar chart example. In the software, the mouse over allows access to more details.

Note: For normalised charts, the normalisation method needs to be selected in the "Calculation setup" section of "Creating a new project".

12.3 PROJECT RESULTS

After you click on "Calculate", a results tab will open showing the compared product systems and the impact assessment results.



Project'results'Results'tab

Moreover, the processes' direct contributions (flow vs impact category) are displayed. You can search for a specific process using the search bar ("Search a process") below. If you select to include cost calculation, the Net Cost or Added Value will be displayed.

To see the report, open the second tab "Report".

12.4 PROJECT REPORT

In the report tab, you will find the calculated results in the template you chose beforehand. It is generated as an HTML file with interactive elements based on Java. The following is directly extracted from a report (Java'elements'can'not'be'displayed'in'this' manual):

Note: If your report is not displayed correctly, make sure you have WebView2 (for Windows) or WebKit (for Linux) installed on your device. Also, make sure that the "Use Edge Browser" box in Preferences > Configuration is checked (see details under Preferences > Configuration in "Toolbar: File").

RESULTS OF THE PROJECT: BOTTLE FILLING COMPARISON

Project variants

This table displays the names and descriptions 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.

Variant	Description
PC	Poly(carbonate) bottles
PET	Poly(ethylene terephthalate) bottles

Selected LCIA categories

The table below displays the LCIA categories associated with the selected LCIA method for 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.

Indicator	Unit	Description
Abiotic depletion	kg Sb eq	
Abiotic depletion (fossil fuels)	MJ	
Acidification	kg SO2 eq	
Eutrophication	kg PO4--- eq	
Freshwater aquatic ecotox.	kg 1,4-DB eq	
Global warming (GWP100a)	kg CO2 eq	
Human toxicity	kg 1,4-DB eq	
Marine aquatic ecotoxicity	kg 1,4-DB eq	
Ozone layer depletion (ODP)	kg CFC-11 eq	
Photochemical oxidation	kg C2H4 eq	
Terrestrial ecotoxicity	kg 1,4-DB eq	

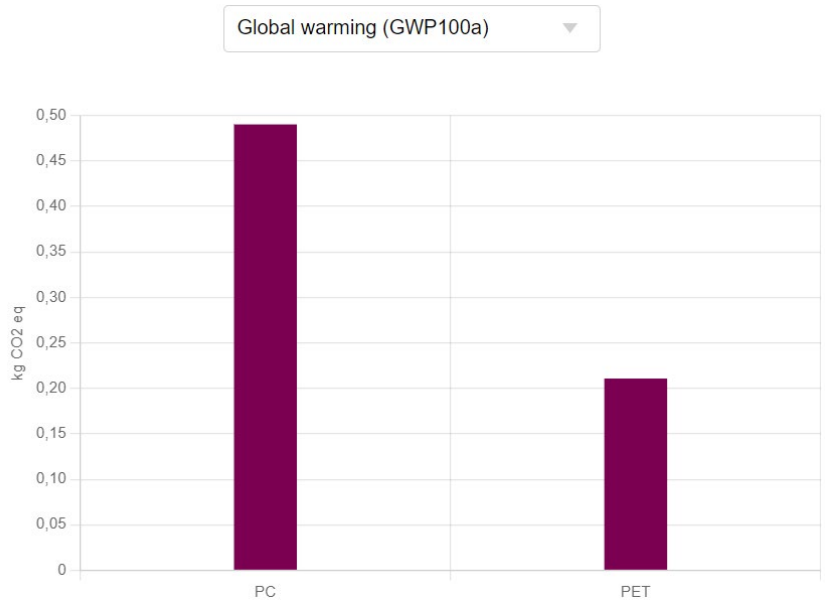
LCIA results

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

Indicator	PC	PET	Unit
Abiotic depletion	8.30177e-8	2.05033e-9	kg Sb eq
Abiotic depletion (fossil fuels)	1.50413e+0	2.06903e+0	MJ
Acidification	1.54539e-3	9.83064e-4	kg SO2 eq
Eutrophication	1.78441e-4	6.37300e-5	kg PO4--- eq
Freshwater aquatic ecotox.	1.42203e-3	2.71658e-4	kg 1,4-DB eq
Global warming (GWP100a)	4.90240e-1	2.10820e-1	kg CO2 eq
Human toxicity	6.15706e-3	1.58586e-2	kg 1,4-DB eq
Marine aquatic ecotoxicity	1.89337e+1	1.60211e+1	kg 1,4-DB eq
Ozone layer depletion (ODP)	1.43767e-11	8.93323e-12	kg CFC-11 eq
Photochemical oxidation	1.05529e-4	6.36538e-5	kg C2H4 eq
Terrestrial ecotoxicity	1.61762e-3	4.97121e-5	kg 1,4-DB eq

Single indicator results

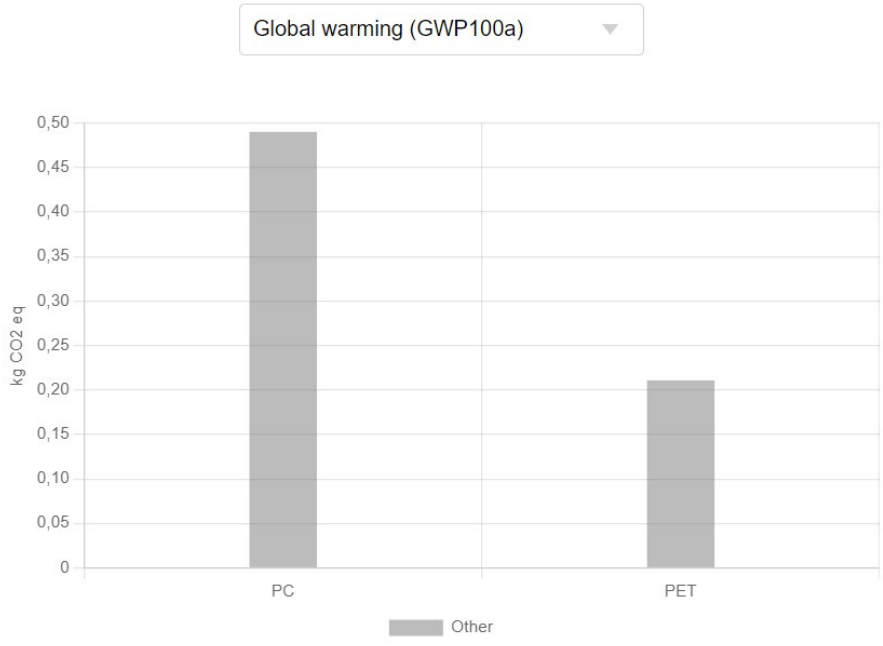
The following chart displays the single results for each project variant of the selected indicator. You can change the selection, and the chart is dynamically updated (although this is not mentioned in the manual, it is implemented in the software itself).



GWP'single'indicator'PC'vs•'PET

Process contributions

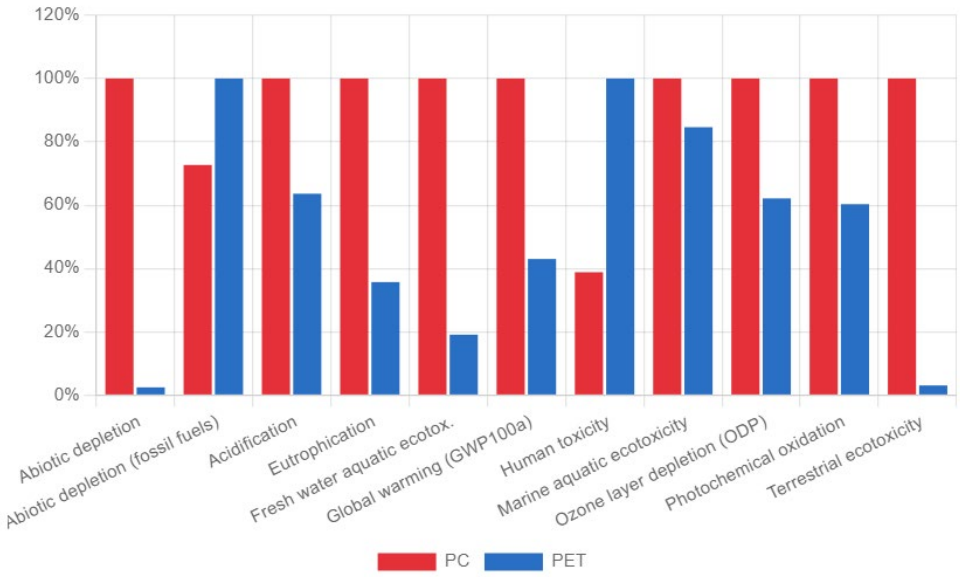
This chart shows the contributions of the selected processes in the project setup to the variant results of the selected LCIA category. As for the single indicator results, you can change the selection, and the chart is dynamically updated.



GWP'process'contributions'PC'vs•'PET

Relative results

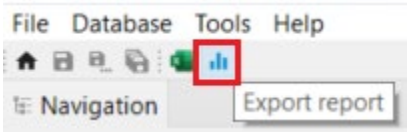
The following chart shows the relative indicator results of the respective project variants. For each indicator, the maximum result is set to 100% and the results of the other variants are displayed in relation to this result.



All' impact' chosen' impact' categories' for' PC' vs' PET

Exporting a project report

You can export a report in HTML format by clicking on the "Export report" icon located above the navigation panel. This option is available when the results window opens in the editor.



Exporting' a' report' in' HTML' format

The program will prompt you to locate the folder where you want to export the HTML file. Once it is saved, you can open the HTML file in a browser (such as Internet Explorer, Microsoft Edge, Safari, Google Chrome, or Mozilla Firefox) to view the report.

13 WASTE MODELLING

Waste refers to any substance or object that needs to be disposed of, such as by-products with no market value, and it can be generated at any stage of a product's life cycle. In openLCA, the results are represented by a specific "Flow" type.

- Material flow logic approach
- Opposite direction approach

MATERIAL FLOW LOGIC

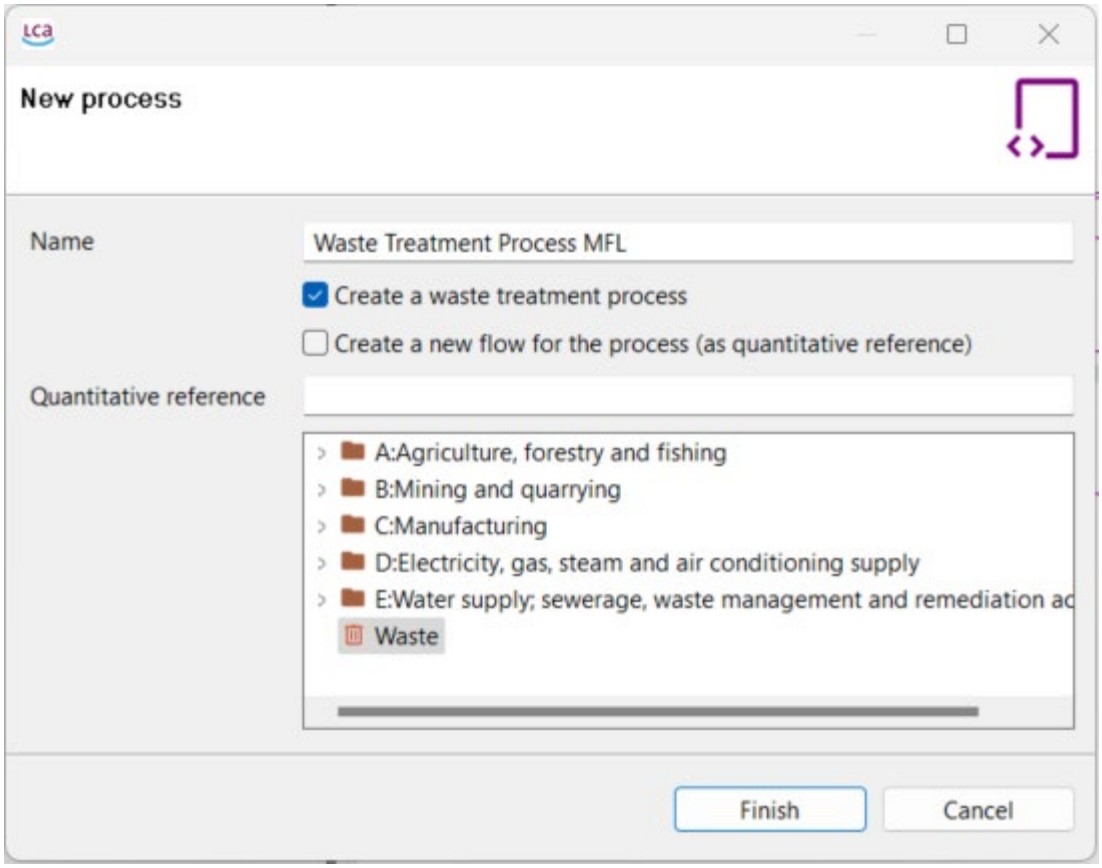
This approach aligns with the "actual" direction (i.e. material flow direction) of what is being modelled and was introduced with openLCA 1.7. Waste flows are generated as

outputs of waste-generating processes. In waste treatment processes, they serve as the quantitative reference and can be found on the input side.

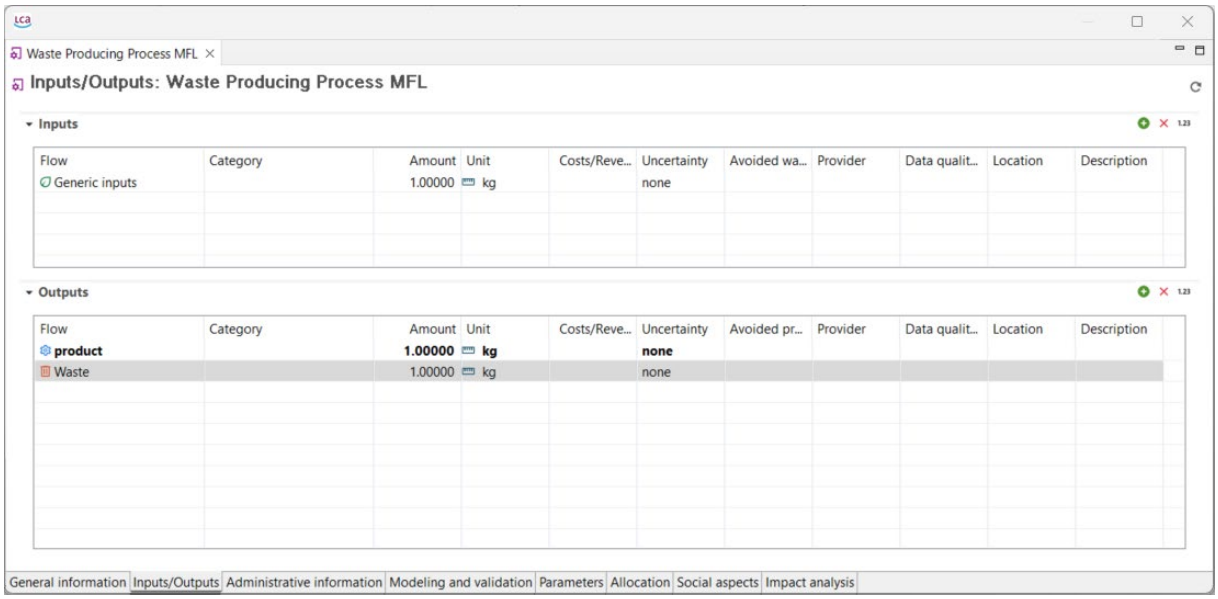
Model graph displaying the material flow logic.

CREATING A WASTE TREATMENT PROCESS (MATERIAL FLOW LOGIC)

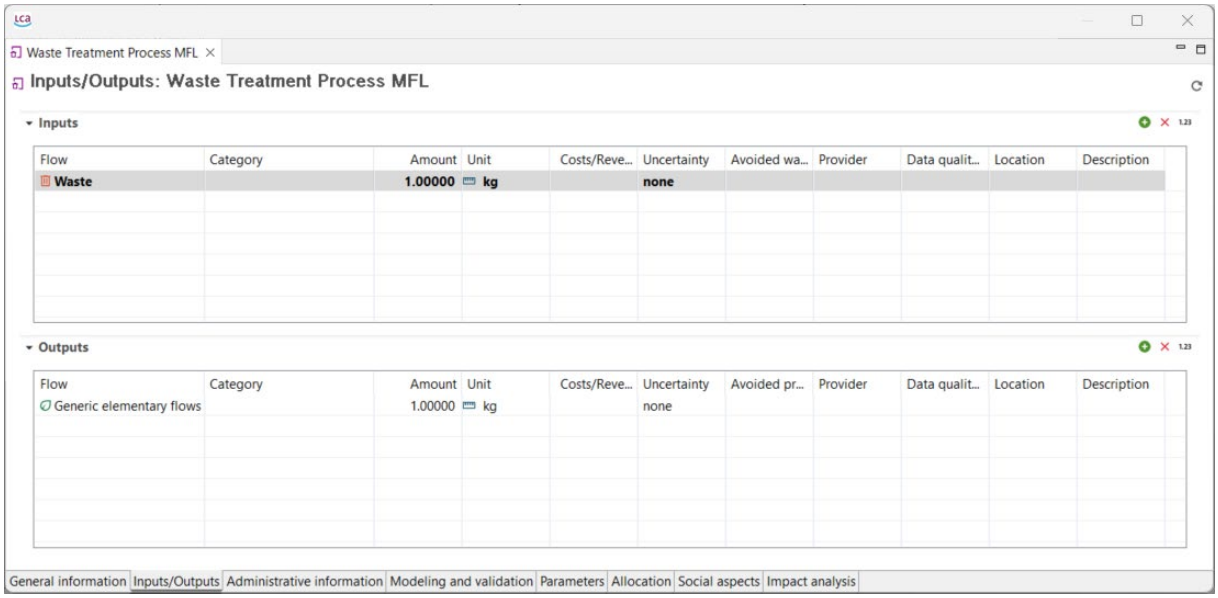
1. Right-click "Processes" → "New process" → "Create a waste treatment process".
2. Choose a (previously created) waste flow as your quantitative reference → click "Finish". The chosen waste flow is now an input to your waste treatment process.



Creation of a waste treatment process & material flow logic

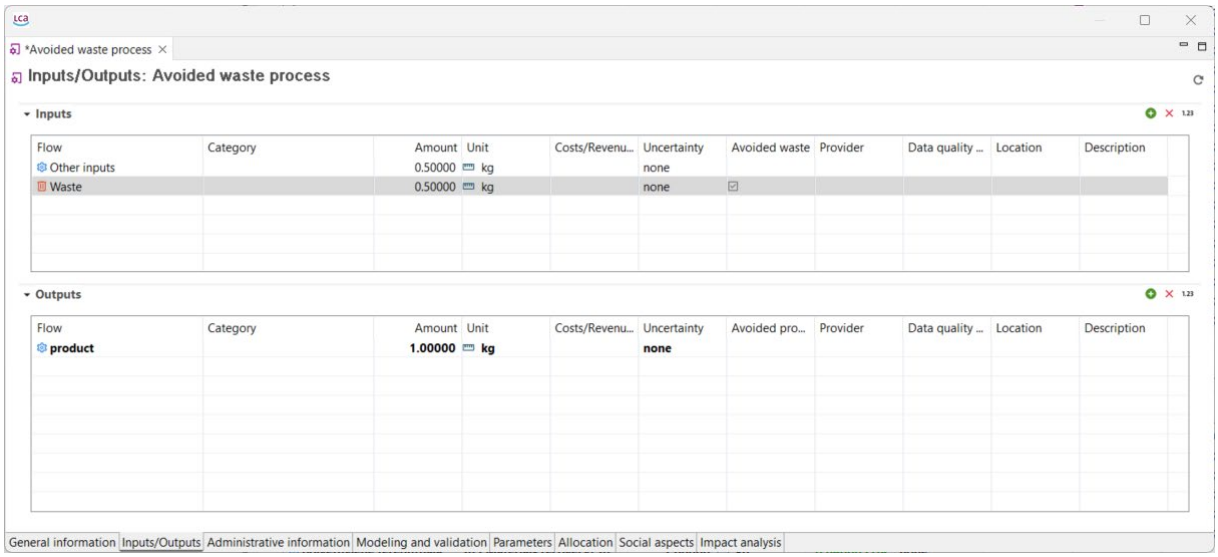


Waste'waste]producing'process'follows'the'material'flow'logic



Waste'treatment'process'following'the'material'flow'logic

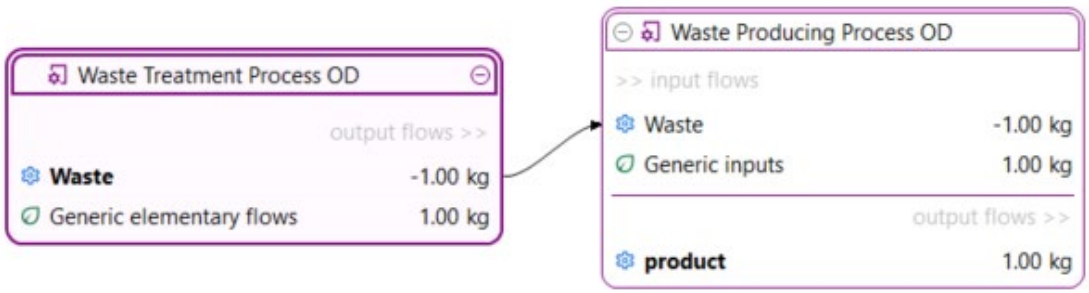
Note: If waste is consumed by a process, system expansion can be applied by checking the box "Avoided waste", as the waste consumed does not need waste treatment elsewhere. A process that utilises waste as an input can be credited with the avoided impact of treating that waste elsewhere.



Waste input flow is marked as avoided waste.

13.1 OPPOSITE DIRECTION APPROACH

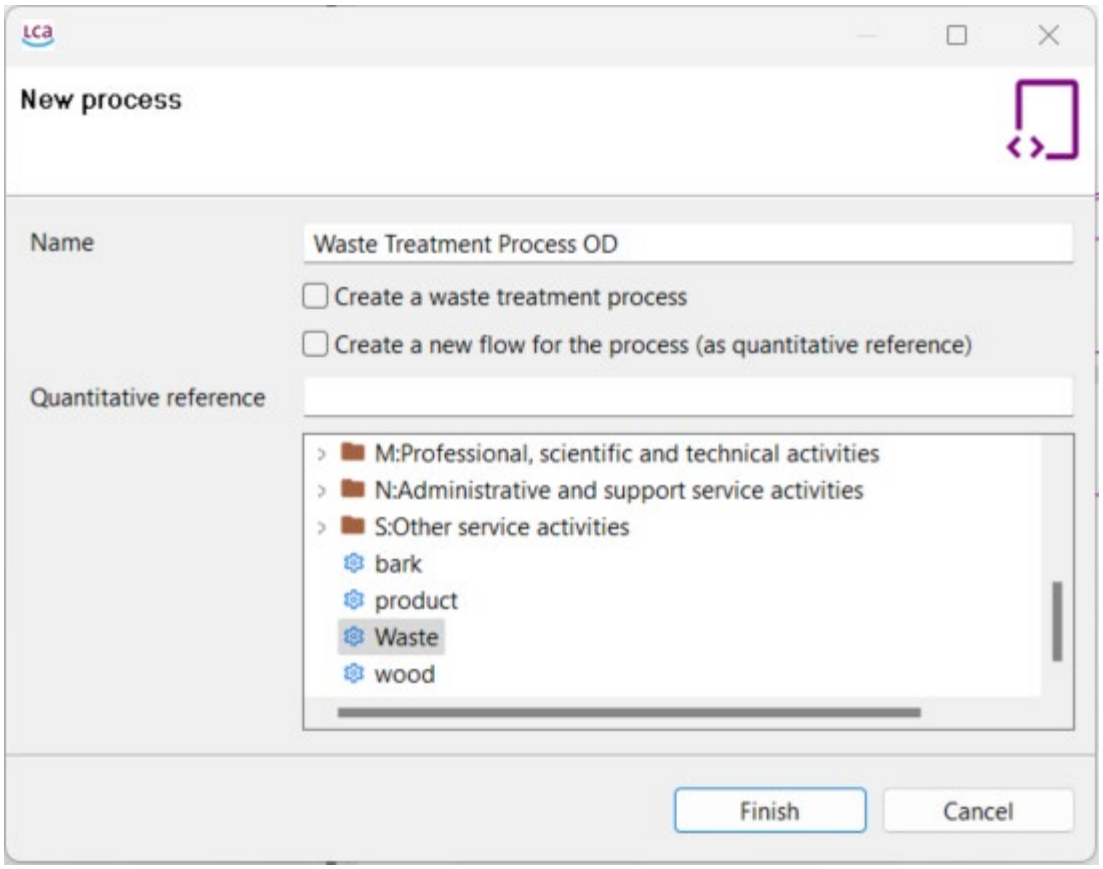
The opposite direction approach works oppositely, making it possible to model waste treatment without using waste flows, but instead using normal process flows. This was the only option up until openLCA 1.7. It is still worth mentioning, especially if you're working with older databases that may not include waste flows. As waste is the quantitative reference of a waste treatment process, but a quantitative reference cannot be an input to a process (since it is, essentially, the main product/output of a process), waste treatment is seen as a service necessary to provide to waste-generating processes. The waste then appears as a negative output (an input) of the waste treatment process, and similarly as a negative input (an output) of the waste-generating process.



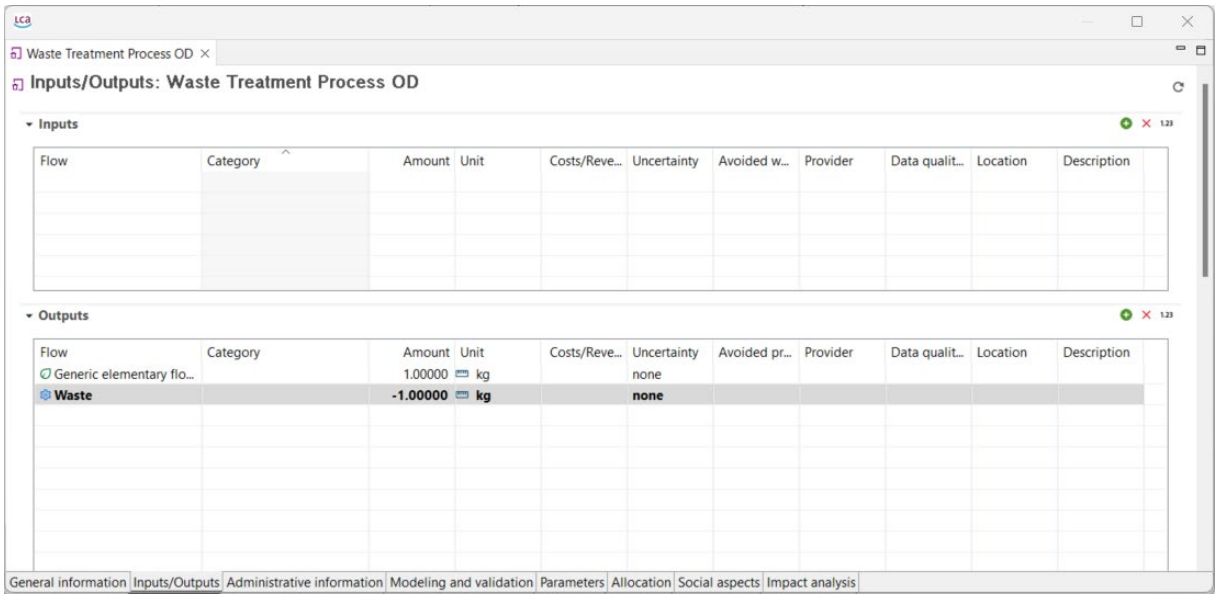
Model graph displaying the opposite direction approach

CREATING A WASTE TREATMENT PROCESS (OPPOSITE DIRECTION APPROACH)

1. Add the waste (type: product) flow as a negative output of a waste treatment process.
2. Add the waste (type: product) flow as a negative input to the waste-producing process considered.



Creation of a 'waste treatment process' in an 'opposite direction' approach



The 'waste treatment process' follows the 'opposite direction' approach

The reason there are two different approaches is that different databases manage waste in different ways, i.e. waste flows are not present in all databases.

14 ALLOCATION

When a process involves several products, you must assign the impact of each product. Typical examples of such processes are cogeneration of heat and power (multi-output) or a landfill (multi-input). These allocation problems can be dealt with using two different strategies: partitioning or system expansion.

PARTITIONING

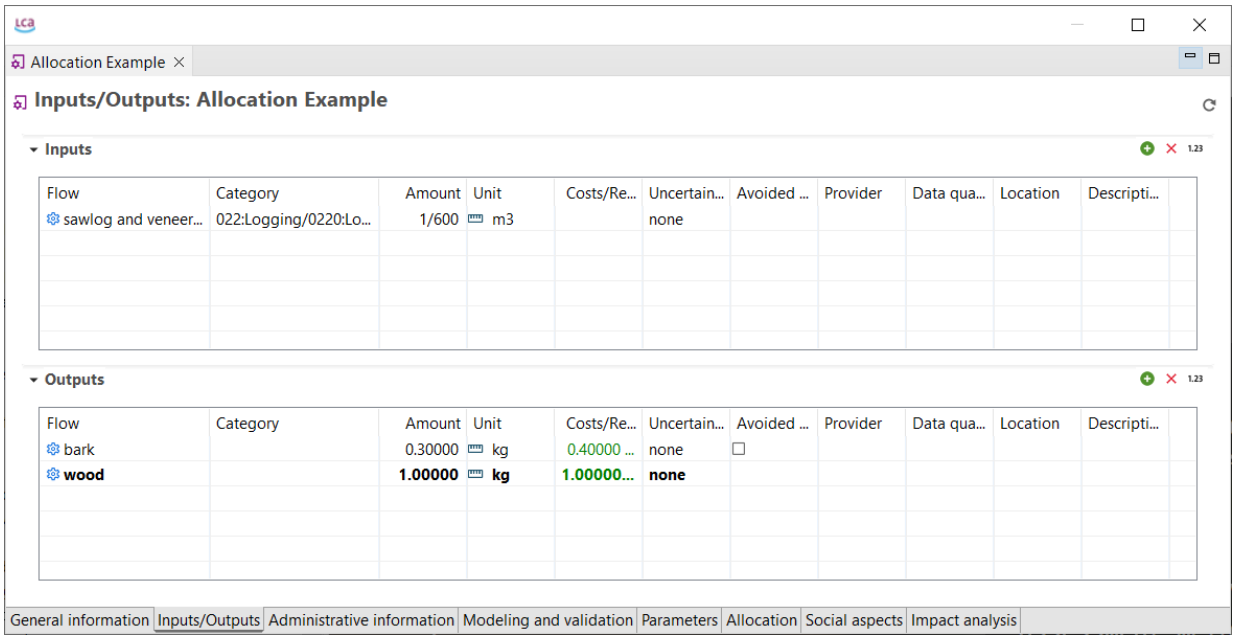
There are three allocations by partitioning methods in openLCA:

- Physical allocation: partitioning based on the physical relationships between the products in terms of, for example, mass.
- Causal allocation: partitioning based on assumptions or former research on the relative impact of different products.
- Economic allocation: partitioning based on the economic (cost or revenue) relationships between products. Consequently, an economic property in terms of cost/revenue has to be added for this to be applicable.

Moreover, we also provide the following technical solutions:

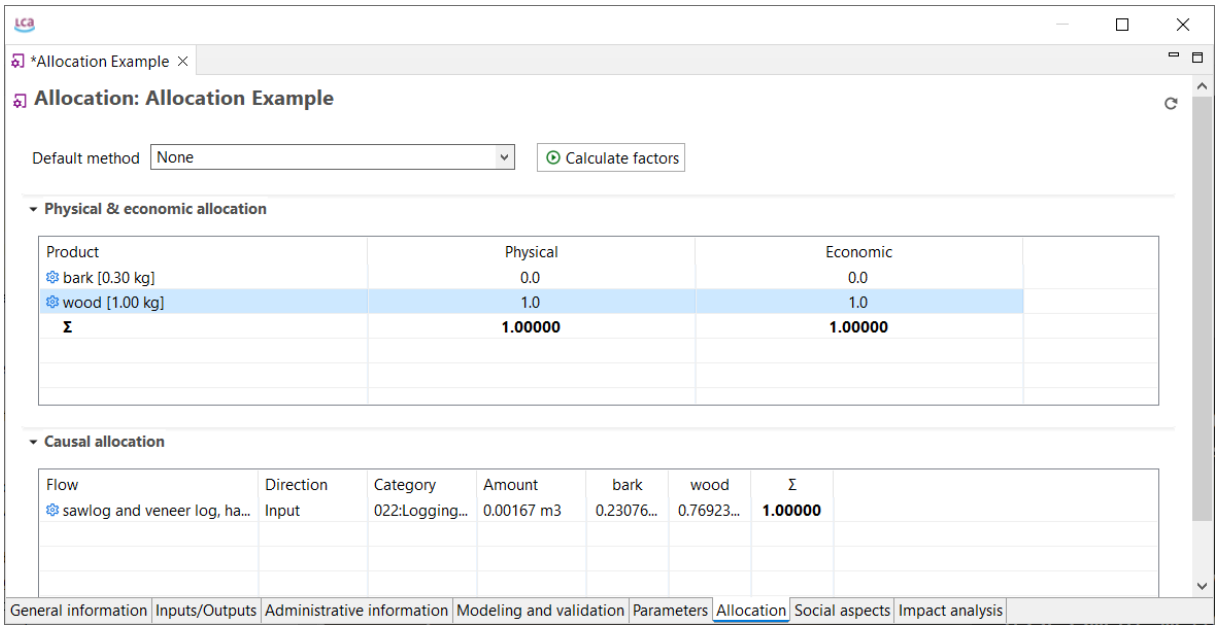
- As defined in processes, this option will perform allocation according to the method used in each individual process along the supply chain.
- None: if none is selected, no allocation will be applied, even for multifunctional processes. Hence, each product of a process gets the entire impact of this process and its supply chain.

Below is an example illustrating how the three different methods are applied in openLCA. In this example, 1 kg of wood and 0.3 kg of bark are produced from 1 kg of saw log (measured as solid wood under bark).

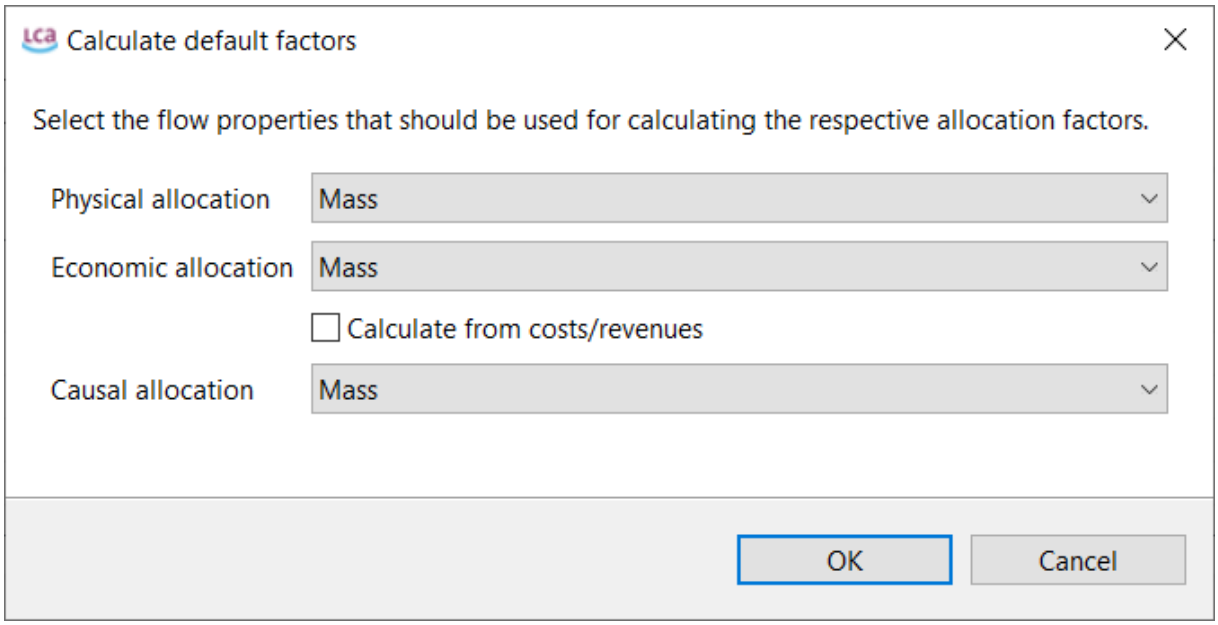


Inputs and Outputs for our example (note that economic properties have been added

The allocation factors for physical, causal and economic allocation can be viewed/altered in the "Allocation" tab of a process. Select the "Calculate factors" button, and the software will automatically calculate the values for the three allocation methods.



The 'Allocation...' tab with the '...Calculate factors...' button

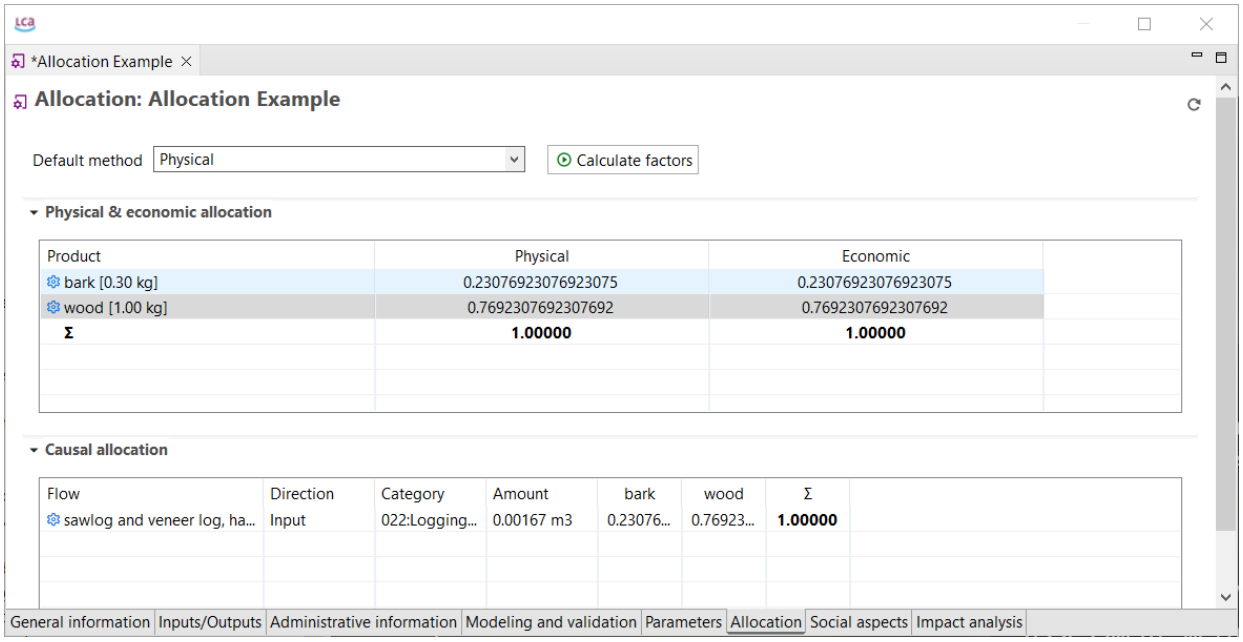


Calculate factors

- The physical allocation factors are calculated based on the ratio between the physical units of the products (wood and bark). Since the outputs of wood and bark are 1 kg and 0.3 kg, respectively, the allocation factors become 0.77 and 0.23.
- For causal allocation, an assumed ratio can be inserted. In this example, we assume that the wood is responsible for 60% of the impacts, whereas the bark is responsible for 40%.

- In the case of economic allocation, we assume a revenue of 1$/kg for wood and 0.4$/kg for bark.

Important: openLCA does not automatically update allocation factors prior to calculating a product system. Hence, it always uses the last saved allocation factors. Therefore, if you work with allocation in your study, ensure that the allocation factors are up to date and in their most recent state prior to creating a product system.



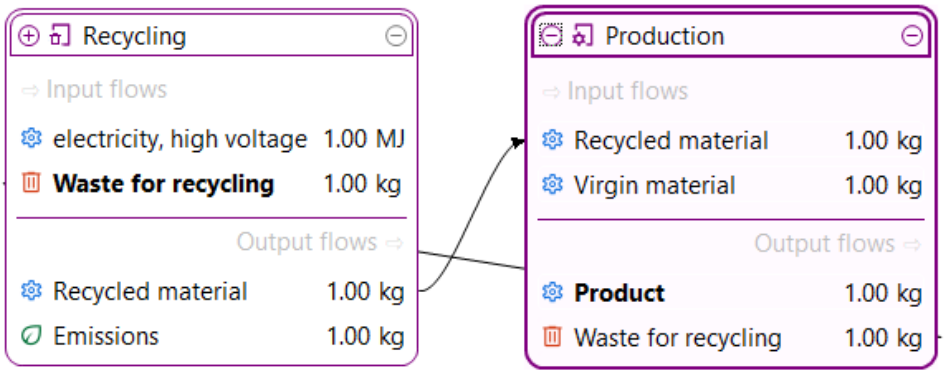
Calculated allocation factors. Causal allocation must be inserted manually; it will by default utilise the physical allocation factors.

Note: For allocation to work, the main product and the by-products need to have the same flow property. But openLCA will tell you if this is not the case.

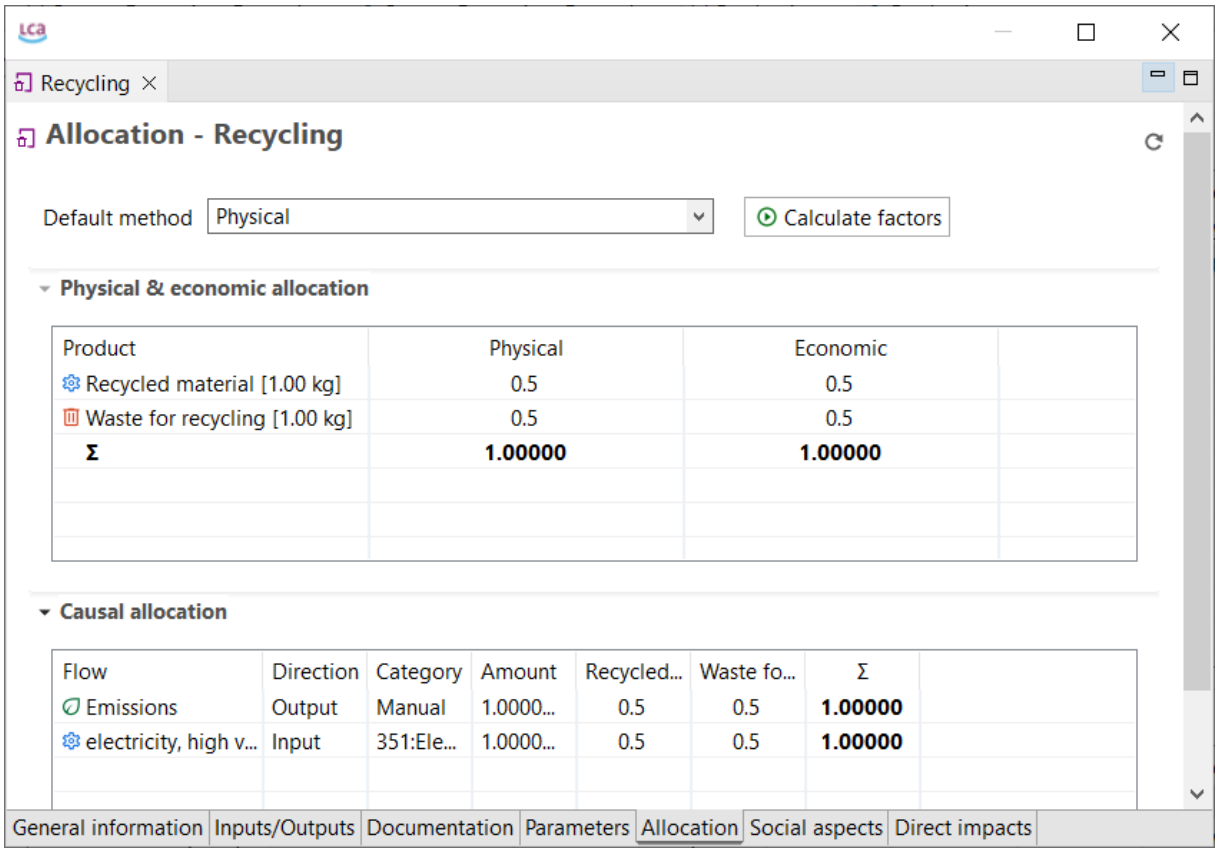
Note: When a currency is unavailable, a new currency can be created under "Currencies" under the "Background data" in the Navigation pane. A conversion factor can be added according to whatever reference currency is set.

ALLOCATION FOR RECYCLING

Remember that recycling processes are also multi-output processes as they treat waste and produce recycled material; hence, they require allocation. It is necessary to use allocation to distribute the impacts according to the linked process. A short example of how to model recycling in openLCA is displayed below:



The model graph for a recycling scenario



As the recycling process is a multi-output process, allocation is needed. Here, physical allocation was applied.

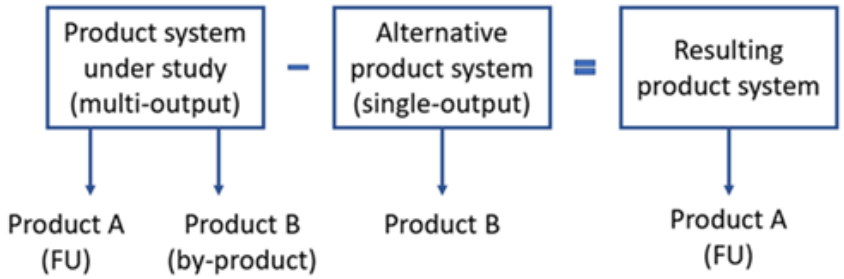
Note: Here, we allocated 50% of the impacts to the recyclate and the waste. This is the only option. However, if you are not modelling a closed-loop scenario, this can be a relevant detail you should consider.

SYSTEM EXPANSION

Another way to address multi-output product systems is through system expansion. In system expansion, the inventory associated with the production of a by-product is subtracted from the total inventory of the multi-output product system. This "avoided

impact" is calculated based on an additional, single-output product system that "expands" the system boundaries.

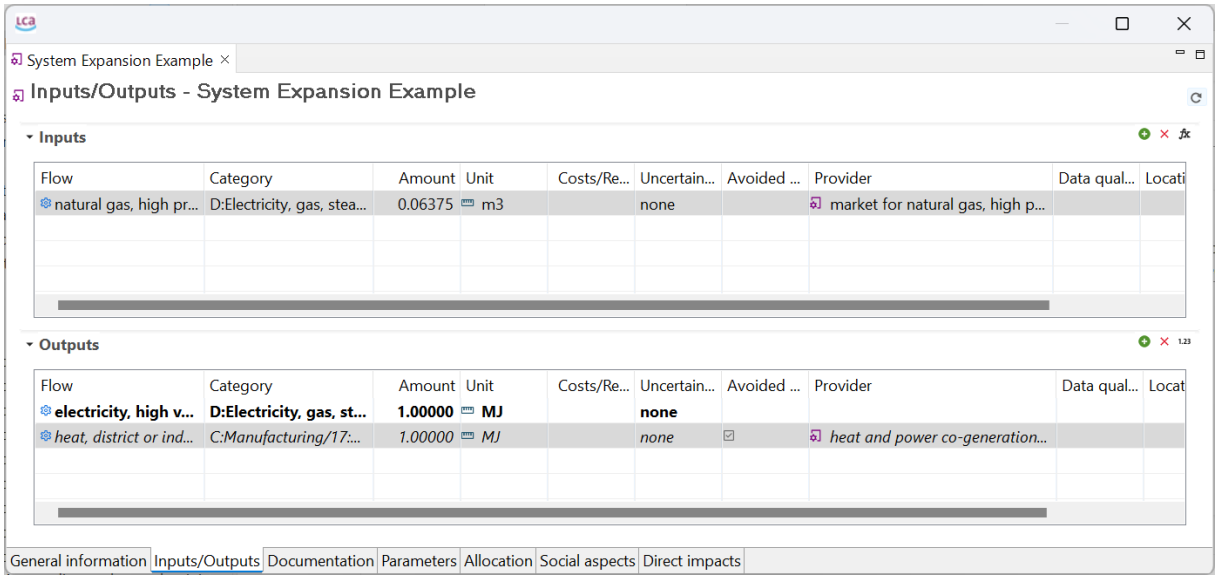
According to ISO 14044, system expansion should be the preferred approach for handling multi-output processes, as it avoids allocation by accounting for the impacts that would be generated if an alternative process produced the by-product.



Expanding the system boundaries to subtract the impact of a by-product from the product system

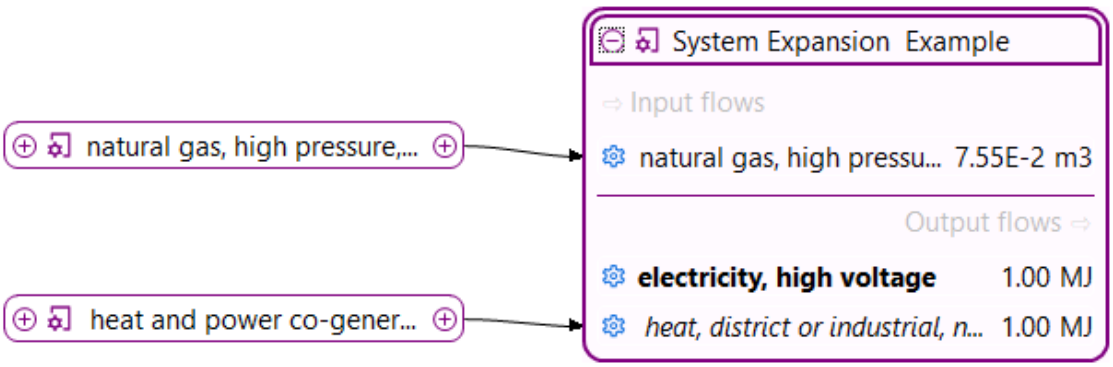
For example, if a process produces electricity and heat (such as in a cogeneration setup), and you want to isolate the impacts of producing the electricity, the heat can be treated as an avoided product. This means that the environmental impact of producing the same amount of heat via another process (e.g., "Heat, gas heating") is subtracted from the total impacts of the cogeneration system. Effectively, the modelled system is "credited" for offsetting that external heat production.

In openLCA, system expansion can be implemented by checking the "Avoided product" box for the by-product, as seen below:



Avoided product check box highlighted in the Inputs/Outputs tab

A process providing the avoided product flow must be present in the database. When creating the Product system, this provider will appear in the Model graph as a supplier on the output side of the original process.



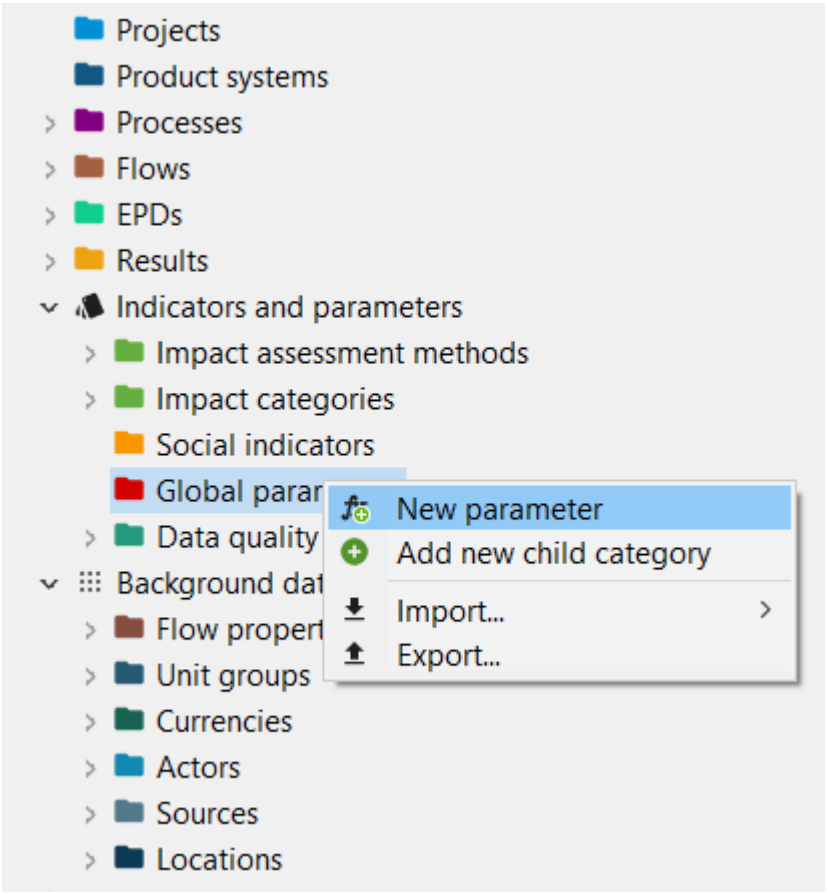
The model graph showing heat as an avoided product with a respective provider for the output

Note: In the model graph, avoided flows are displayed in *italics*, making it easier to distinguish them from regular flows, especially in more complex systems.

15 PARAMETERS

Parameters can be used for the process, impact assessment method, product system, project, and database levels. Parameters display variables instead of concrete values used in the inputs or outputs. They can be defined as simple values, formulas or complex functions. Parameters can overwrite each other (e.g. the value set for a parameter in a process can be overwritten on the product system/project levels).

In practice, parameters facilitate sensitivity analyses to estimate how much modifying any specific aspect of the model will impact the study's outcome. Parameters are also useful when working with preliminary data that is subject to change, or for creating different versions of the same system while modifying specific input/output values.



Adding parameters in openLCA

15.1 TYPES OF PARAMETERS

In openLCA, you can find three types of parameters:

- "Global" parameters can be found and are valid on all levels.
- "Input" parameters are parameters that are only valid for the process/LCIA method/Product system in which they are saved.
- "Dependent" parameters are parameters that include input or global parameters in their formula. The figure below illustrates the view on openLCA for an example.

New* Global, input and dependent parameters can be created within a process or impact assessment method. These are also available in product systems and projects that utilise the process or impact assessment method. It is not possible to create a new parameter on the product system or project level.

CREATE A PARAMETER

To create a Global parameter:

1. Right-click on "Global parameters" in the "Indicators and Parameters" section in the Navigation panel.
2. Select "New parameter".
3. Enter the name (see rules below), description (optional), type (input or dependent parameter) and amount, then click on "Finish".

Creation of a global parameter

4. After creating a global parameter, a general information window will open up in the Editor, and you can add tags and uncertainty (new*).
5. To load in a process the global parameter you have created, select the "reload" button in the "Global parameters" section in the "Parameters" tab in a process or impact assessment method.

Global parameter] general information

6. The global parameters can also be viewed and edited by clicking on "Parameters" under "Database" → "Content". This opens up the window below, which, as a (**new***) feature, allows editing of uncertainty by double-clicking in the "Uncertainty cell".

View and edit Parameters under Database → Content•

To create an **Input and Dependent parameter:**

1. Open the "Parameters" tab of an open process.
2. Select the "+" at the top right-hand corner of the input/dependent parameters section.
3. Assign a name, value, uncertainty (for an input parameter) and description.
4. In the case of a dependent parameter, a formula can be used to link it to the parameters on which it depends. To write a correct formula, you can check the accepted constants, operators and functions in this chapter.

Note: An input/dependent parameter can be converted into a global parameter by right-clicking on it and selecting "convert to global parameter" (new*).

Conversion of an input#dependent parameter into a global parameter

The *use of parameters* within a database can be checked using the "Usage View" feature (right-click on a parameter and select "Usage").

Note: Use the formula interpreter ("Tools" section in "Running openLCA for the first time") to check the functions you want to include in dependent parameters.

PARAMETERS RULES

- Parameter names:
  - Must be one word; underscores (_) are allowed.
  - Cannot contain special characters.
  - Cannot have more than 255 characters.
- Parameter formulas:

    - Can contain single values, simple equations, or complex functions, including logical expressions ("Constants, operators and functions for formulas in openLCA")
    - Do not contain units, so please add them in the comment field.
    - Cannot have more than 255 characters.
- The number of parameters is, theoretically, not limited.
- Use a point (.) instead of a comma (,) for decimal numbers.

NEW FEATURES IN OPENLCA 2

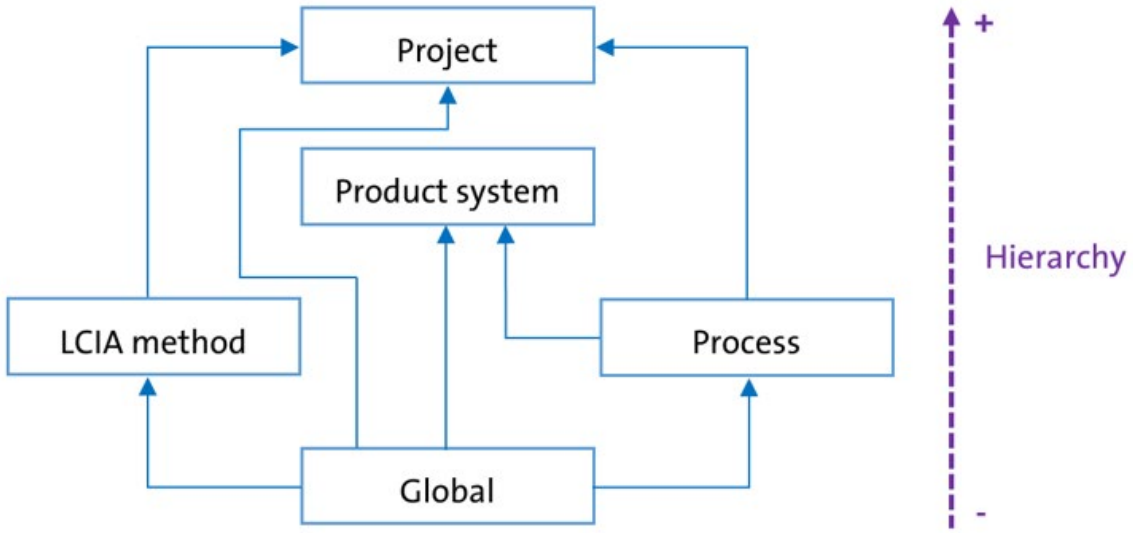
- When you edit a parameter name or value, it will now be automatically updated throughout the database. For example, if the parameter is used in a formula of a dependent parameter, it will be updated accordingly.
- Parameter sets: create some parameters, assign values meant for different scenarios and then save those scenarios and choose them within the same product system. An example is provided in the parameter section of the section Product systems.

15.2 PARAMETER HIERARCHY

If the same parameter has different values at different levels, the system's hierarchy determines which parameter value takes precedence in calculations. The parameter values at the highest hierarchy (+) overwrite the value at the lower level (-).

An illustration of the parameter hierarchy can be seen below.

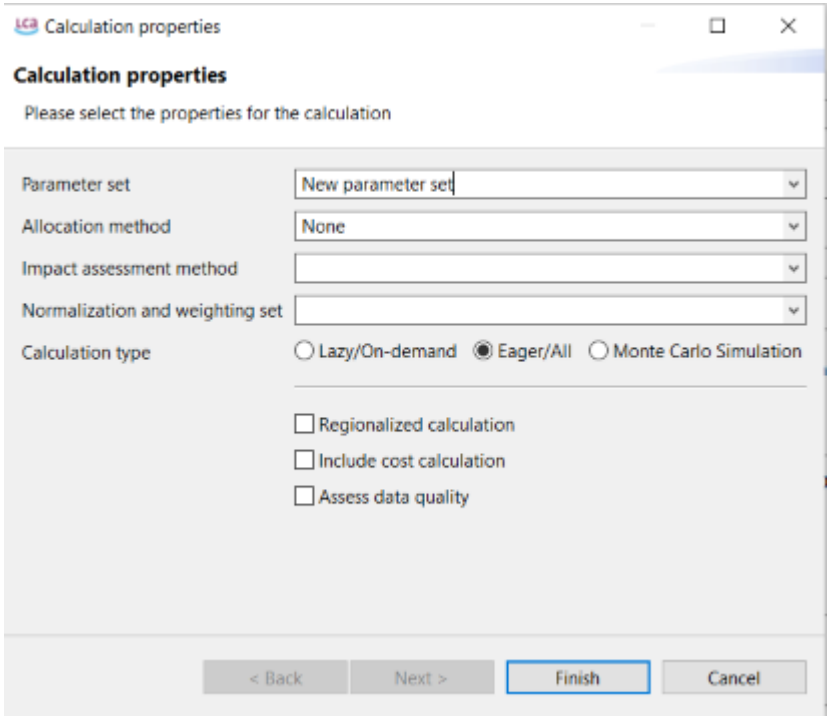
For example, if a process has the same name as a global parameter 'x', then within that process, the parameter will have the process parameter value. While in another process, if 'x' is used, it will have the value of the global parameter.



HIERARCHY OF PARAMETERS IN OPENLCA

15.3 PARAMETER SETS

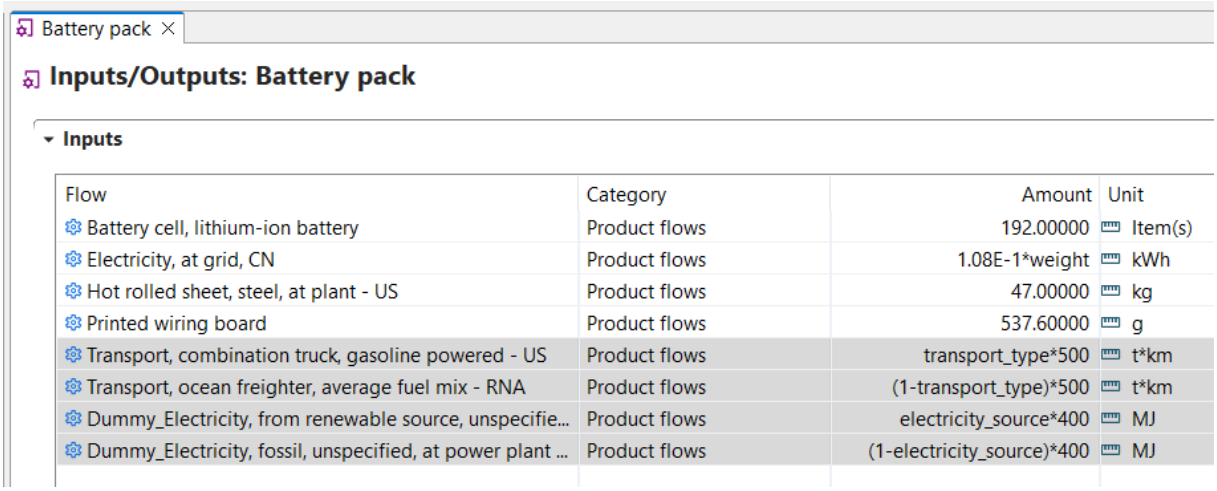
Compared to the previous version of openLCA, in openLCA 2, it is now possible to add so-called "parameter sets", which allow users to switch between parameter scenarios easily. When you create parameter sets, a new input field is added to the calculation properties pop-up window of the product system. This field then allows you to select which specific parameter set should be used for the calculations.



Product'system'] 'Calculation'properties'] 'New'parameter'set

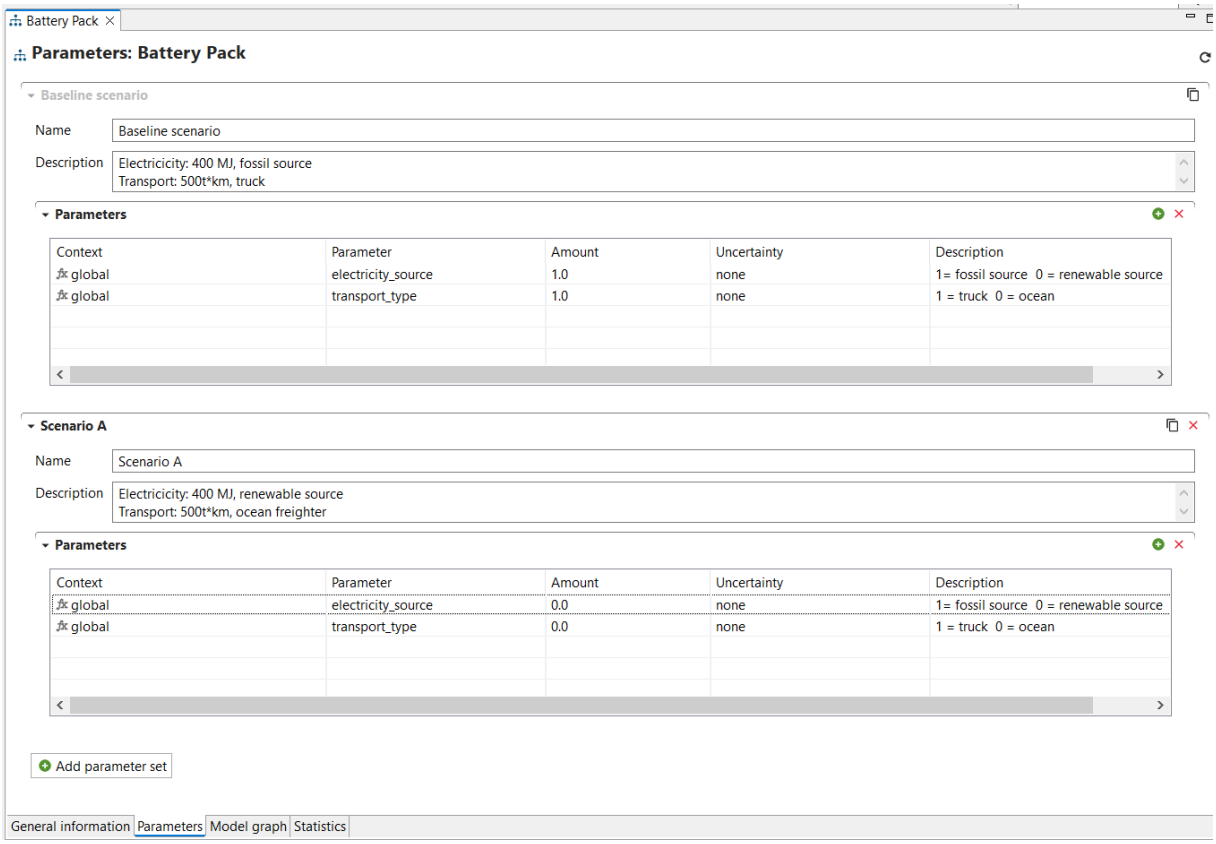
In this example, we show the use of parameters and parameter sets to simulate various scenarios. The battery pack process includes two types of electricity sources and two types of transportation. The parameters "transport_type" and "electricity_source" are

both set to 1, which means that transport by truck and electricity from renewable sources will be used to calculate the Battery pack impacts (see the "Amount" column, parameter 1).



Product'system'] 'Parameter'use

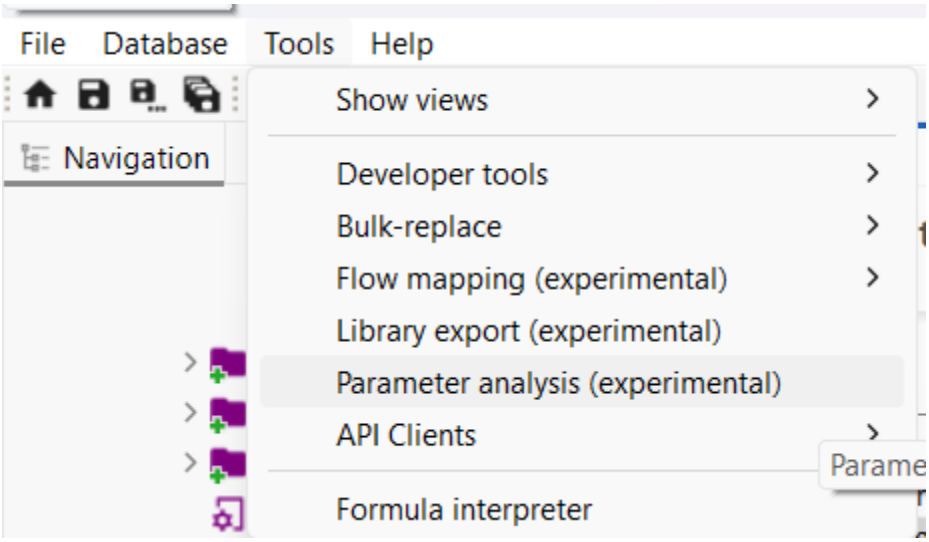
However, in the "Parameters" tab in the Battery Pack product system, you can switch between the different transport and electricity types by creating parameter sets. Refer to the example shown in the following figure.



Product'system'] 'Choosing'a 'parameter'set

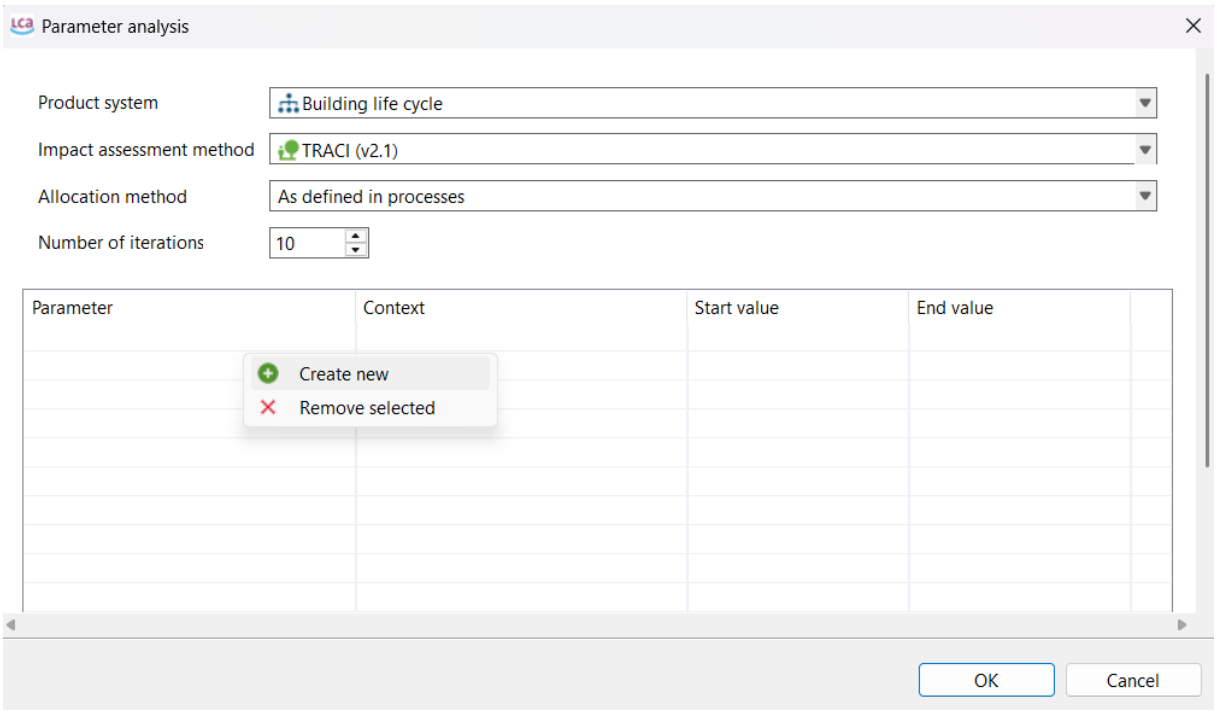
15.4 PARAMETER ANALYSIS

Under Tools → Parameter analysis is a feature that allows you to change given parameter variable(s) across different iterations.

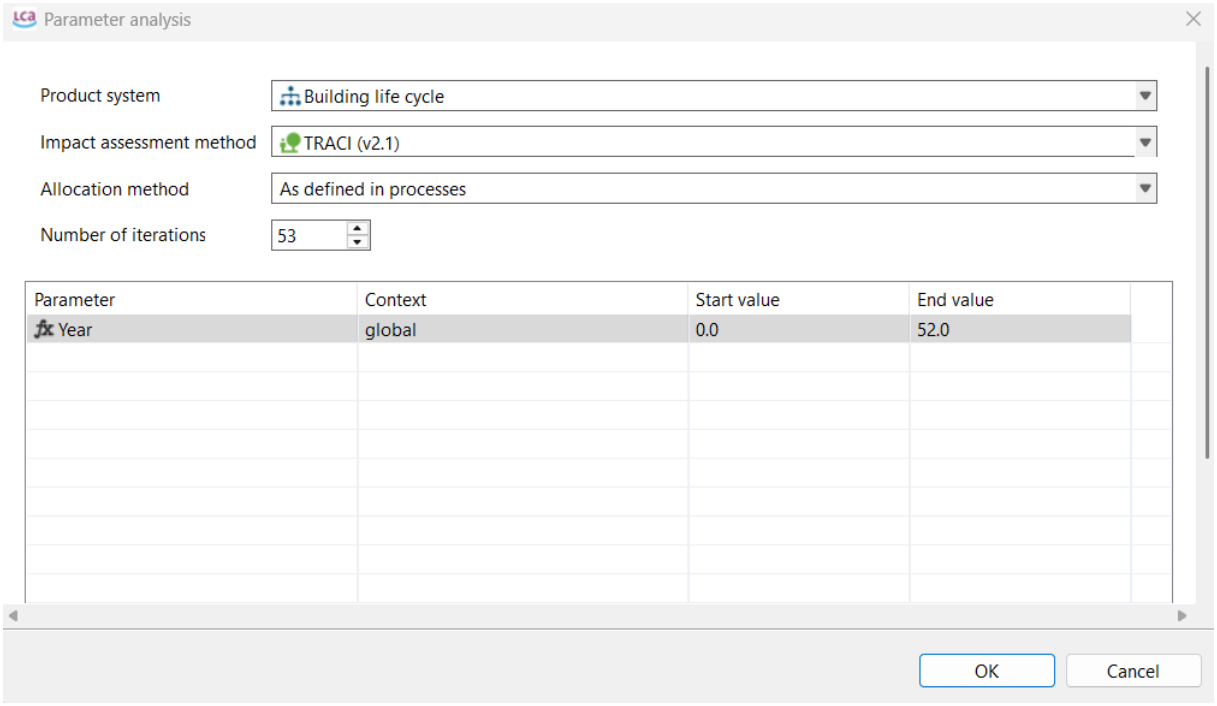


To do so, first define a global parameter that is also used in your process(es). Next, you must create a product system based on that process. Then, when you go to *Parameter' analysis*, as shown above, a pop-up window will appear.

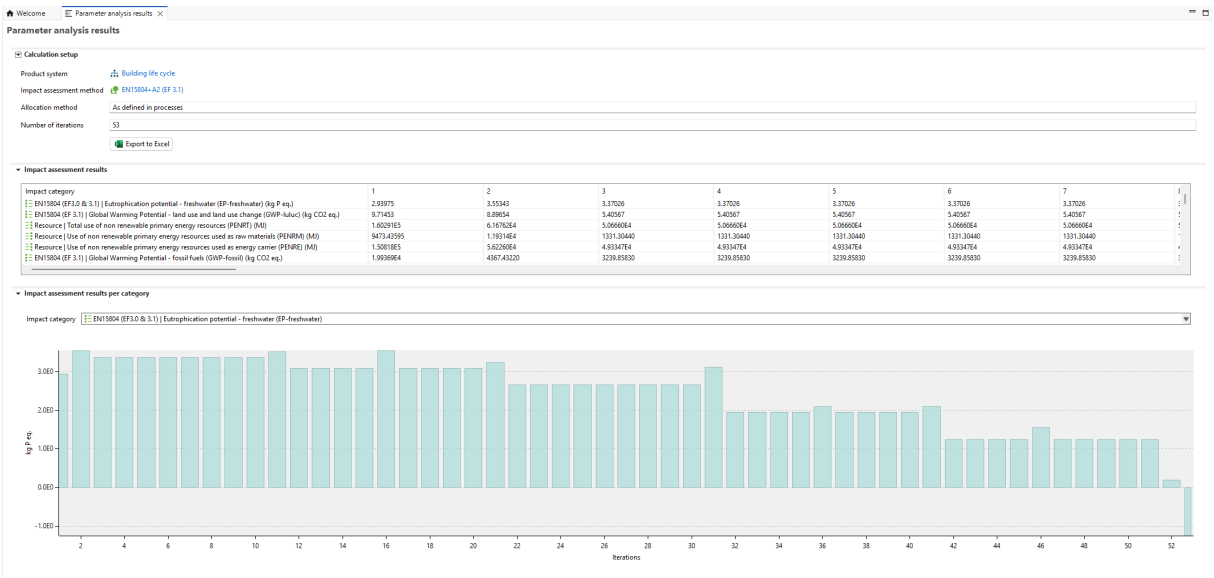
Then you should select the product system, impact method, and so on. Next, set the number of iterations (runs) you wish to perform. In the space below, you should right-click and select *Create'new* to add the parameter they want to change in each iteration.



The parameter will appear in the table below. You must then set the start and end values, which will be divided equally across the specified number of iterations. Finally, you can click OK to run the iterations.



The results will then appear in a table format for each impact category of the selected impact method. You can export the results by clicking Export to Excel at the top.



15.5 ADVANCED: DEPENDENT PARAMETER IN OPENLCA

Dependent parameters in openLCA are useful for dynamically adjusting LCI data based on specific scenarios. They allow users to create complex models where results update automatically as input parameters change. Users can use the constants, operators and functions listed below to create formulas for dependent parameters. This is particularly useful when users wish to connect openLCA to external tools where input parameters may be initialised by or dependent upon user inputs.

Function/ Operator/ Constant	Description	Examples with values	Usage in a Dependent Formula
pi	Ratio of circumference to diameter	pi = 3.141592653589793	circle_area = pi * radius^2
e	Base of natural logarithm	e = 2.718281828459045	exponential_growth = e^growth_rate
+	Addition	1 + 2 = 3	total_cost = material_cost + labor_cost
-	Subtraction	5 - 3 = 2	net_income = revenue - expenses
*	Multiplication	2 * 3 = 6	total_energy = energy_per_unit * units_produced
/	Division	6 / 2 = 3	average_cost = total_cost / quantity
^	Exponentiation	2^3 = 8	compound_interest = principal * (1 + rate)^time
div	Integer division	7 div 2 = 3	batches = total_units div batch_size
mod	Modulus (remainder)	7 mod 2 = 1	remaining_units = total_units mod batch_size
=	Equal to	1 = 1 = true	is_equal = value1 = value2
<> or !=	Not equal to	1 <> 2 = true or 1 != 2 = true	is_not_equal = value1 <> value2
<	Less than	2 < 3 = true	is_less = temperature < setpoint
<=	Less than or equal to	2 <= 2 = true	is_in_range = value <= limit

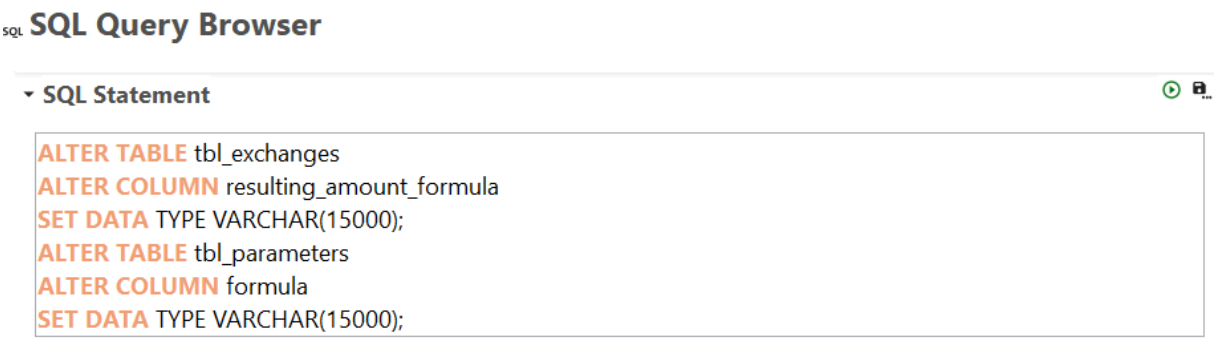
Function/ Operator/ Constant	Description	Examples with values	Usage in a Dependent Formula
>	Greater than	3 > 2 = true	is_greater = pressure > threshold
>=	Greater than or equal to	3 >= 3 = true	is_above_min = score >= passing_score
and or &&	Logical AND	true() && false() = false	in_range = temperature >= low && temperature <= high
or or			Logical OR
abs(x)	Absolute value of x	abs(-1) = 1	magnitude = abs(change)
sqrt(x)	Square root of x	sqrt(4) = 2	side_length = sqrt(area)
ln(x)	Natural logarithm of x	ln(7.389) = 2	decay_rate = ln(remaining_amount)
sin(x)	Sine of x (in radians)	sin(pi/2) = 1	wave_height = amplitude - sin(angle)
cos(x)	Cosine of x (in radians)	cos(0) = 1	horizontal_force = total_force - cos(angle)
tan(x)	Tangent of x (in radians)	tan(pi/4) = 1	slope = rise / tan(angle)
round(x)	Rounds x to the nearest integer	round(2.5) = 3	rounded_value = round(exact_value)
floor(x)	Largest integer not greater than x	floor(2.7) = 2	full_batches = floor(total_units / batch_size)
ceil(x)	Smallest integer not less than x	ceil(2.2) = 3	full_containers = ceil(total_volume / container_volume)
if(b;x;y)	Returns x if b is true	if(1 > 2; 1; 2) = 2	result = if(condition; value_if_true; value_if_false)

Function/ Operator/ Constant	Description	Examples with values	Usage in a Dependent Formula
min(x1;x2;...;xN)	Returns the minimum of x1	min(1;2;3) = 1	minimum_value = min(value1; value2; value3)
max(x1;x2;...;xN)	Returns the maximum of x1	max(1;2;3) = 3	maximum_value = max(value1; value2; value3)
exp(x)	Euler's number e raised to the power x	exp(2) = 7.389	growth_factor = exp(rate - time)

Extending the formula field character allowance

Note: Often, the length of the formula field allowed by the software (150 characters) is insufficient for the formulas users wish to enter. The length of the formulas can be extended using the SQL command below in the SQL query browser of openLCA, located under Tools > Developer Tools > SQL (select the green icon to run). Users may save this formula under the 'scripts' database elements folder, as this script has to be applied to each new database in openLCA, as it is only used in the active database.

```
ALTER TABLE tbl_exchanges
ALTER COLUMN resulting_amount_formula
SET DATA TYPE VARCHAR(15000);
ALTER TABLE tbl_parameters
ALTER COLUMN formula
SET DATA TYPE VARCHAR(15000);
```

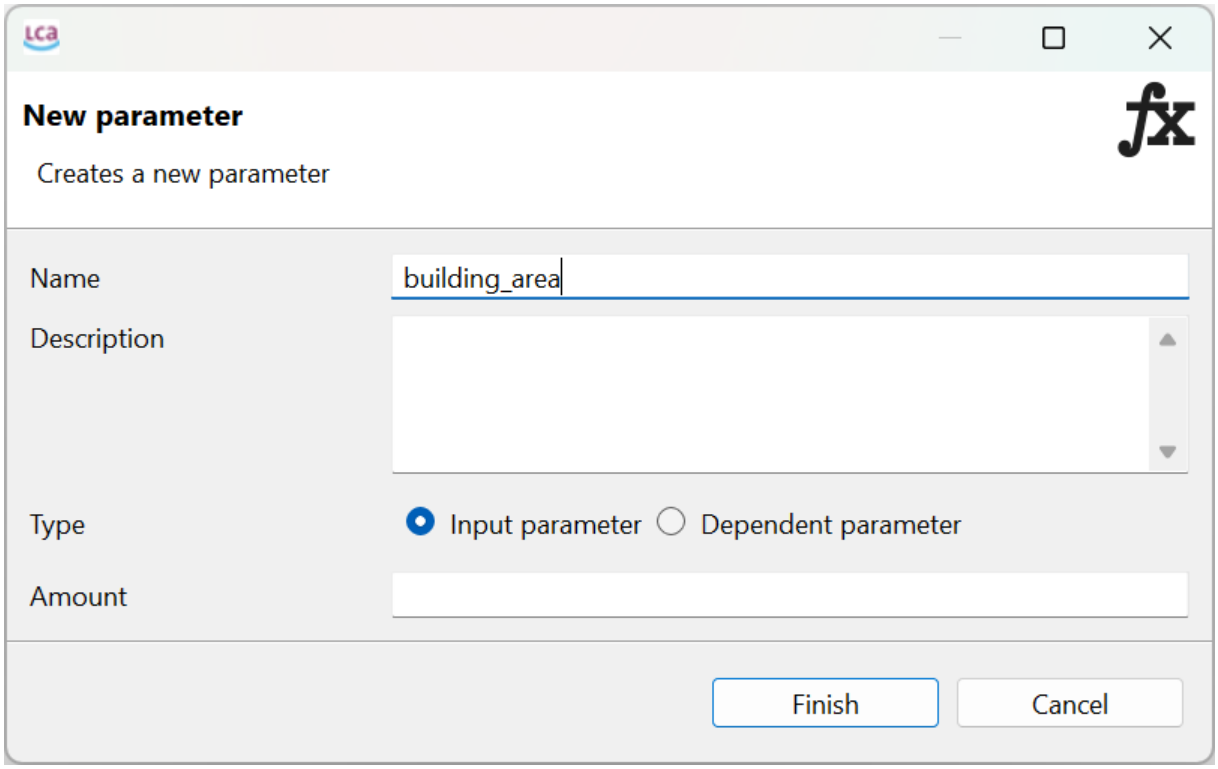


Below are some examples using global parameters that users can try out. In each of these examples, the input parameters are created first as described in the parameter section, so that they can be used in the dependent parameters where the formulas are added. Dependent parameter formulas can also use other dependent parameters.

EXAMPLE 1: THE AMOUNT OF CONCRETE REQUIRED DEPENDS ON BOTH THE AREA AND THE HEIGHT OF THE BUILDING.

Input parameters:

- building_area (m^2)
- building_height (m)

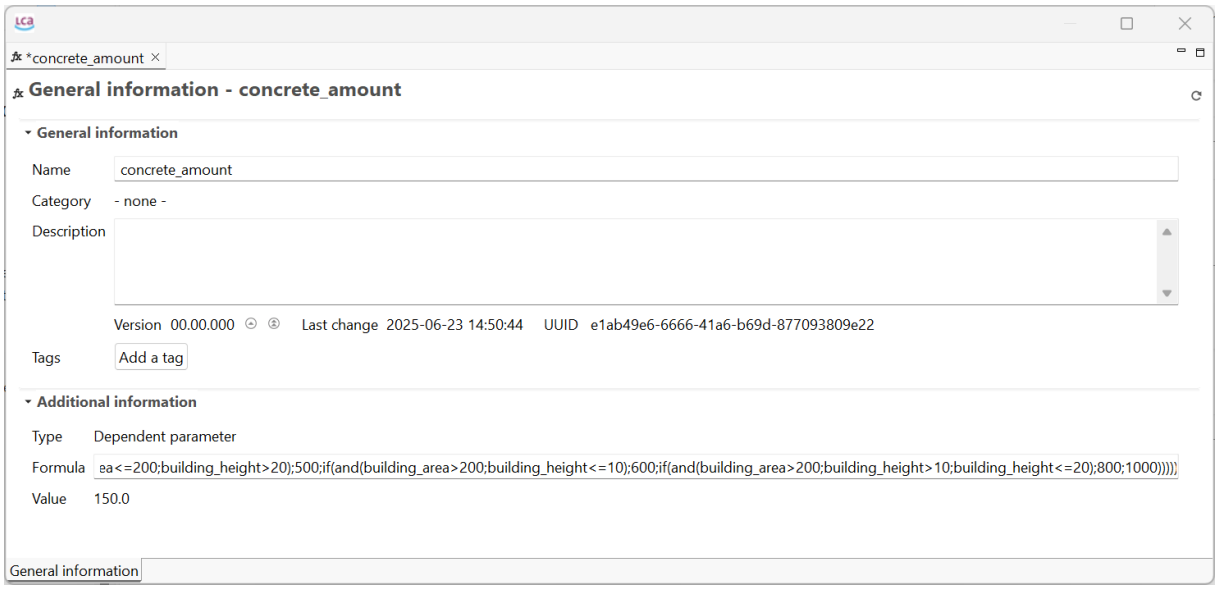


Dependent parameter:

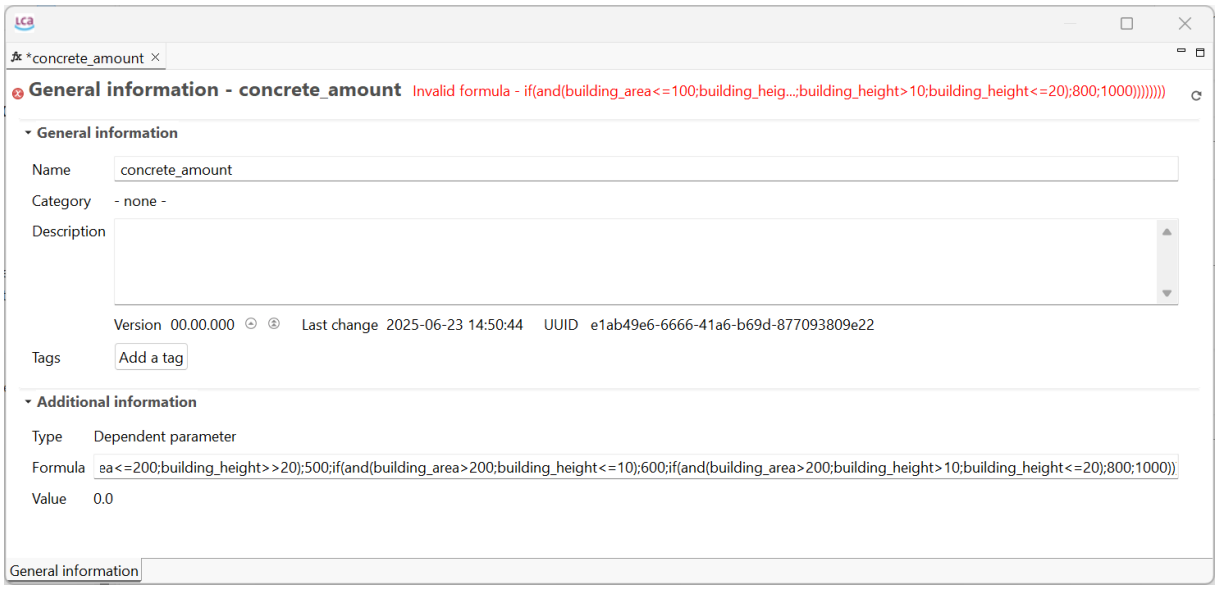
- concrete_amount (m^3)

Formula on openLCA

concrete_amount=
if(and(building_area<=100;building_height<=10);150;if(and(building_area<=100;building_height>10;building_height<=20);200;if(and(building_area<=100;building_height>20);250;if(and(building_area>100;building_area<=200;building_height<=10);300;if(and(building_area>100;building_area<=200;building_height>10;building_height<=20);400;if(and(building_area>100;building_area<=200;building_height>20);500;if(and(building_area>200;building_height<=10);600;if(and(building_area>200;building_height>10;building_height<=20);800;1000)))))))



Note: openLCA requires precise syntax. If there is any mistake in the syntax—such as incorrect usage of operators, missing parentheses, or improper logical conditions—the software will return an error, and the calculation will not proceed. In the example below, the bracket was removed before the first 'if(and' from the concrete amount formula.*



EXAMPLE 2: DETERMINING THE FLOW REGIME IN A PIPE (LAMINAR, TRANSITIONAL, OR TURBULENT) BASED ON THE REYNOLDS NUMBER TO DECIDE ON A PIPE FOR AN EXPERIMENT

Input parameters:

- density = 1000 (kg/m^3) - Fluid density
- velocity = 2 (m/s) - Flow velocity
- diameter = 0.05 (m) - Pipe diameter

- viscosity = 0.001 (Pa·s) - Fluid viscosity

Dependent parameters:

- Reynolds_number (dimensionless)
- flow_regime (numeric code)

Formula:

reynolds_number = (density*velocity*diameter)/viscosity

flow_regime = if(reynolds_number<2000;1;if(reynolds_number<=4000;2;3))

Please note the opening and closing brackets in the if] else statements.

where,

- flow_regime = 1 indicates laminar flow and uses pipe material design 1
- flow_regime = 2 indicates transitional flow uses pipe material design 2
- flow_regime = 3 indicates turbulent flow pipe material design 3

EXAMPLE 3: CALCULATION OF TOTAL COST CONSIDERING PRODUCTION VOLUME AND WASTAGE OF A MATERIAL. (USING AND() AND IF())

Input parameters:

production_cost_per_unit = 10 ($/unit)

production_volume = 1000 (units)

wastage = 50 (units)

Dependent parameters:

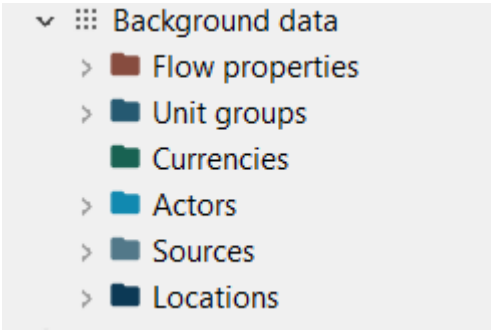
total_cost ($)

Formula:

total_cost = if(and(production_volume>500;wastage>30); (production_cost_per_unit-(production_volume+wastage));production_cost_per_unit*production_volume)

16 BACKGROUND DATA

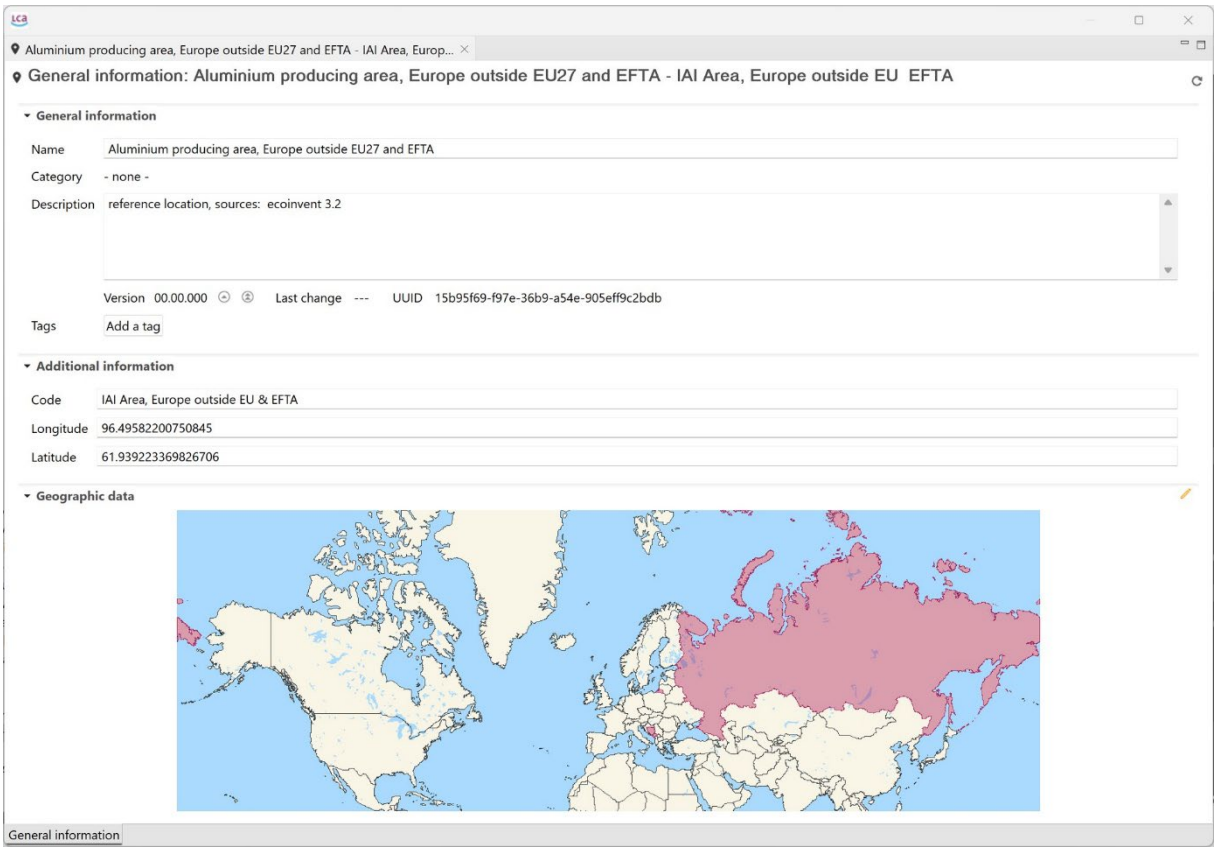
In "Background data," you can find all the elements that users typically don't engage with often, such as units, sources, locations, and so on. You can freely explore this section on your active database.



Background information in a database

LOCATIONS

Locations can be regions, countries, or any other point on a map. They are important for localising the supply chain and for calculating regional impacts. Here is an example of how locations are shown in openLCA when you click on them.



Example of how locations are shown in openLCA

The advanced knowledge base

17 ADVANCED TOPICS

This section addresses advanced aspects of openLCA and requires a solid understanding of life cycle assessment principles, impact assessment methodologies, and the software's functionality.

The following topics will be covered:

- Regionalized LCA
- Monte Carlo Simulation
- Life Cycle Costing
- Data Quality
- Social aspects

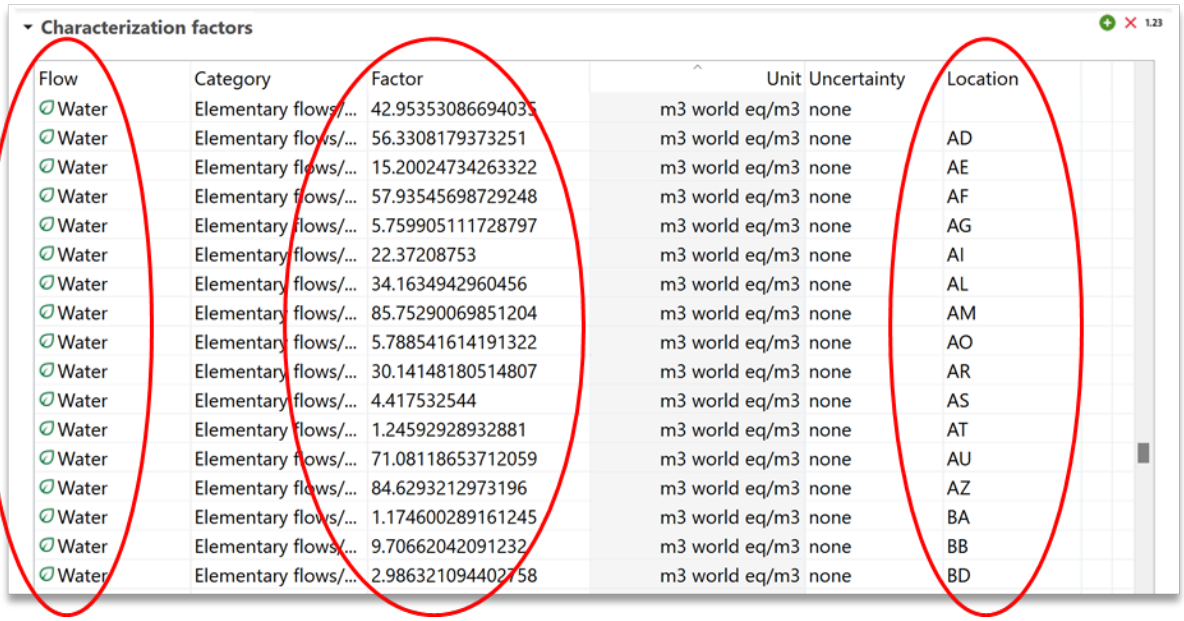
Please take a look at our interactive forum "ask openLCA", where you will find the latest user questions and our answers.

17.1 REGIONALIZED LCA

With openLCA, you can perform regionalised impact assessment, accounting for specific conditions and characteristics of the location where the processes occur. With parameters, you can define regional characteristics affecting the impacts. Regional characteristics and information about geographic locations are contained in GeoJSON files that can be imported into openLCA.

The new regionalised calculation employs a location-based approach. Here, locations are independent entities within the database, interacting with impact factors, processes, and exchanges to generate region-specific impact assessments. This approach differs from the traditional flow-based regionalisation, which relies on region-specific flows to incorporate regional Characterisation Factors (CFs).

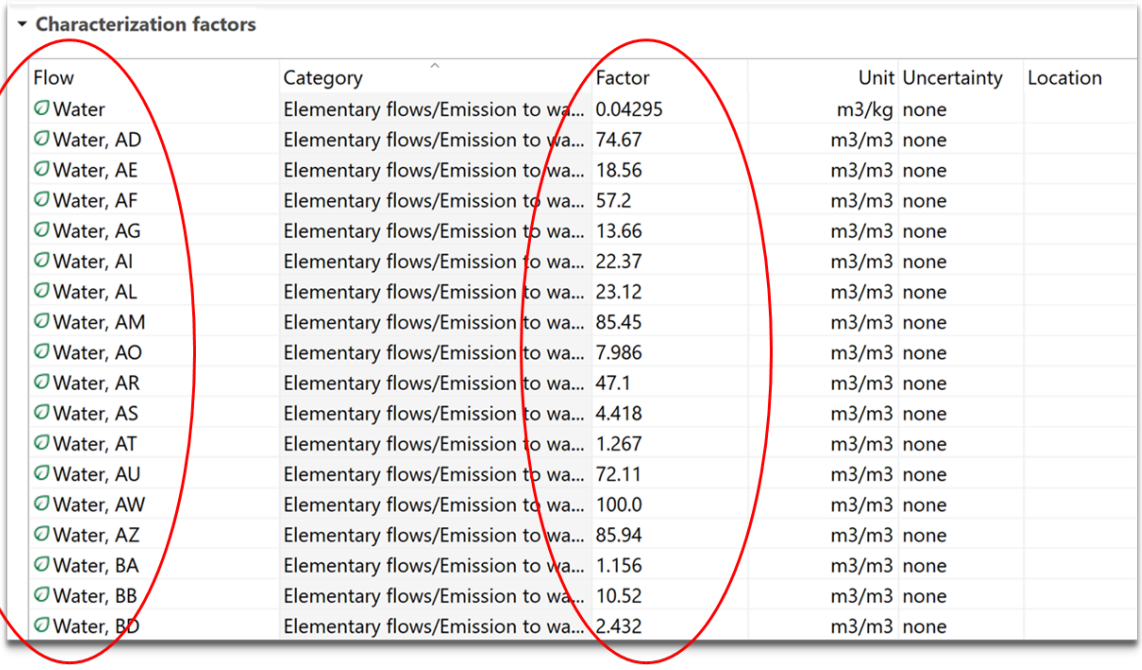
This location-based approach is more flexible, as it enables the addition of new regionalised CFs at any scale (e.g., basin-level, sub-country level) without the need to introduce new flows. The pictures below illustrate the key differences between location-based and flow-based regionalisation approaches.



Characterization factors

Flow	Category	Factor	Unit	Uncertainty	Location
Water	Elementary flows/...	42.95353086694035	m3 world eq/m3	none	
Water	Elementary flows/...	56.3308179373251	m3 world eq/m3	none	AD
Water	Elementary flows/...	15.20024734263322	m3 world eq/m3	none	AE
Water	Elementary flows/...	57.93545698729248	m3 world eq/m3	none	AF
Water	Elementary flows/...	5.759905111728797	m3 world eq/m3	none	AG
Water	Elementary flows/...	22.37208753	m3 world eq/m3	none	AI
Water	Elementary flows/...	34.1634942960456	m3 world eq/m3	none	AL
Water	Elementary flows/...	85.75290069851204	m3 world eq/m3	none	AM
Water	Elementary flows/...	5.788541614191322	m3 world eq/m3	none	AO
Water	Elementary flows/...	30.14148180514807	m3 world eq/m3	none	AR
Water	Elementary flows/...	4.417532544	m3 world eq/m3	none	AS
Water	Elementary flows/...	1.24592928932881	m3 world eq/m3	none	AT
Water	Elementary flows/...	71.08118653712059	m3 world eq/m3	none	AU
Water	Elementary flows/...	84.6293213973196	m3 world eq/m3	none	AZ
Water	Elementary flows/...	1.174600289161245	m3 world eq/m3	none	BA
Water	Elementary flows/...	9.70662042091232	m3 world eq/m3	none	BB
Water	Elementary flows/...	2.986321094402758	m3 world eq/m3	none	BD

Location] based' regionalization



Characterization factors

Flow	Category	Factor	Unit	Uncertainty	Location
Water	Elementary flows/Emission to wa...	0.04295	m3/kg	none	
Water, AD	Elementary flows/Emission to wa...	74.67	m3/m3	none	
Water, AE	Elementary flows/Emission to wa...	18.56	m3/m3	none	
Water, AF	Elementary flows/Emission to wa...	57.2	m3/m3	none	
Water, AG	Elementary flows/Emission to wa...	13.66	m3/m3	none	
Water, AI	Elementary flows/Emission to wa...	22.37	m3/m3	none	
Water, AL	Elementary flows/Emission to wa...	23.12	m3/m3	none	
Water, AM	Elementary flows/Emission to wa...	85.45	m3/m3	none	
Water, AO	Elementary flows/Emission to wa...	7.986	m3/m3	none	
Water, AR	Elementary flows/Emission to wa...	47.1	m3/m3	none	
Water, AS	Elementary flows/Emission to wa...	4.418	m3/m3	none	
Water, AT	Elementary flows/Emission to wa...	1.267	m3/m3	none	
Water, AU	Elementary flows/Emission to wa...	72.11	m3/m3	none	
Water, AW	Elementary flows/Emission to wa...	100.0	m3/m3	none	
Water, AZ	Elementary flows/Emission to wa...	85.94	m3/m3	none	
Water, BA	Elementary flows/Emission to wa...	1.156	m3/m3	none	
Water, BB	Elementary flows/Emission to wa...	10.52	m3/m3	none	
Water, BD	Elementary flows/Emission to wa...	2.432	m3/m3	none	

Flow] based' regionalisation

HOW TO PERFORM REGIONALIZED LCA-STEP BY STEP

Note¾egionalised calculation is an advanced form of impact calculation. It is more resource-intensive than a normal impact calculation, and it needs to be handled carefully. We advise to allocate enough memory for the calculations (check how to do it under Preferences > Configuration in "Toolbar: File"), to perform it using a location-based regionalized method, and to check that the locations of processes are the intended ones along the whole supply chain (check section "Assign locations to processes and exchanges" below for more details).

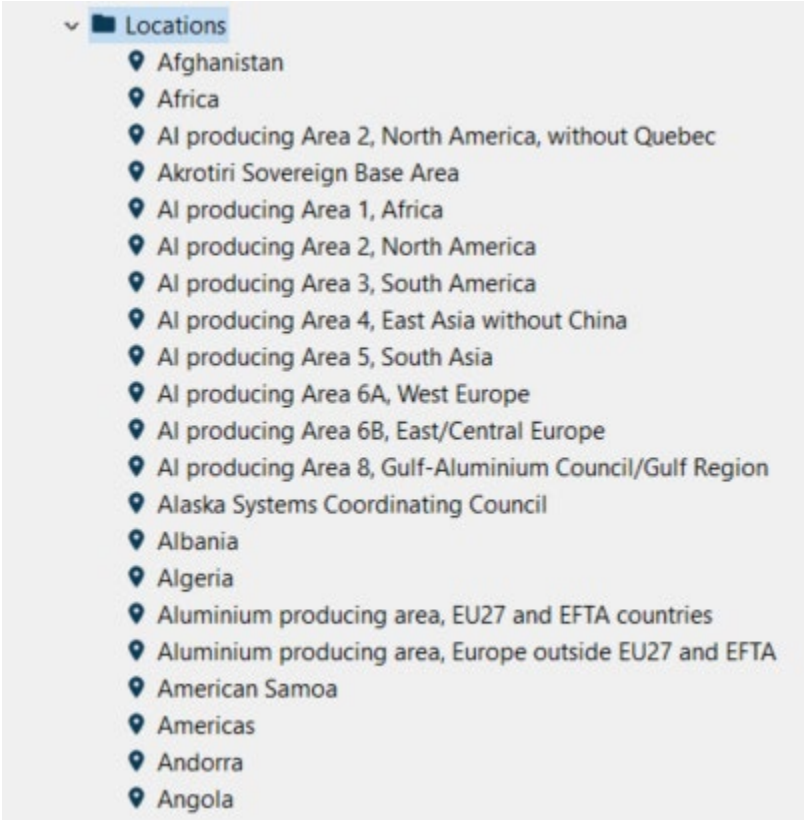
At the moment, these are the methods we offer that are location-based and regionalised:

- EF 3.1 (adapted): available in the openLCA method package from v2.4.0 upward. Regionalised in "hybrid" format (meaning that it can be used with the new regionalisation tool, but it's still compatible with traditional flow-based regionalised databases).
- TRACI 2.2 (freshwater and marine eutrophication impact categories): available in the openLCA method package from v2.5.0 upward. Regionalised in "hybrid" format.
- AWARE 1.2: available in the openLCA method package from v2.6.0 upward. Regionalised in "hybrid" format.
- LC-Impact: available in Nexus as a standalone (compatible with the same databases as our method pack). Location-based regionalised only. For LC-Impact, we also provide regionalisation setups in JSON format, where the flow binding has already been set.

Nonetheless, in this chapter, you will learn how to bind flows yourself and calculate characterisation factors for specific locations, which works for both methods already regionalised and those that are not yet updated, but which provide geographic information for their impact factors.

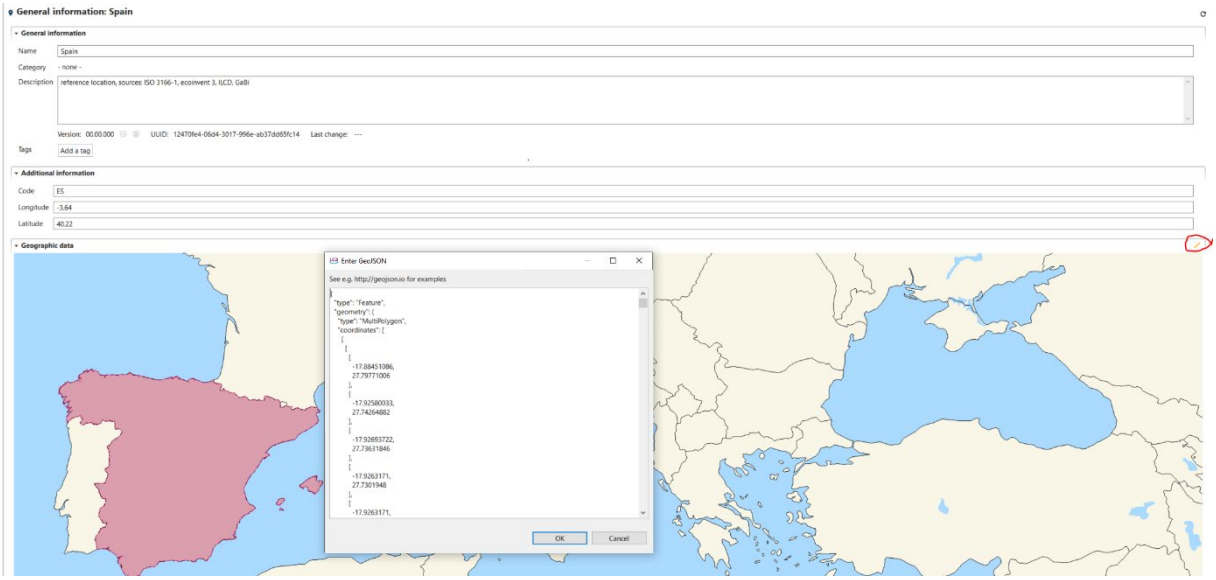
CHECK LOCATIONS IN OPENLCA

A regionalised LCA needs to understand locations. In openLCA 2, available locations in the database are displayed in the navigation tab under Database → Background Data → Locations.



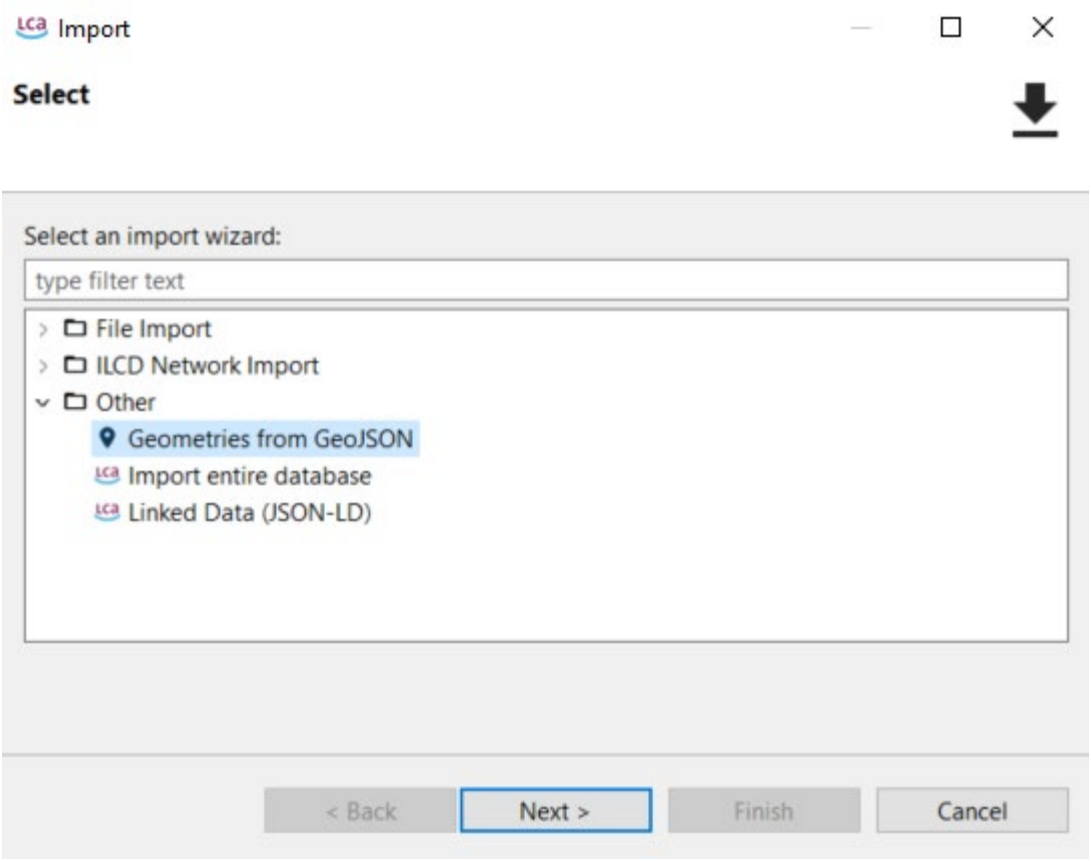
Available locations in a database

In opening one, you will see geographic data, including latitude, longitude, and country code (e.g., ES for Spain), as well as the covered area defined by GeoJSON. It is also possible to modify the coordinates by using the text editor, which can be opened by clicking on the pencil icon in the "Geographic data" section.



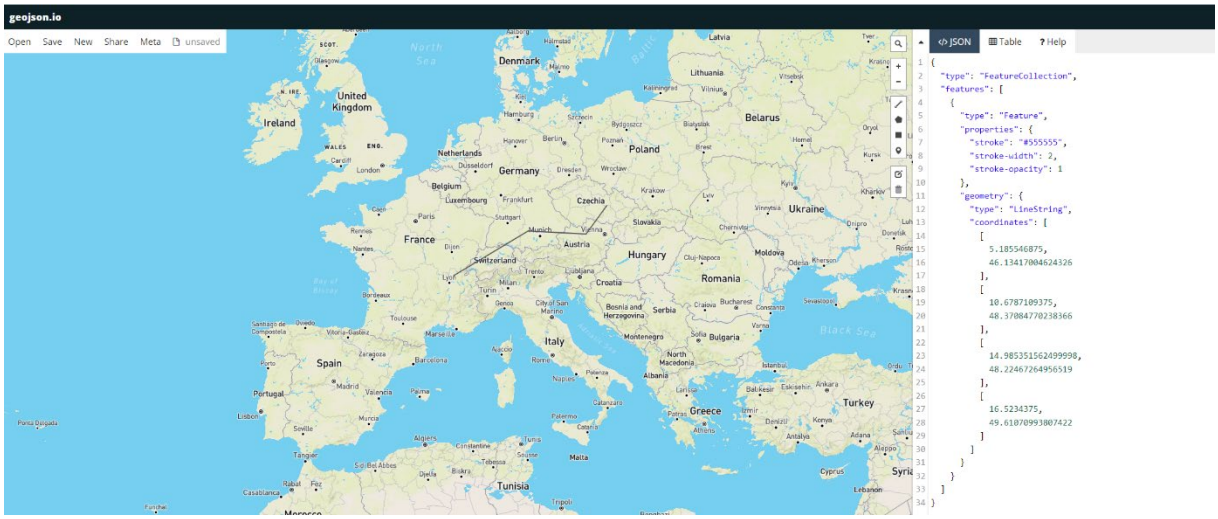
General geographic data] Example Spain

Locations can also be imported into the active database, for instance, from a GIS software, as GeoJSON files. File → Import → other → geometries from GeoJSON.



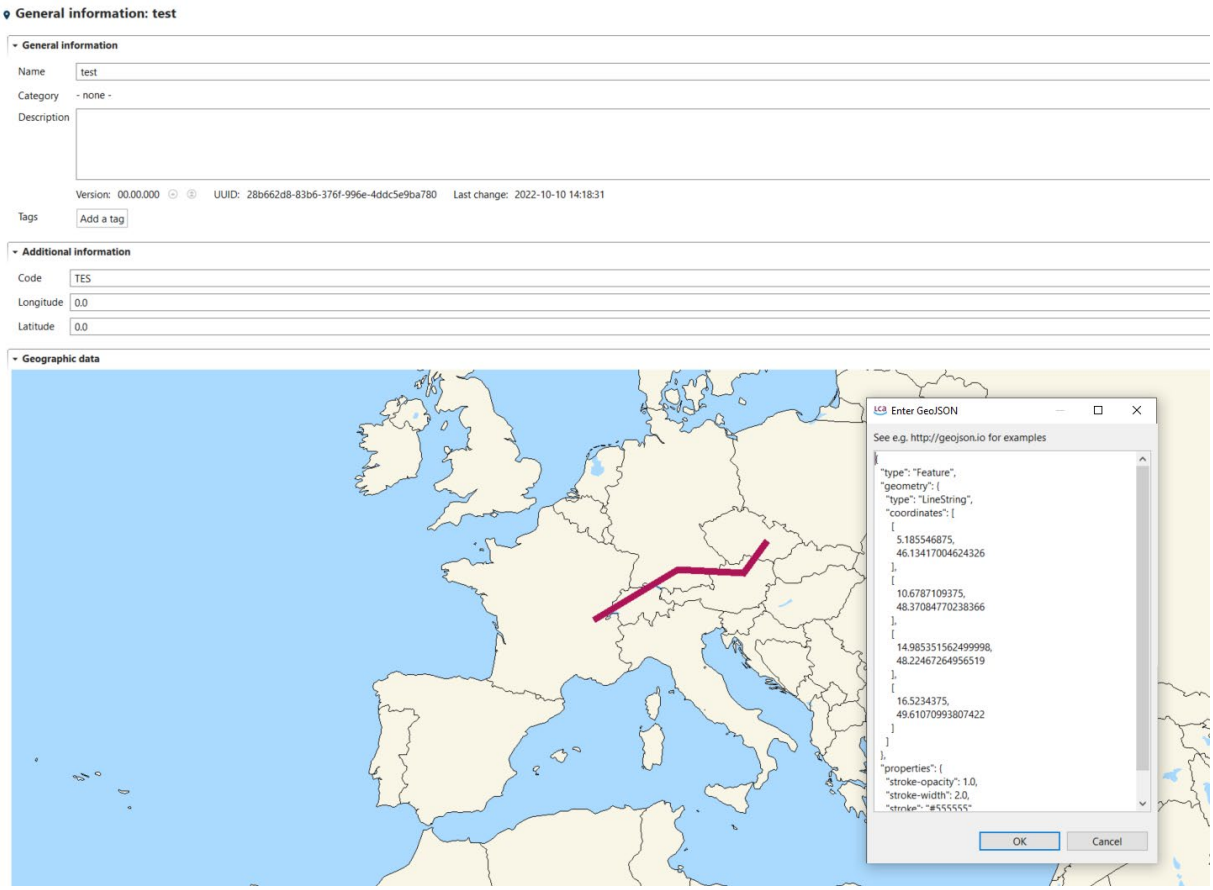
Import of locations into the active database

Alternatively, locations can also be drawn by users in geojson.io as polygons, lines or points.



geojson.io example

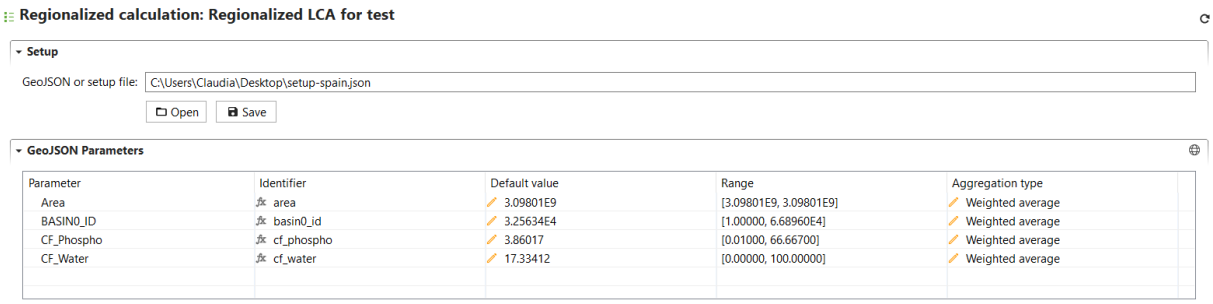
The coordinates text can then be just pasted in the text editor in openLCA, after the creation of a new location (right click on location folder → new location → add name and country code → open the text editor in the geographic data ("pencil" icon) → paste coordinate text from geojson.io).



Use of coordinates text from geojson.io example in the openLCA text editor

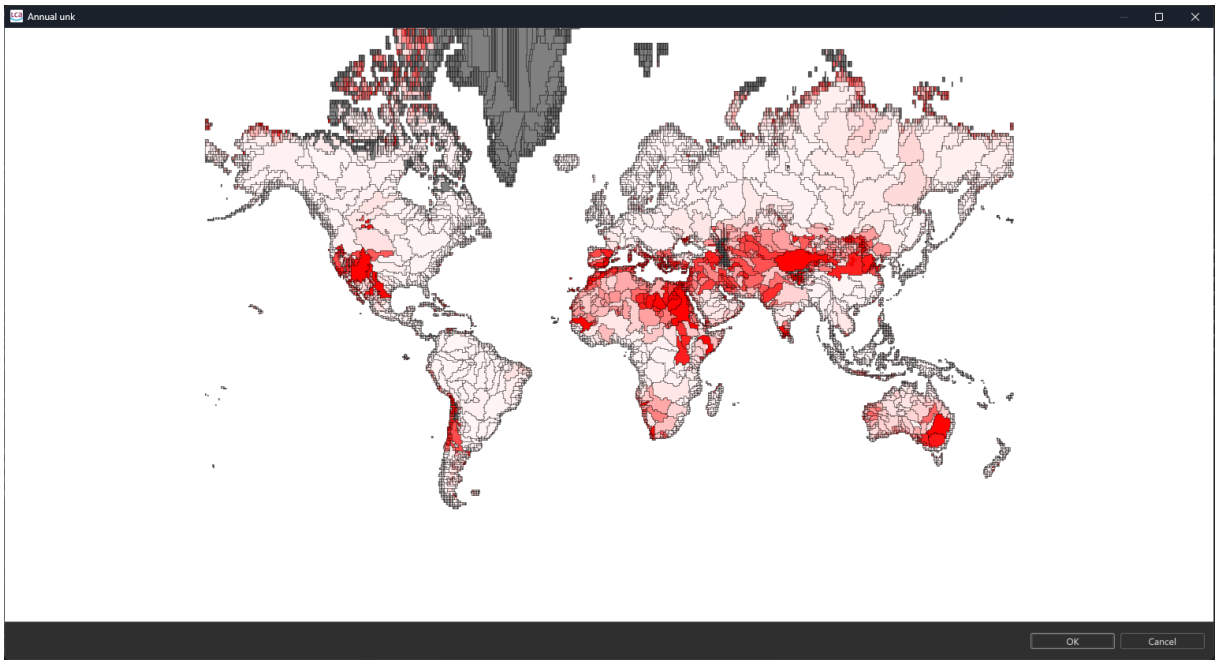
IMPORTING REGIONAL CHARACTERISTICS AS A GEOJSON FILE

Data for regional characteristics are contained in GeoJSON files, which can be imported into openLCA. To regionalise an impact category, first go to the "impact categories" folder and open an existing category (or create a new one). Then, go to the "Regionalised Calculation" tab for the opened category. Here, you need to import regional characteristics (e.g., population density, watershed area, characterisation factors) by clicking on "Open" and selecting the GeoJSON files available on your laptop (e.g., previously exported from a GIS software). Parameters are extracted during the import of the GeoJSON file and are available in the "GeoJSON Parameters" section.



Regionalized calculation

Each imported parameter can be visualised in a map by selecting the parameter and clicking on the "world" icon in the GeoJSON Parameters section.



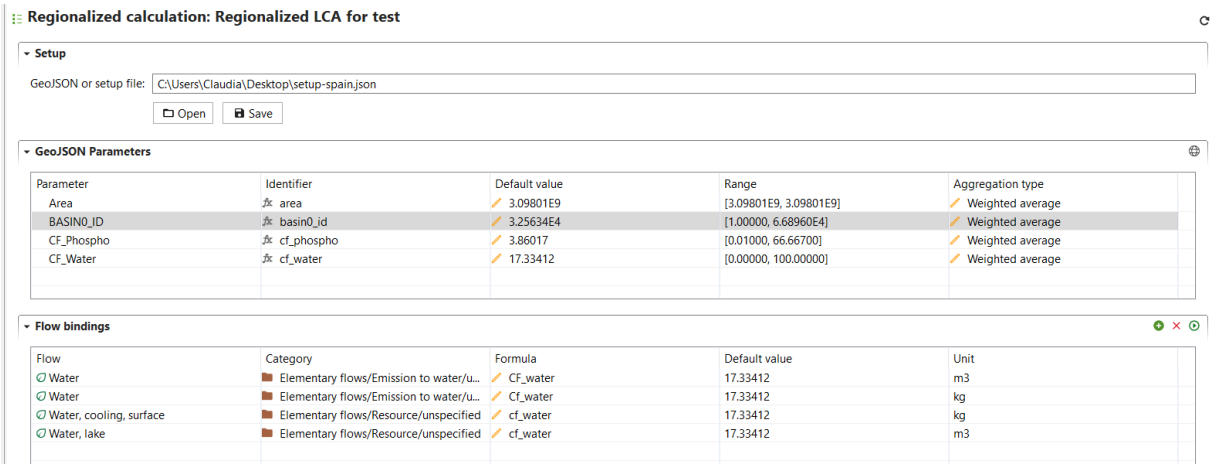
Visualisation of parameters

BINDING REGIONAL CHARACTERISTICS (GEOJSON FILES) TO FLOWS

Flows for which you want to calculate geo-spatial based CFs need to be bound to the regional characteristics contained in GeoJSON files, so that the CFs can vary based on the selected location for exchanges and processes. In the "flow bindings" section under "regionalised calculation" in the open impact category, add the flows that you want to regionalise (use the "+" icon) and parametrise the "formula" field using the parameters extracted during the regional characteristics import and available under "GeoJSON parameters". In a regionalised assessment, the parameter value derived from the GeoJSON file is used to evaluate the formula. Instead, if you apply non-regionalised LCIA or no location is available for exchanges and processes, the default CF value will be used in the calculations.

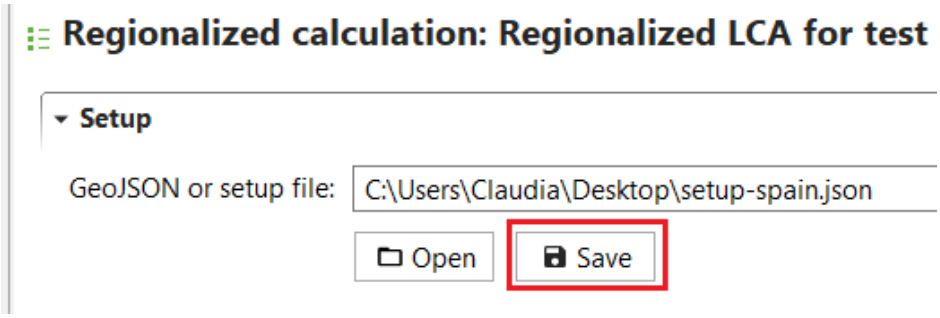
In the "Formula" field, you can choose the parameter of your geoJSON that you want to use for the calculation of the CF of the flow you chose. You can treat that field as any other formula in openLCA. For instance, if you have a water flow expressed in Kg and the parameter of your geoJSON is in m^3, you can see.

In the "Range" field, you can view the minimum and maximum values for each parameter. The "Aggregation Type" field allows you to choose the aggregation type for the calculation of your CFs: "Weighted Average" (N.B.: area-weighted average), "Average," "Minimum," or "Maximum." The "Default Value" displays the value derived from the selected aggregation type, which is performed for each parameter on your entire map.



Example of flow binding and parameterisation

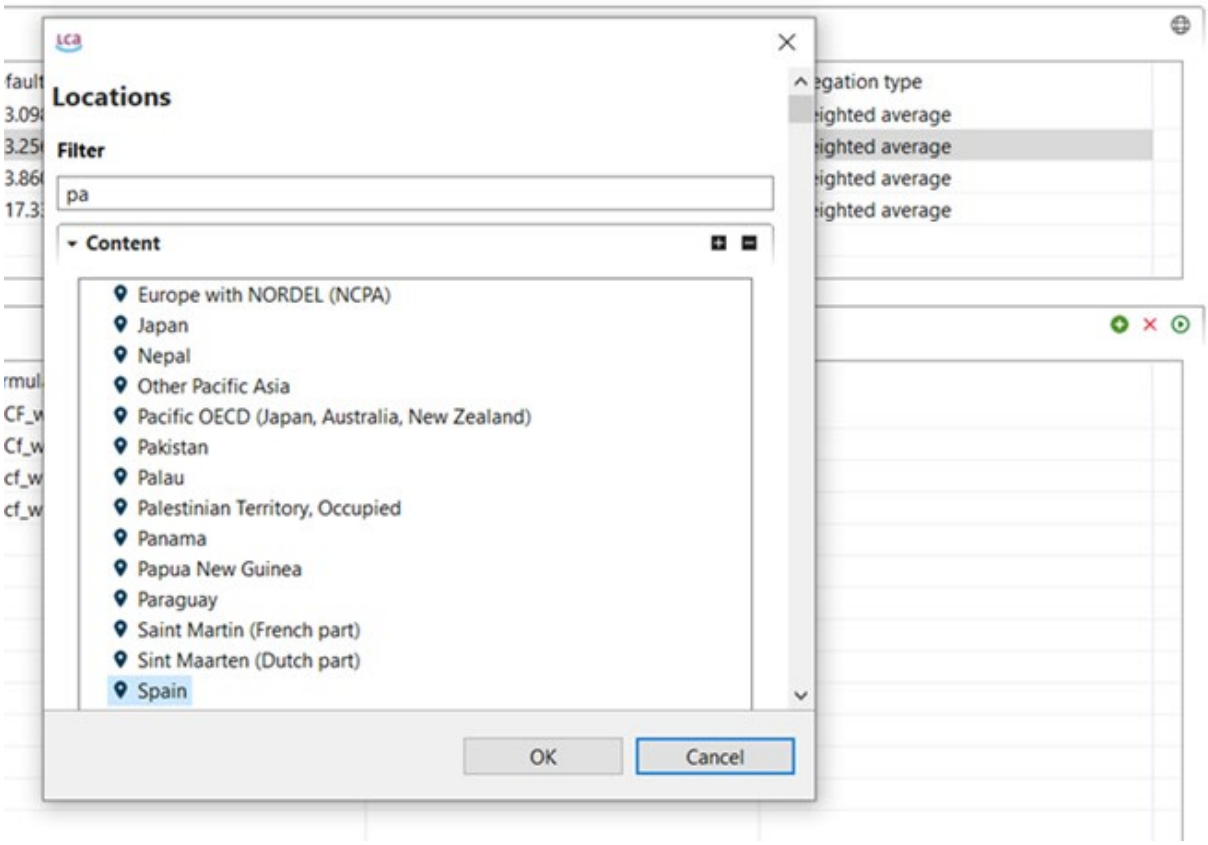
Currently, openLCA cannot store the GeoJSON parameters and flow bindings; however, you can save and export your setup by clicking "Save". You can import this configuration again at any time by clicking on "open" and selecting the exported setup. The calculated CFs instead (see below) can be saved and therefore permanently stored in the impact category of choice-



Saving geojson parameters and flow bindings

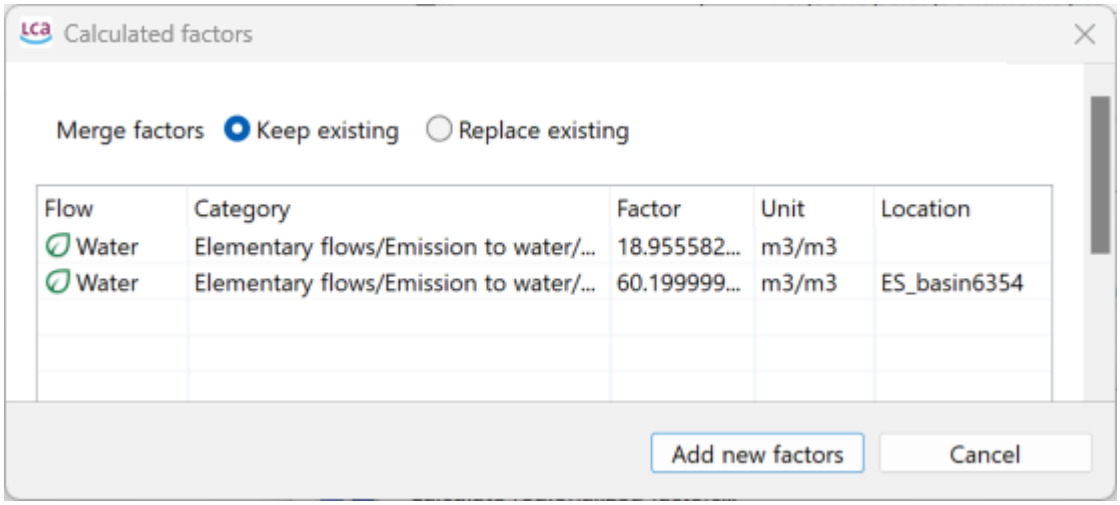
CALCULATE CFS FOR SELECTED LOCATIONS

The last step in setting up the regionalised LCIA method is to link process locations and the LCIA methods' spatial units. Therefore, the intersection between GeoJSON file features and process geometries (stored in "Locations") is calculated by the software, thus resulting in dedicated CFs for locations selected by the user. By clicking the "Calculate" icon in the "Flow Bindings" section, the user defines the locations for which CFs are to be calculated for the flows added in the "Flow Bindings" section.



Defining the location for which the characterisation factors are calculated

A window will open with the resulting characterisation factors. The system will calculate, using the aggregation type you choose (see the above section) two values: 1) a value based on the geometry of the specific location you select; 2) a default value representing a global factor (what was called "default value" in the GeoJSON Parameters table) without a specific location, useful for instance when the location of a process is unknown.



Example results of newly calculated Characterisation Factors

You can choose between two saving options:

- Keep existing: This option preserves any existing CFs. For example, if the method you're using already includes a global default value, selecting this option ensures it remains unchanged.
- Replace existing: This option overwrites all values. It will add or replace both the specific CF for the selected location and the default global value.

Eventually, click on "Add new factors". The resulting CFs for the selected locations and flows are available in the tab "characterisation factors" for the open impact category. A flow is created for each selected location, and the same flow without a specific location is assigned a CF depending on the location, or a default CF value is used in the case of the flow without a specific location.

ADD THE REGIONALIZED IMPACT CATEGORY TO AN IMPACT ASSESSMENT METHOD

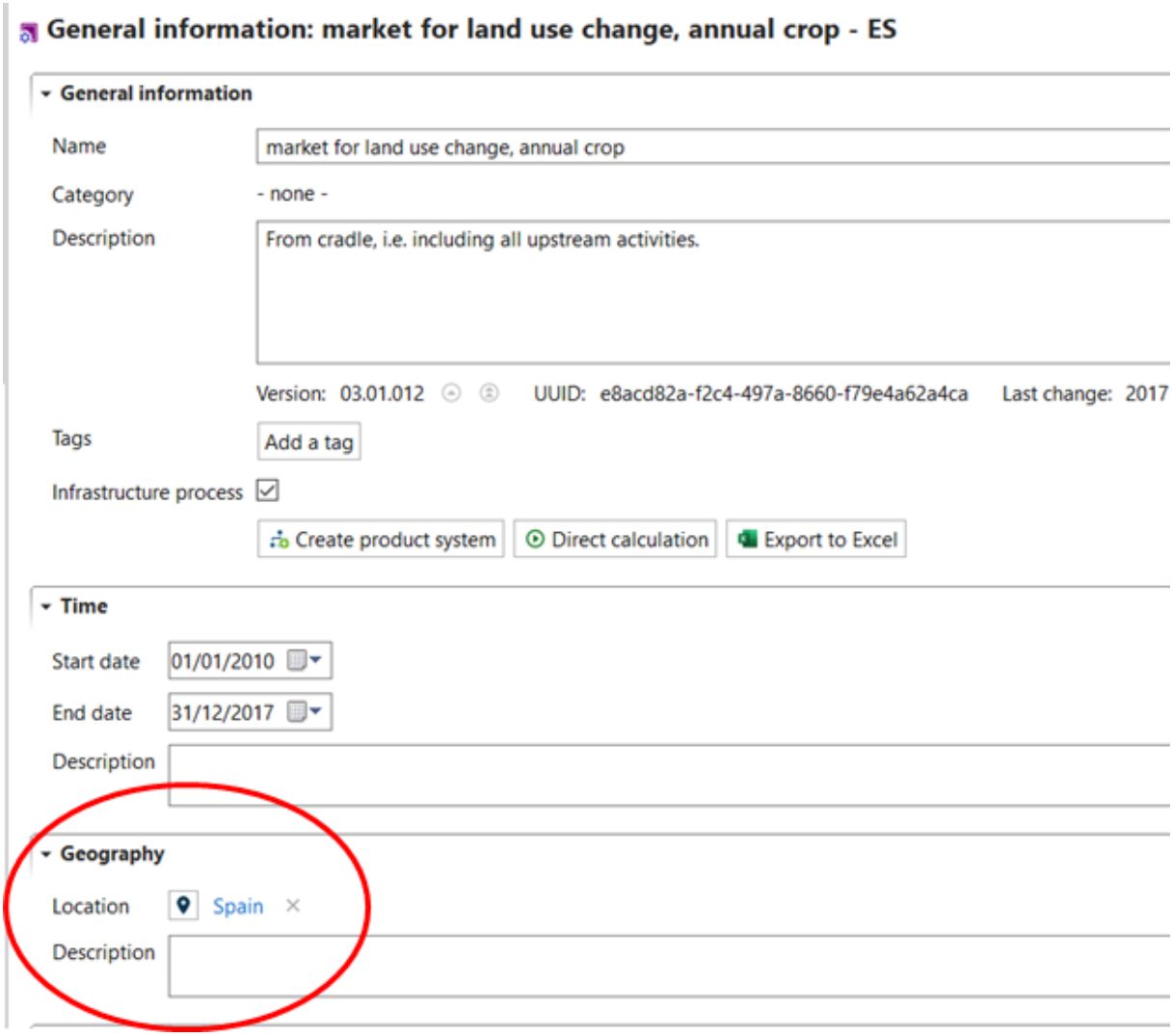
When running LCIA, you need to select an impact assessment method. Therefore, the regionalised impact categories) need to be added to the method used to calculate the product system impact. To create a new regionalised method, right-click on the "Impact Assessment Methods" folder and select "New LCIA method". Then, you can add the previously created impact category in the "Impact Categories" section on the first tab, "General Information".

Adding an impact category to the tab ...General information...

ASSIGN LOCATIONS TO PROCESSES AND EXCHANGES

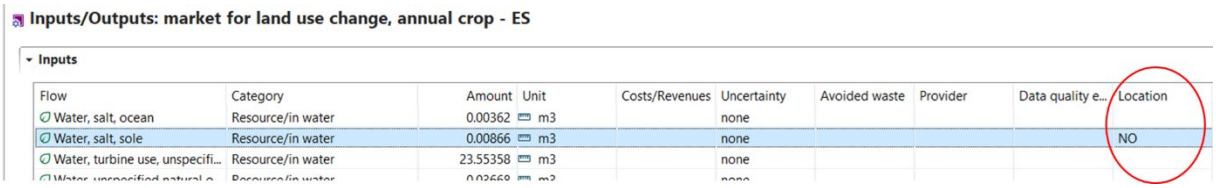
To perform a regionalised LCIA, ensure that the correct locations are assigned to your processes and/or exchanges.

For process locations, go to the 'Geography' section in the 'General Information' tab of a process and select the desired location.



Process'with'Spain'as'assigned'location

For exchange locations, add them to the 'Location' field in the 'Input/Output' tab of a process.

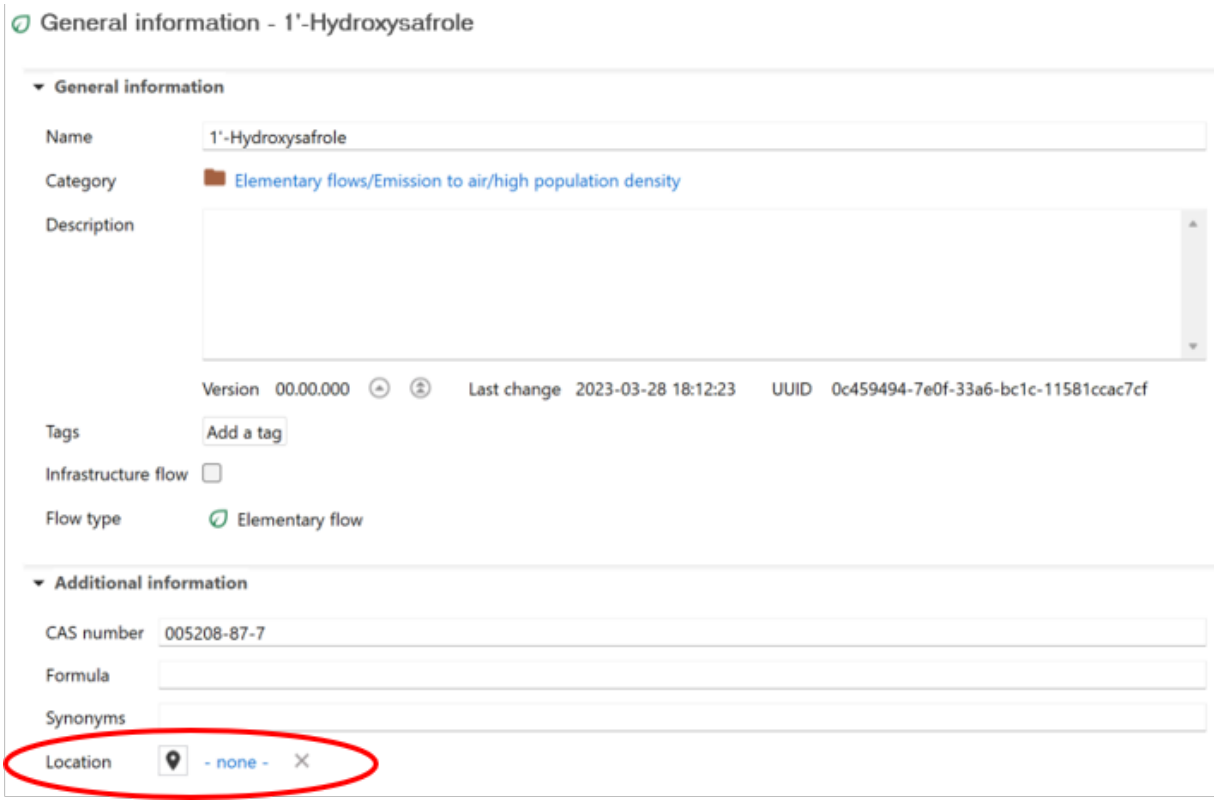


Exchange'with'Norway'as'the'assigned'location

Note that the locations of exchanges take priority over the location of the process if they differ. For instance, if a process has "Italy" assigned as its location, but some of its exchanges are designated with more specific regions (e.g., Sicily or a particular water basin), the impact will be calculated based on the exchange locations. If no specific location is given for an exchange, the impact will then be calculated using the process location (therefore, it is not mandatory to specify locations for every exchange).

Note Instead, locations specified in flows (if any) are not considered in the regionalised impact calculation! These locations primarily pertain to product or waste flows and do

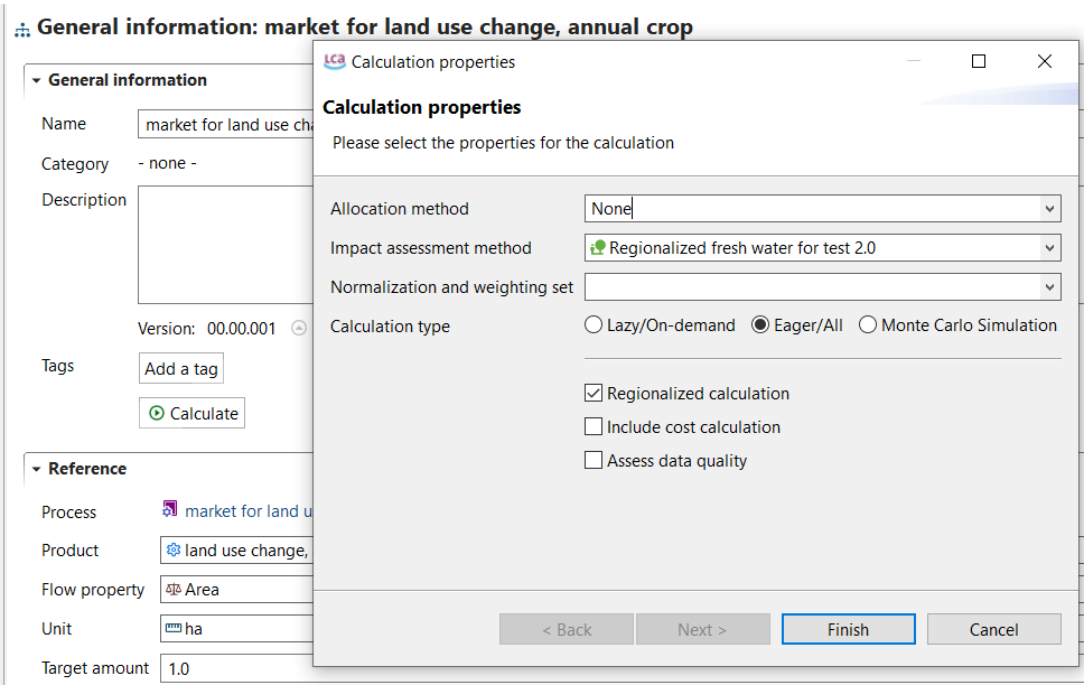
not apply to regionalised impact calculations, which only account for process or exchange locations. See below:



If a location is specified at this level, it will not be taken into account during the regionalised impact calculation.

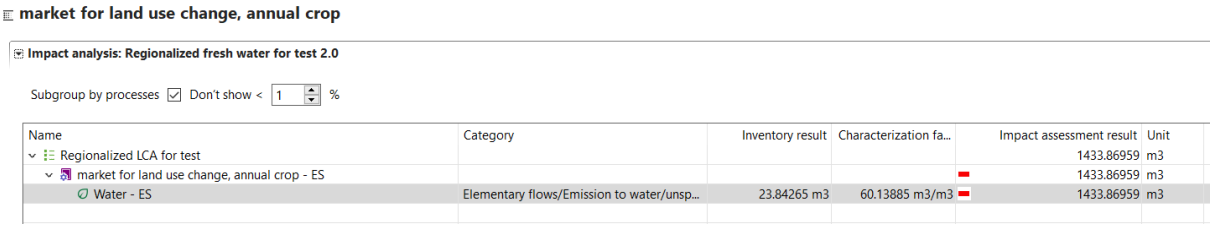
RUN REGIONALIZED LCIA OF A PRODUCT SYSTEM

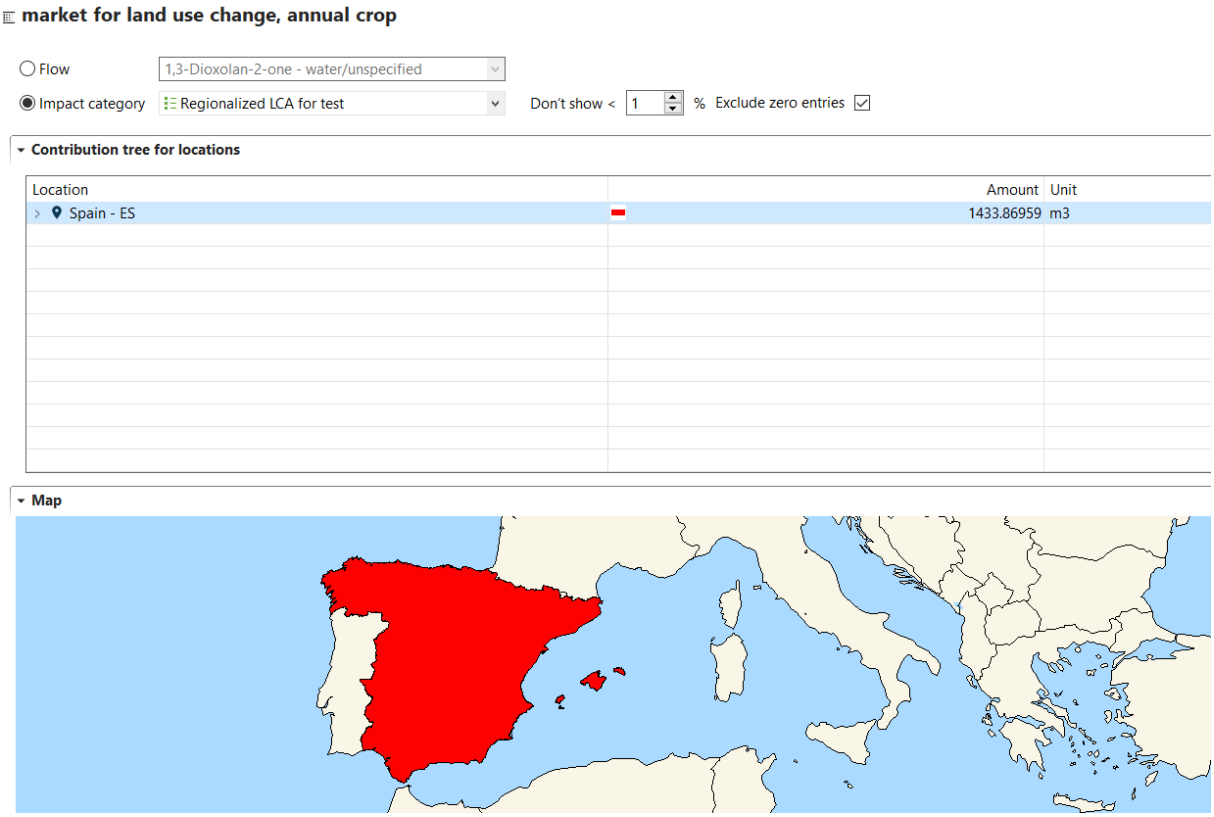
To run a regionalised LCIA for a product system, select a regionalised impact assessment method and check the "regionalised calculation" box. Click on "Finish" to start the calculations.



Calculation of a 'regionalised' LCIA

Regionalised results can be analysed using different tabs, such as "Impact Analysis" and "Locations".





Example 'results' of a 'regionalised' LCIA

17.2 LIFE CYCLE COSTING

Life Cycle Costing (LCC) is a method that assesses the costs of a product over its entire life cycle.

LCC AND VALUE ADDED IN OPENLCA

Costs are modelled in the software as associated with products, waste or elementary flows, which are inputs and outputs of processes. They can be positive or negative, while a negative cost is regarded as a value added. Generally, there is no need to create a method for LCC calculation. Have also a look at our LCC documentation.

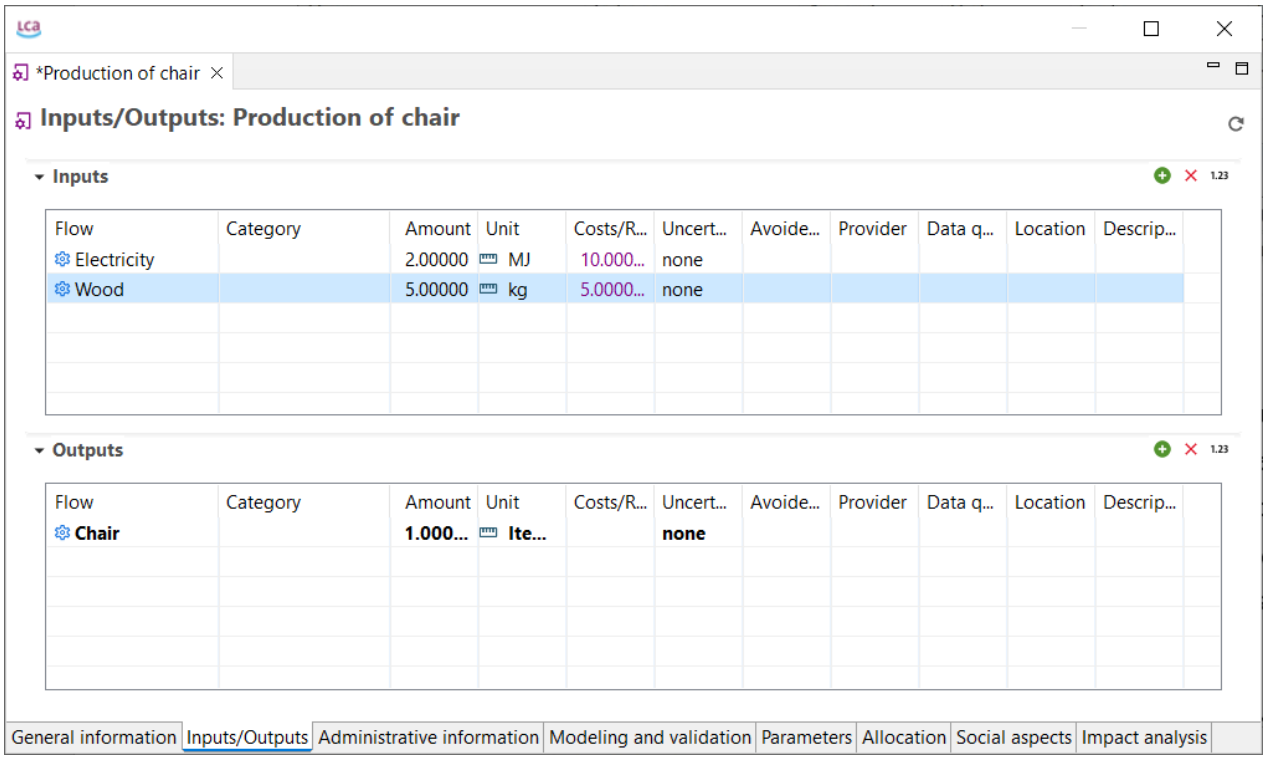
The implementation in openLCA follows the proposal of the SETAC working group, for costs, with some modifications, as follows:

- Costs are modelled as properties of exchanges, i.e. of inputs and outputs of processes;
- Costs can be positive or negative; negative costs are added value
- Costs are displayed in the process editor, in a new column for the exchanges.
- When a product system is calculated, both costs and added value are available, in parallel to inventory and impact assessment results.

Value added builds on this concept, taking value added as "negative costs", i.e. reversing the sign.

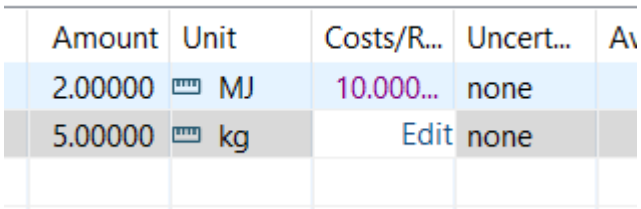
A CLOSER LOOK AT HOW COSTS ARE SPECIFIED IN THE PROCESS EDITOR

The starting point for the cost model and LCC calculation in openLCA is the cost of process data sets. In the process editor, costs can be entered for each exchange, i.e. for each input and output, of a process. Both costs and revenues can be considered:



Costs and revenues for flows in a process

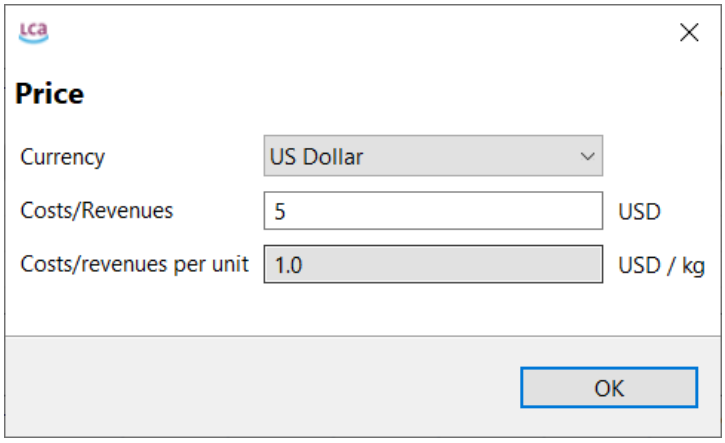
Costs on the input side are costs. On the output side, for products, amounts in this column are revenues (the product is sold), while the release of elementary or waste flows might cause a cost, e.g., the release of CO2 or emission of wastewater with heavy metals. Therefore, any positive amount entered for a product on the output side refers to revenue, while every positive amount entered for an elementary flow reflects costs. To help distinguish between the, which are shown in purple, and revenues are shown in green. To edit the costs or to enter new costs, click in the cost column and click on edit.



Entering or editing costs in the process editor

A new window will appear for specifying the currency and the cost amount. The amount is meant to be entered as an absolute value, i.e., as the costs for the amount of the exchange as it is entered for the exchange. For example, the second figure represents the costs for 0.12 kg. The costs per specified unit, e.g., per kg, are calculated

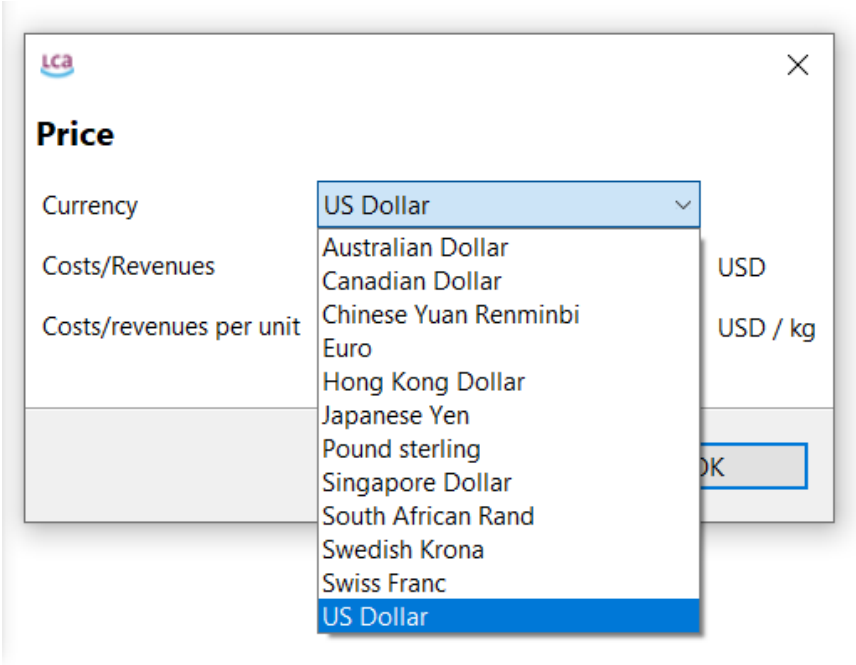
automatically and displayed in the small window for entering costs that opens when clicking on 'Edit' in the cost/revenue column.



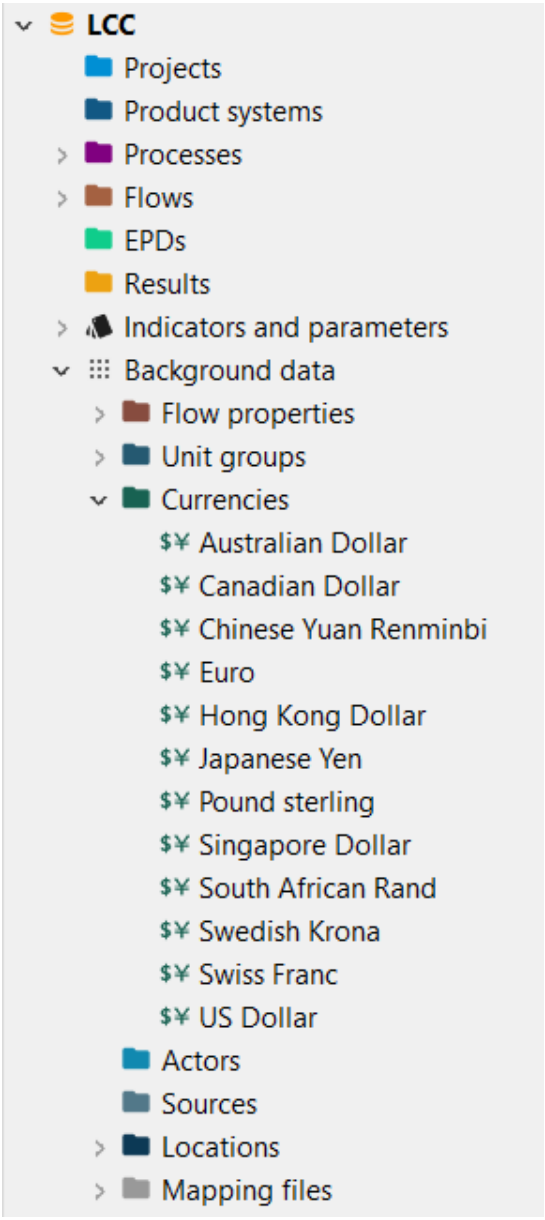
Entering or editing costs in the detail window with absolute costs / costs for the amount specified for the exchange, and costs per unit which are calculated

CURRENCIES

As shown in the figures above, costs are expressed in currencies. It is possible to switch between different currencies for a cost entry in the detailed cost window. All currencies available in the database can be found under Background Data, in the Currencies folder. For an entire database, one currency is selected as the reference currency. For the other currencies, an exchange rate is stored to facilitate the recalculation of costs in a different currency. The exchange rates are used to calculate the conversion factors applied when different currencies are selected.

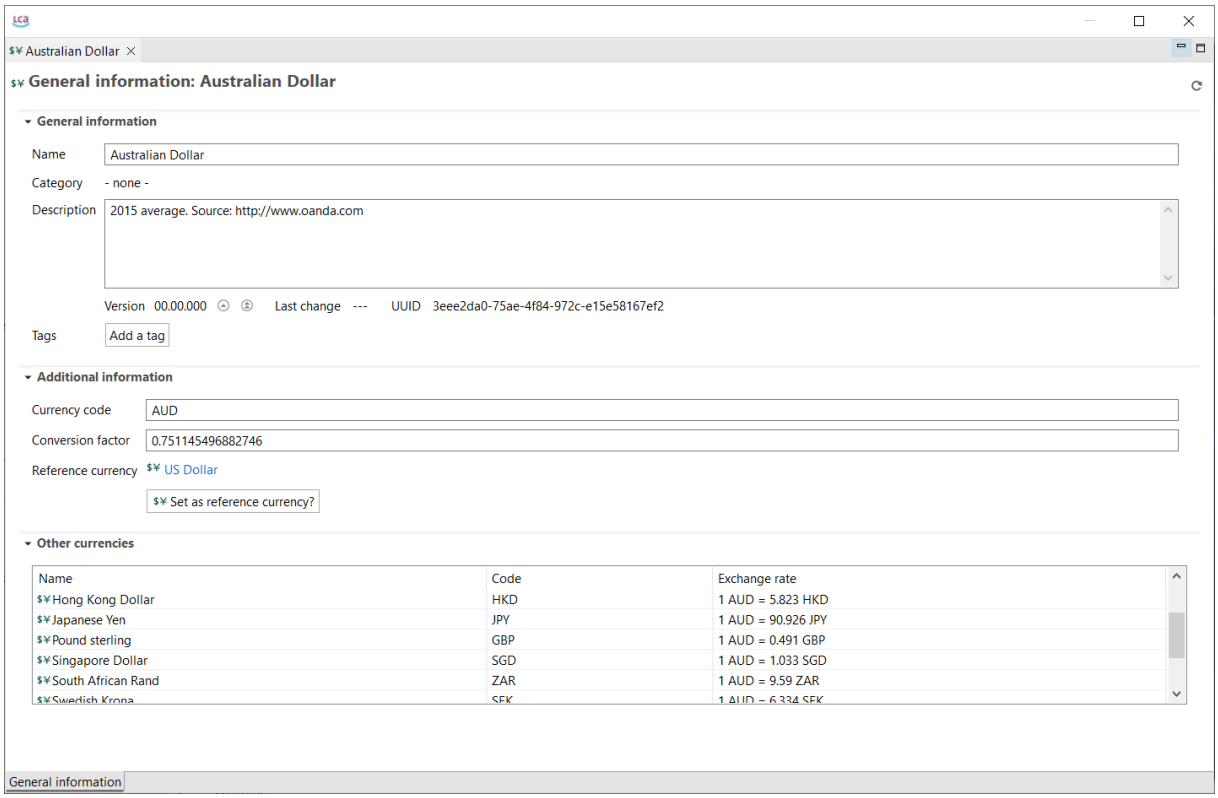


Changing the currency of a flow



Under the background data you can find the available currency or add your own

The reference currency can be changed within one currency (click on "set as reference currency?").



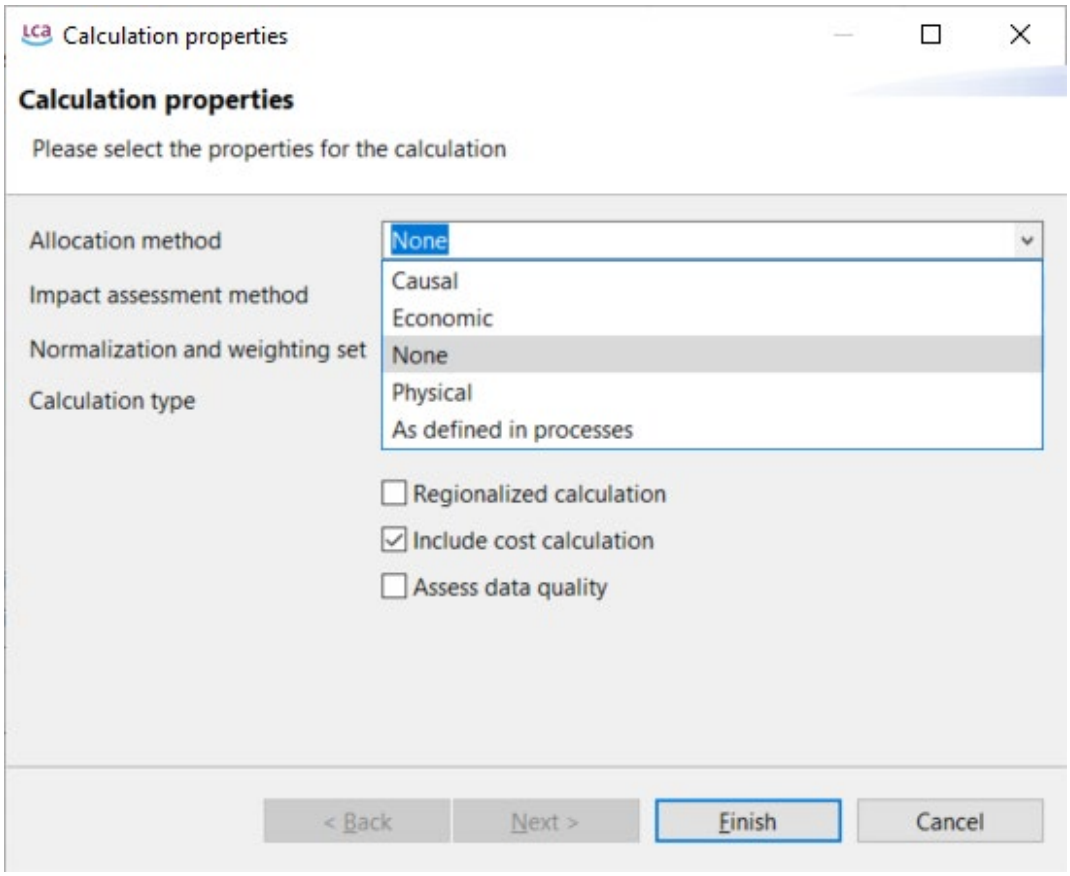
General information on a currency

When changing the reference currency, all open currency editors will be closed to update the conversion factors, and the editor for the new reference currency will be reopened.

MULTI-OUTPUT PROCESSES (ALLOCATION OF COSTS)

In the case of multi-output processes, the consideration of by-product costs depends on the choice of allocation options when setting the calculation properties (see "Allocation"). If no option is selected, the price of the by-products is considered as revenue. However, if a type of allocation is chosen, the allocation factors are applied to the exchanges, and the by-product cost is not considered. The third possibility is to select the option "as defined in processes": As before, if a type of allocation is chosen, the allocation factors are applied to the exchanges and the by-product cost is not considered; on the contrary, if no allocation is selected, all costs are calculated excluding those from the by-products.

For multi-output processes in the database, it is essential to understand how the costs of by-products are accounted for during the calculation of a product system. You have different options for setting the allocation method in the calculation properties.



Choosing the allocation method in openLCA during the calculation setup. The box for „Include cost calculation…" is checked

Note: Furthermore, LCC can be performed standalone by selecting 'No Method' when the impact assessment is run.

Depending on this choice (and depending on what is defined in the processes themselves) the following rules will be applied:

- **None:** All costs are considered (the price of the by-product as revenue)
- **Physical, causal or economic:** The allocation factors are applied to the exchanges and the price of the byproduct is not considered.
- **As defined in processes:** The physical, causal or economic allocation is chosen as defined in the processes themselves. Again, the allocation factors are applied to the exchanges, and the price of the by-product is not considered, and no allocation ("none") is selected in the processes; all costs except the one from the by-product are considered

If you want to apply system expansion, i.e. one of the output products is marked as "avoided product", the calculation is as follows:

When no allocation is selected in the calculation properties, the following formula is applied:

- Added value = Price Reference_Product – Price elementary flows/inputs – Price ByProduct – Added value of avoided supply chain

When allocation is selected (e.g. "As defined in processes"), the following formula is used:

- Added value = Price Reference_Product +Allocation_factor*(– Price elementary flows/inputs – Price ByProduct – Added value of avoided supply chain)

As you can define an economic flow property and hold a cost/revenue entry in the process, it is assumed that the process-specific information is more precise, and the following rule is applied:

When economic allocation is selected, and all output products have an economic value (revenue) defined in the process editor, those values will be taken. However, if not all output products have a defined revenue, then the economic flow properties will be used for the calculation (if applicable).

Another important issue is considering market variability through uncertainty models. OpenLCA presents a column to assign an uncertainty to the input and output flows of a process, but not to the price directly. This can be solved by making the price a Parameter and assigning uncertainty directly to it.

AVAILABLE DATA

The Ecoinvent database v. 3.3 in openLCA format provides prices for all products, except for waste materials and their disposal. Otherwise, prices can be inserted manually in the input/output section for each process.

Several currencies are available in the database, and for the entire database, one currency can be selected as a reference for all the others.

The software allows for modelling different prices for the same material, referred to different processes or countries, as the price per reference unit associated with the material is open and can be changed in the product system processes. In this way, there is no need to create the same material with a different name and price associated.

A SMALL CASE STUDY EXAMPLE

For example, a small case study is presented below. The case study is based on Moreau and Weidema (2015), who in turn refer to a publication by Heijungs and colleagues (Heijungs et al., 2013), and was rebuilt using openLCA.

The case study examines the life cycle of a wooden chair, with the functional unit defined as sitting on the chair for ten years. Overall, the chair is assumed to have a lifetime of 2 years, which is quite short. The simplified life cycle consists of a few processes only:

- Production of wood
- Production of electricity
- Production of the chair
- Usage of the chair
- Disposal of the broken chair

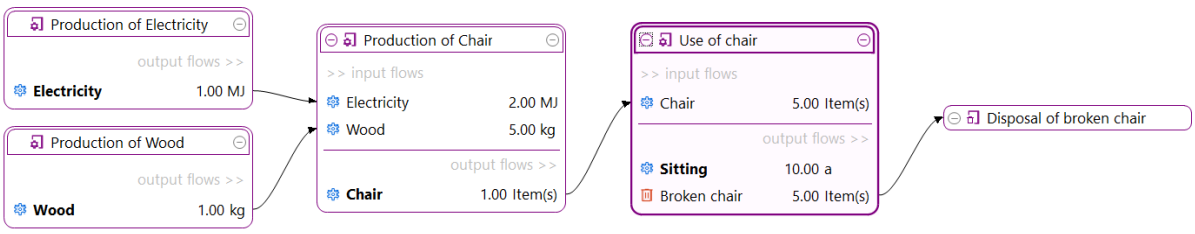
Costs and material exchanges between these processes are shown in Table 1. Since the functional unit is 10 years of sitting, five chairs are required.

Chair case study: Processes, physical exchanges, costs and value added, Moreau and Weidema 2015, modified

Phase	Product	Amount	Costs per unit*	Costs**	Value added
Production of electricity	electricity	1 MJ	5 €/MJ	5 €	5 €
Production of wood	wood	1 kg	1 €/kg	1 €	1 €
Production of a chair	electricity	2 MJ	5 €/MJ	-10 €	10 €
	wood	-5 kg	1 €/kg	-5 €	
	chair	1 piece	25 €/piece	25 €	
Use of a chair	chair	5 pieces	25 €/piece	-125 €	-135 €*
	broken chair	5 pieces	2 €/piece	-10 €	
	sitting	10 years	0 €/year*	0 €*	
Disposal of a broken chair	broken chair	1 piece	-2 €/piece	2 €	2 €

*in Moreau and Weidema 2015: "price"; **in Moreau and Weidema 2015: "monetary amount"

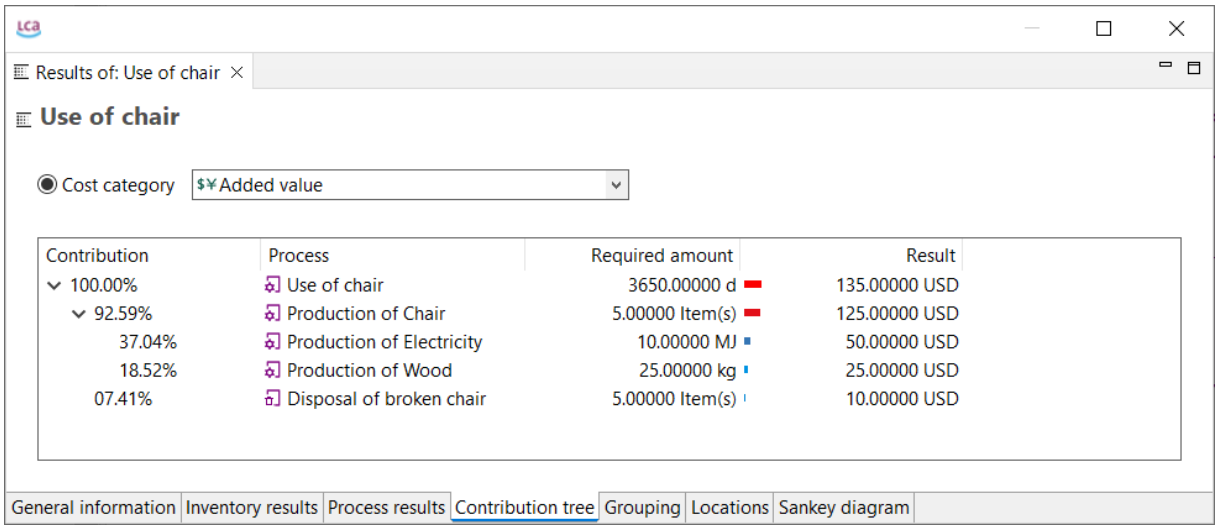
In openLCA, the processes have been created, and a product system has been built where these processes exchange their products. Note that the disposal (end of life) of the chair is modelled as provided service to the use of the chair, following the typical ecoinvent (and SimaPro, e.g.) modelling of end-of-life treatment.

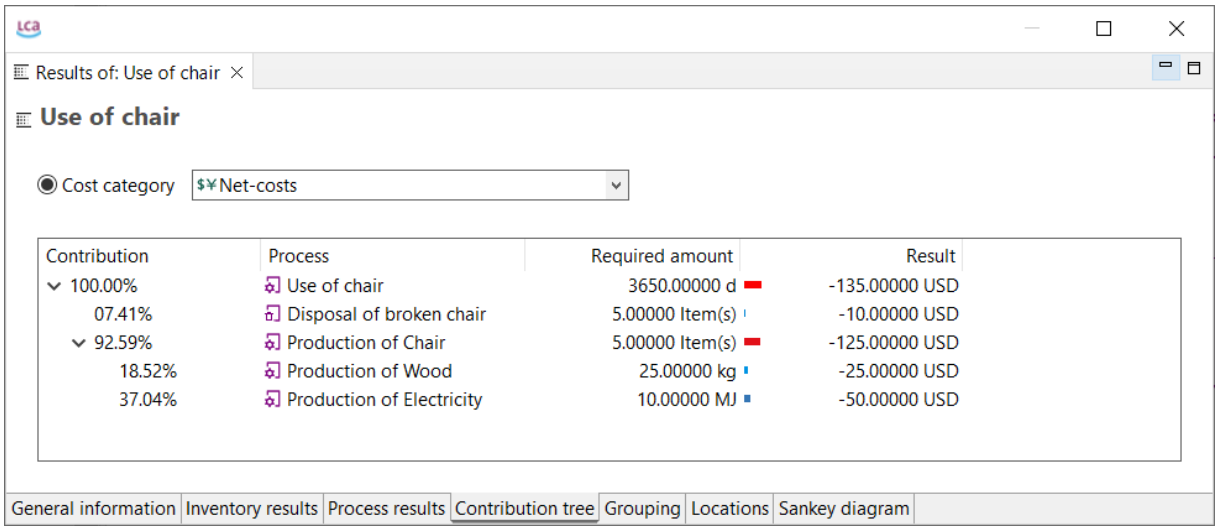


The created product system in the model graph in openLCA

One example of a process with costs is already shown in the first figure on this page: the production of a chair.
When the product system is calculated, several summaries of results for costs and added value are available. For example, in the Process Contributions tab, a new section,

"costs/added values", is available, which shows the contribution of different processes to the final cost and added value results. It is possible to switch between costs and value added; costs are value added multiplied by -1, i.e. costs for input products "purchased" for one process, minus the price of the generated products.





Value added and net costs in the process contributions tab

For the production of the chair, for example, the net costs are (5 + 10) € - 25 € = -10 €; for 5 chairs required in the product system, the total amount is -50 €. In the contribution tree, value-added and life cycle costs are available as a new section, in addition to LCIA categories and elementary flows.

openLCA provides a detailed document on how to conduct LCC studies in openLCA's available for free here. The database with the case study is available for download here.

17.3 SOCIAL ASPECTS

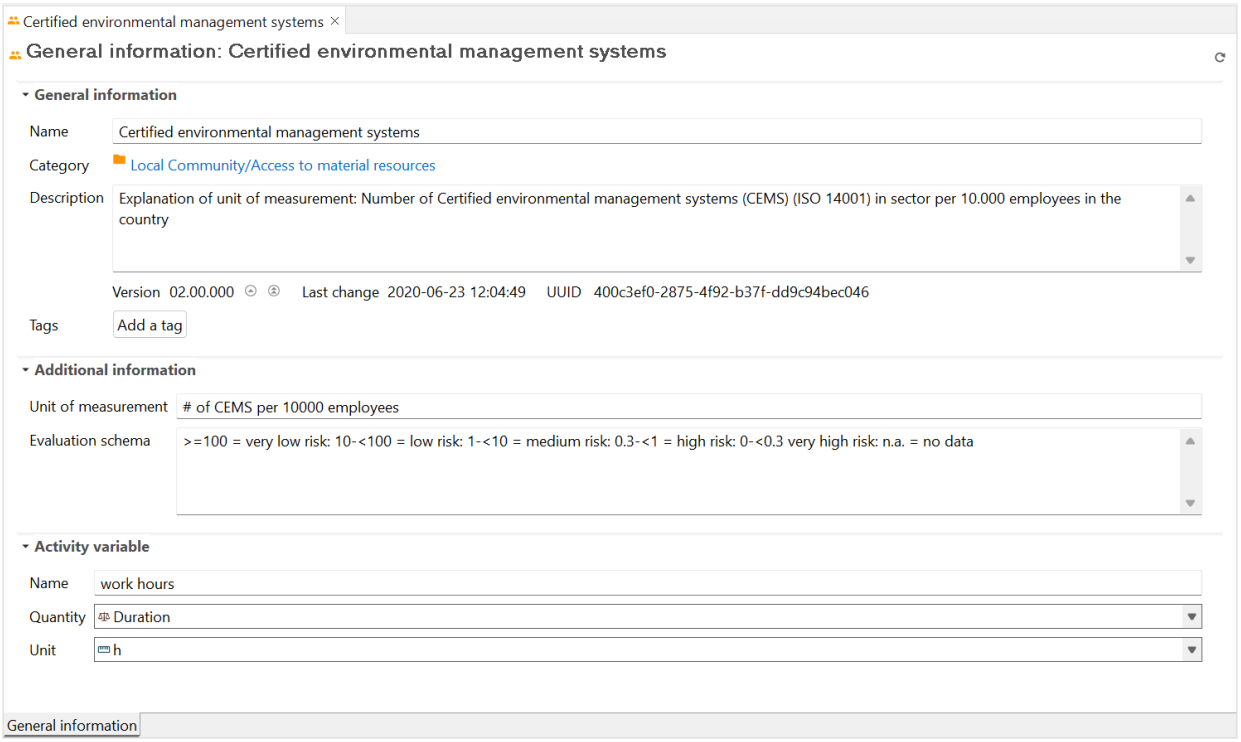
openLCA can also be used to conduct social lifecycle assessments (SLCA) for any product or project. SLCA is a part of a sustainability assessment that focuses on the social impacts throughout a product's lifecycle. Guidelines for carrying out SLCA were developed (and were last updated in 2020) by the United Nations Environment Programme (UNEP) and can be freely accessed on their website.

Similar to conventional environmental LCA, background databases are used for SLCA. In openLCA, PSILCA and SHDB are examples of social databases that can be used. You can also integrate SOCA, an add-on for ecoinvent LCI databases, to carry out SLCA. Social LCA databases are available on openLCA Nexus, under the Database section.' This section will display content only if processes have social-related information.

In an active social database, you can find the "Social Indicators" in the "Indicators and parameters" directory.

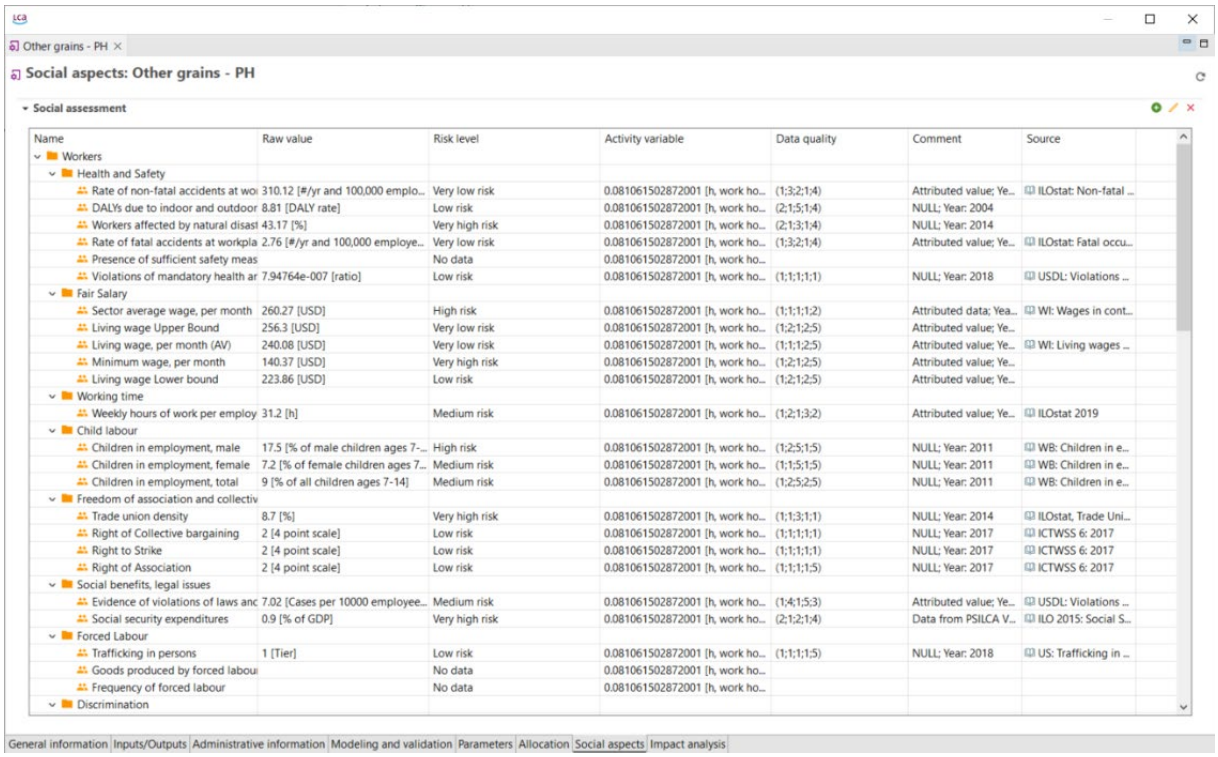
Social'indicators'in'the'..Indicators'and'parameters...'directory

To learn more about any social indicator, you can double-click on it. In the General Information tab, additional information about the unit of measurement, evaluation schema, and activity variable is displayed.



General'Information'on'a'Social'Indicator

Information regarding the social indicators for each process can be viewed in the "Social Aspects" tab. Information on the raw values, risk level (evaluated according to the amount of the "raw value"), activity variable, data quality, comment and source can all be displayed. The activity variable characterises the risk-assessed indicators. For instance, for the time being, all indicators use working hours as an activity variable. To learn more about this and about each social indicator, it is recommended to visit the PSILICA manual, which is available on the Nexus website.



Process 'social aspect' tab

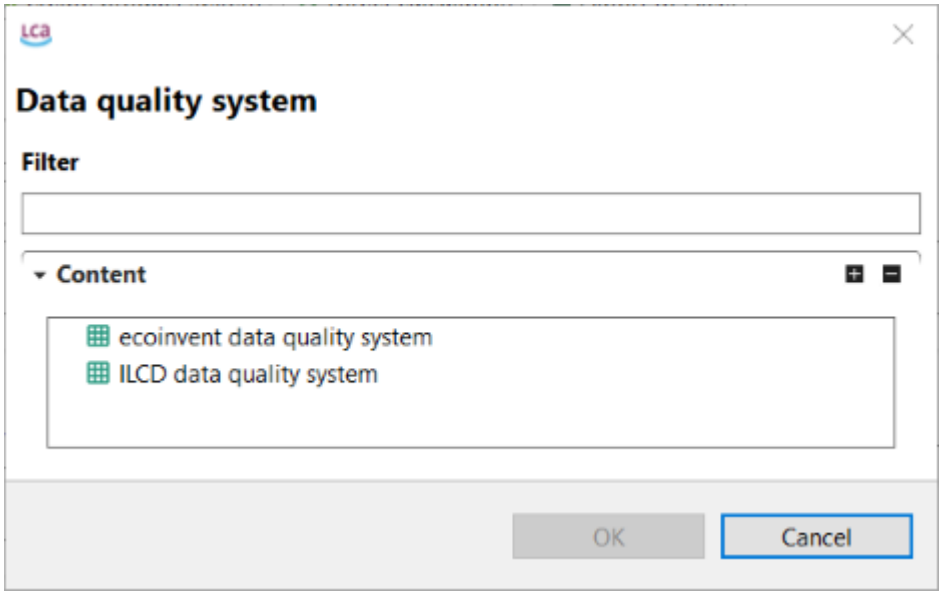
17.4 DATA QUALITY

Data quality is a critical aspect of life cycle assessment (LCA) studies, and it is addressed in ISO 14040 and ISO 14044 standards. openLCA provides comprehensive support for entering, managing, and assessing data quality in LCA models. Before we begin, let's remind ourselves that, according to ISO 14040, data quality is defined as fitness for purpose.

Below, we describe how to work with data quality in openLCA.

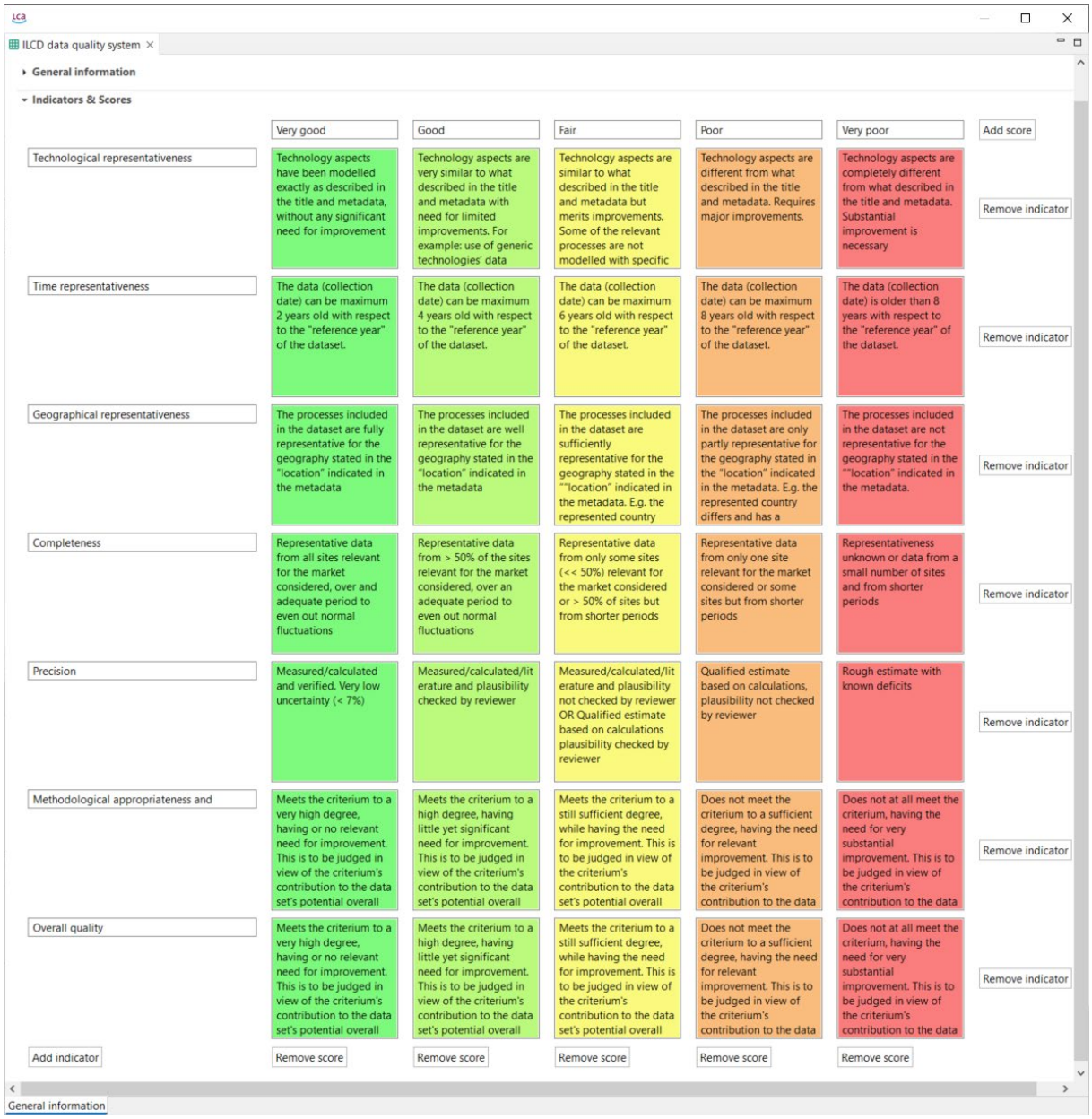
CHOOSING A DATA QUALITY SYSTEM

First, you need to define a data quality flow schema. If you generate a database with complete reference data, we provide you with two data quality systems. You can choose one of them in the "General information" tab, see "Process tab content":



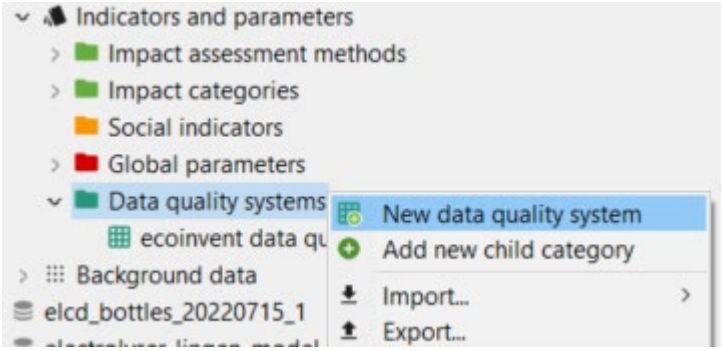
Available 'data 'quality' systems' in 'a 'database' with 'complete' reference' data 'in' openLCA

You can also create your own data quality system or modify existing quality systems according to your own criteria. In openLCA, it is assumed that all data quality systems follow a pedigree matrix "style", i.e. there are data quality indicators that are evaluated in classes, from good to bad. These pedigree matrices can be defined from scratch, but openLCA already contains some predefined data quality systems.

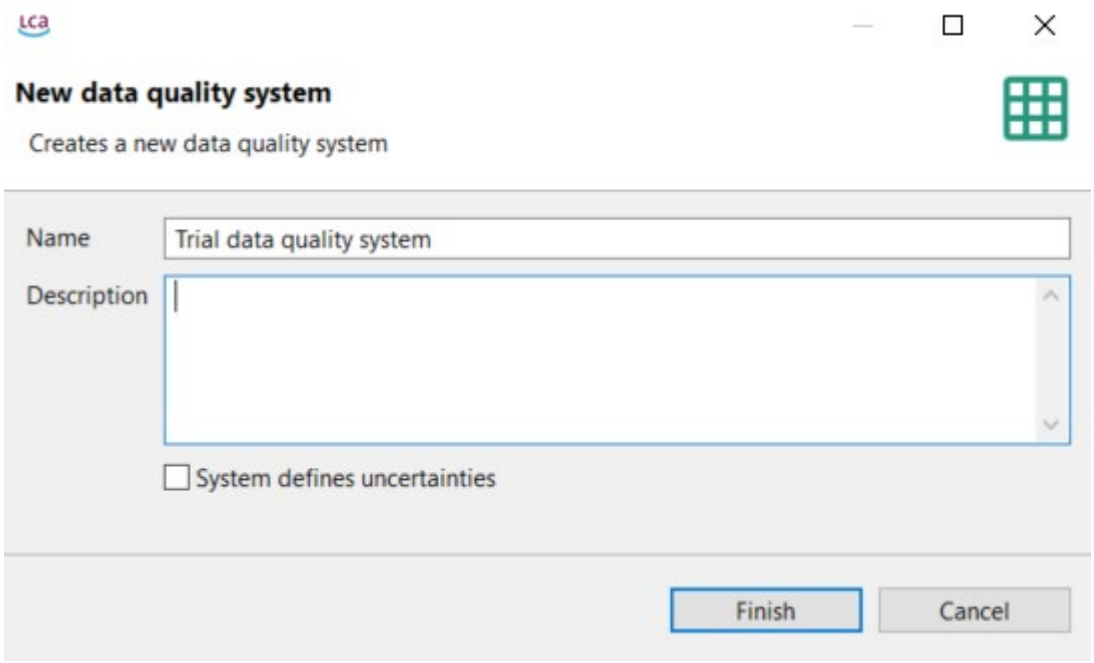


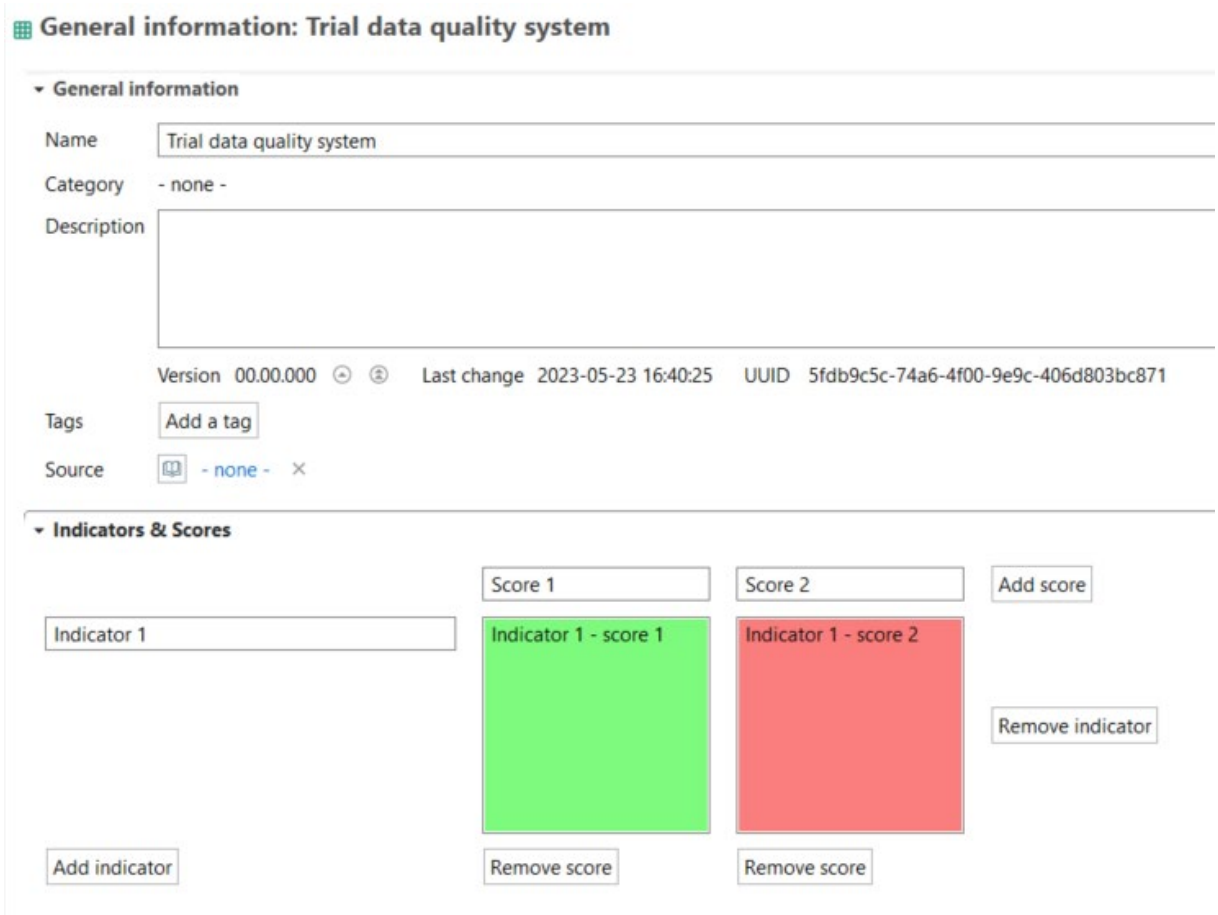
Data 'quality' system 'according 'to 'the 'ILCD 'data 'quality' system 'requirements

To create a new data quality system, right-click on the "Data Quality Systems" directory and select "New data quality system". Then you can add indicators, scores and uncertainties.



Step 'H?€reating 'a 'new 'data 'quality' system



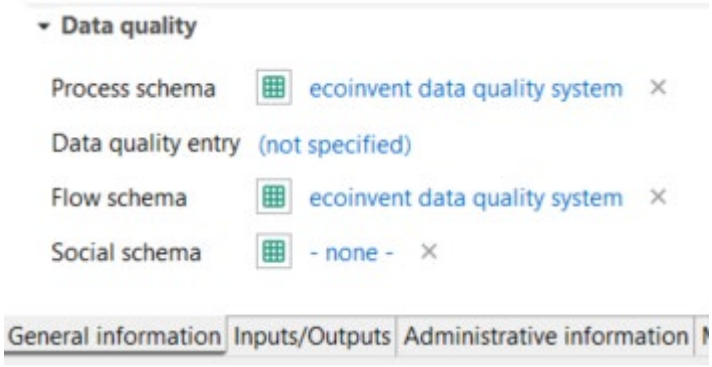


Step 1/5 Set up a new data quality system

WORKING WITH DATA QUALITY

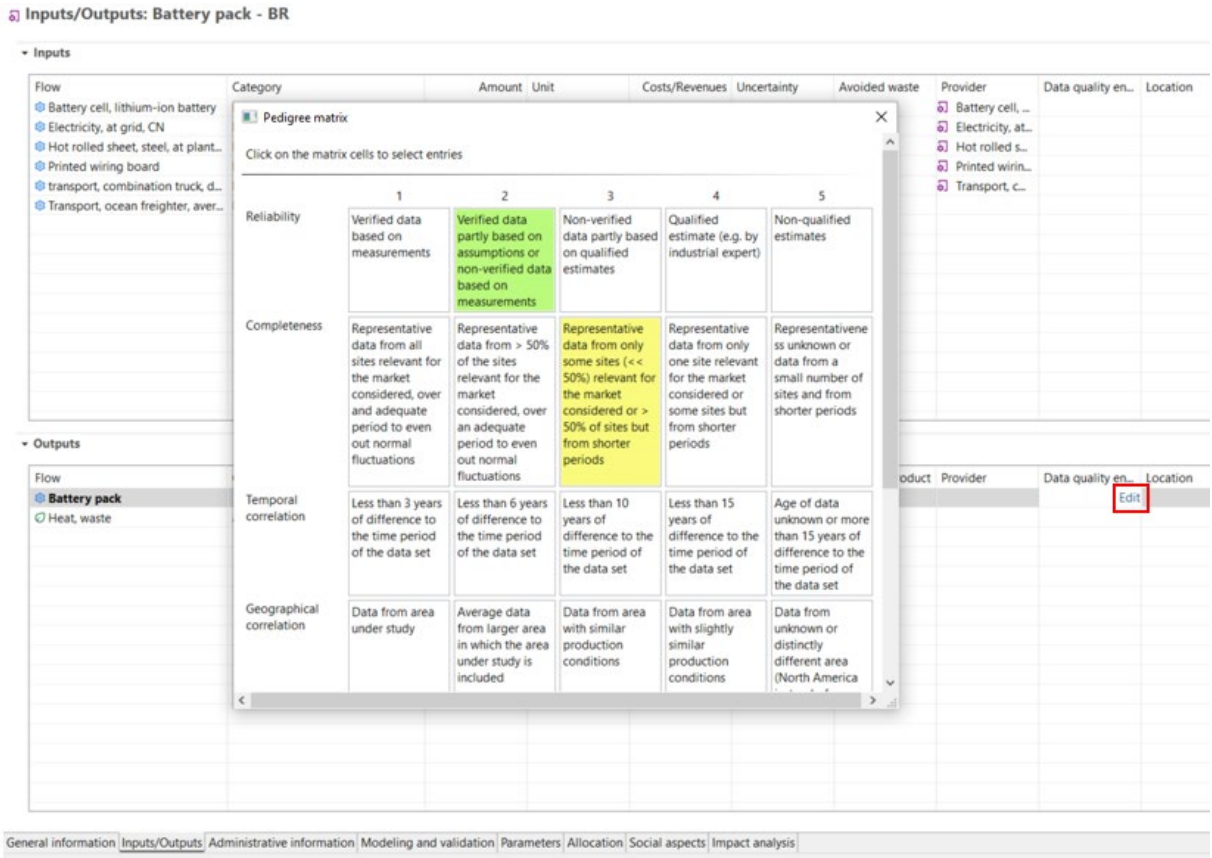
Now you can select a data quality system for the process, flows and social aspects.

1. Data quality information for processes must be defined in the "Data quality" section in the "General information" tab of a process window.



Process'window'tab']'general'information'data'quality

2. On the other hand, data quality information for flows and social assessments must be selected under the data quality columns in the "Input/Output" tab or in the "Social aspects" tab, as shown in the "Process tab content".

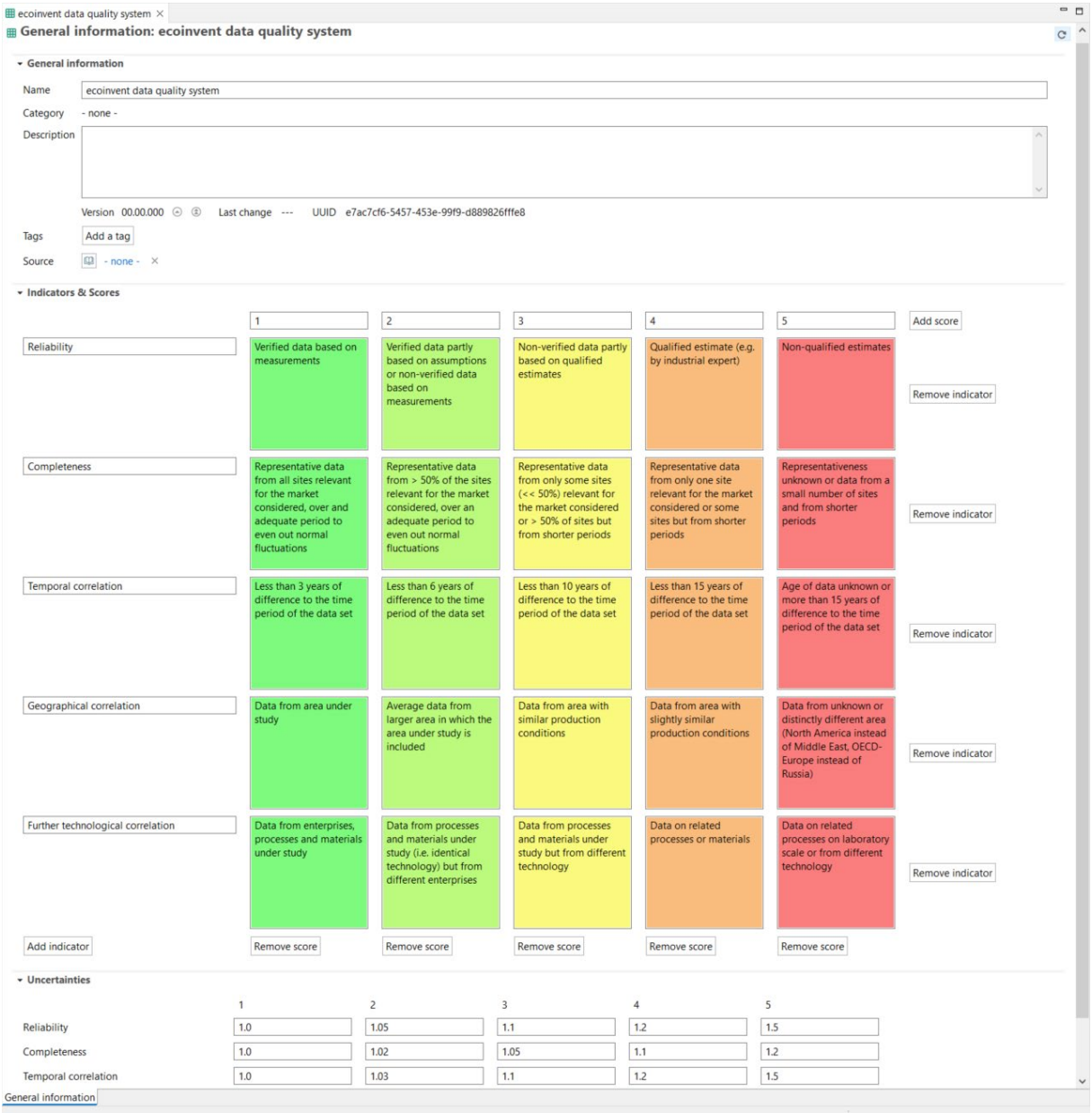


Process'window'tab']'Inputs#Outputs'Data'quality'for'flows

A data quality system can be selected from the systems available in the "Data quality systems" directory in the "Indicators and parameters" section of the active database.

Data 'quality' systems' directory' in' an' active' database

You can access the existing data quality system in the "Data quality system" folder in the navigation panel. You can use for example the ecoinvent data quality system improved by Dr. Andreas Ciroth (click here to read the complete report) When you open a data quality system in the Editor, you'll see a "General information" tab. This tab displays scores for various indicators and provides options to assign uncertainty values to these indicators, as illustrated below.

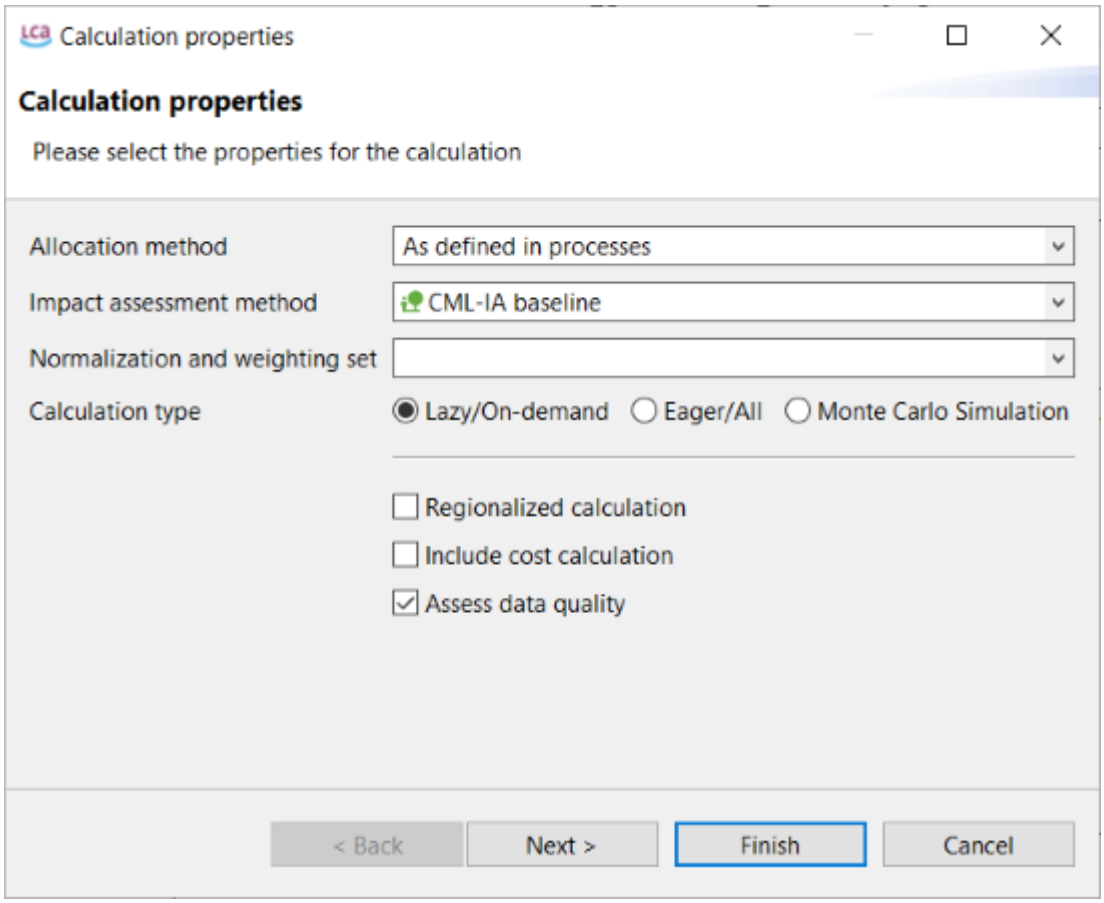


Data 'quality' systems, indicators and scores

As visualised above, adding uncertainty values enables the performance of "Monte Carlo Simulations" in openLCA.

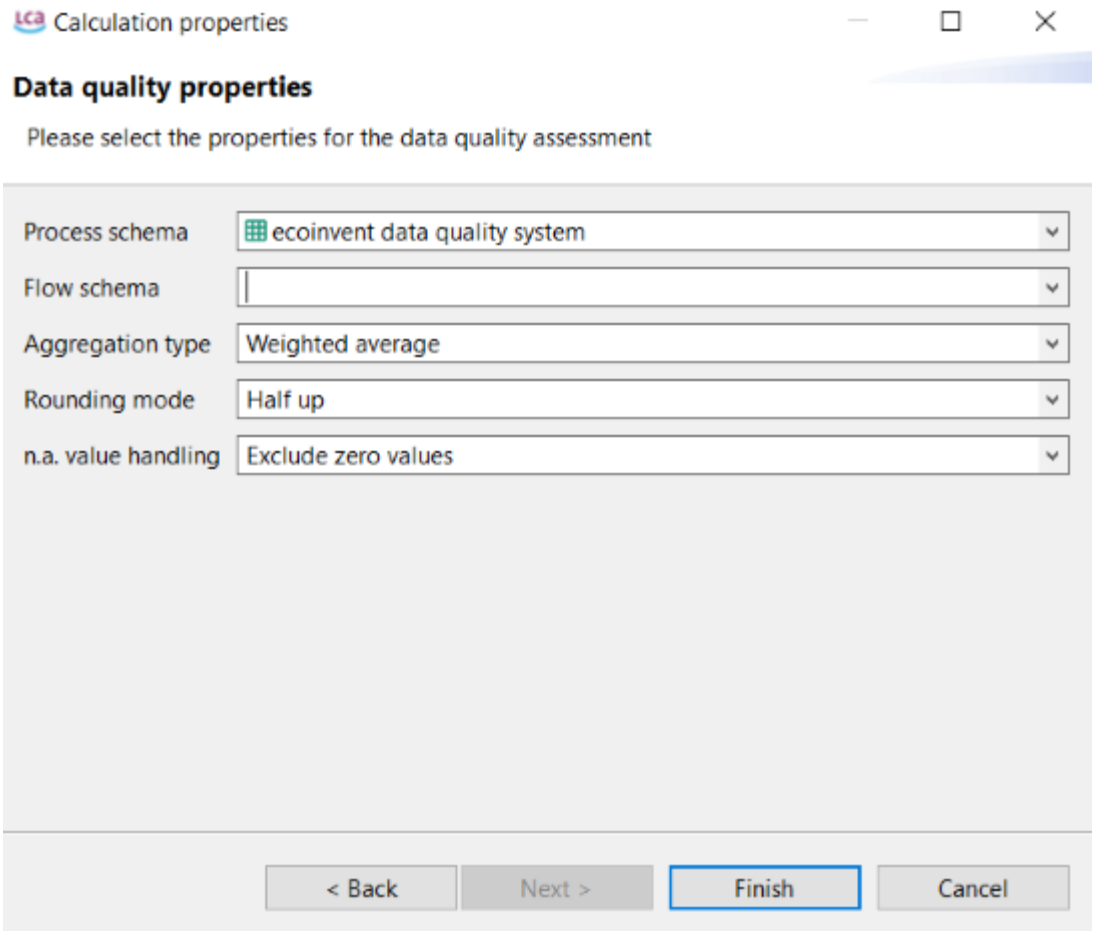
SETUP

To assess data quality during a calculation, check the "Assess data quality" box when setting the calculation properties.



Checking the box for including a data quality assessment

Then, click "Next" and the "Data quality properties" window will open, allowing you to access the details on the data quality assessment.



Set up for the data quality assessment.

You can choose the aggregation type, a rounding method, and how to handle exchanges that lack data quality values. Then, click the "Finish" button to initiate the calculation, including the data quality assessment.

RESULTS

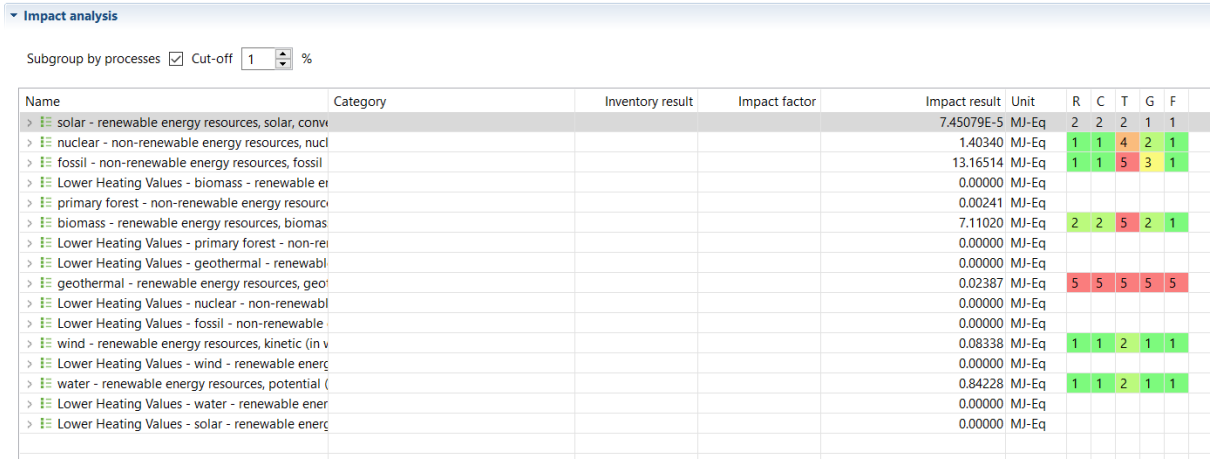
When the calculations are done, the results window will open in the Editor. You will notice that the data quality of the inventory analysis is now shown in the inventory analysis tab with colour-coded numbers.

Sub-category		Amount	Unit	R	C	T	G	F
in ground		0.23498	kg	3	3	5	5	3
in ground		8.40286E-5	kg	1	3	5	5	1
0810:Quarrying of stone, sand and clay		7.79835E-5	kg	1	3	5	5	1
0810:Quarrying of stone, sand and clay		5.02312E-6	kg	1	3	5	1	1
in ground		0.11672	kg	1	1	5	5	1
0520:Mining of lignite		0.11219	kg	1	1	5	5	1
0520:Mining of lignite		0.00274	kg	1	1	5	1	1
in ground		2.68976E-5	kg	2	4	4	5	1

Inventory analysis' data quality information

The abbreviations for the columns are Reliability, Completeness, Temporal correlation, Geographical correlation, Further technical correlation as defined in your data quality scheme, see "Processes".

Similarly, the data quality for the impact analysis tab is displayed after the calculation is performed.



Name	Category	Inventory result	Impact factor	Impact result	Unit	R	C	T	G	F
solar - renewable energy resources, solar, conv				7.45079E-5	MJ-Eq	2	2	2	1	1
nuclear - non-renewable energy resources, nucl				1.40340	MJ-Eq	1	1	4	2	1
fossil - non-renewable energy resources, fossil				13.16514	MJ-Eq	1	1	5	3	1
Lower Heating Values - biomass - renewable er				0.00000	MJ-Eq					
primary forest - non-renewable energy resourc				0.00241	MJ-Eq					
biomass - renewable energy resources, biomas				7.11020	MJ-Eq	2	2	5	2	1
Lower Heating Values - primary forest - non-re				0.00000	MJ-Eq					
Lower Heating Values - geothermal - renewabl				0.00000	MJ-Eq					
geothermal - renewable energy resources, geo				0.02387	MJ-Eq	5	5	5	5	5
Lower Heating Values - nuclear - non-renewabl				0.00000	MJ-Eq					
Lower Heating Values - fossil - non-renewable				0.00000	MJ-Eq					
wind - renewable energy resources, kinetic (in v				0.08338	MJ-Eq	1	1	2	1	1
Lower Heating Values - wind - renewable energ				0.00000	MJ-Eq					
water - renewable energy resources, potential (				0.84228	MJ-Eq	1	1	2	1	1
Lower Heating Values - water - renewable ener				0.00000	MJ-Eq					
Lower Heating Values - solar - renewable energ				0.00000	MJ-Eq					

Impact'Analysis'] 'data 'quality

17.5 MONTE CARLO SIMULATION

As life cycle assessment models typically rely on many assumptions, methods to determine the associated uncertainty in life cycle inventory and life cycle impact assessment can help communicate the effect of those assumptions on the results. Hence, openLCA supports performing Monte Carlo Simulation (MCS) within a product system using per-exchange uncertainty information. The produced MCS result will display values such as the mean result from the number of calculations performed, along with standard deviation, 5th percentile and 95th percentile boundaries, as well as the median value of the simulated results. Particularly, the standard deviation can be helpful in expressing the overall uncertainty in product system results. For further investigation and interpretation, exporting the results of the MCS to Excel may be useful.

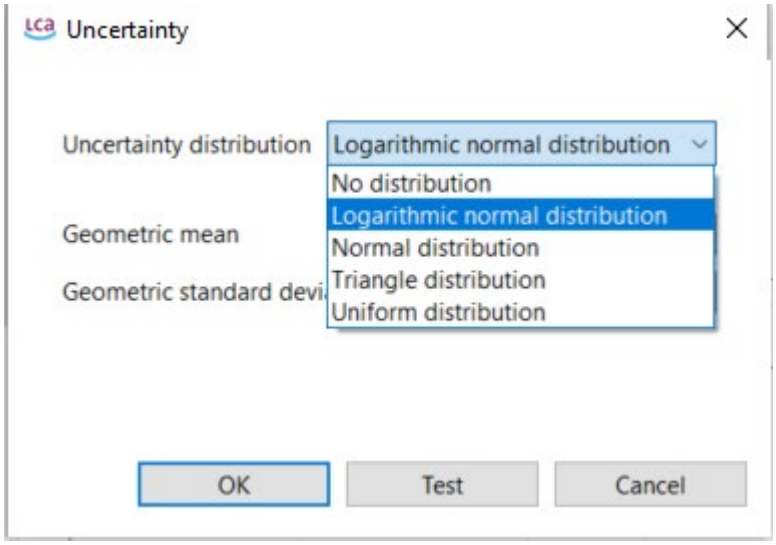
PRINCIPLE

The Monte Carlo simulation randomly varies your model's input data using uncertainty distributions. This calculation method accounts for the uncertainty in the input data, yielding multiple calculation results, each with a distinct uncertainty distribution. Typically, several thousand iterations are carried out to obtain robust results.

ADDING UNCERTAINTY INFORMATION

The first step in openLCA is to add uncertainty data to all input and output flows in the processes. To add uncertainty data to flows, open a process, click in the uncertainty field and select "Edit". A pop-up wizard opens where you can choose between:

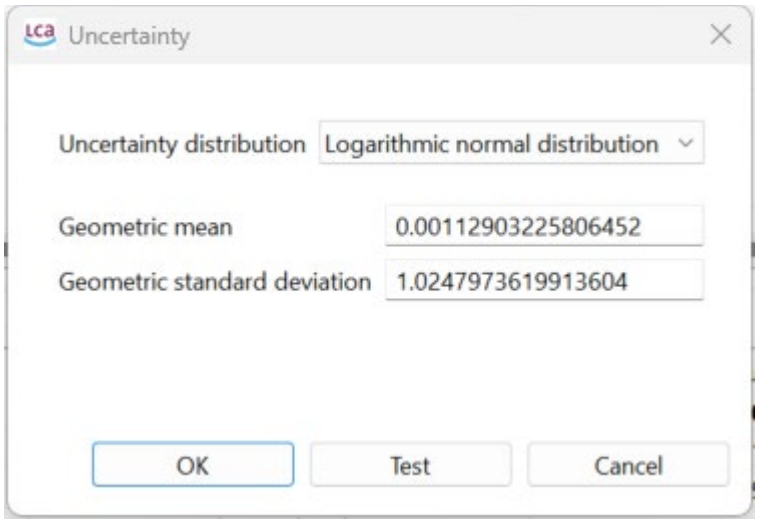
Logarithmic normal distribution (Geometric mean, Geometric standard deviation), Normal distribution (Mean, Standard deviation), Triangle distribution (Minimum, Mode, Maximum), Uniform distribution (Minimum, Maximum)



Adding'uncertainty'to'flows

Likewise, it is also possible to define uncertainty data for parameters as well as for LCIA characterisation factors or to derive the uncertainty values from the respective data quality.

Luckily, some databases, e.g. ecoinvent, already provide uncertainty values for flows as visualised below (editing uncertainty as described above in the "Input/Output" tab of a "Process"):



Defined'logarithmically'standard'distributed'uncertainty'of'a'flow'as'found'in'the'input#output'tab'of'a'process

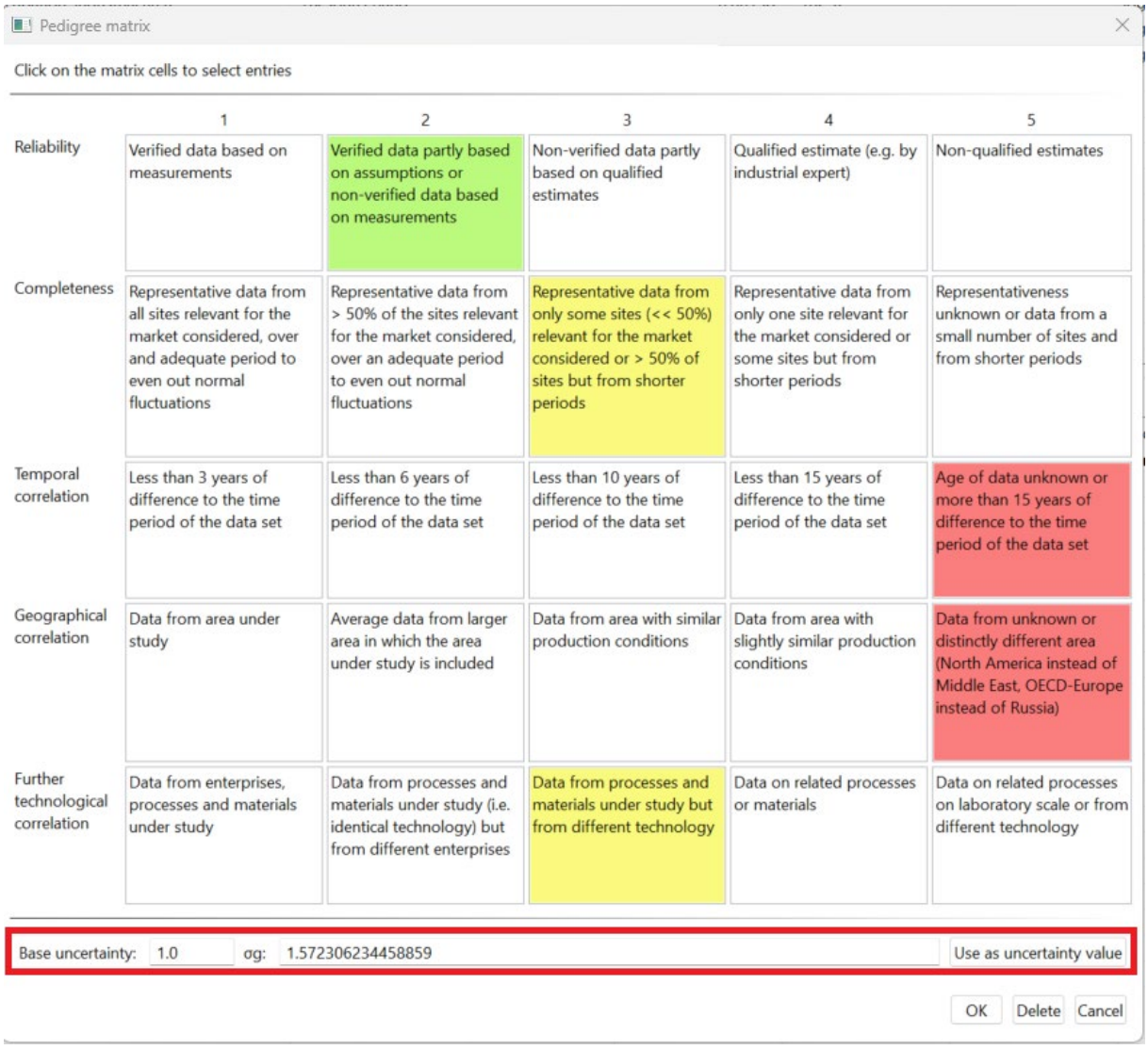
These are primarily based on a specific base uncertainty, which is combined with an additional uncertainty derived from data quality, and can be used directly in the Monte Carlo Simulation.

If you use the ecoinvent database, we highly recommend the respective chapter about uncertainty, Uncertainties - ecoinvent Support.

DERIVING UNCERTAINTY FROM DATA QUALITY PEDIGREE MATRICES

An alternative approach to setting exchange uncertainties is to utilise the data quality pedigree matrices that accompany the openLCA reference data. The predefined data quality pedigree matrices can be used to set the uncertainty of processes based on the confidence in the collected data. To use this feature, the flow data quality must be defined; see "Data Quality". Following that, the "Use as uncertainty value" button allows the use of the documented data quality uncertainty, as defined in the data quality system (ecoinvent or Weida/Müller/Ciroth/Lesage).

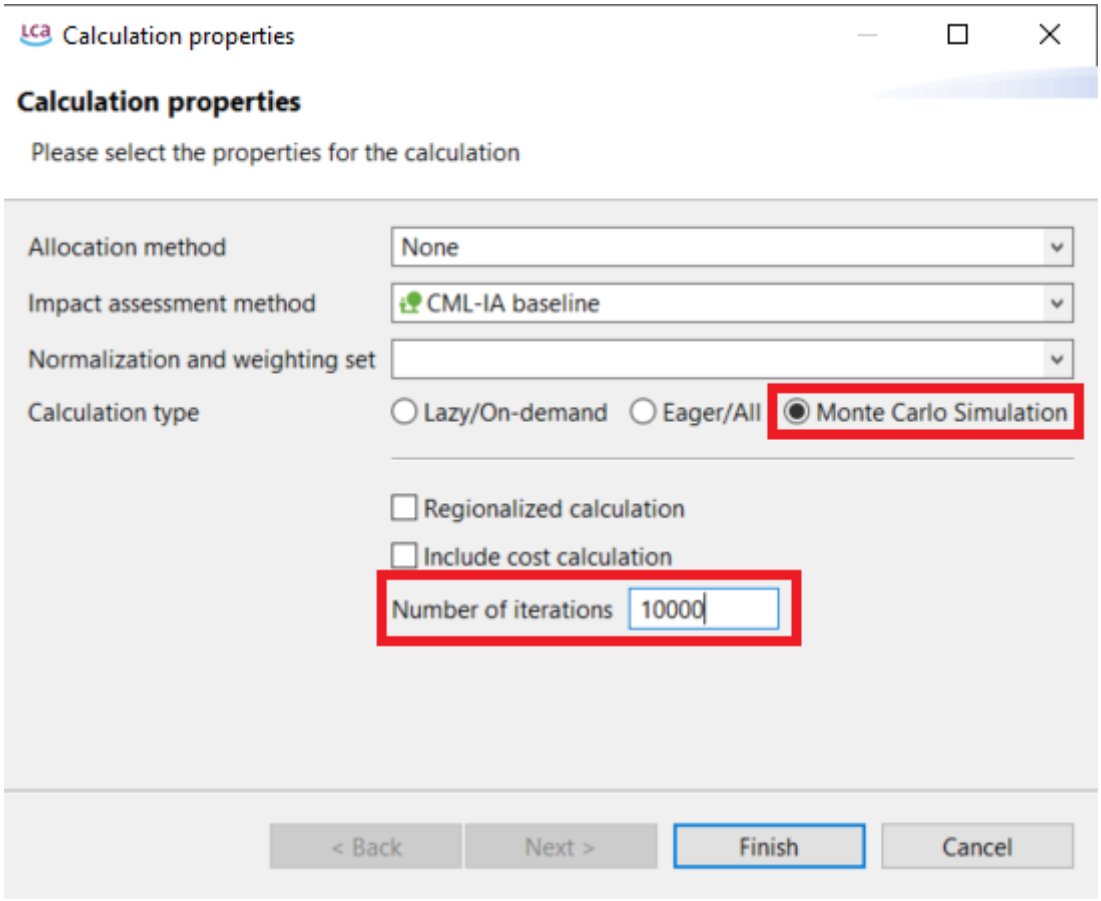
This uncertainty value will be set in a logarithmic normal distribution and use the values defined in the pedigree matrix window.



Example exchange data quality highlighting the function of using the data quality matrix for the determination of uncertainty values

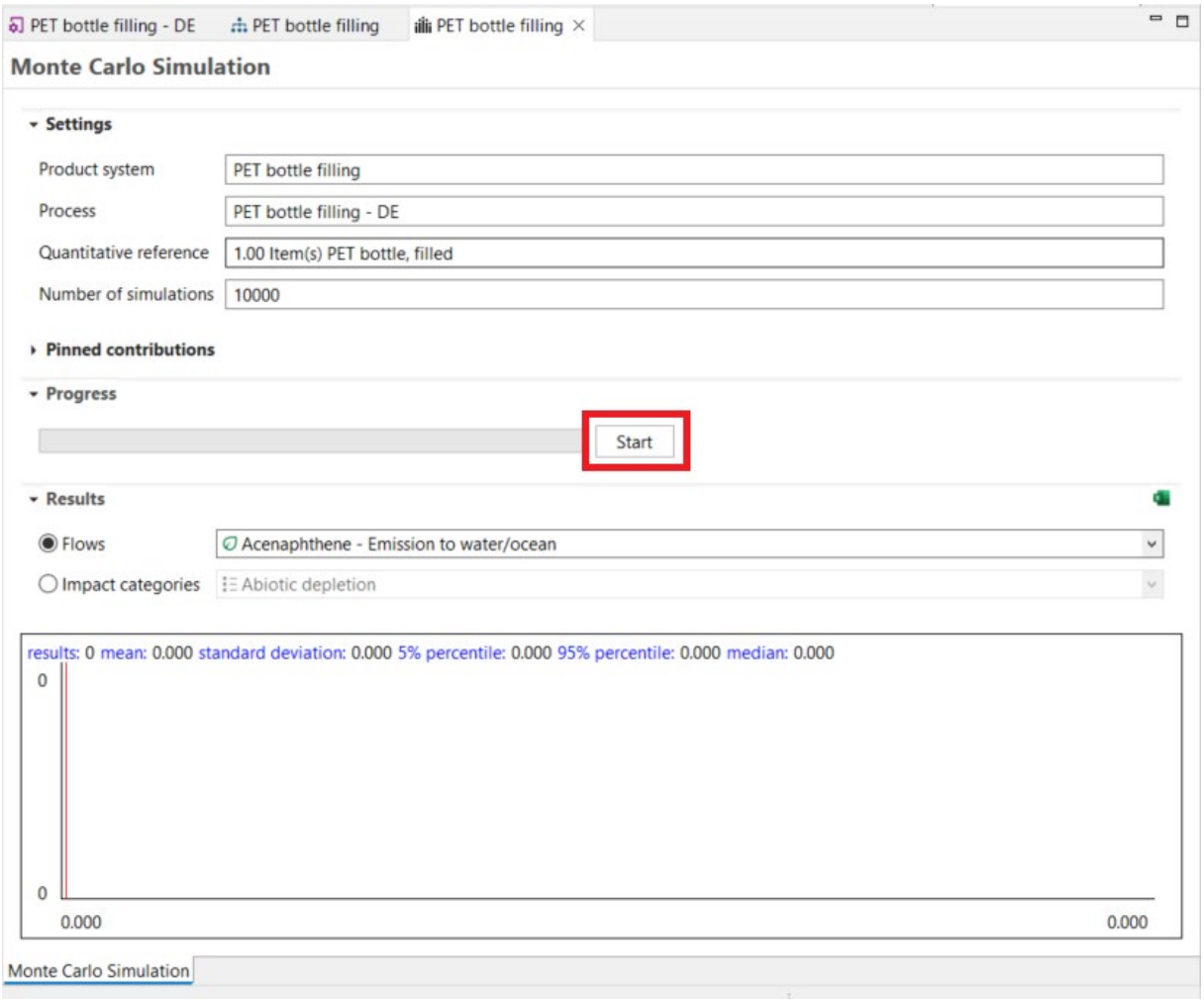
STARTING THE MONTE CARLO SIMULATION

Clicking on "Calculate" in a product system opens the pop-up wizard "Calculation properties". In this wizard, you can select the Monte Carlo simulation calculation type and define the number of iterations.



Calculation properties for Monte Carlo simulation

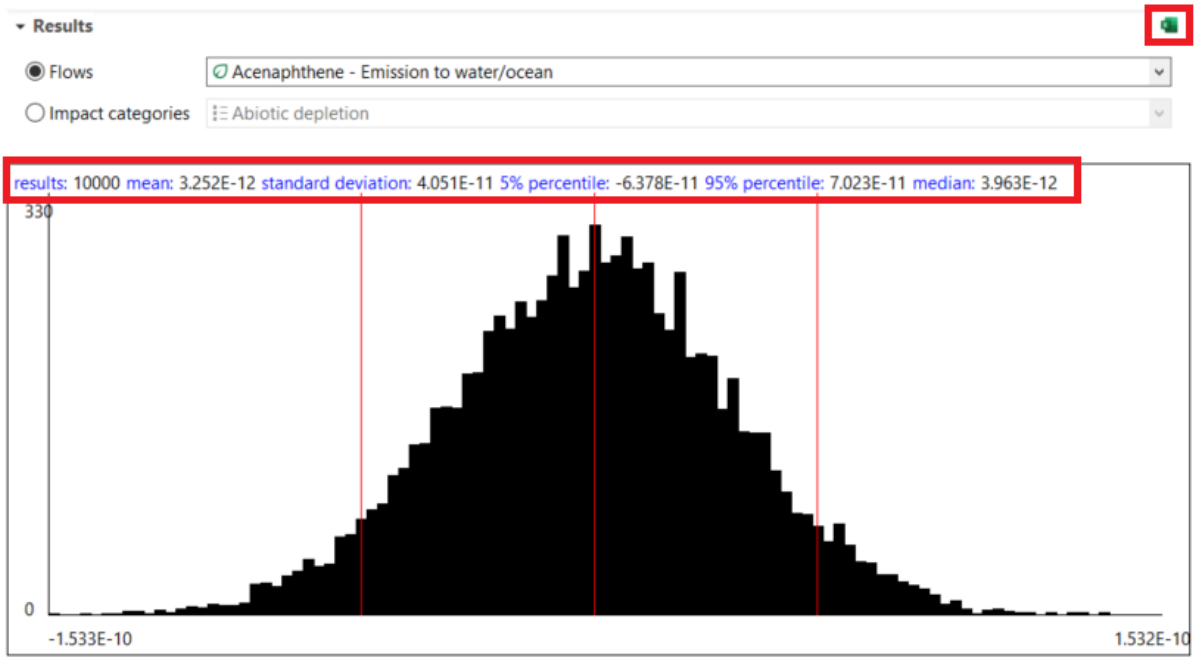
Afterwards, the simulation editor will open. Select "Start" to begin the calculations. The calculation time required depends on the complexity of the database and product system, as well as the selected number of simulations. The results for each flow and impact category will be displayed during the simulation, although only one will be displayed at a time.



Starting a 'Monte' Carlo' Simulation

[Monte Carlo Results]

The results will be displayed live and provide you with information about:



- Results: Number of iterations
- Mean: The arithmetic mean of the results obtained in the total number of iterations performed so far, signified by one of the central red lines in the graph.
- Standard deviation: The standard deviation associated with the mean of the data set of results produced so far. This describes how dispersed the produced results are around the mean value.
- 5% percentile: The lower boundary value, which demarks the area of results produced by only 5% of iterations. It is marked with the leftmost line in the graph.
- 95% percentile: The upper boundary value, which demarks the area of results produced by only 5% of iterations. It is marked with the rightmost line in the graph.
- Median: The centre value of the distribution of iterations. For different types of distributions, this can differ considerably from the mean. This value is marked by the second of the central lines in the graph.

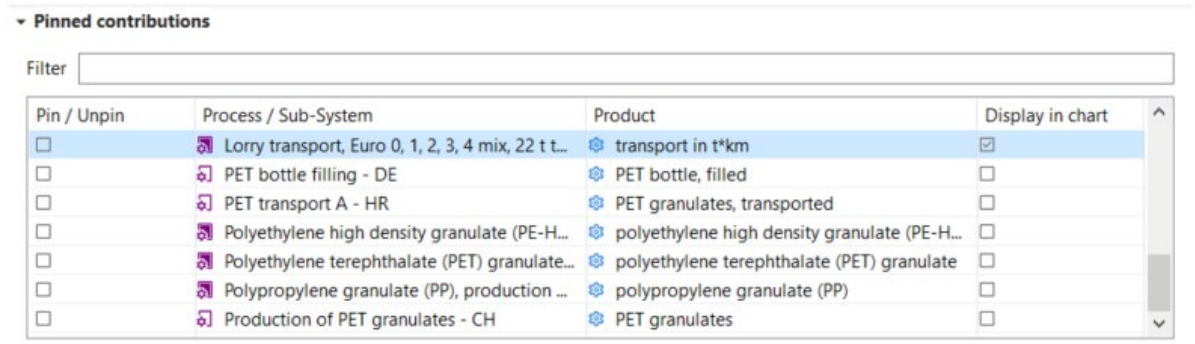
The accuracy of the results strongly depends on the number of iterations performed!

However, all results can be exported directly as an Excel document to further assessment. Click on the Excel icon on the right-hand side of the editor (see above).

Note[3] Depending on the type of uncertainty distribution most prevalent in the product system, the resulting mean may not match the value calculated in LCIA through regular product system result calculation. This results from a cumulative effect of skewed product system uncertainty distribution types propagating to the reference flow.

PINNING OF MONTE CARLO SIMULATION RESULTS

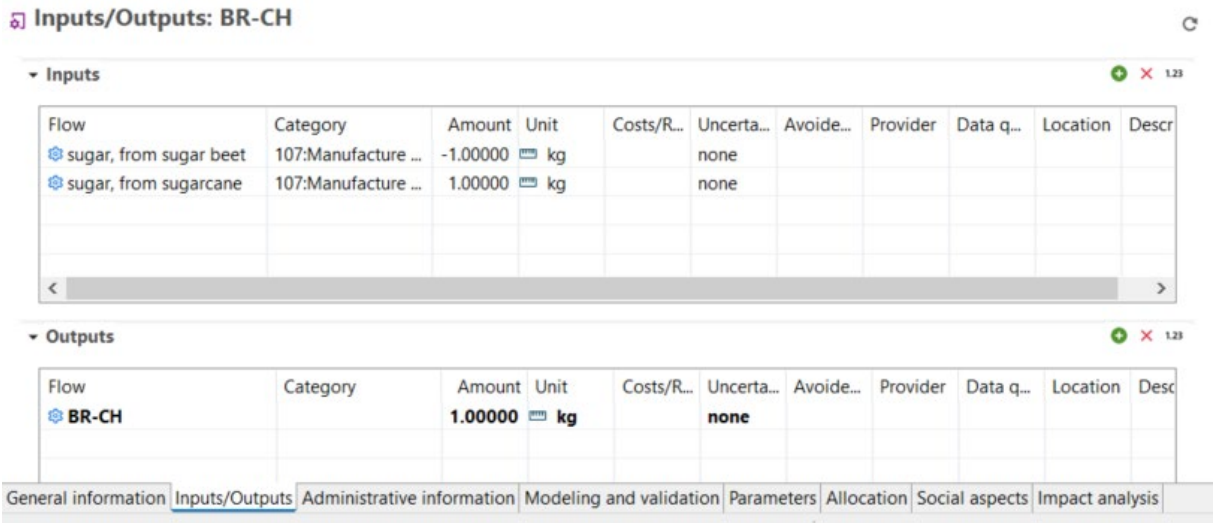
The results of all processes and sub-product systems that are part of a product system can be displayed separately in the Monte Carlo Simulation tab. For easy navigation, individual processes can be pinned.



Pin#Unpin'processes'or'subsystems

COMPARING TWO PROCESSES IN THE MONTE CARLO SIMULATION

It is also possible to compare two processes using a Monte Carlo simulation, provided you create a process and its corresponding product system, where one process is subtracted from the other to avoid double-counting of uncertainties.

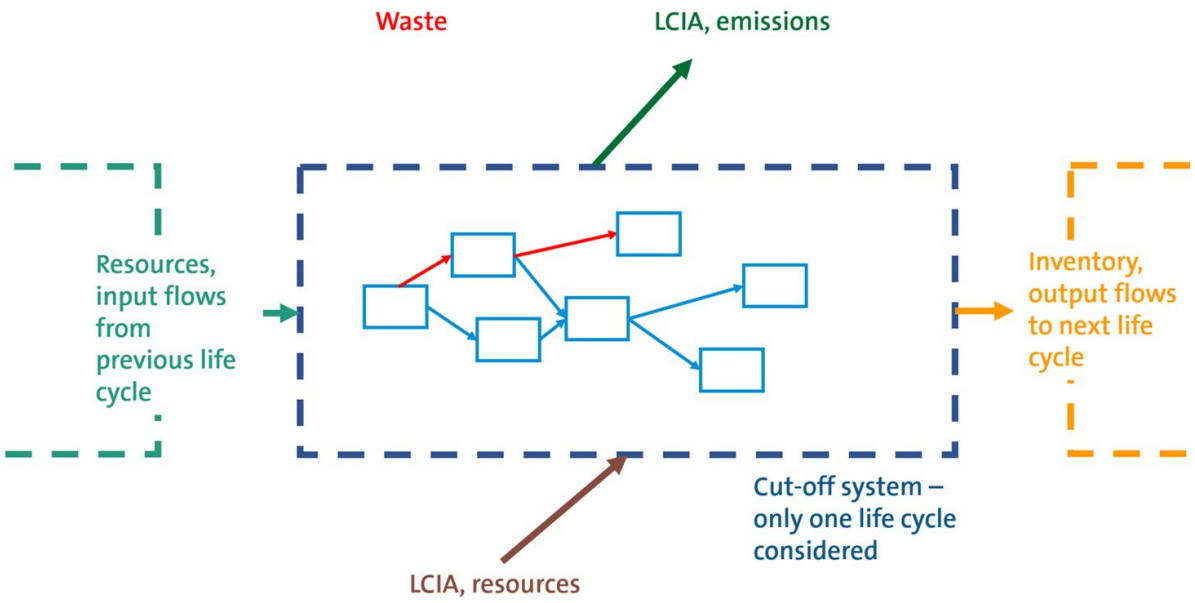


Creation'of'a'process'subtracting'one'process'from'the'other'for'future'comparison'in'the' Monte'Carlo'simulation

18 NEW ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

In openLCA 2 we added EPDs as new elements. EPDs in openLCA contain the LCA information that is part of an EPD (not the technical product information) and the text "around" the EPD result that makes a complete EPD. EPDs in openLCA contain the full impact assessment results, per life cycle stage, for a given reference product unit.

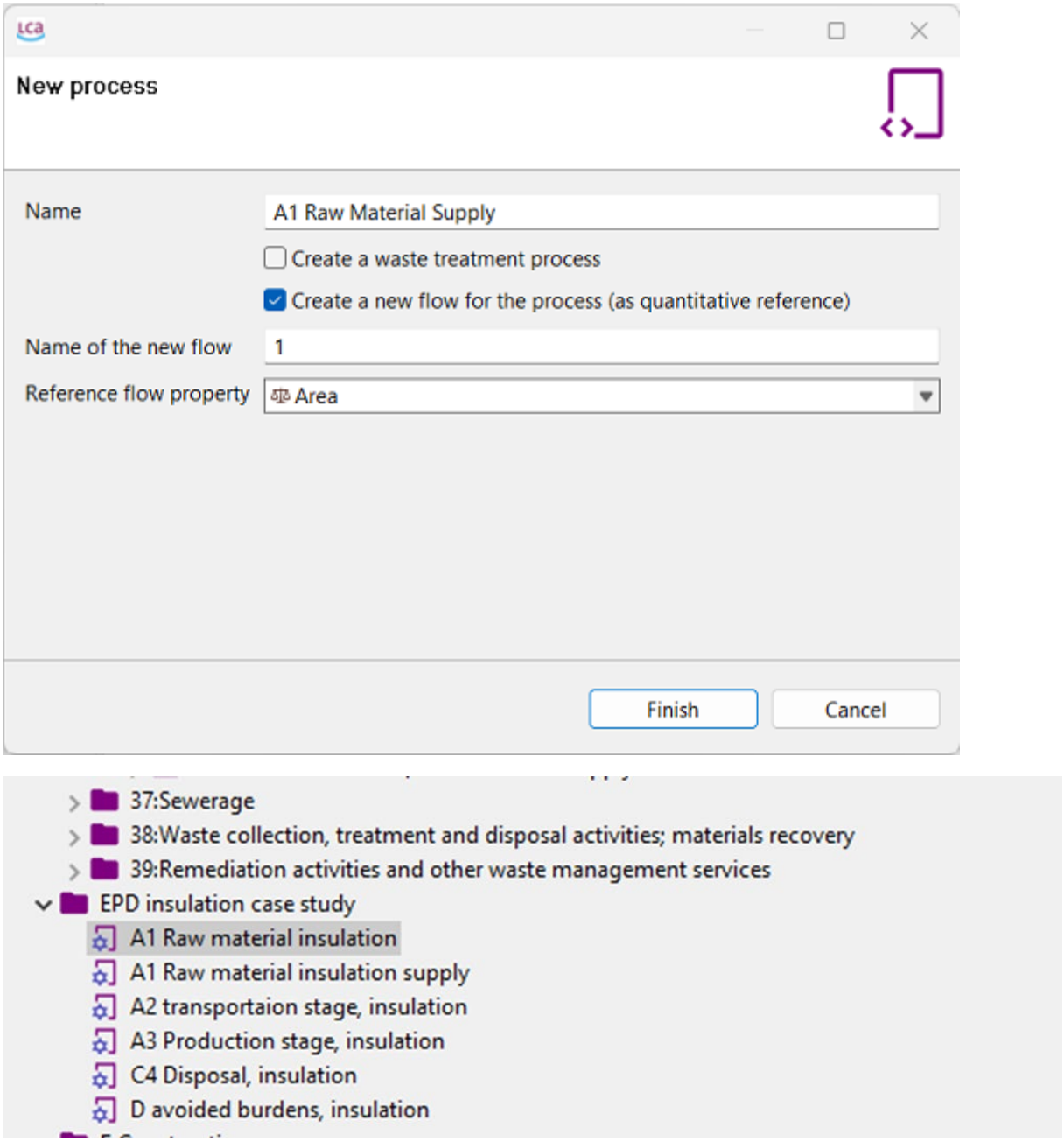
Users are advised to use the EN15804 add-on for ecoinvent, created by GreenDelta GmbH in accordance with the EN15804 norm, when navigating through this section.



18.1 CREATING NEW PROCESSES FOR TARGET PRODUCTS

To create an EPD, you must create the processes of a target product. In the figure below, various processes are shown, each of which has been generated according to the lifecycle stages nomenclature outlined in EN 15804+A2 and saved in a respective folder. The creation of these processes works in the usual way in open LCA (see the 'Create New Process' section).

It is recommended that you ensure the reference flow property matches the declared unit and remains consistent across each lifecycle stage.

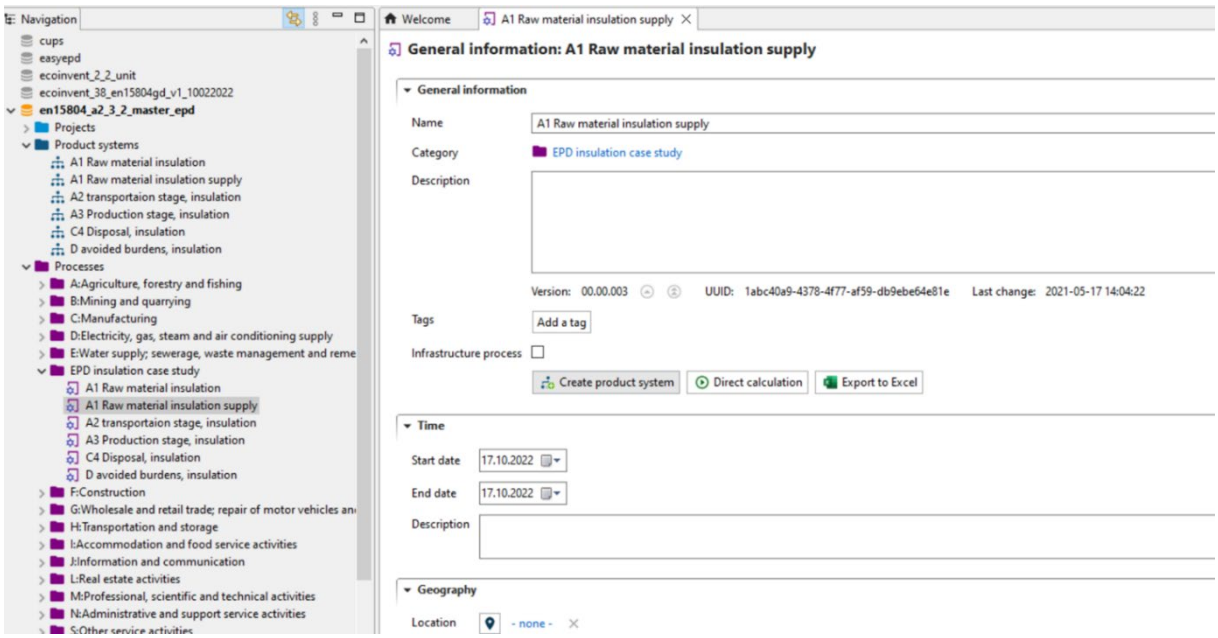


Created and saved processes for an EPD

18.2 CREATE PRODUCT SYSTEMS FROM YOUR PROCESSES

In the next step, product systems must be created from the respective processes.

To do so, go to the "General information" tab in the respective process and click on "Create product system". Do this for all processes that should be included in the EPD, ensuring all relevant modules are included.



...General information...' tab of a 'process

18.3 CALCULATE THE IMPACT ASSESSMENT

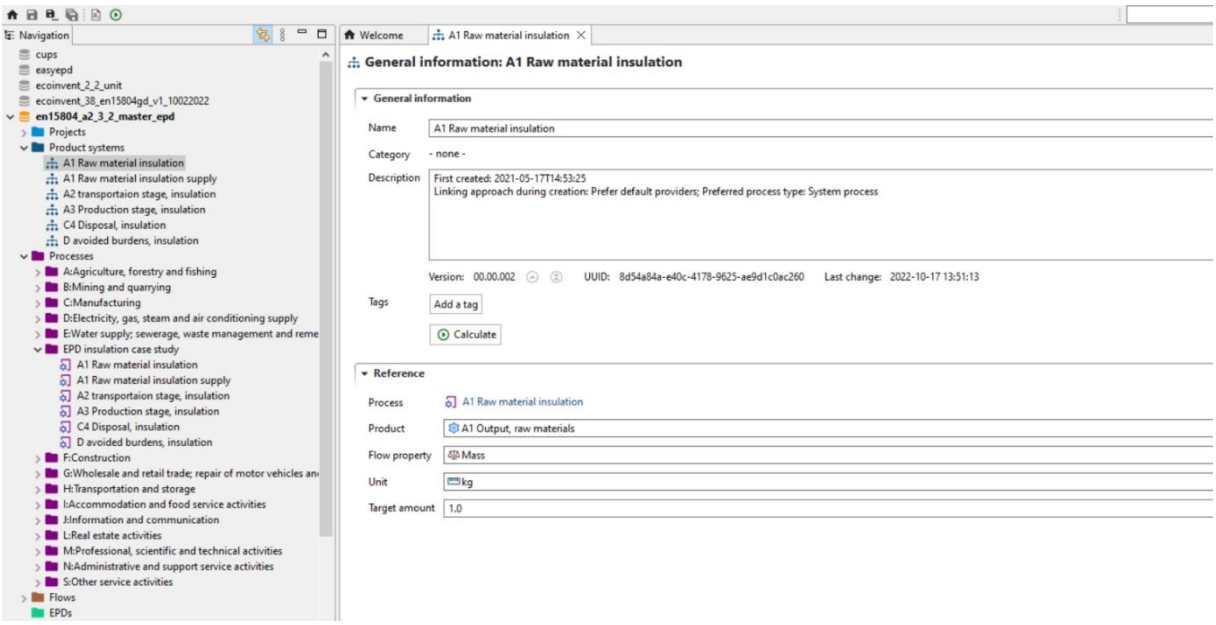
This section summarises different ways to produce impact assessment results using the EPD format. There are three different methods:

- Calculate the results of a product system
- Calculating the results using lifecycle stages as product systems
- Calculating the results using projects

CALCULATE RESULTS OF A SINGLE PRODUCT SYSTEM

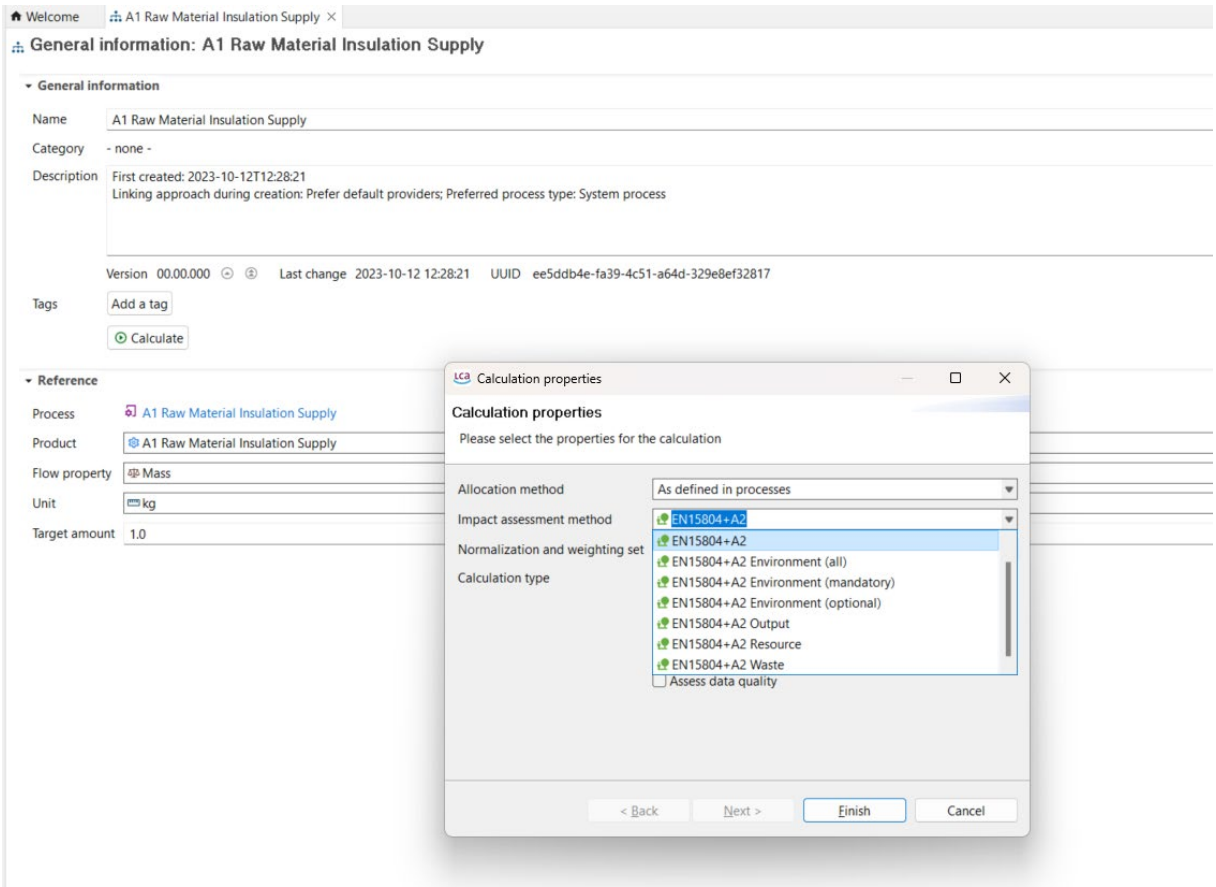
After the product system is created, you can calculate the impact results by choosing an LCIA method.

1. To include the results in the EPD, the product systems must be calculated. To do so, go to the "General information" tab of the product systems and right-click on "Calculate". This must be performed individually for each product system that you want to include in your EPD.



...General'information...'tab'of'the'product'system

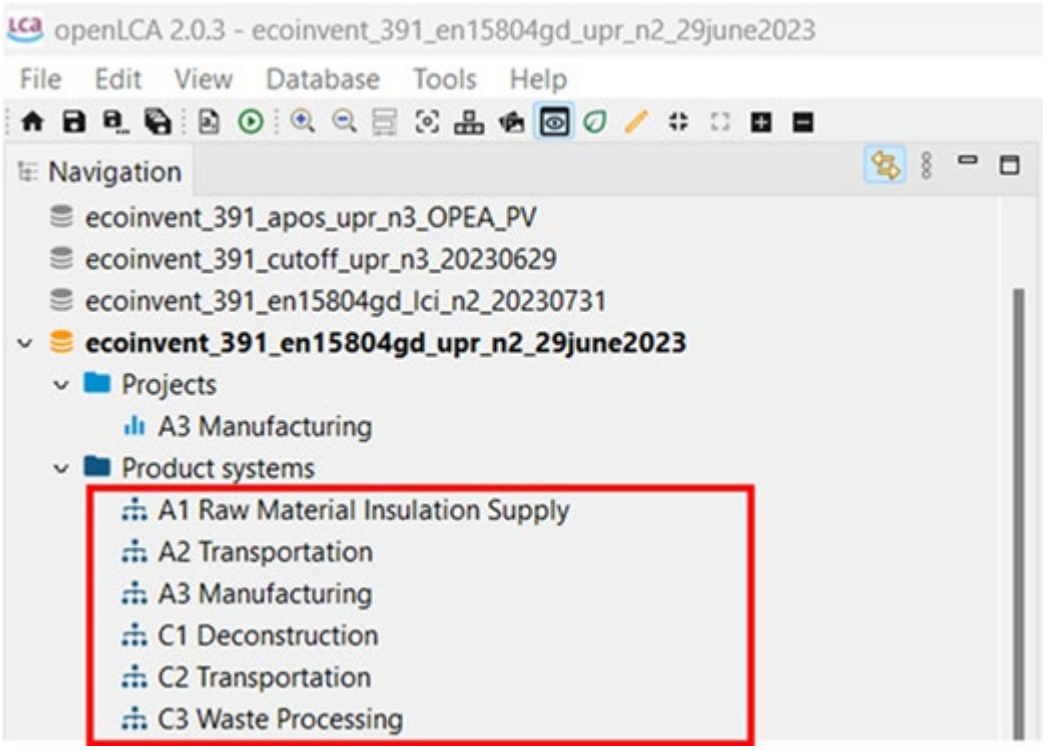
2. After clicking on "Calculate", you will see the interface depicted below. Here, you must now choose the set of indicators you would like to calculate and select the calculation type "Eager/All". After this, the results will appear automatically.



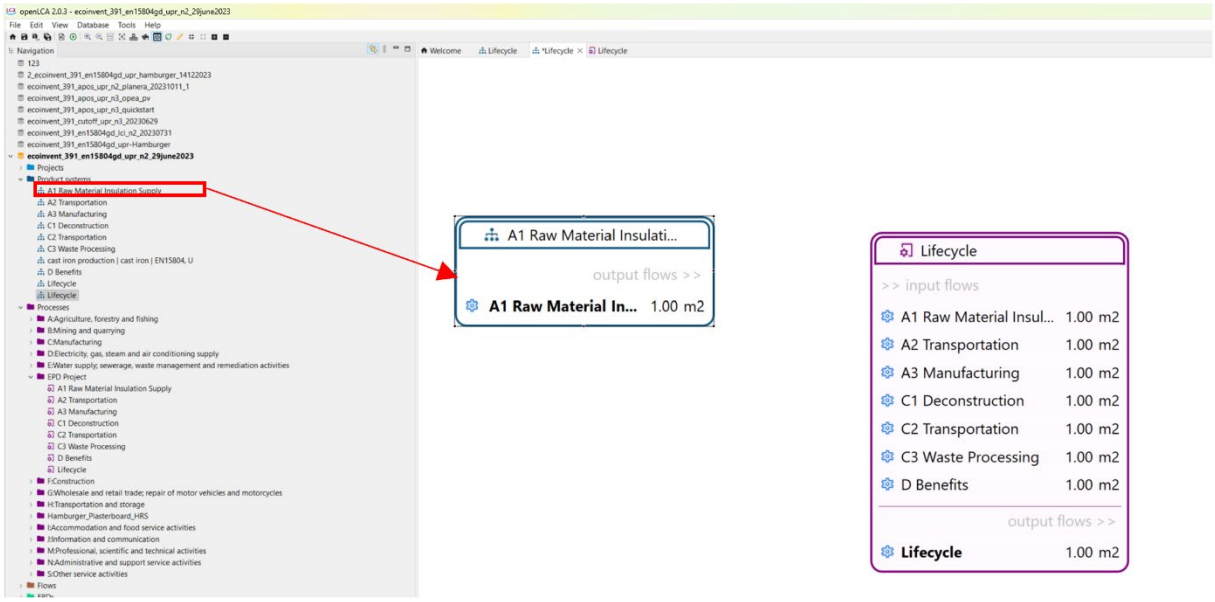
Selection'of'Impact'Assessment'Methods'in'the'calculation'of'a'product'system

CALCULATING THE RESULTS USING LIFECYCLE STAGES AS PRODUCT SYSTEMS

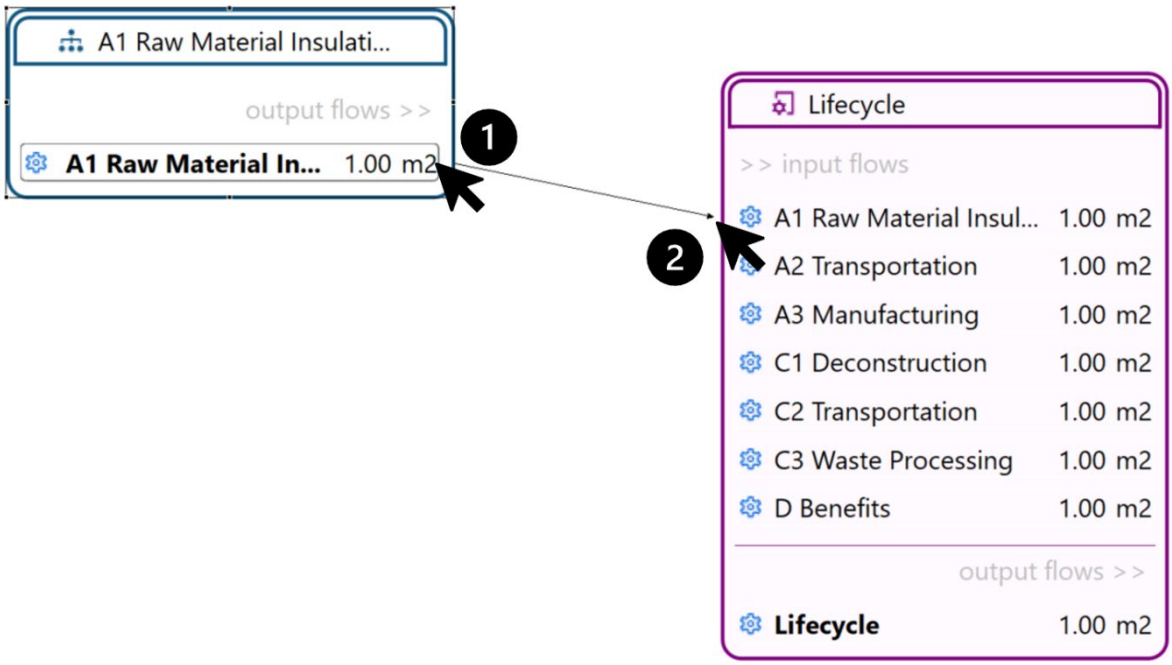
To view the results of the LCA study for the product of interest in an EPD format by lifecycle stage, you can create a product system for each process, as shown below.



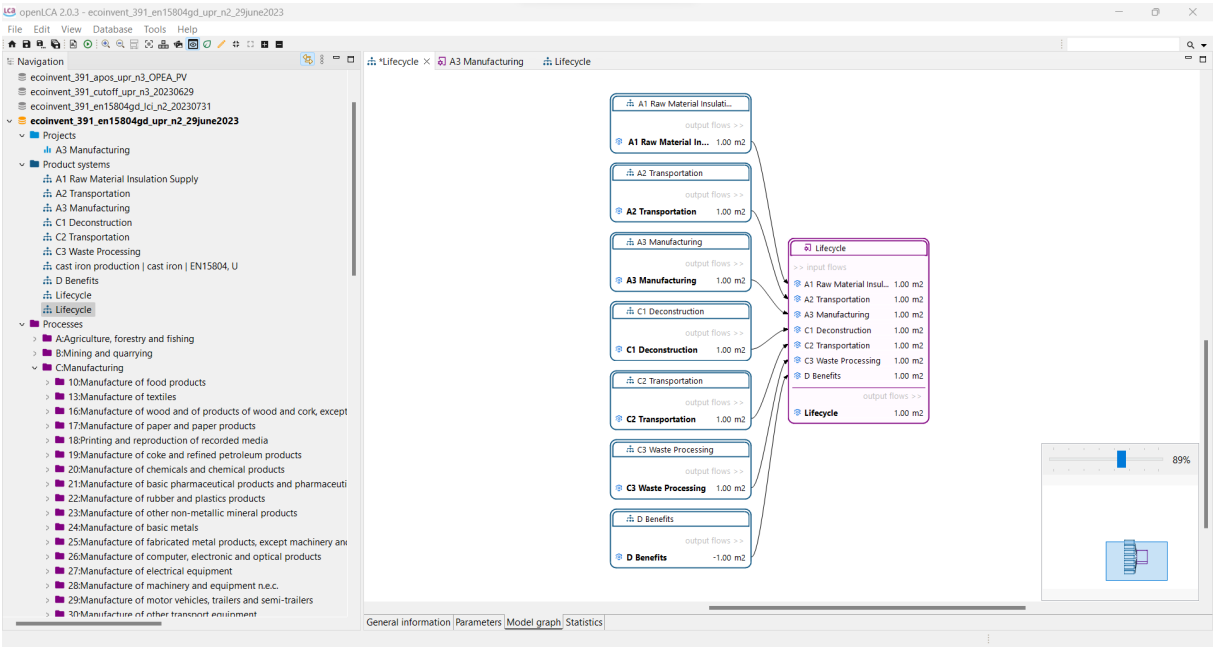
Then, create a process system with the flow of each lifecycle stage added. After that, create a product system, but make sure to uncheck the “Auto-link Process” option. Then, in the Model Graph tab of the newly created product system, as shown below, you can drag and drop the product system for each stage.



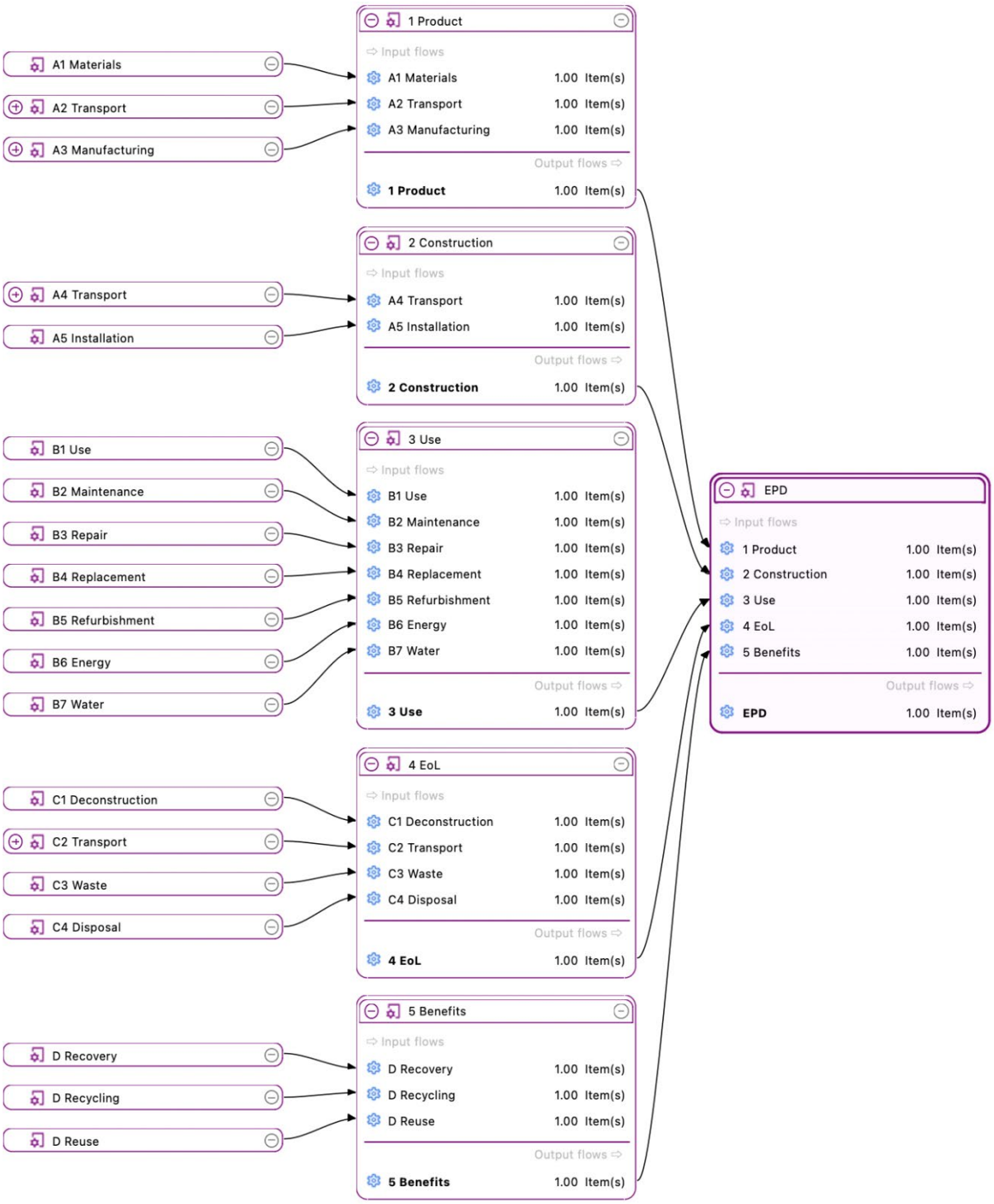
Then, as demonstrated in the image below, you can move the pointer to the flow of the product system (1) and drag it to the flow of the existing product system in the “Lifecycle” product system (2).



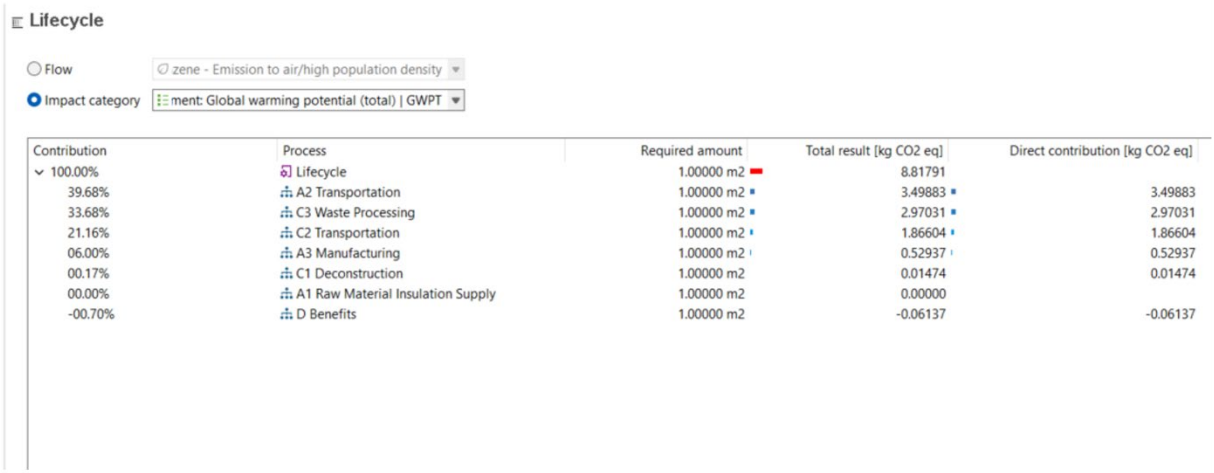
Eventually, you will be able to set up the model graph using the product system of each lifecycle stage, as seen below.



Note: The picture above represents a simplification. In a real-life scenario, you would most likely model the life cycle with items and product flows; therefore, the graph would look more like the picture below:



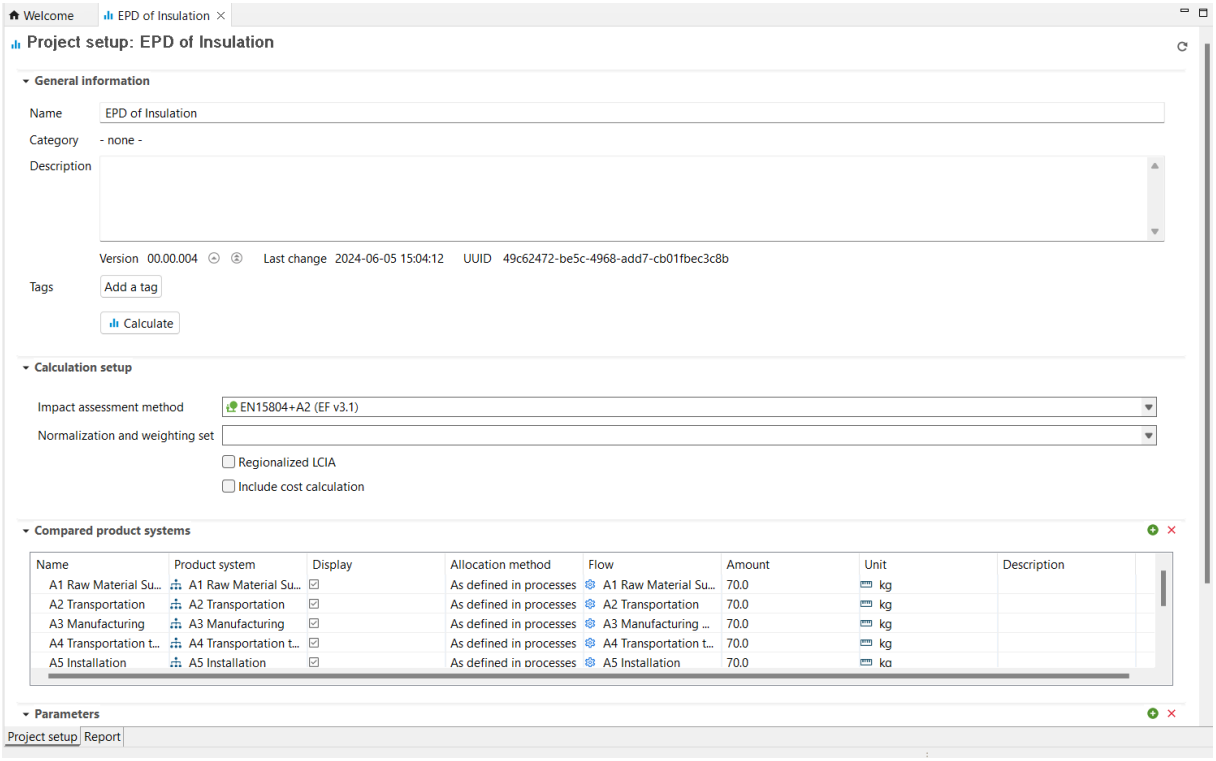
Results for the calculated product system of “Lifecycle” can then be viewed in the following format:



Contribution	Process	Required amount	Total result [kg CO2 eq]	Direct contribution [kg CO2 eq]
100.00%	Lifecycle	1.00000 m2	8.81791	
39.68%	A2 Transportation	1.00000 m2	3.49883	3.49883
33.68%	C3 Waste Processing	1.00000 m2	2.97031	2.97031
21.16%	C2 Transportation	1.00000 m2	1.86604	1.86604
06.00%	A3 Manufacturing	1.00000 m2	0.52937	0.52937
00.17%	C1 Deconstruction	1.00000 m2	0.01474	0.01474
00.00%	A1 Raw Material Insulation Supply	1.00000 m2	0.00000	
-00.70%	D Benefits	1.00000 m2	-0.06137	-0.06137

CALCULATING THE RESULTS USING PROJECTS

Alternatively, you can create a new project with a report and add all the lifecycle stage product systems, as seen below.



With this approach, you can view the results collectively for all impact categories at each stage, as shown below. You can copy the results that are displayed this way and insert them directly into the EPD report.

Impact assessment results

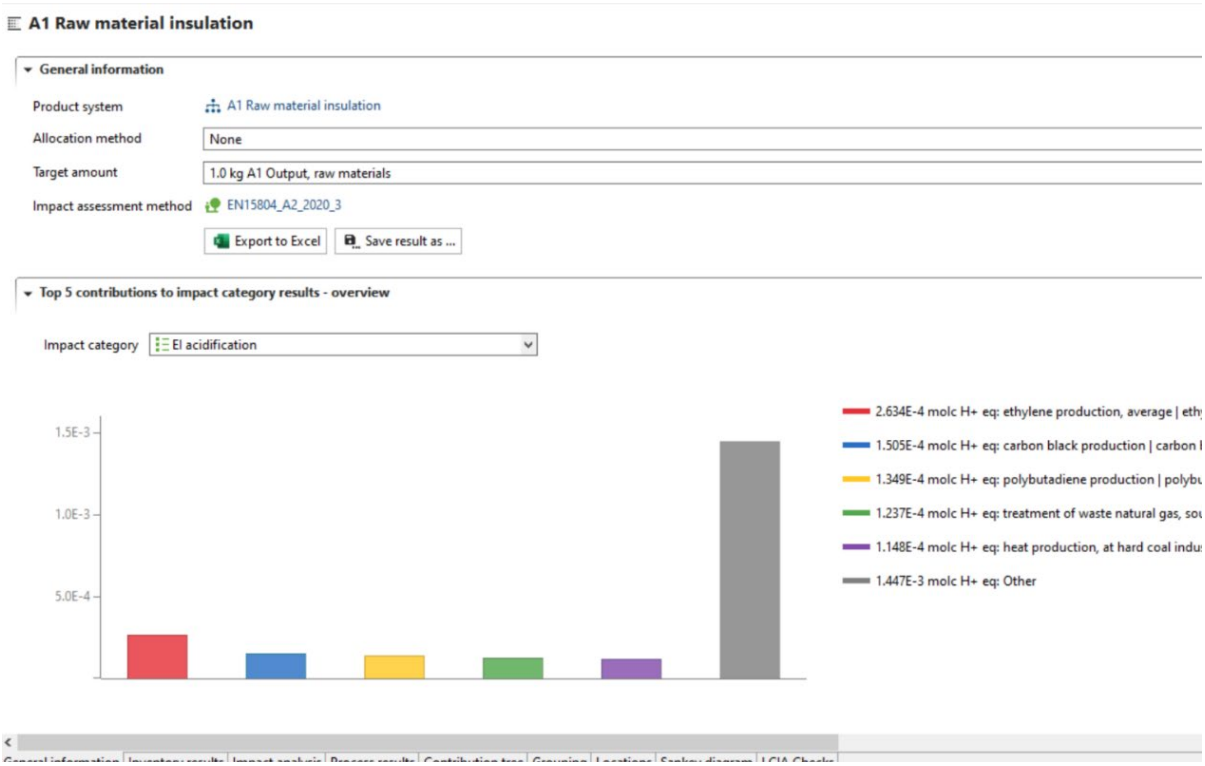
The table below shows the impact assessment results of the different project variants.

Indicator	A1 Raw Material Insulation Supply	A2 Transportation	A3 Manufacturing	C1 Deconstruction	C2 Transportation	C3 Waste Processing	D Benefits	Unit
Environment: Abiotic depletion potential (elements) | ADPE	0.00000e+0	1.15505e-5	1.80715e-6	1.77555e-8	6.16027e-6	1.72903e-9	-4.17721e-7	kg Sb eq
Environment: Abiotic depletion potential (fossils) | ADPF	0.00000e+0	4.98681e+1	1.07476e+1	1.03055e+0	2.65963e+1	6.34935e-2	-7.57538e-1	MJ (net calorific)
Environment: Acidification potential | AP	0.00000e+0	1.37169e-2	2.12367e-3	3.36292e-5	7.31568e-3	1.43882e-4	-3.75694e-4	mol H+ eq
Environment: Ecotoxicity potential (freshwater) | ETPF	0.00000e+0	2.50614e+1	2.76371e+1	4.17660e-2	1.33661e+1	1.07483e+0	-7.32618e-1	CTUe
Environment: Eutrophication potential (freshwater) | EPF	0.00000e+0	2.42524e-4	2.79558e-3	8.58025e-7	1.29346e-4	1.48470e-7	-4.05914e-5	kg P eq
Environment: Eutrophication potential (marine) | EPM	0.00000e+0	5.20435e-3	2.01995e-2	1.01541e-5	2.77565e-3	5.14940e-5	-6.75864e-5	kg N eq

18.4 SAVE YOUR RESULTS

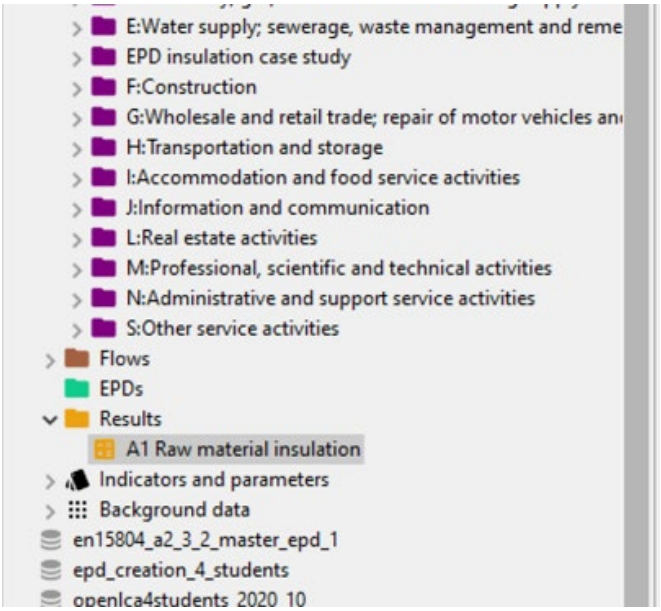
openLCA allows storing the results to use them for an EPD or in further calculations.

1. In order to save the result of the calculation of a product system, go to the "General information" tab of that specific result. Click on "Save result as". In the window that opens, select "As a result".



General information tab of a result

2. The results are now saved and available under the folder "Results". The results of the calculations of all product systems that could be included in the EPD must be saved additionally.



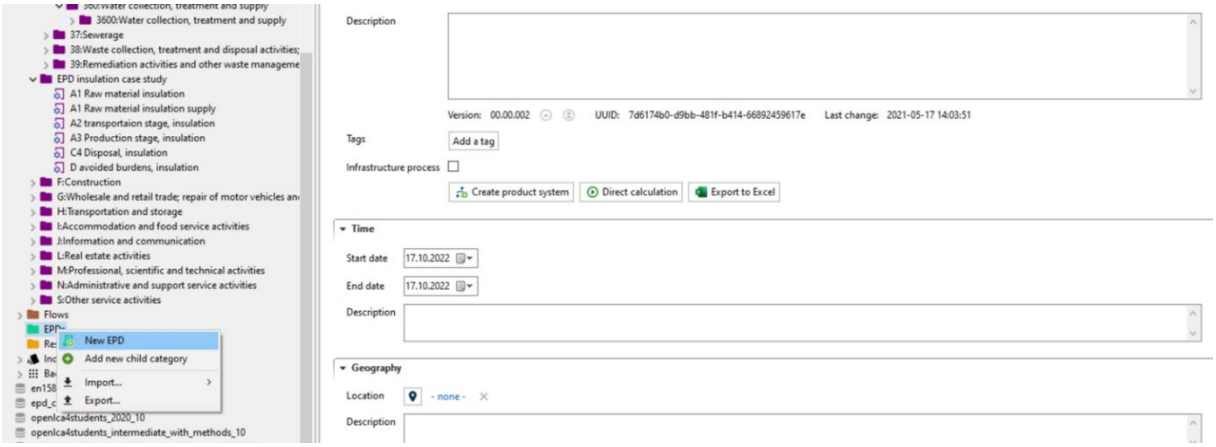
Navigation window showing results.

18.5 CREATING EPDS IN OPENLCA

An EPD structure can be created to store information using the official nomenclature of the life cycle stages. In openLCA 2.4, there are two ways to create an EPD. The first way

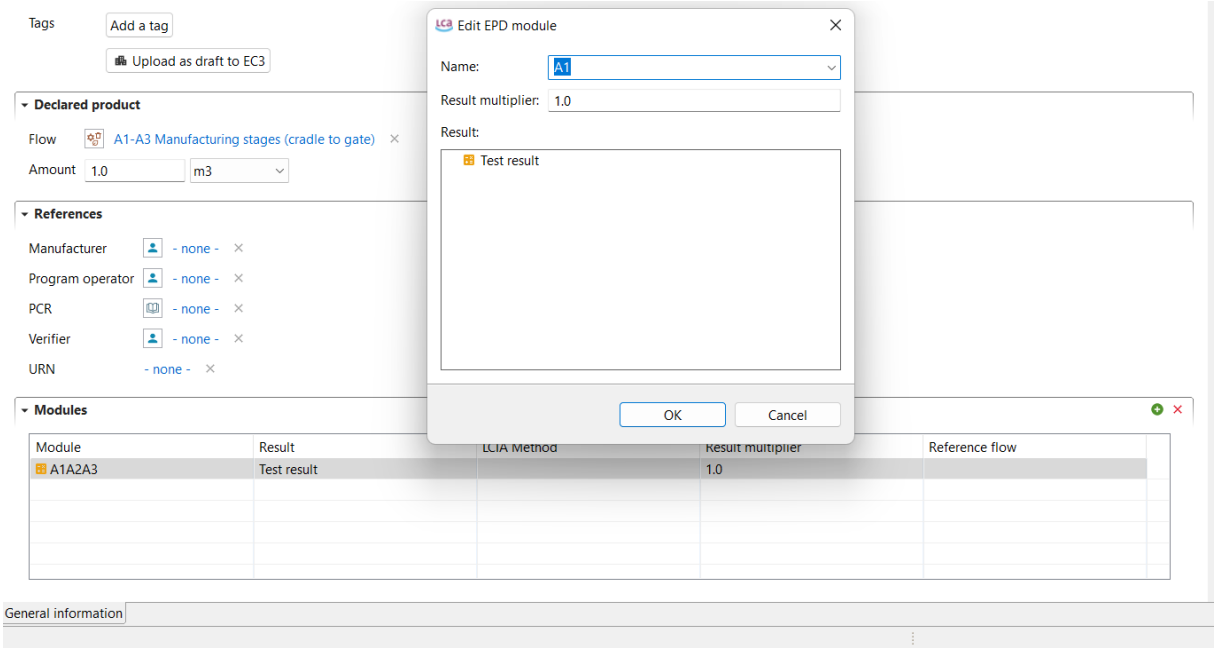
is explained below in this section, while the second way is described in the Analysis group section.

1. To create a new EPD, you can now right-click on the folder "EPDs" and select "New EPD". In the window that opens, please enter the name of the EPD.



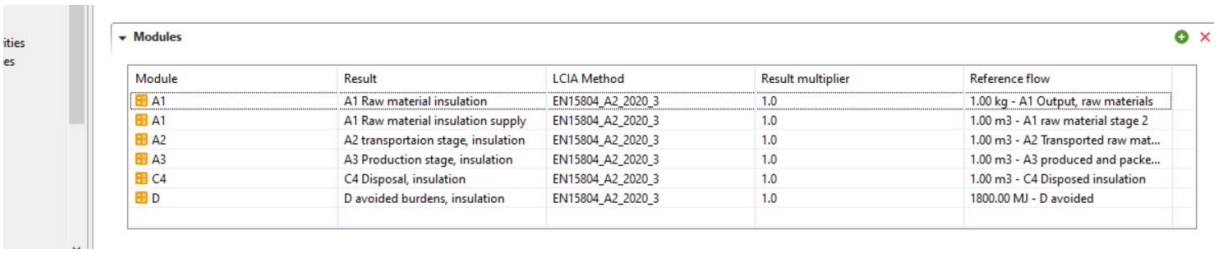
Creating 'a 'new' EPD

2. Next, navigate to the "Modules" section under "General information" in the EPD. Here, you need to add all modules that should be included. You must select your declared product (flow) in the respective section under "General information".



„Modules..' section 'in 'an 'EPD

3. It is now possible to export the completed EPD by clicking on "File" and selecting "Export". Select "JSON-LD" and click on "Next". Your EPD should be selected. Click on "Finish". Your EPD is now saved in the folder you selected. This enables the exchange of EPDs and their transmission to the responsible parties.



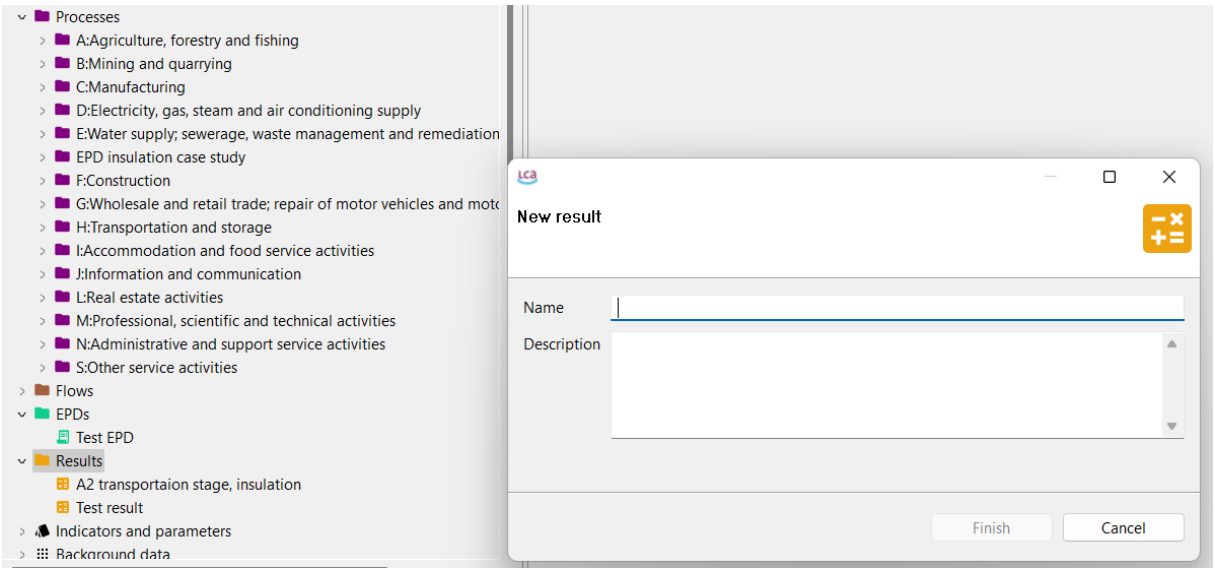
EPD'example

18.6 ADDING EPD RESULTS FROM VARIOUS SOURCES

EPDs are often available as PDF documents with a unique design, hence they cannot be imported directly into any LCA software. However, a new feature allows you to manually add results from publicly available EPDs or to import EPDs using their ILCD files.

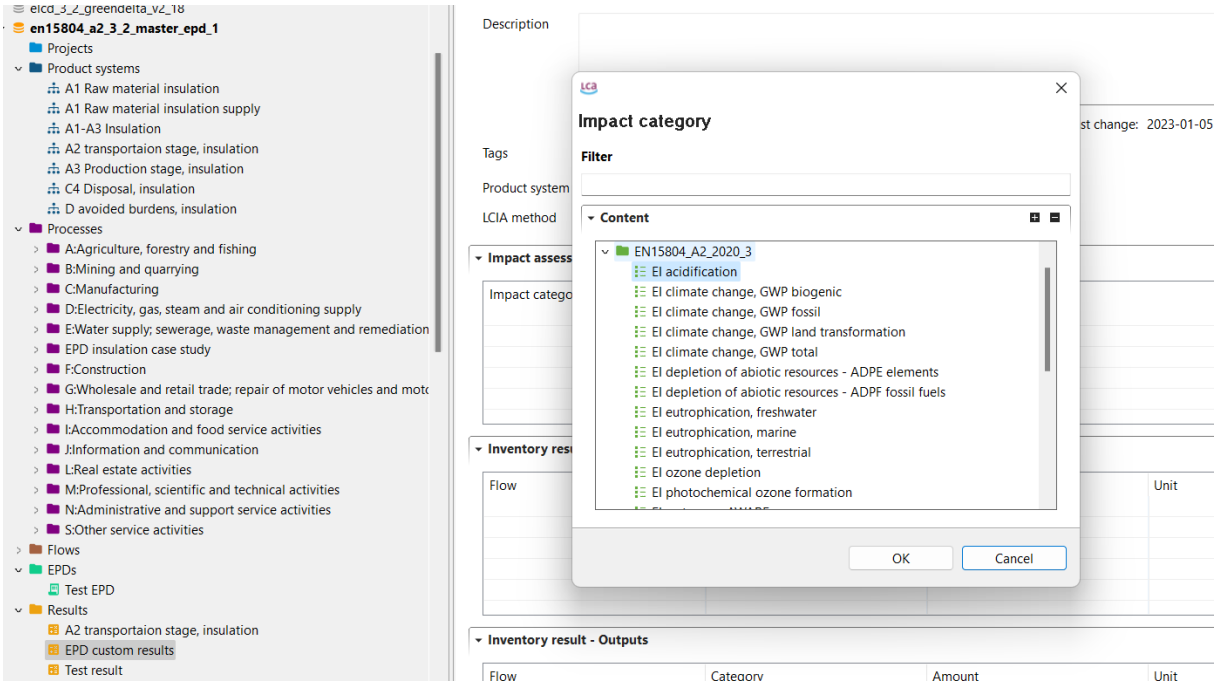
ADDING EPDS MANUALLY

1. To do so, you need to create a custom set of results by clicking on the "Results folder" and then "New results". It will create a template that requires additional information to be filled in.



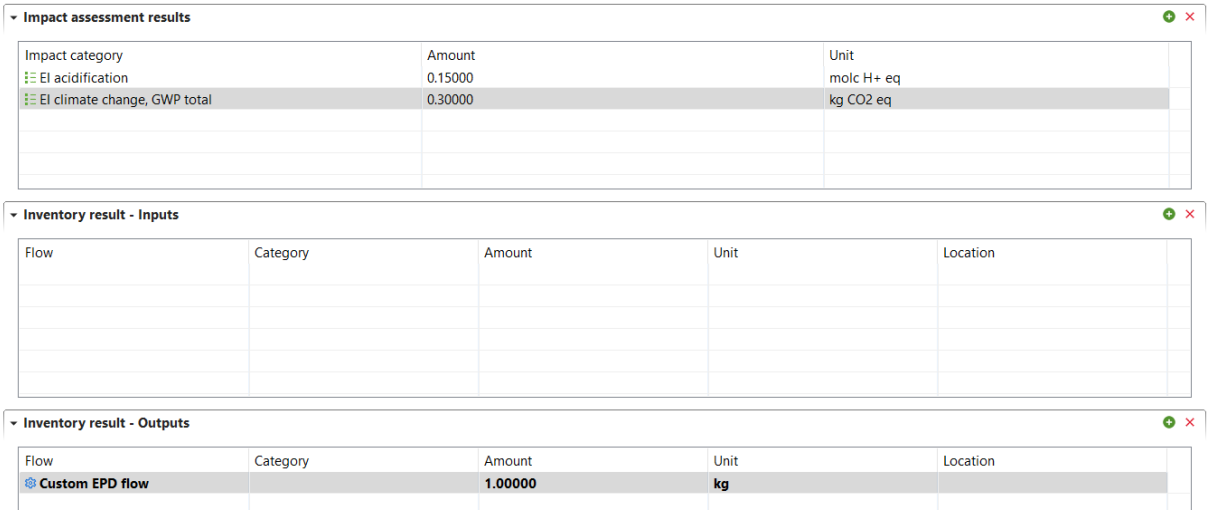
Creation'of'the'result'example

2. Next, the results can be completed by adding an impact category from the respective method. It can be done by clicking on the "Impact assessment" field and browsing through the list of available categories.



Adding results to an impact category

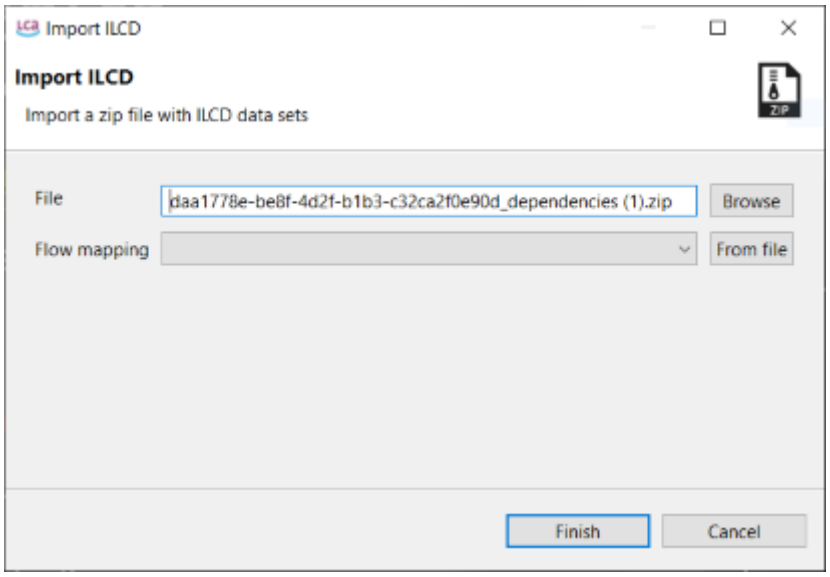
3. After all necessary impact categories are added, a comprehensive list of associated impacts is displayed. However, it is essential to associate the burdens with a specific flow that represents a functional unit. Thus, an existing or custom flow can be selected by right-clicking the "Inventory results – Outputs" field and selecting the appropriate option from the list. Once finished, it is necessary to right-click on the target flow and set it as a reference. The amounts of the output flow must correspond to the original EPD or be converted according to the new functional unit, including all associated emissions.



The finished results

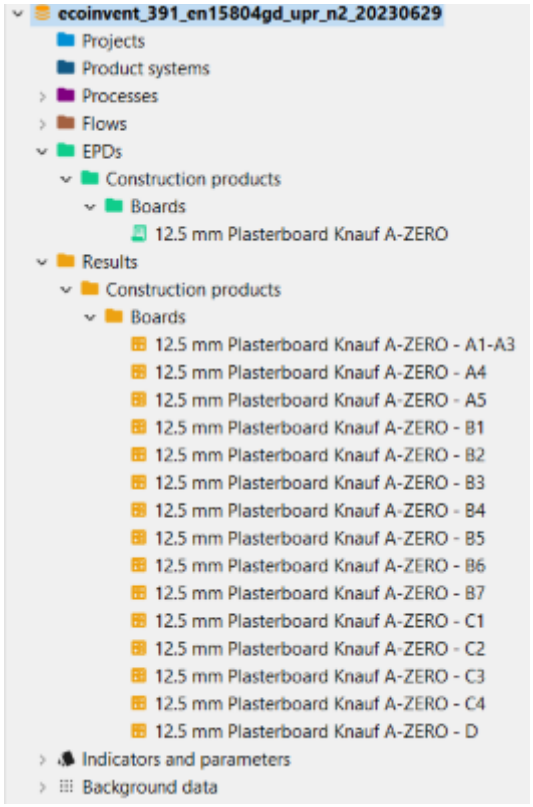
IMPORTING EPDS FILES IN ILCD FORMAT

It is also possible to import EPDs that have an ILCD format (zip file), e.g. Environdec by using the import function whilst an EPD-suitable database is active.



Imported EPD appearing in the EPD and Result folder

After the import, openLCA will display whether the import process succeeded with or without any issues. Now, the EPD and its respective results can be found directly in both folders (EPD and Results).

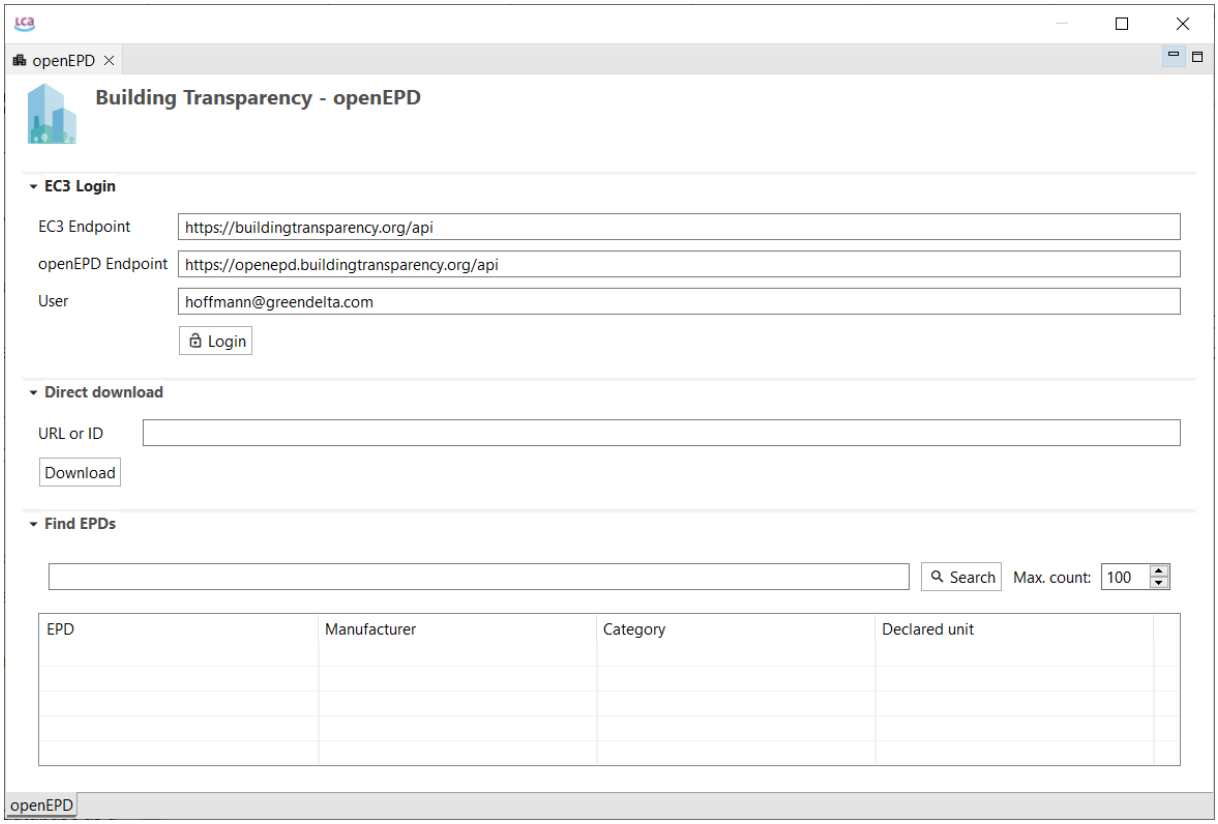


The finished results

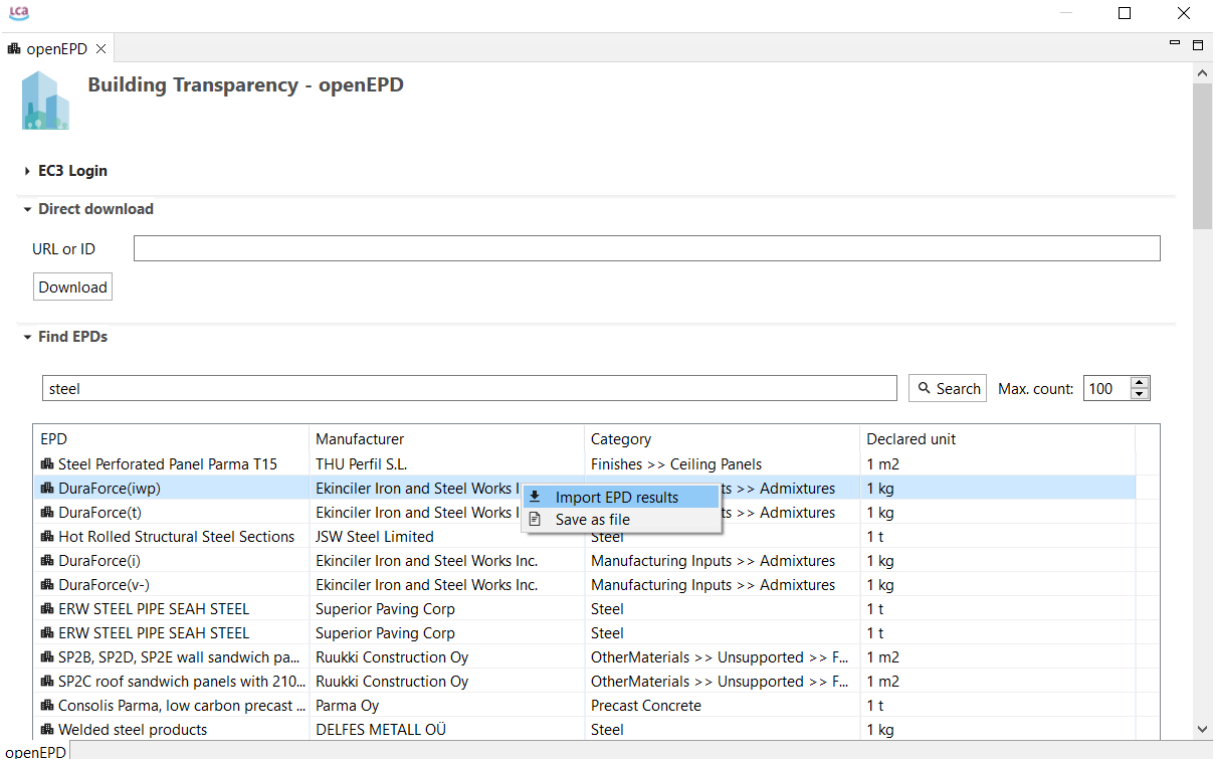
18.7 GET EPDS FROM EC3

With openLCA 2 it is now possible to download or upload EPDs to EC3 (Embodied Carbon in Construction Calculator) by Building Transparency; requires access (account) to the respective OpenEPD API.

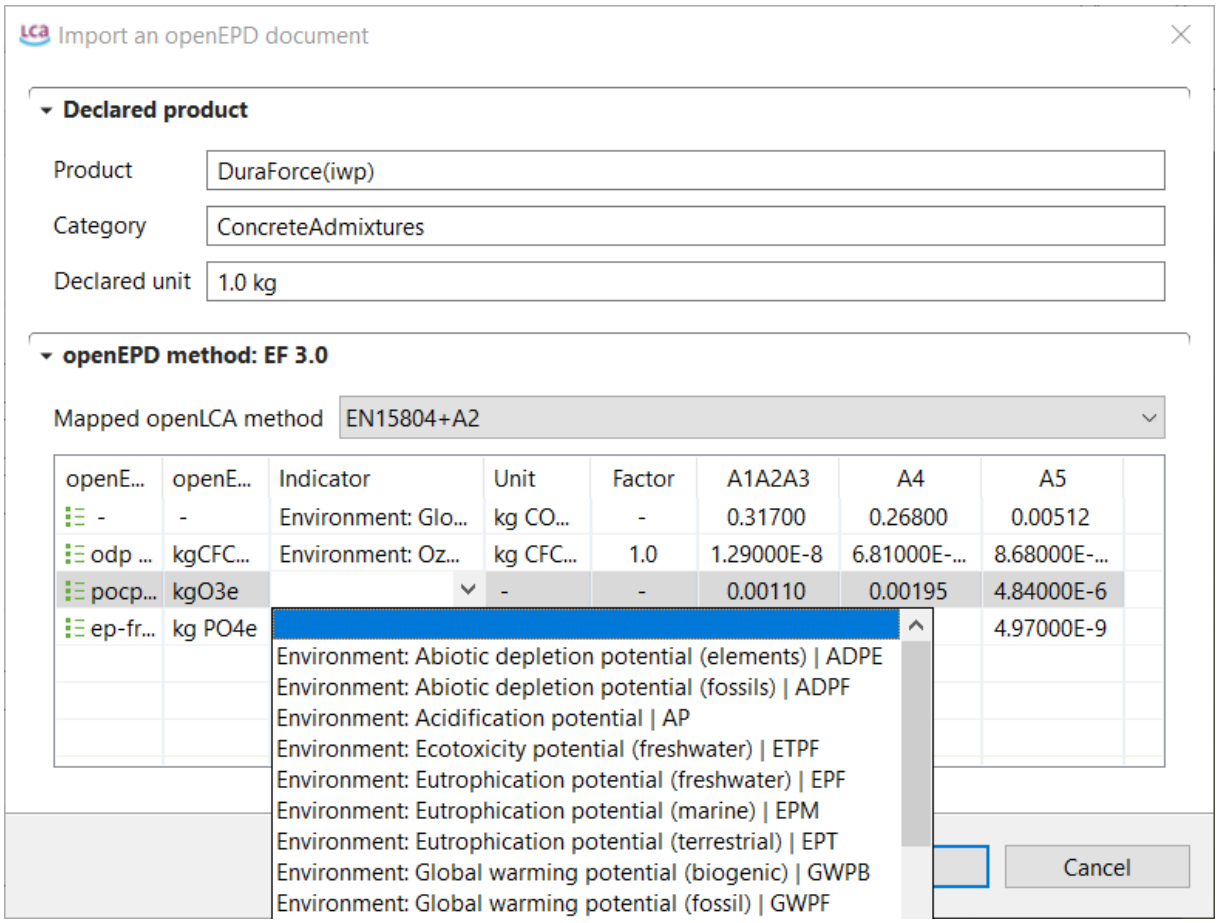
To access the EC3 with openLCA, open under Tools → Get EPDs from EC3. The following window will open:



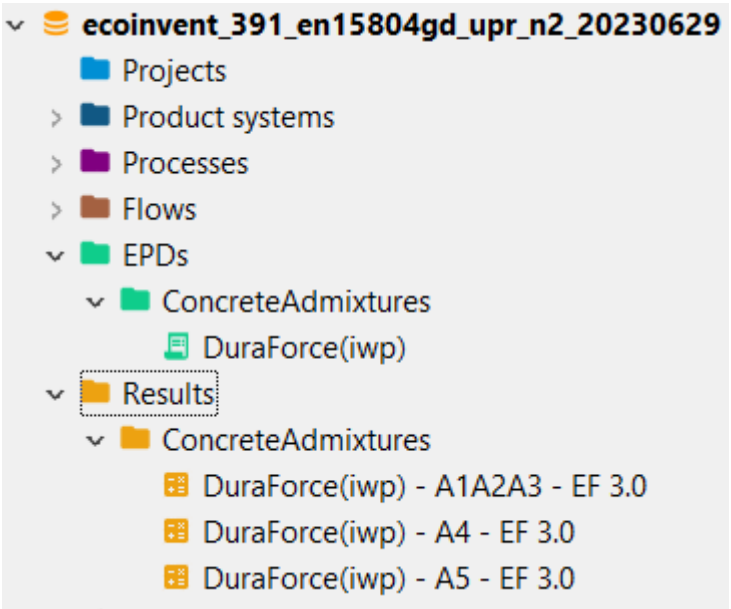
Insert your username, click 'Login', and enter your EC3 account password. Once you are connected, you can download via URL/ID or search and import EPDs directly in openLCA.



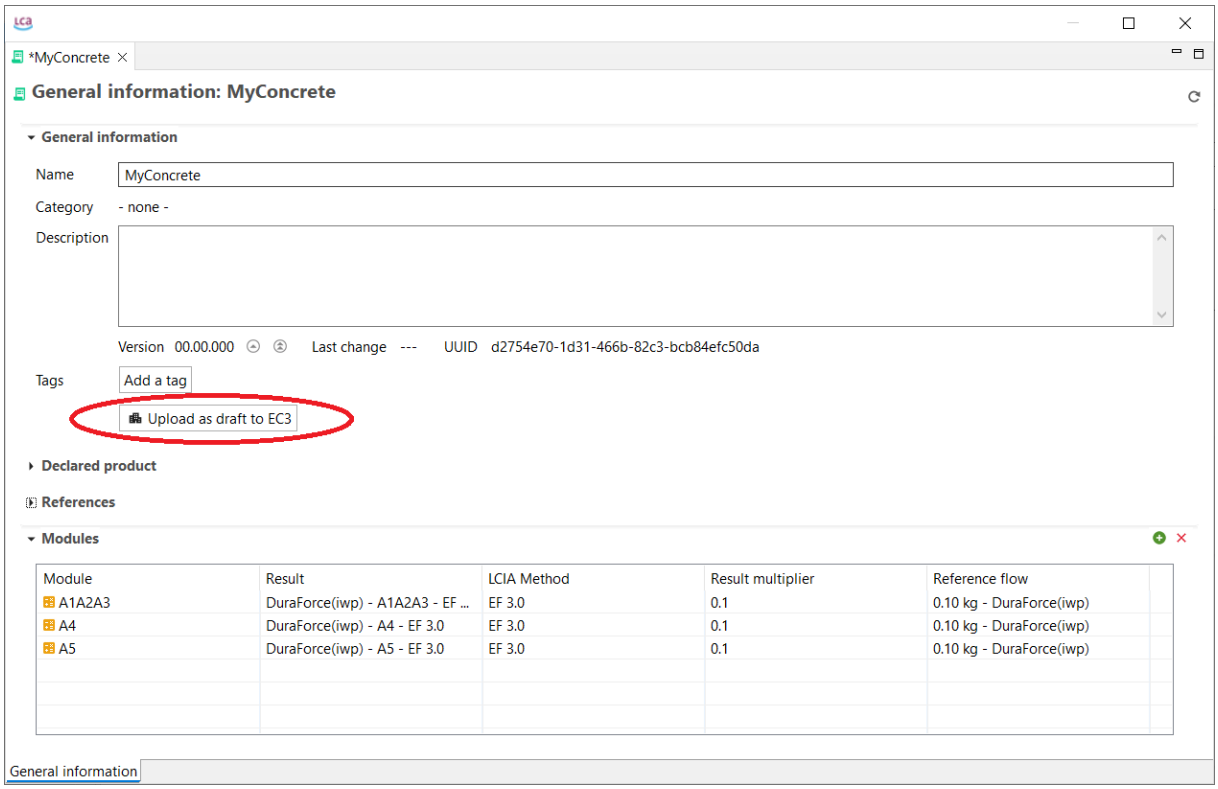
openLCA will attempt to match openEPD LCIA methods with the openLCA indicators in the active database automatically; however, this can be configured individually by the user.



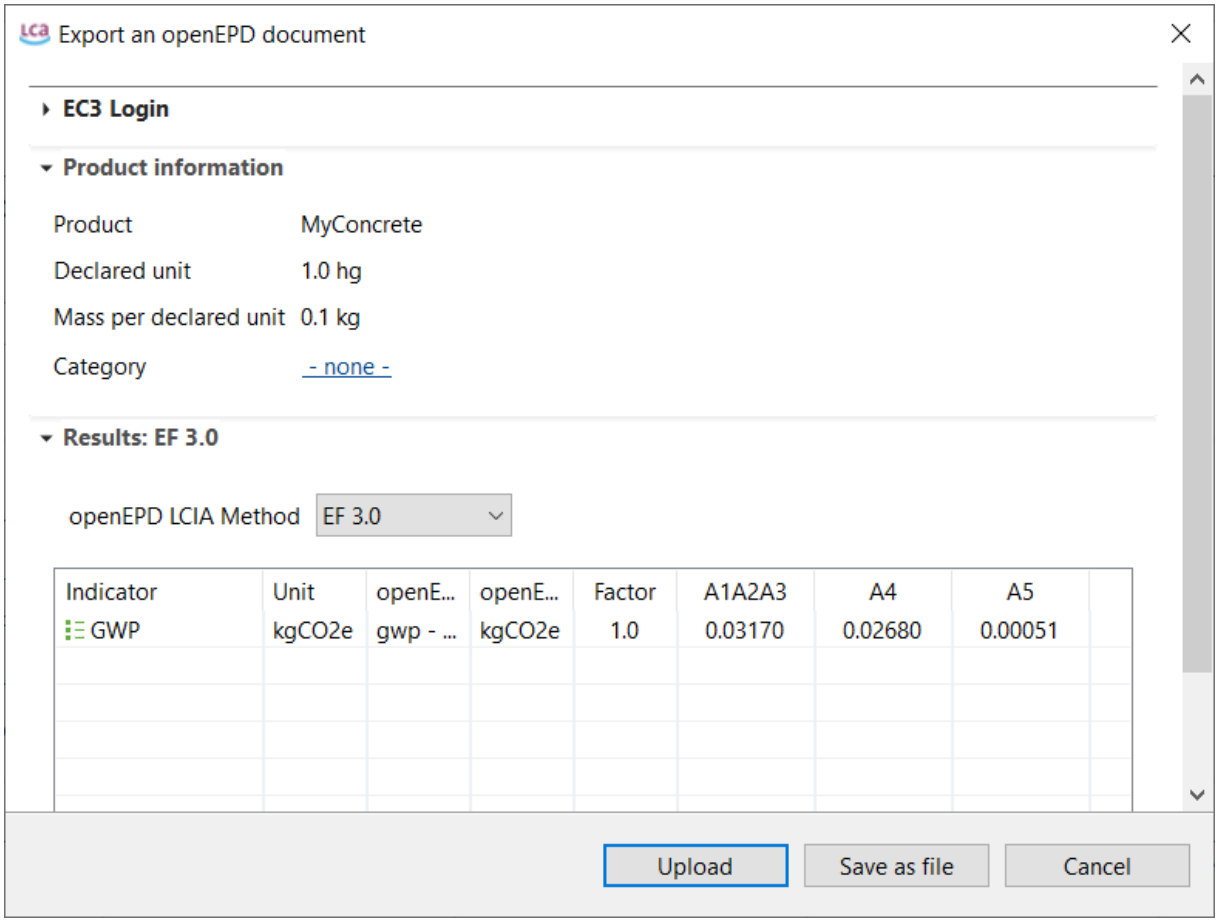
The imported EPDs will be displayed in the navigation panel under the "EPDs" section. An EPD can contain multiple result modules, and hence, the results are also stand-alone models. They can be flexibly combined in EPDs and have a quantitative reference, making them suitable for use in product systems.



It is also possible to upload your EPD drafts to the EC3 server. To do this, open an EPD and select "Upload (Update) EPD on results on EC3". For this, please fill out all the required information, particularly the declared product and the URN.



Then a new window will appear, and you can click on "Upload (Update)".



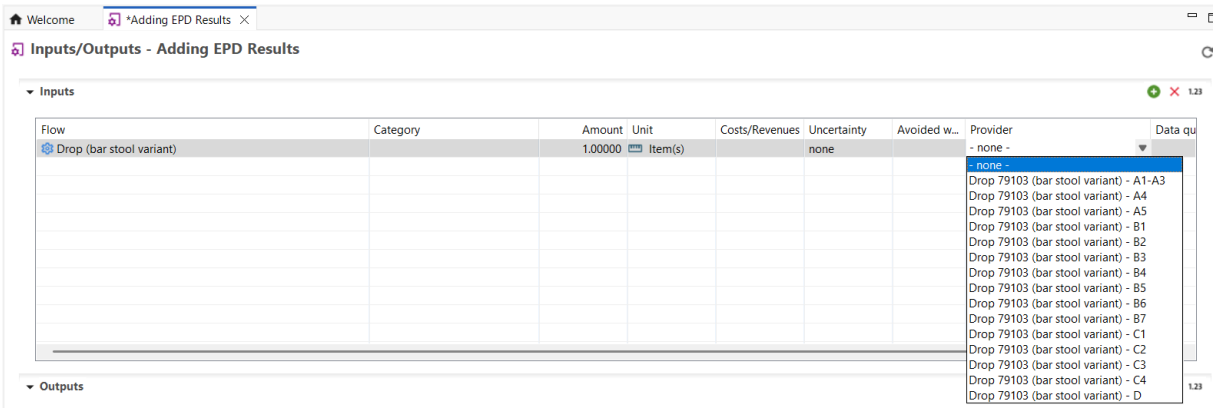
Then, you can check your uploaded version at https://buildingtransparancy.org/ec3/epds/URN (replace "URN" with your specific URN).

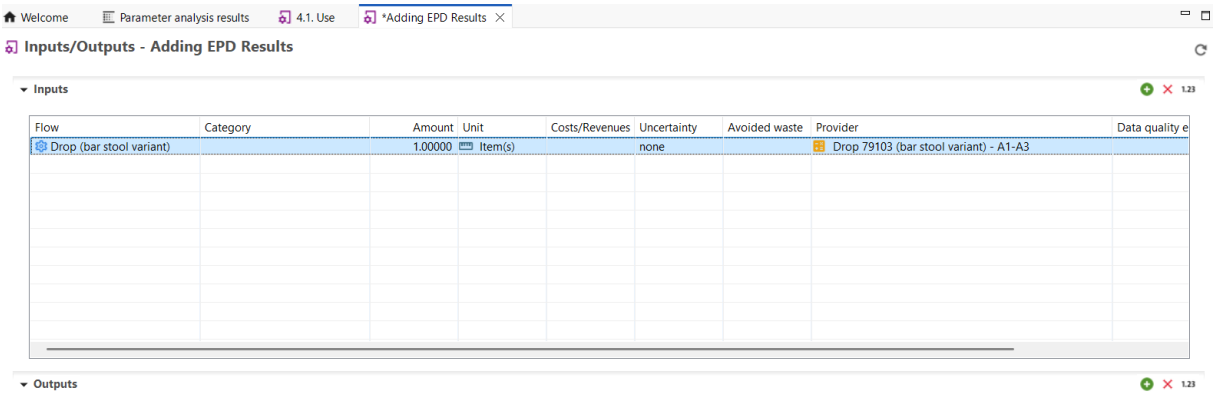
18.8 USING RESULTS OF EPDS IN THE PRODUCT SYSTEM

To connect EPD results to your product system, this can be done in two ways (1) adding the result output flow into your respective process, (2) adding the result output flow through the model graph.

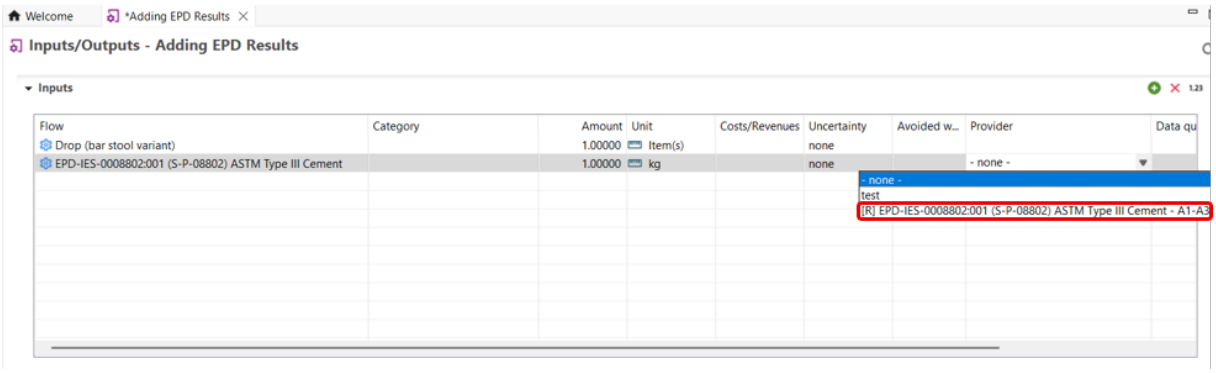
METHOD 1: ON PROCESS LEVEL

In openLCA v2.5.0, within the process, add the product flow corresponding to the EPD result as an input. Then, as usual, use the provider dropdown to select the appropriate module (i.e., the process or result) you want to link to your system.





Bonus: If your product flow is connected to normal processes and results, the results are indicated by [R] as a prefix.



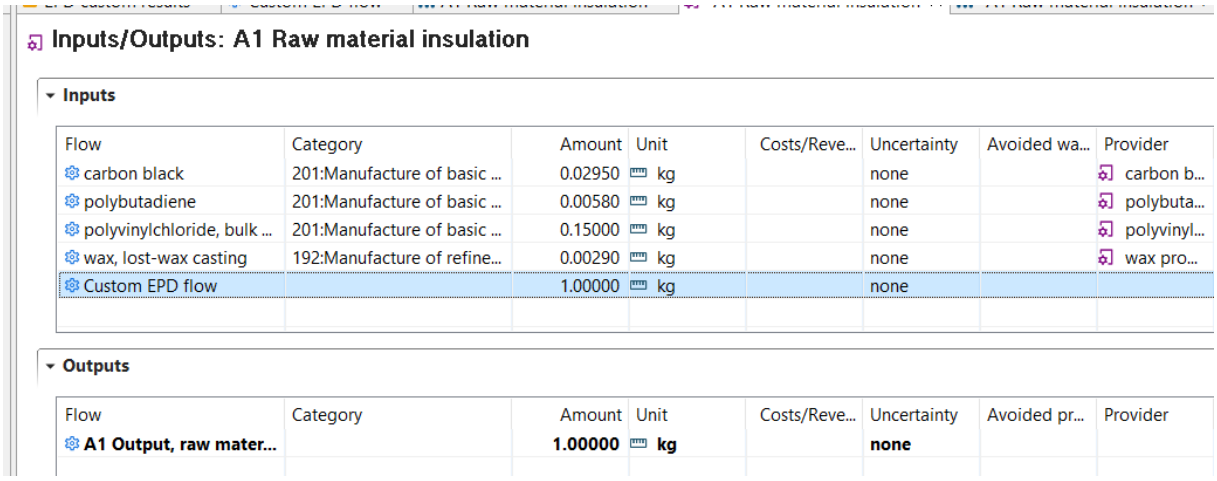
Note: Ensure that the results you connect are based on the exact impact assessment method you will use later for your impact assessment. If you choose an alternative method, those results will not be considered (only EF 3.1 LCIA results can be used in conjunction with the EF 3.1 method; using TRACI will not incorporate those results). However, it is not required to fulfil this criterion when the result contains inventory results, and it will calculate the impacts from these inventory results in that case.

METHOD 2: VIA MODAL GRAPH EDIT MODE

You can also add the EPD result's output flow directly via the model graph edit mode by drawing the connection between your process and the EPD result. This method offers a visual way to integrate the flow into your product system.

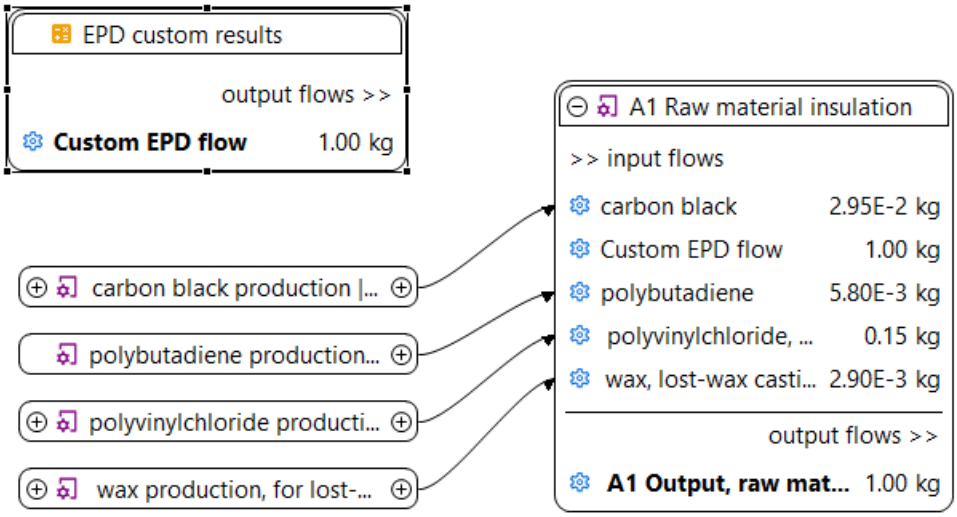
The introduced or saved results can be directly used in a supply chain.

1. The flow must be added to the inputs of a target inventory that will be connected with a respective result.



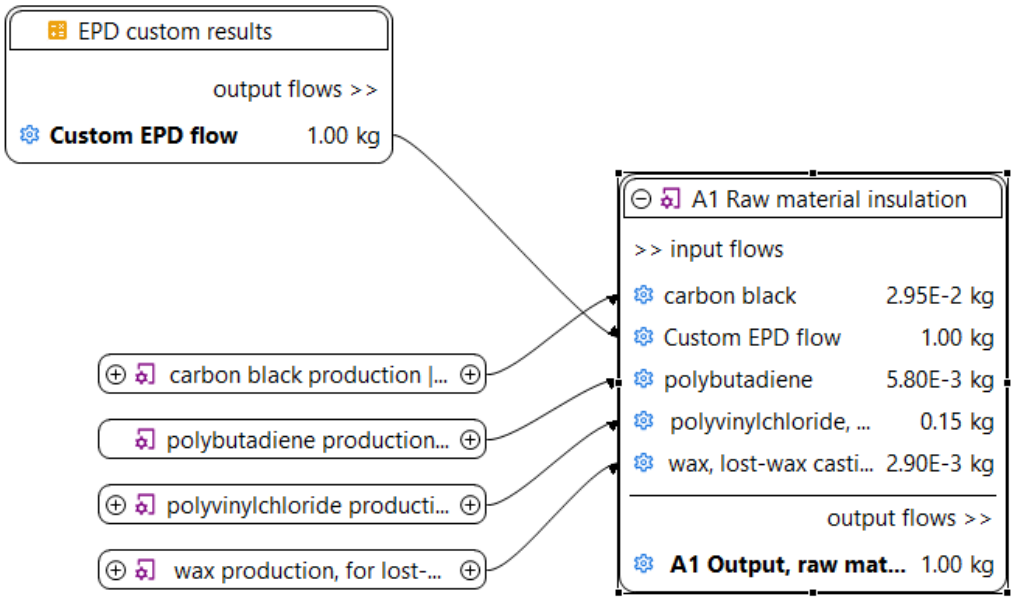
Linking the impacts with an inventory

2. Unlike the provider selection, the results can be connected to a respective flow only via the "model graph". Thus, a product system needs to be created first. After the supply chain is created, it is necessary to open the "model graph" under the product system element and drag and drop the result into the editor area. It is essential to keep track and select the correct reference flow to link to the result accurately.



EPD'example

3. Once the results are in the editor area, they can be manually connected to the flow. That is done by dragging a connection from the target flow to the results element.



EPD'example

4. After all connections are established and the target amounts are set, it is essential to save all changes before performing the impact assessment. Then, the results can be analysed as usual.

Notes

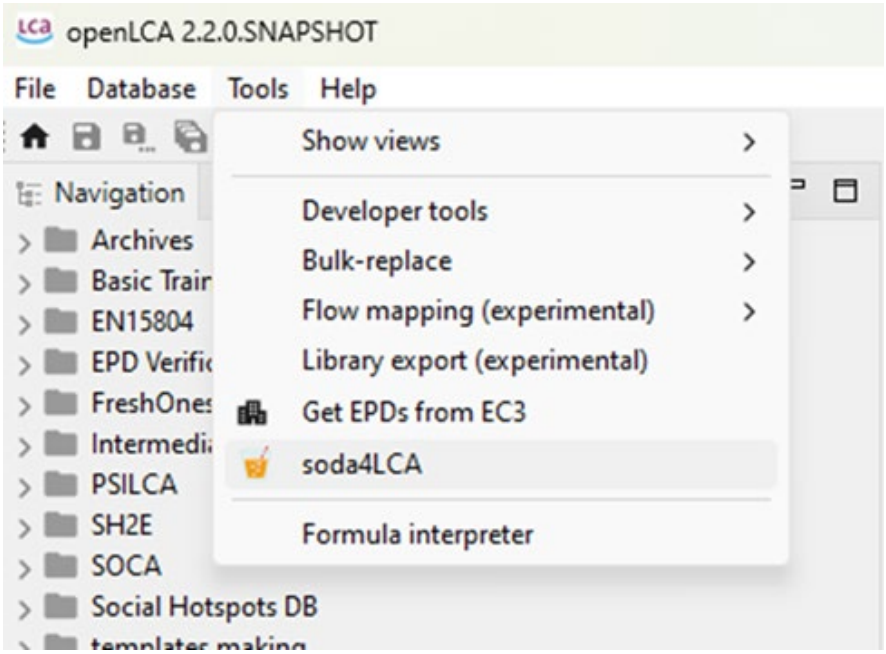
For users using the Ecoinvent v3.9 EN15804+A2 add-on database or previous versions: EPDs imported via ILCD formats cannot be integrated into the results of the EPD when used as part of a product system created in openLCA. Therefore, you

must manually add the EPD results OR map the impact categories of the EPD results by creating a new process and adding suitable elementary flows representing each impact category.

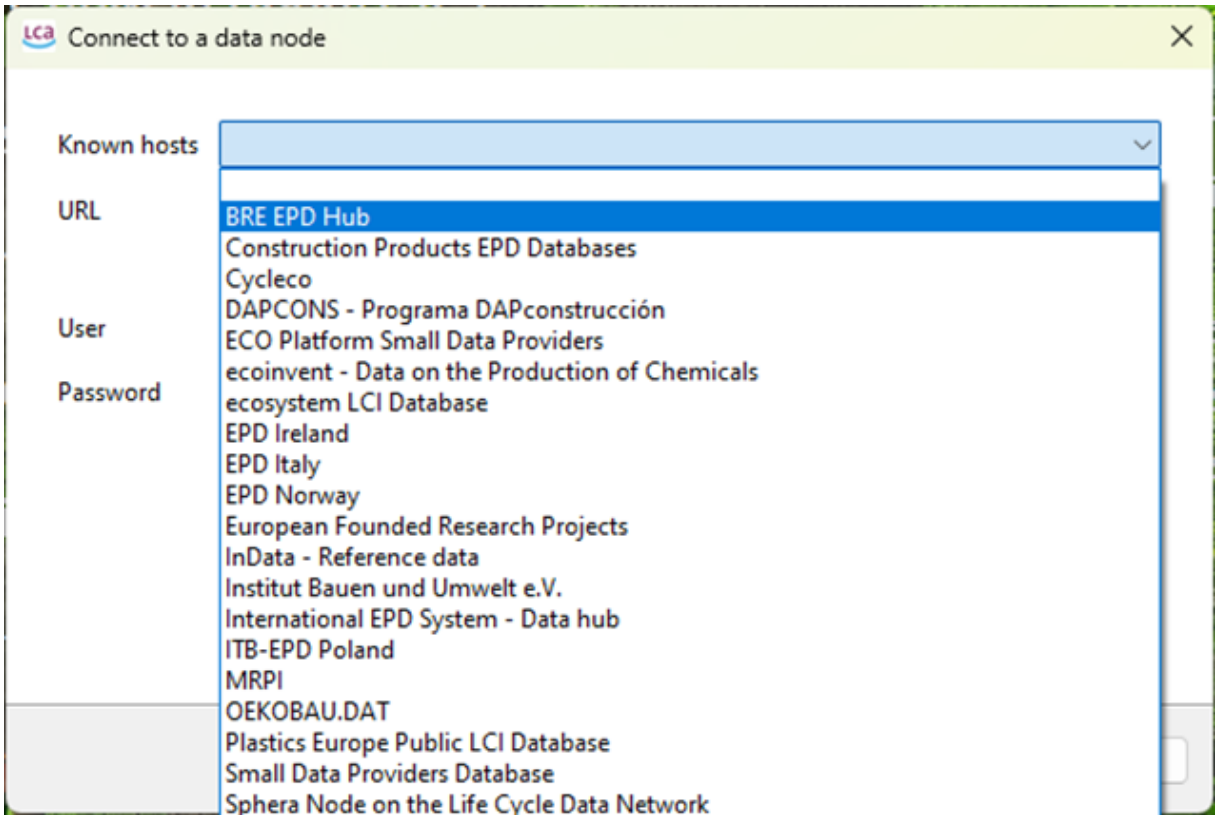
For users using the Ecoinvent v3.10 EN15804+A2 add-on database with openLCA v2.2: EPDs imported via the ILCD format can now be directly integrated into the product system. You should use openLCA v2.2 with the v3.10 add-on to import the EPDs and map them to the impact categories. However, we advise you always to verify that the impact categories are mapped correctly, as the online repository from which the EPD is imported does not always accurately link the impact categories to their corresponding unique identifiers.

18.9 USING soda4LCA

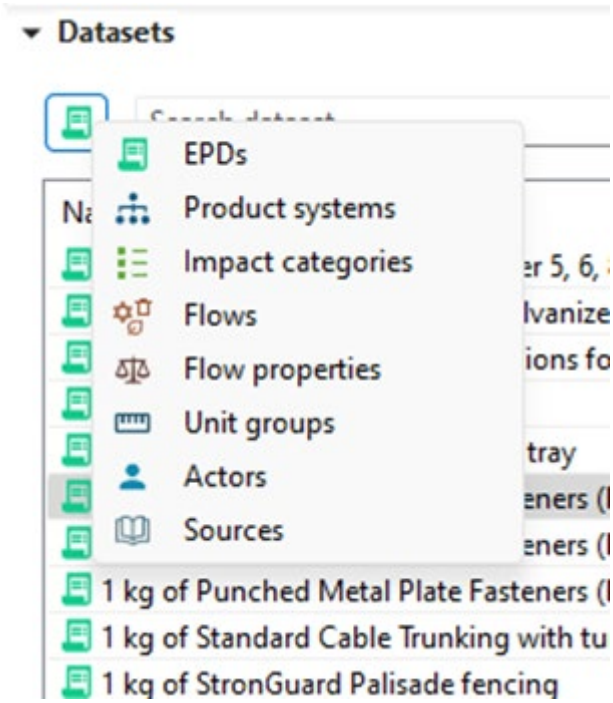
With openLCA v2.2, you can now access a wide range of ILCD nodes through the soda4LCA tool. This also includes various EPD-focused nodes, such as International EPD and ÖKOBAUDAT. The soda4LCA tool can be accessed by going to Tools > soda4LCA, as seen below:



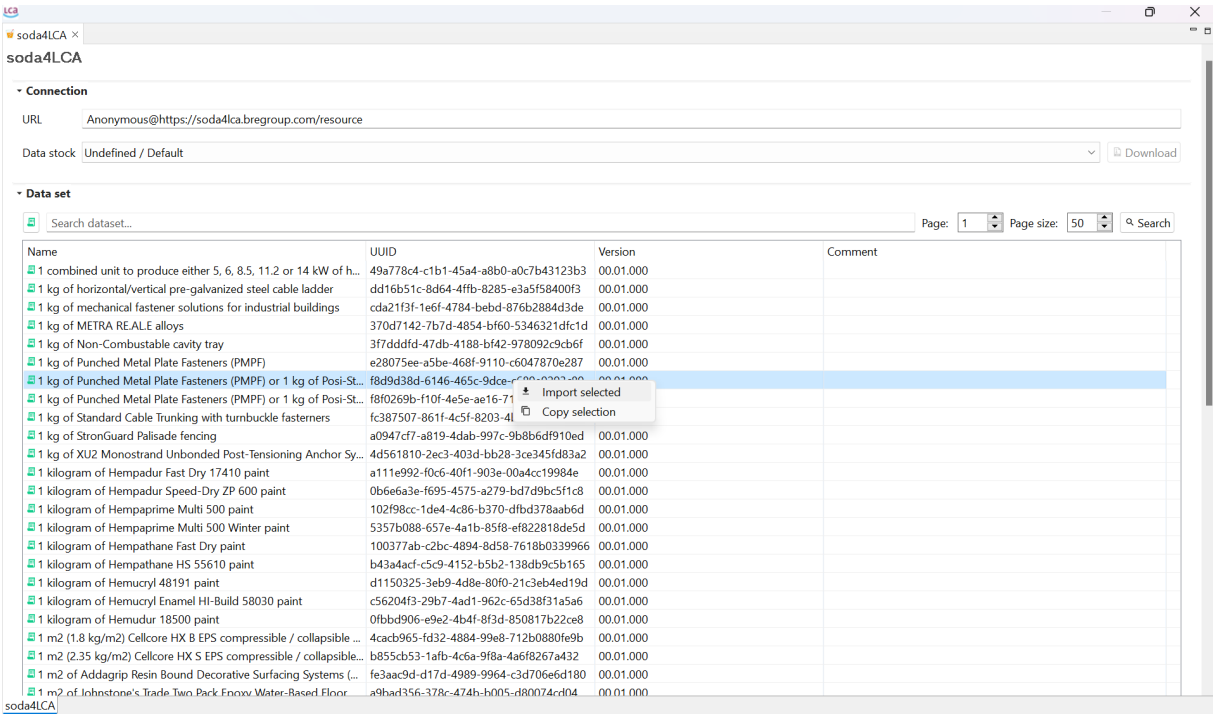
Then, a pop-up window will appear, where you can select the desired database node (host), as shown below, and then click "OK".



You can search the library by "EPD", "impact category", and more.



With an active database, it is then possible to import the results by right-clicking on the desired entry and selecting "Import Selected". To ensure a smooth integration of the EPD in your database, make sure that you use an EN15804-compatible database like the EN15804 version of ecoinvent. If your active database does not contain the required impact methods, as specified in the EN 15804 version, openLCA may download them from the respective soda4LCA node, which can take some time.

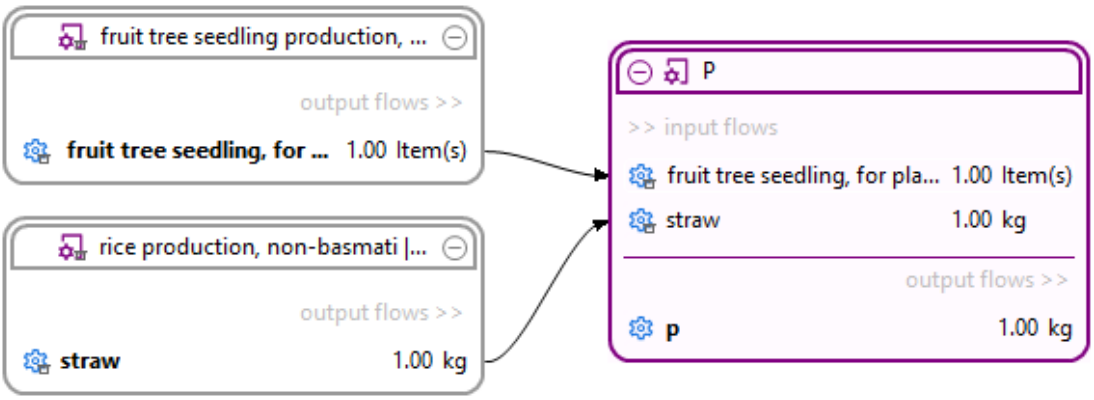


If you have imported an EPD, it shall appear under the "EPD" folder in the working database. If you have imported an impact category, it will appear under the "Impact Categories" folder and so on. To integrate the results of EPD into the product system, please refer to the "Using results of EPDs in the product systems" section. Ensure that you use the same impact method to calculate impacts as was used to generate the EPD. Otherwise, the impacts of the EPD will not be considered.

Tip: When importing an EPD result to include it in your product system in openLCA, make sure there is a product flow set as the quantitative reference under Inventory result → Outputs (as shown below). If no product flow was available, you can simply create a new one, add it to the outputs, and set it as the quantitative reference. This ensures the EPD integrates correctly into your system model.

19 *NEW* LIBRARIES IN openLCA

Libraries are a new feature in openLCA 2.0. They are a tool that enables faster impact calculations and the use of processes, flows, impact categories, and other relevant information across databases. The faster impact calculation results arise from precalculated matrices (see section "Library file system" for more information). Databases can be exported as libraries, and vice versa; these libraries can be added to existing databases. The data from these imported libraries can then be used normally in the database for LCA modelling. Additionally, libraries enable a more straightforward overview when using the graphical editor, as some details are hidden without compromising the accuracy of the impact calculations.



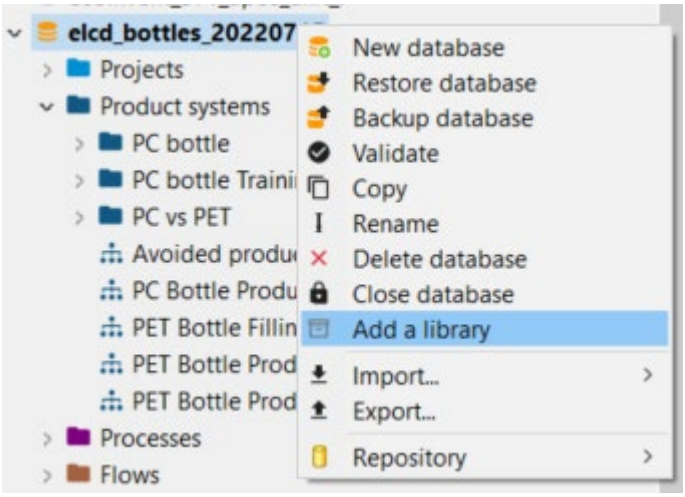
Example of a 'library' product system displayed in the graphical editor of openLCA 1.4

Using libraries also allows for more accurate data exchange with the Collaboration Server, as library data will not be exchanged but instead only referenced.

19.1 ADDING A LIBRARY TO A DATABASE

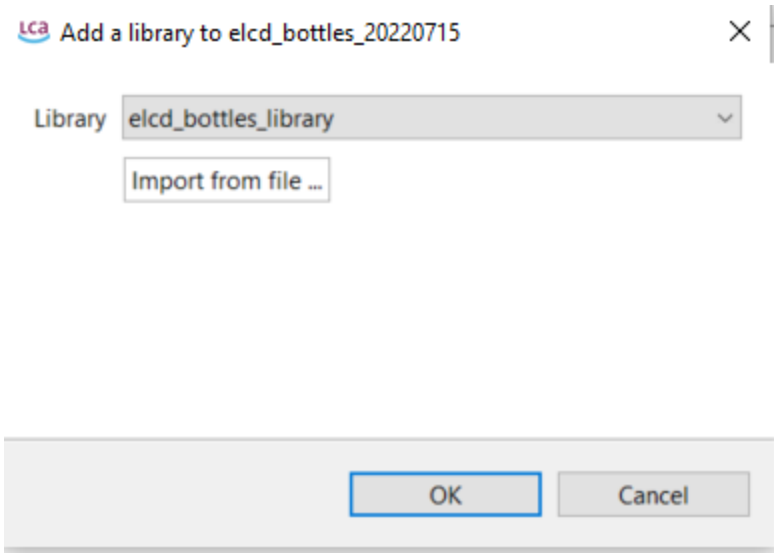
You can add a library to an existing database. To do so:

1. Right-click on the database you wish to add a library to
2. Select "Add a library".



Right click menu data appears in openLCA 1.4 when you click on an existing database

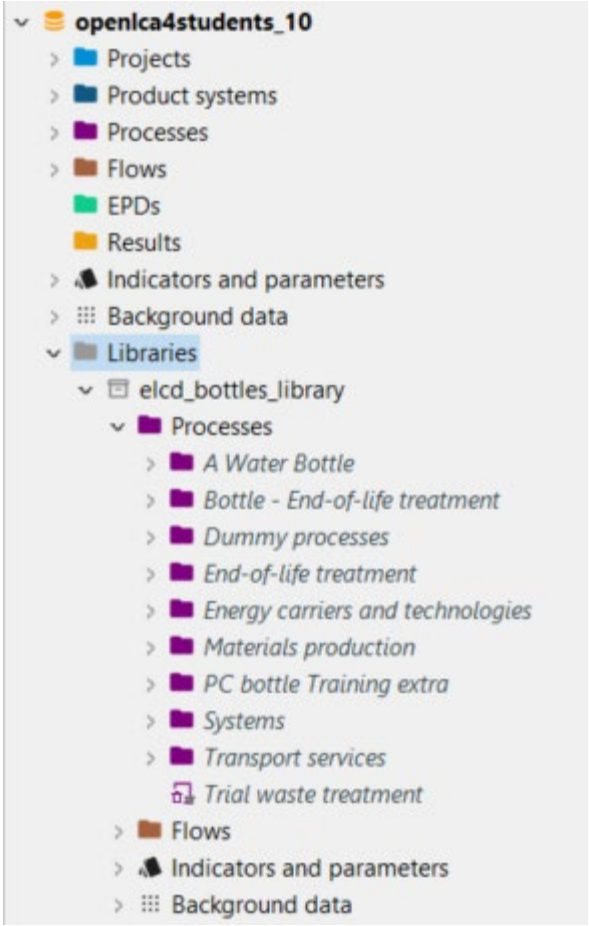
A window will appear, allowing you to select the library you wish to import into the database. The drop-down menu allows you to choose one of the openLCA libraries. If you wish to import an external library, you can do so by clicking on the button "Import from file ...". This will open a conventional explorer window from which you can import a zip-formatted library file. For more information about zip-formatted library files, read the section "Library file system".



The dialogue box that opens when you select to add a library to a database in openLCA. The drop down menu allows you to select from the set of saved libraries.

Before finalising the library import into the database, you will be prompted to confirm whether you wish to add the library to the database. Simply press enter to proceed.

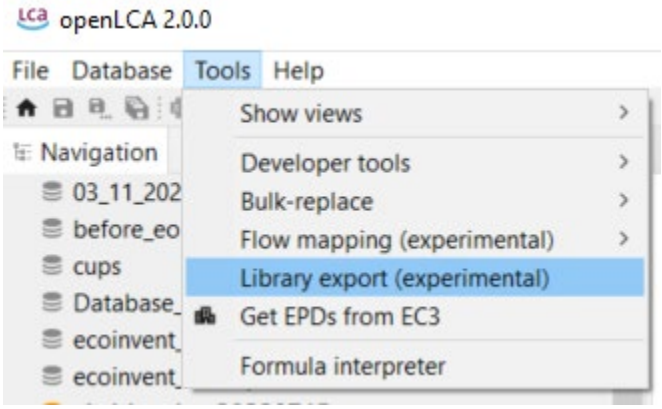
Once added to the database, the processes, flows, etc. will be available in the database. You can recognise everything added from the library by its distinctive cursive font. If you open a library-derived process, be aware that you will be unable to alter the amounts of the inputs or outputs. If you wish to do so, you will need to copy the process in question and make your alterations to the copy. In every other respect, however, you can use processes, flows, etc. from libraries just as you would with those native to the database.



Example of a library that was added to a database in openLCA

19.2 EXPORTING A DATABASE AS A LIBRARY

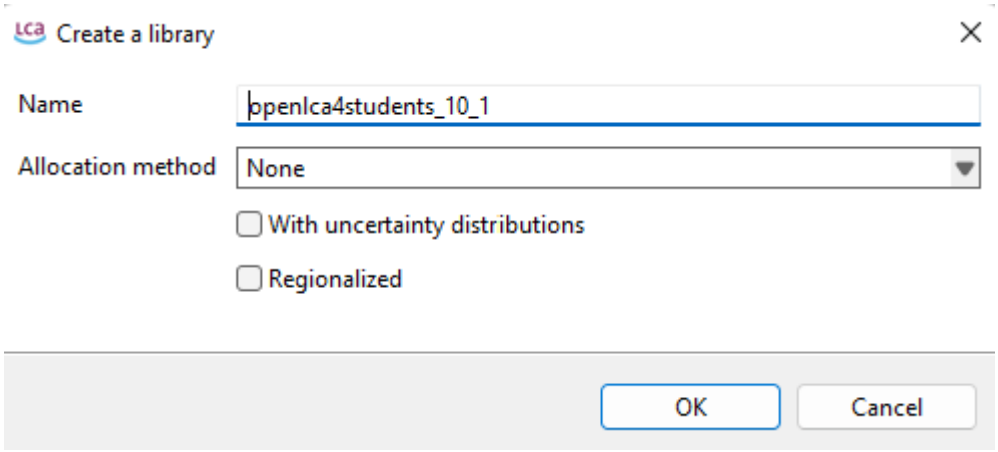
To export a database as a library, open the database you wish to export. In the menu bar of openLCA, go to "Tools"> "Library export".



Menu bar in openLCA to carry out a library export

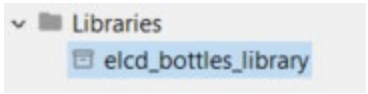
A window will appear in which you can choose the name of your library as well as the allocation method. You can also choose to have the library include regionalisation and uncertainty distributions. Note that including regionalisation and uncertainty

distributions may result in your memory usage becoming very large. Once all settings have been selected as desired, click "OK" to create the library.



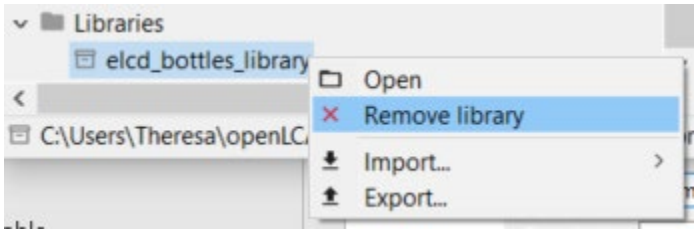
A dialogue box which appears in openLCA when exporting a database as a library

At the bottom of the Navigation bar, a Library folder icon will appear, which is where you will find all libraries you have created and saved.



Examples of libraries in openLCA that were created from existing databases

If you wish to delete a library, you can do so by right-clicking on the library you wish to remove and selecting "Remove library". Ensure the library is not being used in any of your databases, as openLCA checks for library usage and will not allow you to delete the library if it is in use.



The right-click menu data appears when you click on a library in openLCA

19.3 LIBRARY FILE SYSTEM

Libraries enable rapid regionalised calculations of impacts and utilise NumPy matrices to store information. In general, libraries are saved as zip files that can be shared and imported into the openLCA 2.0 database using the "Import from file ..." button. A library contains the following files:

- **A•npy**: This file stores the square A matrix in a numpy format. Each column and row label represents a process-flow pair. Along the diagonal (i.e. where the process-flow pair is identical both in the column and the row axis), the value will be either 1 (for product flows) or -1 (for waste flows). All other entries within the matrix represent the exchanges relative to the base value of 1 or -1 along the diagonal. If an exchange does not occur in a certain process, the value in the square matrix will be 0. All columns and rows are labelled numerically. These labels act as IDs and link to their respective process-flow pairs, referencing IDs in the file indexA.csv.

	process-flow pairs				
	1	0	0.3	0.4	0.2
process-	0	**1**	0	0	0
flow	0.2	0	**1**	0.3	0
pairs	0	0	0	**1**	0
	0.4	0.2	0	0.1	**1**

Schematic representation of the A matrix saved in a 'numpy' file in an openLCA library zip file

- **B•npy**: This file stores the B matrix. This matrix is not square. The columns mirror the rows of the A matrix. This means the columns again represent the identical process-flow pairs of the rows in the A matrix. However, in the B matrix, the rows represent a pair of elementary flows and their corresponding locations. If the elementary flows are not regionalised, only the elementary flow will be indicated here. If an elementary flow-location pair is not associated with a process-flow pair, the indicated amount in the matrix will be 0. All columns and rows are labelled numerically. These labels act as IDs and link to their respective process-flow pairs reference IDs (i.e. column labels) in indexA.csv as well as elementary flow-location pairs reference IDs (i.e. row labels) in indexB.csv.
- **C•npy**: This file stores the C matrix. This matrix is not square and represents the characterisation factors. The columns of the C matrix mirror the rows of the B matrix. Therefore, the columns represent elementary flow-location pairs. The rows in the C matrix represent the impact assessment categories. All columns and rows are labelled numerically. These labels serve as IDs, linking to their respective impact assessment category reference IDs (i.e., row labels) in indexC.csv, as well as elementary flow-location pairs reference IDs (i.e., column labels) in indexB.csv.
- **INV•npy**: This file stores the inverse of the A matrix (i.e. the row and column axes are flipped).
- **M•npy**: This file stores the M matrix, which is the product of the B matrix times the inverted A matrix (INV x B = M).
- **A•npz**: This zip file stores the same A matrix as the one that can be found in A.npy. However, this is a version of that file with all zero-value entries removed to save memory.

- **B.npz**: This zip file stores the same B matrix as the one that can be found in B.npy. However, this is a version of that file with all zero-value entries removed to save memory.
- **C.npz**: This zip file stores the same C matrix as the one that can be found in C.npy. However, this is a version of that file with all zero-value entries removed to save memory.
- **indexA.csv**: This file acts as a mapping file for the numeric column and row labels in the A matrix, as well as the column labels in the B matrix. These mappings associate these matrix labels with the reference IDs of their respective flows and processes in the database.
- **indexB.csv**: This file acts as a mapping file for the numeric row labels in the B matrix as well as the column labels in the C matrix. These mappings associate these matrix labels with the reference IDs of their respective elementary flows and locations in the database.
- **indexC.csv**: This file acts as a mapping file for the numeric row labels in the C matrix. These mappings associate these matrix labels with the reference IDs of their respective impact assessment categories in the database.
- **library.json**: This file contains metadata about the library itself. Parameters include the library name and whether the library is regionalised or not.
- **meta.zip**: This file contains a folder system of openLCA types (e.g. Processes, Flows, Impact Assessment Categories, etc.). Within these folders, you will find the respective openLCA type's JSON-LD files, which mirror the entries in the associated openLCA database from which the library was derived. However, it should be noted that these JSON files do not contain the relative amounts associated with each object (e.g., exchanges or impact fact values), as these are contained within the matrix files. Only the process JSON-LD files contain a reference to the respective values within the A matrix (the values that sit along the diagonal line) to allow for an association between the matrix system and the JSON-LD files.

20 SCRIPTING IN openLCA

openLCA provides powerful scripting capabilities to automate tasks, analyse models, and integrate life cycle data into external tools or workflows. There are two main approaches for scripting:

- Jython (Python) scripting within the openLCA application itself
- Inter-process communication (IPC) using the openLCA IPC API

Both approaches enable automation and interaction with openLCA models, but they differ significantly in terms of how and where scripts are executed, their use cases, and their respective limitations.

JYTHON

Jython is a Python interpreter for the Java platform, and its interpreter is embedded within the openLCA application. Python scripts are compiled to Java bytecode and

executed within the same Java runtime environment as openLCA. This allows the scripts to directly access and interact with openLCA's internal resources—such as the user interface, the current database connection, and other Java components.

It's ideal for small tasks, data extraction, custom calculations, or batch modifications within the openLCA GUI. Since Jython runs inside openLCA, you have access to internal variables like the current database connection and the graphical interface.

📘 We provide a dedicated manual for Jython scripting in openLCA, including real-world examples: Jython scripting manual.

You can also check out some examples on our GitHub.

INTER-PROCESS COMMUNICATION (IPC)

The openLCA IPC (Inter-process communication) protocol allows you to control openLCA from an external script or application. This is especially useful for integrating LCA calculations into automated workflows, external tools, or larger systems. The IPC protocol is language-agnostic and can be used by any application written in any programming language (e.g. Python, JavaScript/TypeScript, .NET, Go, etc.).

This protocol is provided by an openLCA IPC server, which can be either a running instance of the desktop application or a web server with an openLCA backend. An application can connect to such an IPC server to call functions in openLCA, perform calculations, or interact with the database remotely.

📘 To get started, check out the official API documentation: openLCA IPC API.

You can also check out some examples on our GitHub.

WHEN TO USE JYTHON VS. IPC

Both Jython scripting and IPC scripting offer powerful ways to interact with openLCA—but which one is right for your use case? The decision depends on factors such as whether you prefer scripting within openLCA or from an external environment, the level of integration required, and how your workflow is configured.

To help you decide, we've created a comparison table that highlights the key differences between the different approaches.

	Jython	IPC
Can I use this without writing any code?	❌ No	❌ No
Can I use it directly inside the openLCA desktop application?	✅ Yes	⚠️ Only as server
Can I automate repetitive tasks inside openLCA?	✅ Yes	✅ Yes
Can I import data from Excel files (e.g. .xlsx) programmatically?	✅ Yes	✅ Yes

	Jython	IPC
Can I export data or results to Excel automatically?	✅ Yes	✅ Yes
Can I generate custom reports (e.g. Excel summaries, Word reports, etc.)?	✅ Yes	✅ Yes
Can I create/modify processes and flows programmatically without persisting?	✅ Yes	✅ Yes
Can I run SQL commands directly on the openLCA database?	✅ Yes	❌ No
Can I use modern Python libraries, such as NumPy, SciPy, and Pandas?	❌ No	✅ Yes
Can I run scripts from outside openLCA (e.g. from VS Code)?	⚠️ Difficult	✅ Yes
Can I integrate openLCA with other tools or workflows (e.g. REST APIs)?	⚠️ Difficult	✅ Yes
Can I schedule calculations or run them in the cloud?	❌ No	✅ Yes
Can I use it with other languages besides Python (e.g., JavaScript, Go, .NET)?	❌ No	✅ Yes
Does it integrate autocompletion and type annotations?	⚠️ Difficult	✅ Yes

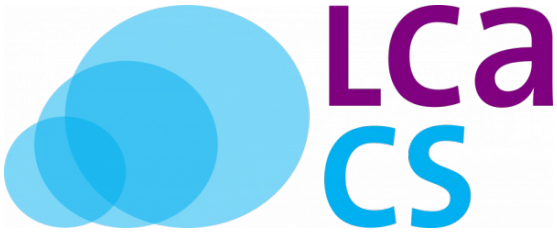
NOTE: Some of the features above can also be done in openLCA without the need for any additional scripting. For example, you can use the openLCA GUI to import and export data from/to Excel files or run SQL commands directly on the database.

21 COLLABORATION IN TEAMS

With the general advancement of Life Cycle Assessment (LCA) and the spreading of Life Cycle Thinking (LCT), collaborative work on LCA studies becomes increasingly common e.g. within a company or team at the exact location, within a company or team at different locations within multilateral projects (e.g. in research) on an international level and under participation of various entities such as companies, universities or consultancies as well as co-development of an LCA among executing contractors and clients. Moreover, it is becoming increasingly commonplace to use reference data for background processes, elementary flows, impact assessment methods, and other elements of existing LCA models. Often, the sharing of reference data for updating databases and distribution to users who are also) Distributed comes along with

technical issues. In addition, the quality assurance and review of LCA models by an external reviewer is of interest to anyone who wants to create a consistent LCA database. The LCA Collaboration Server, now in version 2.0, is a server application that complements openLCA (the LCA desktop application). It is available for free, and support is available on demand.

If you wish to learn more about the collaboration server, please visit the collaboration server manual.



22 openLCA CHEAT SHEET

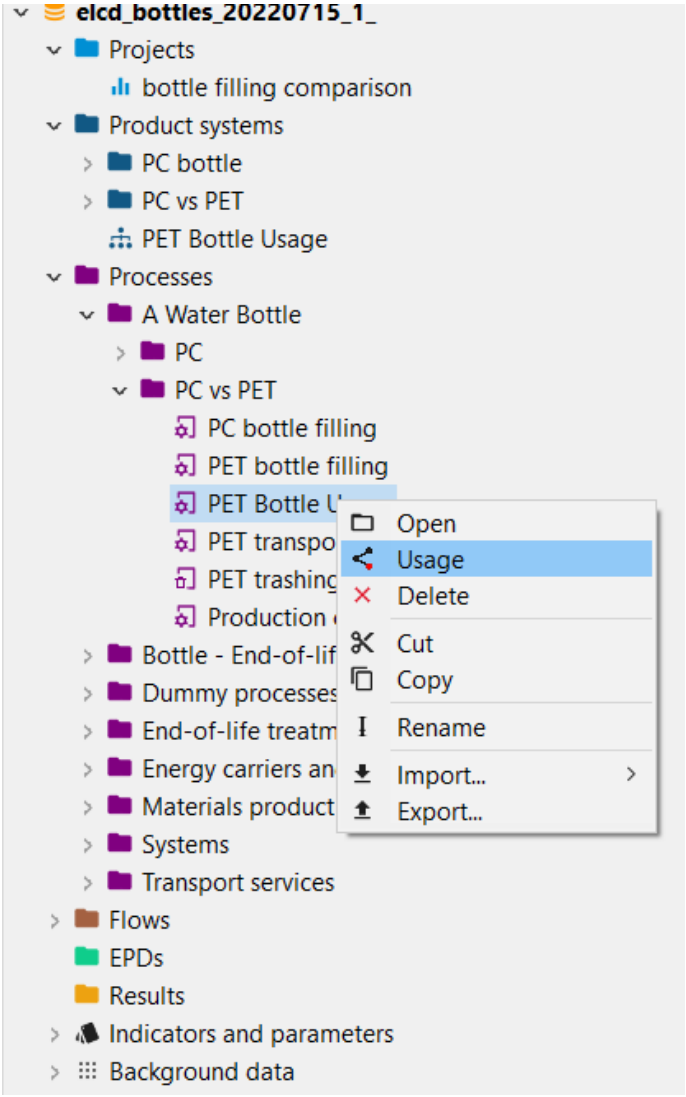
TRICKS CHEAT SHEET

This section is designed to serve as your quick reference guide, providing essential tips, shortcuts, and key insights to maximise your efficiency and productivity when working with openLCA. Whether you are a seasoned user seeking time-saving techniques or a newcomer looking for a comprehensive overview, this cheat sheet will empower you to navigate openLCA's features with ease and confidence.

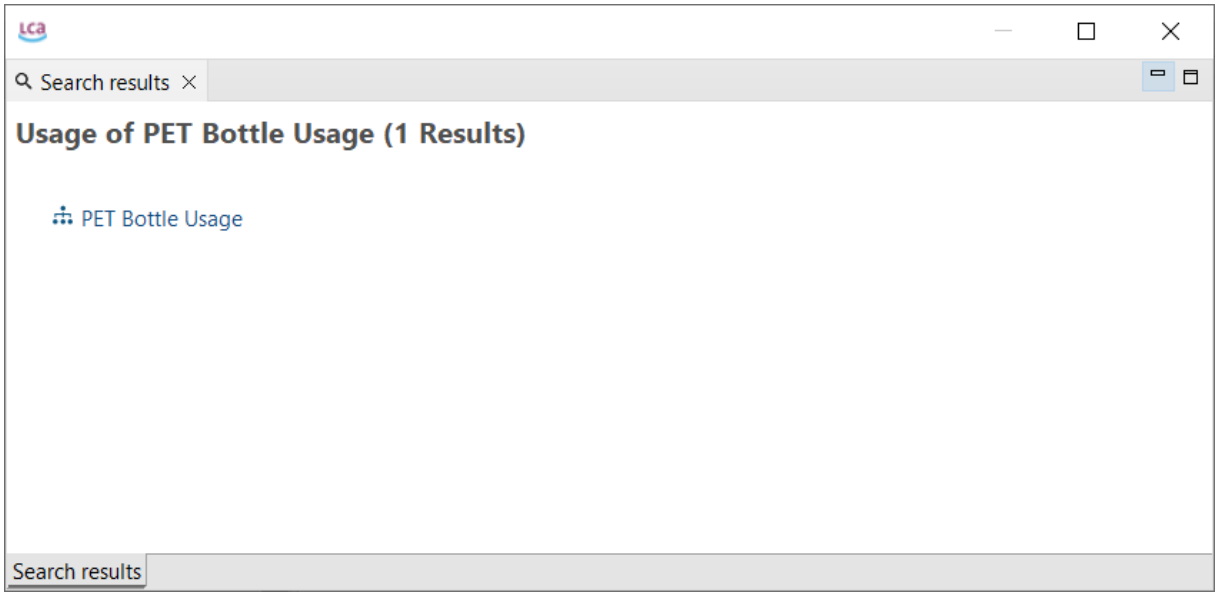
Let us dive in and unlock the full potential of openLCA together. Happy exploring!

22.1 USAGE

The "Usage" function allows you to find where the selected "Flow", "Process", etc., is utilised within the system. For this, right-click on a database element:



After clicking on "Usage", the following window will show where the selected process is used:



This function is helpful, for example, if you want to delete a connected process/flow.

Note: Moreover, the "Used in processes" section in every product or waste flow (General information tab) shows you more detailed "Usage" information.

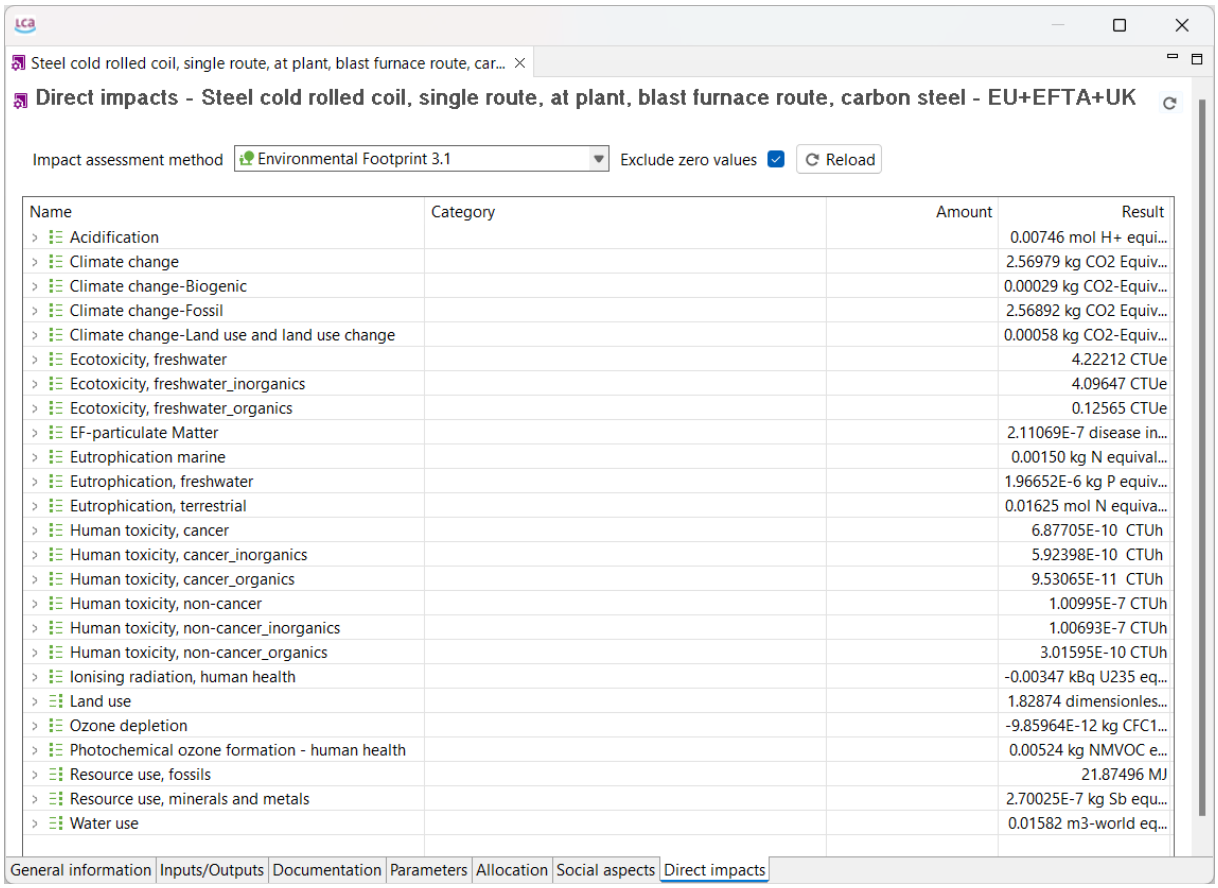
22.2 DIRECT CALCULATIONS IN PROCESSES

openLCA provides the flexibility to calculate the impacts of processes directly, without the need to create product systems. You can either use the "Impact analysis" tab (only direct impacts) or the "Direct calculation" function directly within a process.

DIRECT CALCULATIONS IN THE IMPACT ANALYSIS TAB

If you don't want to generate a product system to calculate the direct impacts of a process, you can directly use the "Impact Analysis" tab in processes! It enables you to select raw materials and services with low environmental impacts directly from an LCI database without the need to create a product system.

In the "Impact Analysis" tab of a process, the process's direct impact is calculated. Hence, only elementary flows present in this process will be considered (no upstream impacts). You can select the impact assessment method directly within the tab, and the results will update dynamically accordingly.

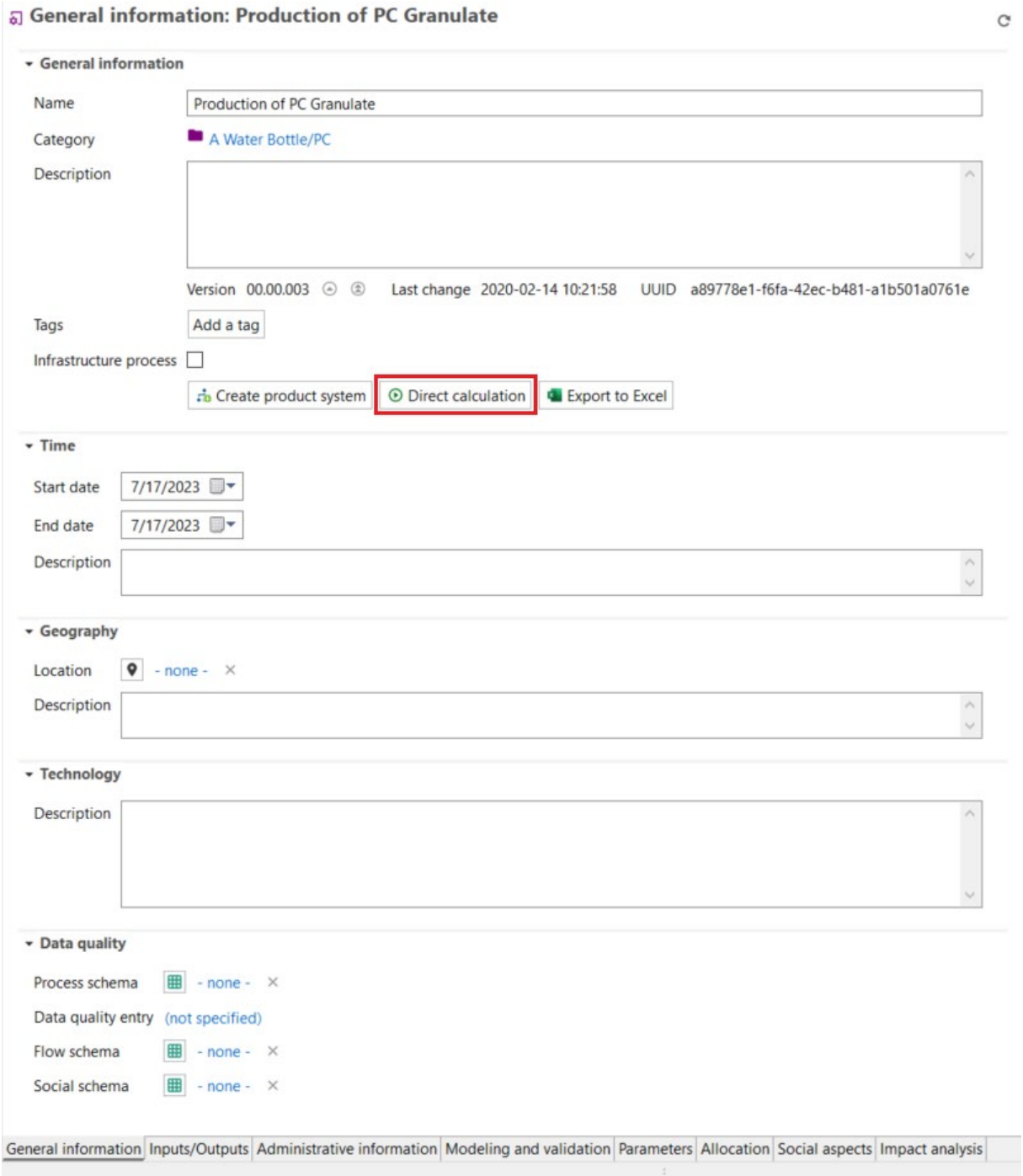


Impact analysis of a process representing the direct impacts

However, to perform overall impact calculations, you can explore the sections "Calculation and Result Analysis" and "LCIA methods and categories".

DIRECT CALCULATION IN THE GENERAL INFORMATION TAB

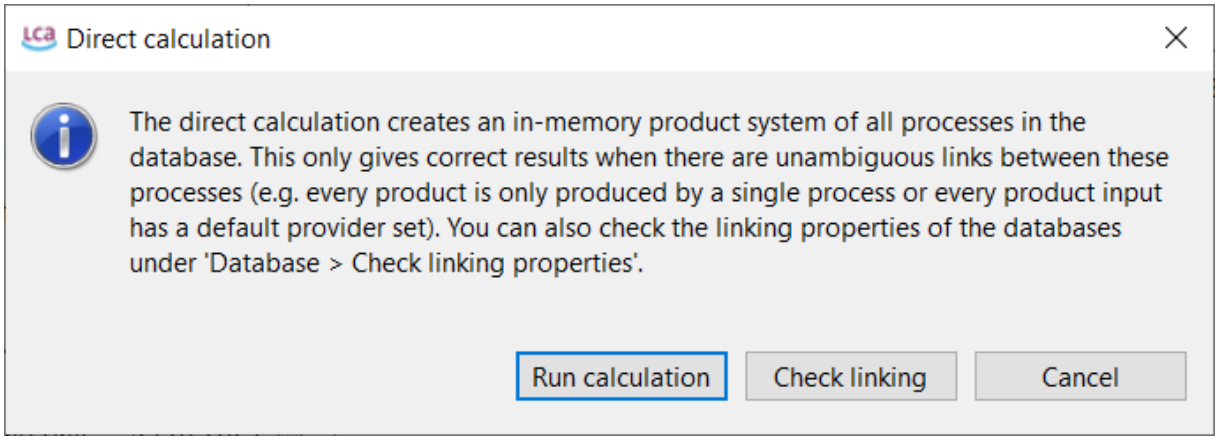
A fast way to perform overall calculations without generating a product system is by using the "Direct calculation" button in the "General information" tab of a process. This feature generates an in-memory product system comprising all processes in the database.



Direct calculation option in the „General information" tab of a process

However, accurate results are only obtained when there are unambiguous connections between these processes.

For example, each product should have a single process responsible for its production, and every product input should have a default provider assigned to it. To ensure the integrity of the connections (linking) between processes in the database, you can navigate to "Database → Check linking properties" or use the "Check linking" option in the pop-up window after selecting "Direct calculation".



Check the linking prior calculation.

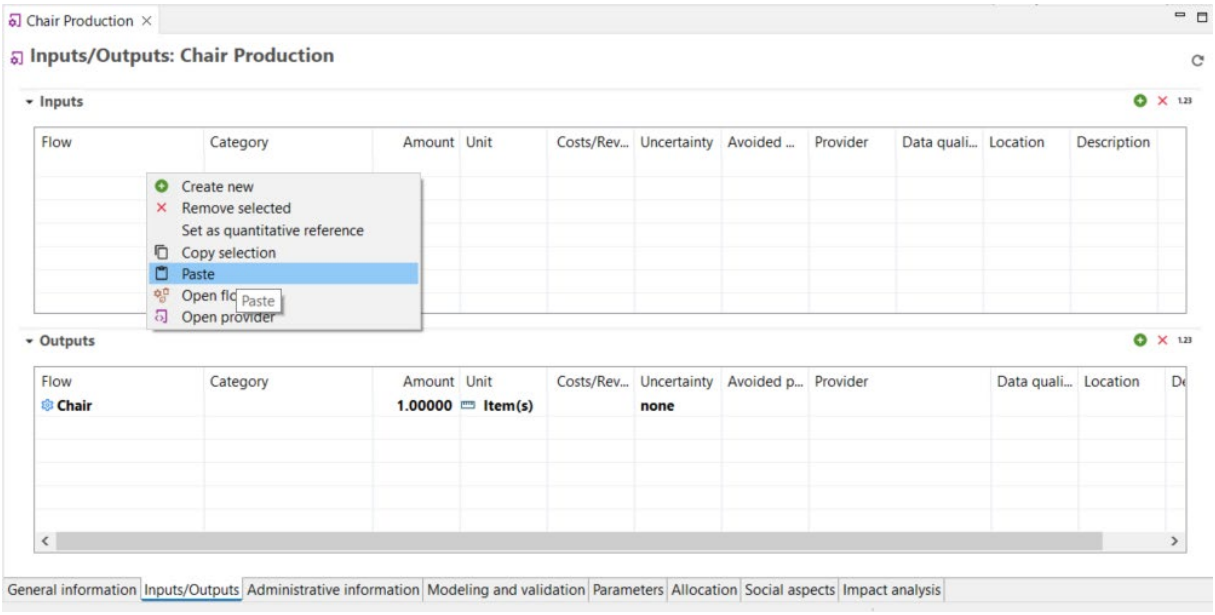
The main advantage of "Direct calculation" is its efficiency in terms of memory usage. It eliminates the need to create a product system in advance, offering a practical solution. This is particularly advantageous for large databases such as PSILCA, Exiobase, and GaBi.

22.3 openLCA AND EXCEL

It is possible to copy data from Excel into a process in openLCA, provided the Excel table has the same column structure and column headings as the process inputs/outputs table in openLCA. See below.

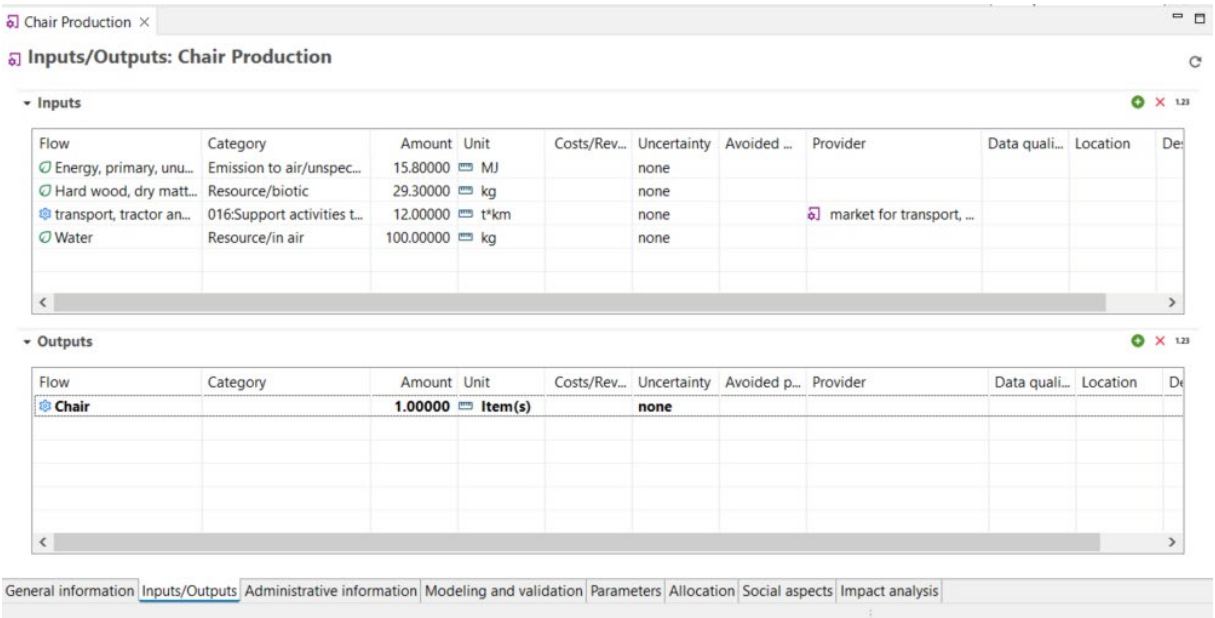
	A	B	C	D	E	F	G	H	I	J	K
1	Flow	Category	Amount	Unit	Costs/Revenues	Uncertainty	Avoided waste	Provider	Data quality entry	Location	Description
2	Energy, primary,	Emission t	15.8	MJ		none					
3	Hard wood, dry r	Resource/	29.3	kg		none					
4	transport, tracto	016:Suppc	12	t*km		none		market for			
5	Water	Resource/	100	kg		none					

Excel template.



Paste Excel data into a process in openLCA

Copied data:



Copied Excel data into openLCA

To select specific columns and rows for copying, follow these steps:

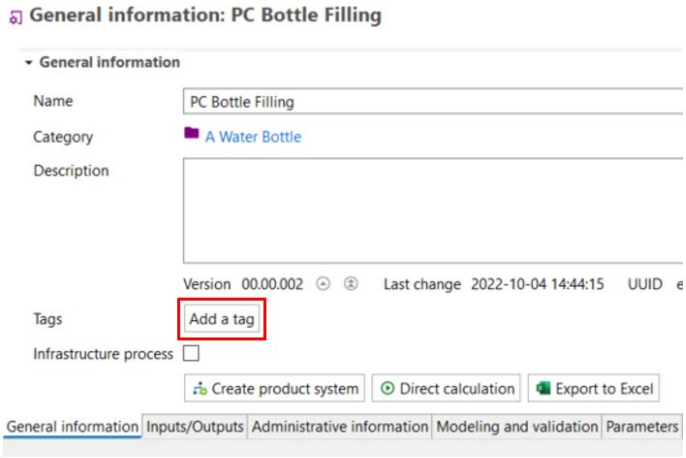
1. Click on a cell within the table to begin the selection.
2. Hold the "Shift" button on your keyboard.
3. Click on another cell in the table to mark a range of rows and columns. All the rows and columns between the initial and final selection will be highlighted.
4. Right-click within the selected area.
5. Choose "Copy selection" from the context menu.

22.4 TAGS

In openLCA, tags are a feature used to organise and search data objects within the software. They provide a way to assign labels or keywords to elements in your LCA model, such as processes, flows, or impact categories, and can be later used to analyse your results or organise your data by tags.

ADDING TAGS

Each element within openLCA can have multiple tags associated with it. To add tags, navigate to the "General information" tab of a flow, process, product system, or impact category, or the "Project setup" tab of a project, and click "Add a tag." A wizard will appear, allowing you to specify the tag's name and provide a description.



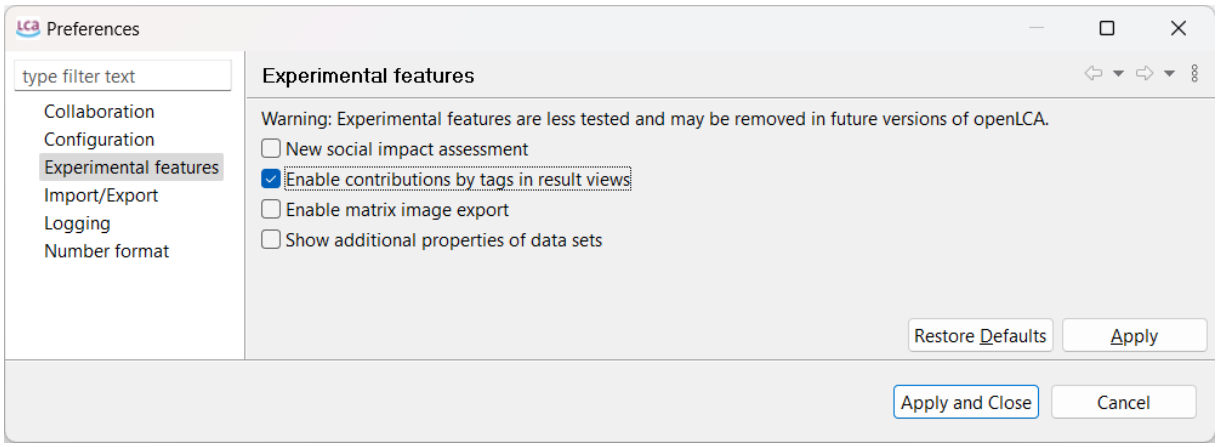
SEARCHING USING TAGS

You can search by tags by prefixing a word with #. This only works with single-word tags.

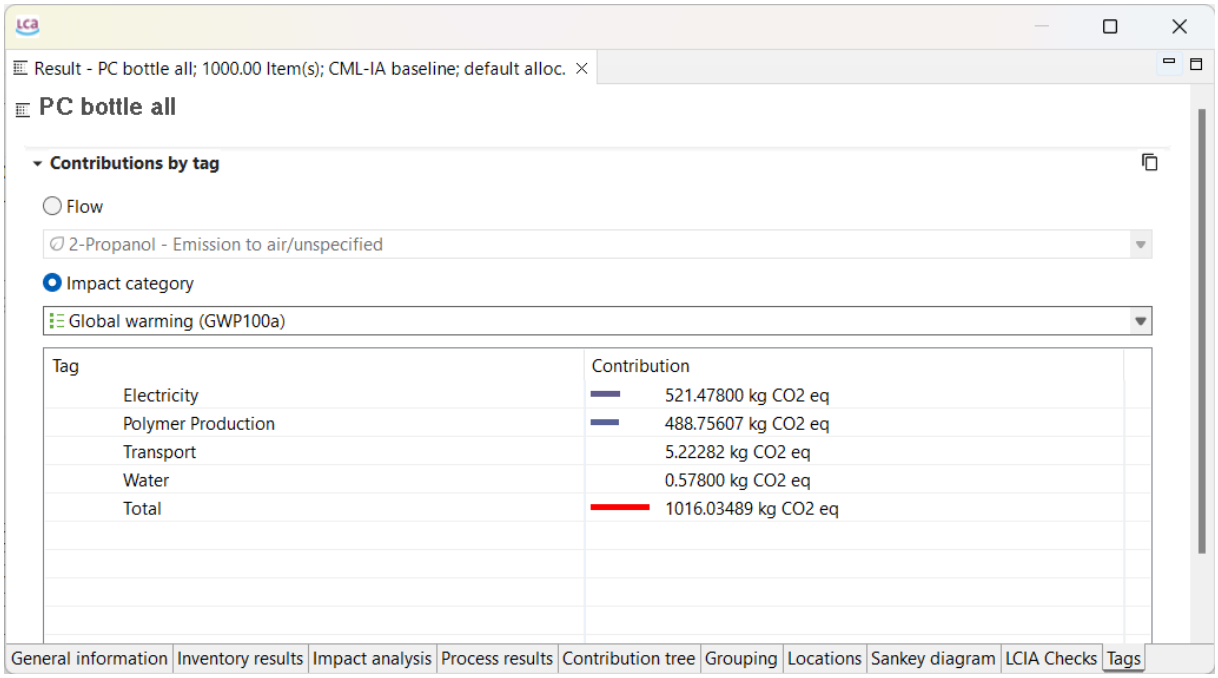
TAGS IN THE RESULTS

In contrast to using the "Grouping" function in openLCA, you can also analyse your results by using tags that have been added to flows/processes/product systems.

To display the "Tags" tab in the results, you have to activate the options prior to the Preferences:



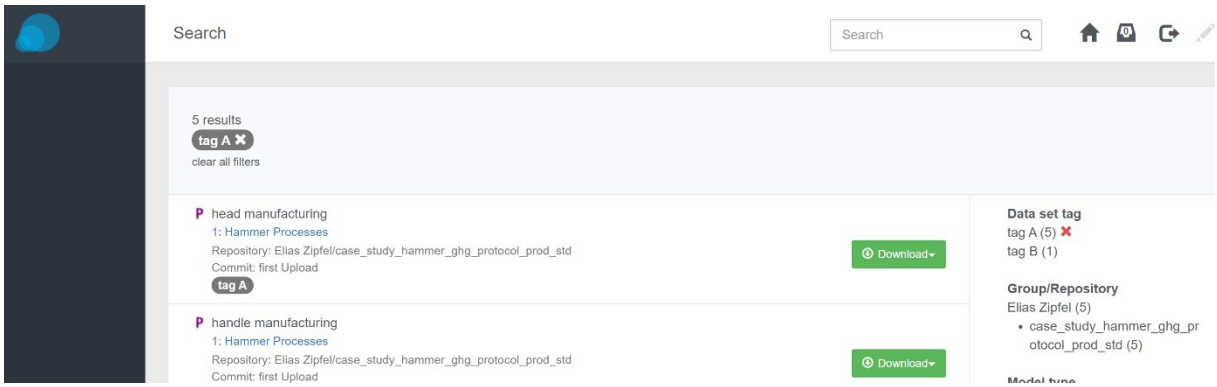
After the restart of openLCA, you will be able to analyse your results using the provided tags:



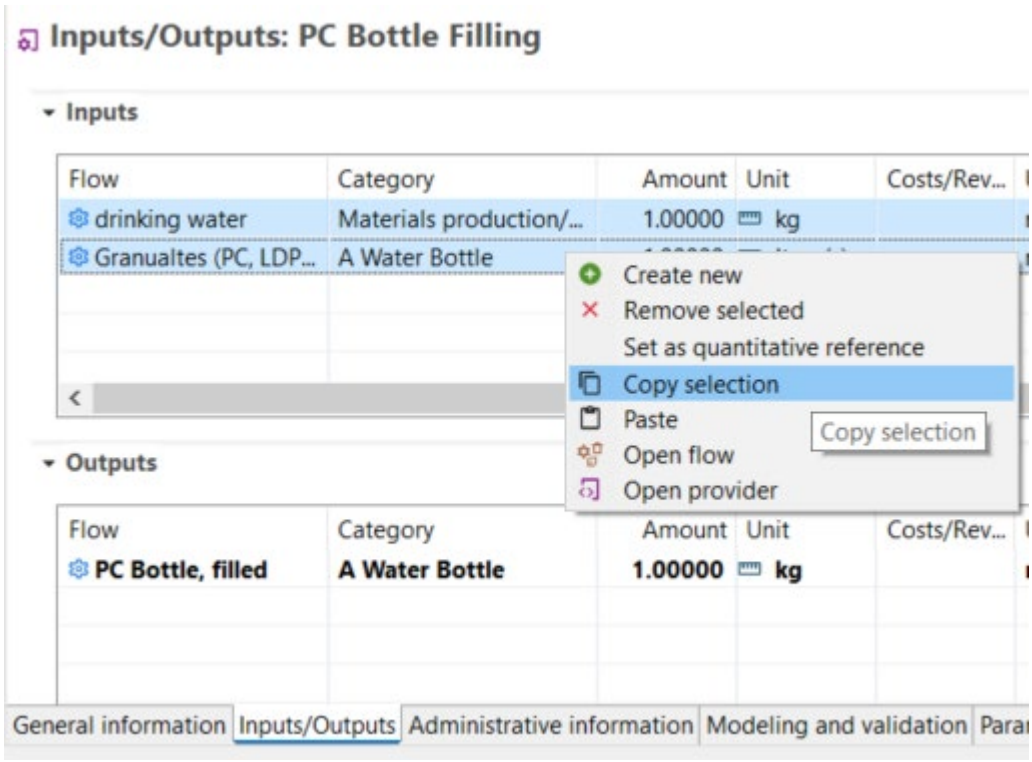
Tags are already provided for some databases, e.g. ecoinvent. Hence, you can analyse your results accordingly. As you can also assign several tags to a flow/process/product system, multiple mentions in the "Tags" tab can occur.

TAGS IN THE COLLABORATION SERVER

In addition, users can filter by tags on the Collaboration Server, which is a great way to locate and organise shared data if a consistent tagging system is used within the team.



Searching for Tags in Collaboration Server



Copying data from openLCA tables

22.5 CONSTANTS, OPERATORS AND FUNCTIONS FOR FORMULAS IN OPENLCA

When you add a formula in openLCA (e.g. in the amount cell of the Inputs/Outputs tab), the formula interpreter allows you to use these constants, operators and functions.

CONSTANTS

Constant	Description	Value
pi	the ratio of the circumference to the diameter of a circle	3.141592653589793
e	base of the natural system of logarithms	2.718281828459045

OPERATORS

Precedence	Operator	Description	Example
7	- (unary)	negation	-1 #> -1
6	^	exponentiation	2^3 #> 8
5	*	multiplication	2*2 #> 4
5	/	division	2/2 #> 1
5	div	integer division	7 div 2 #> 3
5	mod	modulus	7 mod 2 #> 1
4	+	addition	1+1 #> 2
4	-	subtraction	1-1 #> 0
3	= ==	equal to	1 = 1 #> true
3	<> !=	not equal to	1 <> 2 #> true
3	<	less than	2 < 2 #> false
3	<=	less than or equal to	2 <= 2 #> true
3	>	greater than	3 > 2 #> true
3	>=	greater than or equal to	3 >= 4 #> false
2	& &&	logical and	true() & false() #> false
1	| ||	logical or	true() | true() #> true

FUNCTIONS

Function	Description	Example
abs(x)	the absolute value of x	abs(-1) #> 1
acos(x)	arccos(x) the inverse cosine of x	acos(-1) #> 3.14159265
and(x1;x2;...xn)	logical and	and(1<2;2>1) #> true
asin(x)	arcsin(x) the inverse sine of x	asin(-1) #> -1.57079633
atan(x)	arctan(x) the inverse tangent of x	atan(-1) #> -0.785398163
avg(x1;...;xN)	mean(x1;...;xN) the arithmetic mean of the given numbers	avg(1;2;3) #> 2
ceil(x)	the smallest integer not less than x	ceil(2.2) #> 3
cos(x)	the cosine of x	cos(0) #> 1
cosh(x)	the hyperbolic cosine of x	cosh(0) #> 1
cotan(x)	cot(x) the cotangent of x	cotan(pi/2) #> 0
exp(x)	Euler's number e raised to the power of x	exp(2) #> 7.38905609893065
floor(x)	the largest integer not greater than x	floor(2.7) #> 2
frac(x)	the fractional part of x	frac(2.7) #> 0.7
if(b;x;y)	iff(b;x;y) iif(b;x;y) returns x if b evaluates to true, otherwise y is returned	if(1>2;1;2) #> 2
ipower(x;y)	raises x to a power of y (y is an integer)	ipower(4;2) #> 16
ln(x)	the natural logarithm (base e) of x	ln(7.38905609893065) #> 2
lg(x)	log(x) the base 10 logarithm of x	lg(1000) #> 3

Function	Description	Example
max(x1;...;xN)	the maximum of the given numbers	max(1;2;3) #> 3
min(x1;...;xN)	the minimum of the given numbers	min(1;2;3) #> 1
not(b)	The logical complement of b	not(false) #> true
or(x1;x2;...;xn)	logical or	or(1<2;2<1) #> true
power(x;y)	pow(x;y) raises x to a power of y	power(4;2.2) #> 21.112126572366314
random()	Returns a random number between 0 and 1	random() #> ...
round(x)	rounds x to the nearest integer	round(2.5) #> 3
sin(x)	the sine of x	sin(2*pi) #> 0
sinh(x)	the hyperbolic sine of x	sinh(0) #> 0
sqr(x)	the square of x	sqr(2) #> 4
sqrt(x)	the square root of x	sqrt(4) #> 2
tan(x)	the tangent of x	tan(pi/4) #> 1
tanh(x)	the hyperbolic tangent of x	tanh(0.5) #> 0.46...
trunc(x)	int(x) the integer part of x	trunc(2.7) #> 2

22.6 SHORTCUT KEYBOARD

openLCA allows you to use keyboard shortcuts. Here is a small selection:

Shortcut	Action
Ctrl + C	Copy
Ctrl + V	Paste
Ctrl + X	Cut
Ctrl + A	Select All
Ctrl + S	Save
Ctrl + E	Switch editor
Ctrl + M	Maximise/minimise editor
Ctrl + W	Closes active tab
Space	Reloads the current tab

Contact and Support

ECOThink (questions about this manual and the ECOThink training):

For questions related to this adapted manual or ECOThink training activities, please use the contact form on the official ECOThink Hub website: ecothink-hub.eu

openLCA (official documentation and software support):

Official openLCA 2 online manual (maintained by GreenDelta): available via the openLCA manual site.

Software-related questions: please use the ask.openlca.org user forum.

Manual-related feedback (official manual): manual-feedback(at)greendelta.com.