QLCA v3

Step by Step Tutorial

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1 Theoretical Framework of an LCA

Functional Unit: The first step in a life cycle assessment is to define a functional unit. This unit is what you will be comparing. Choosing the right functional unit is important because it ensures that you can compare apples to apples. A functional unit must have the following characteristics:

- Quantified: It should be a measurable unit (consumption per year, per km, per hour, per cycle of use). Here it is important to choose a metric that makes sense. For many automotive cases, this can be per vehicle, per km or per production run.

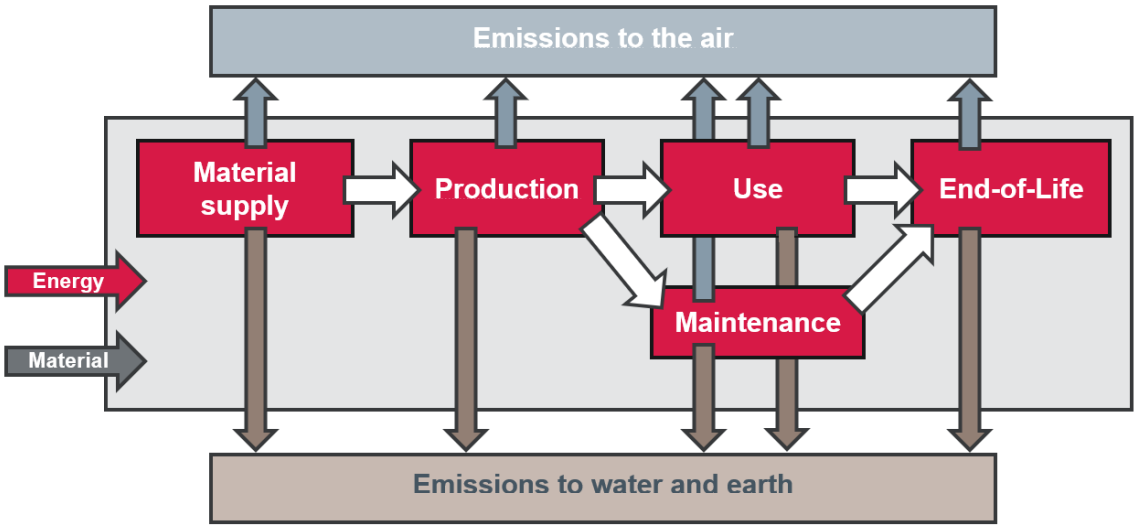
- Function: You should preferably describe a functional outcome rather than a product (e.g. transporting goods, drinking coffee, keeping feet warm, carrying a chassis). The reason for this is that products are used by people to perform a function and it does not necessarily matter what kind or how many products are needed to achieve the desired result.

Example 1: To compare two trucks with different maximum loads, one could compare truck A (maximum load 1.5 t) with truck B (maximum load 1 t). But if truck B has to drive 1.5 times to transport the same amount of material as truck A, the comparison from vehicle to vehicle is not meaningful. A better functional unit would be the transport of 1 kg (or 1 tonne) over a distance of 1 km. For truck A, the vehicle emissions would be divided by 1.5 (it only takes 75% of these emissions to transport 1 tonne), but for truck B by 1. This gives a fair comparison.

Other examples of functional units:

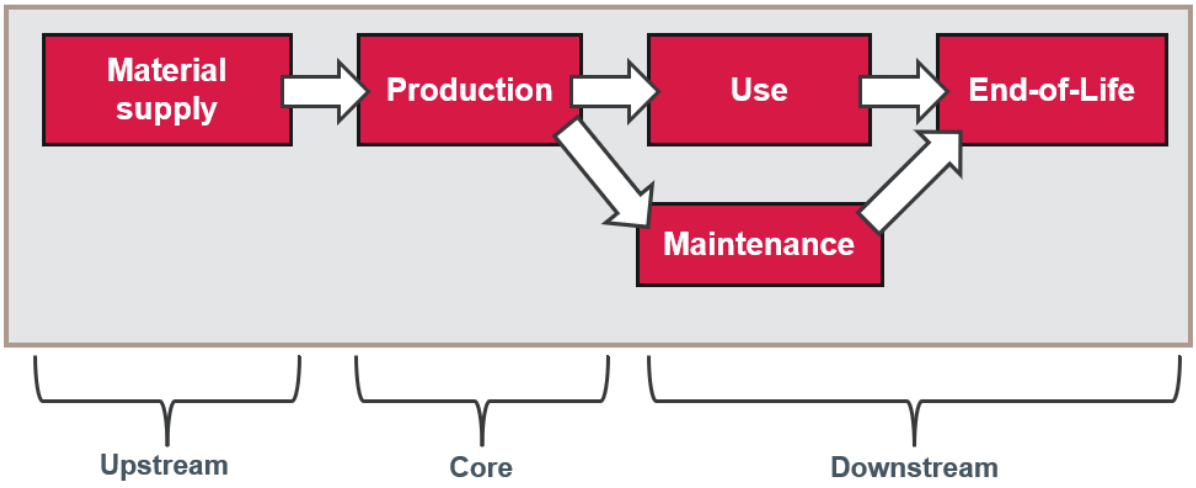
- Lighting a 10 m² room with 1000 lumens for one year.
- The floor of a 300 kg car lasts 300,000 km without corrosion.
- 1 year of parts production in factory X.
- Transporting 1 person over 1 km
- Fixing and protecting (water, dust) of component X.

System boundary: System boundaries are important to know what to include and what to leave out. An important point to keep in mind when setting system boundaries is how much control you have over your product at different stages of its life and how much responsiveness you assume for your product. There are different types of analysis and it is important to know what type of analysis you are doing as this will affect the data you enter into your life cycle analysis. Let's first look at a full product life cycle within its boundaries (the grey box), then we can see what types of analyses there are and when they are relevant:

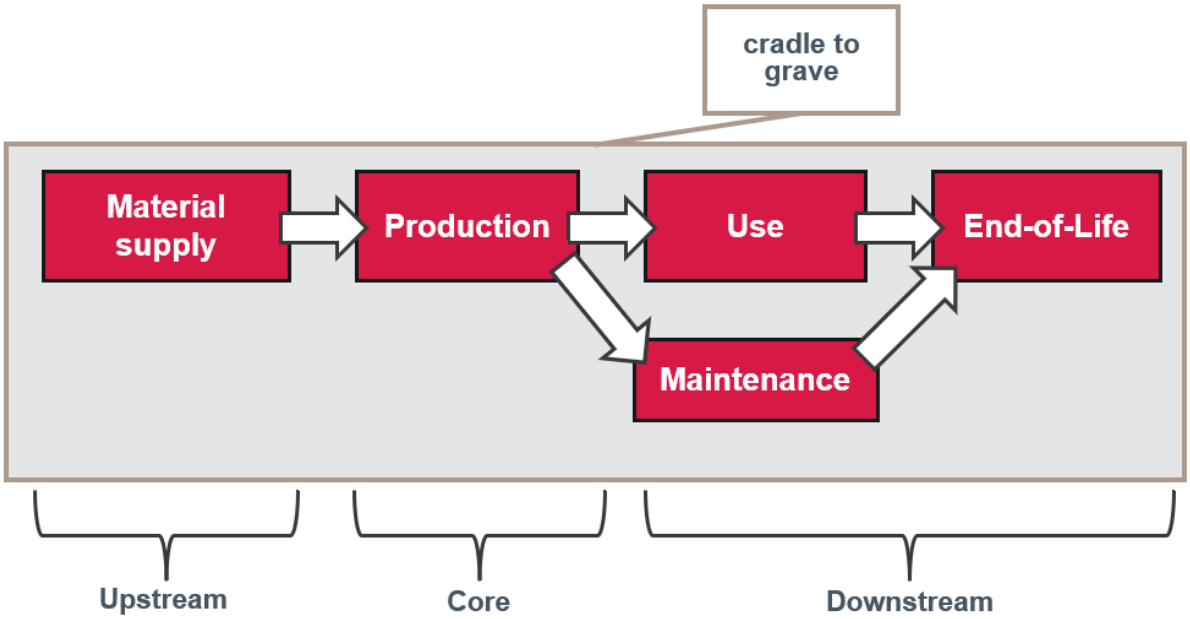


The grey box (in the middle) shows the system boundary of the entire product life cycle. A life cycle assessment analyses all the materials and energies that go into this system, and it quantifies and shows the impact of the emissions that leave the system.

This product life cycle can be divided into the following phases:

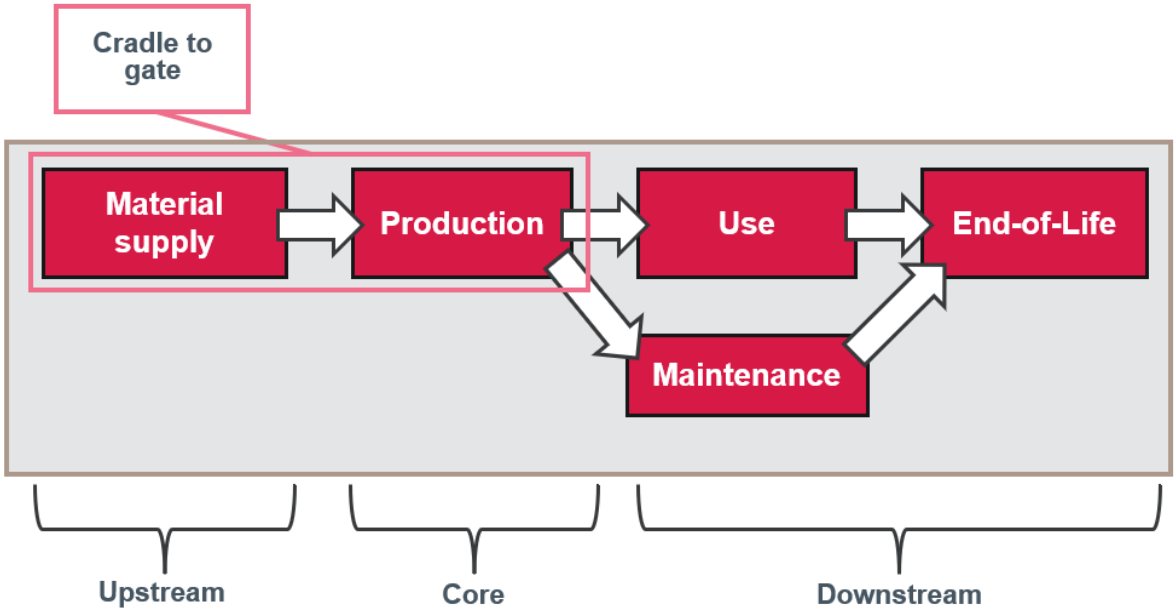


To improve clarity within the system boundaries, a division into "Upstream", "Core" and "Downstream" phases was made.



A cradle to grave analysis analyses the complete product lifecycle.

What most people understand by an LCA would be called a cradle to grave analysis. Here the system boundary (shown in yellow brown) is the same as the system boundary for the entire product life cycle. This analysis is performed when the customer is responsible for all aspects of the product life cycle. The customer has the power to select suppliers, specify materials, select powertrains and set product quality standards. This LCA is performed to inform decision makers and legislators about the emissions of your product. Typical clients for this type of analysis are OEMs.

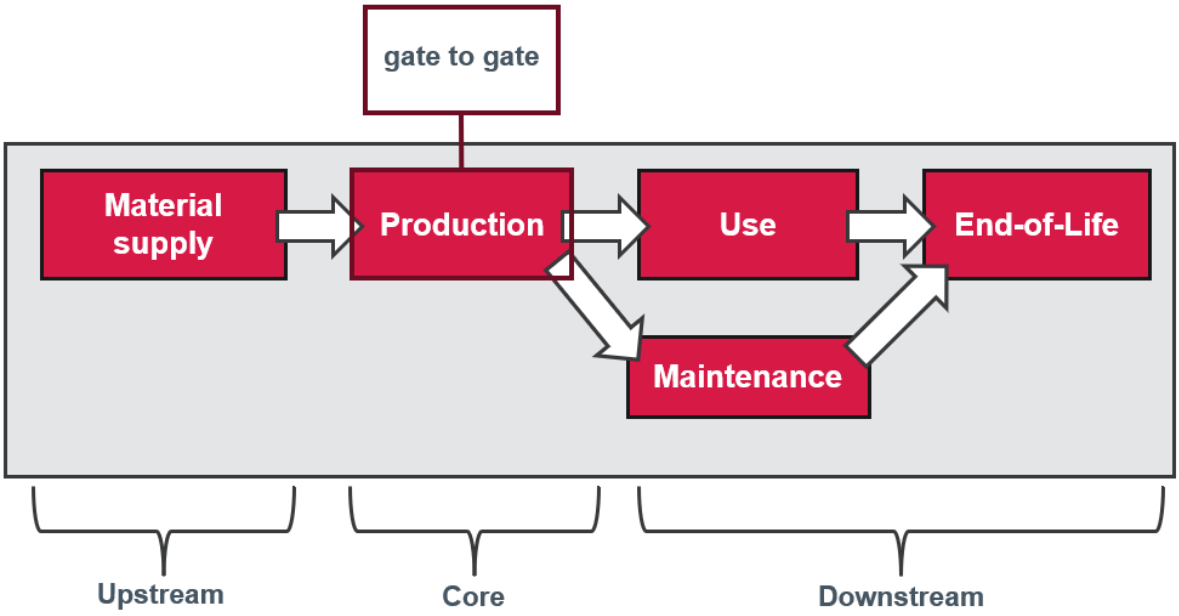


A cradle-to-gate analysis looks at everything from the early product phase to the point where the product leaves the factory to go to the customer.

In many LCAs, especially when carried out by suppliers, they have no control or influence over certain stages of the product. It is important for them and their customers to know everything that has happened up to the point where they sell their product to the OEM. This is where the control and responsibility for the wider impact of the product shifts to the OEM.

This system boundary, which covers only the part of the product life cycle from the beginning to the moment it leaves the supplier's factory gate, is called cradle-to-gate analysis. This type of analysis is useful when you have control over your material suppliers and your internal processes, but no control over exactly what type of product your parts are used in. Your data is used as input for a cradle-to-grave analysis, which is performed by the OEM. Typical customers for a cradle-to-gate analysis are first-tier suppliers (system suppliers).

In some cases, you just want to see where the emissions are coming from in your operation. This type of analysis is useful when you have no control over the material selection of your products or when you add new processes to existing products (e.g. surface treatments or special machining operations). This is called gate-to-gate analysis. It examines the processes, process losses and material consumption during these processes (lubricants, cleaning agents, etc.). The results of a gate-to-gate analysis can feed into a cradle-to-grave or cradle-to-gate analysis. Typical customers for this type of analysis are build-to-print suppliers, surface treatment companies and suppliers of a specific product treatment or process.



A gate-to-gate analysis only examines what happens inside the factory walls.

2 Introduction

The QLCA tool was developed internally by EDAG to get a first impression of a CO2 footprint with little and only estimated inputs. It is used for estimation and comparison of different concepts in early development phases.

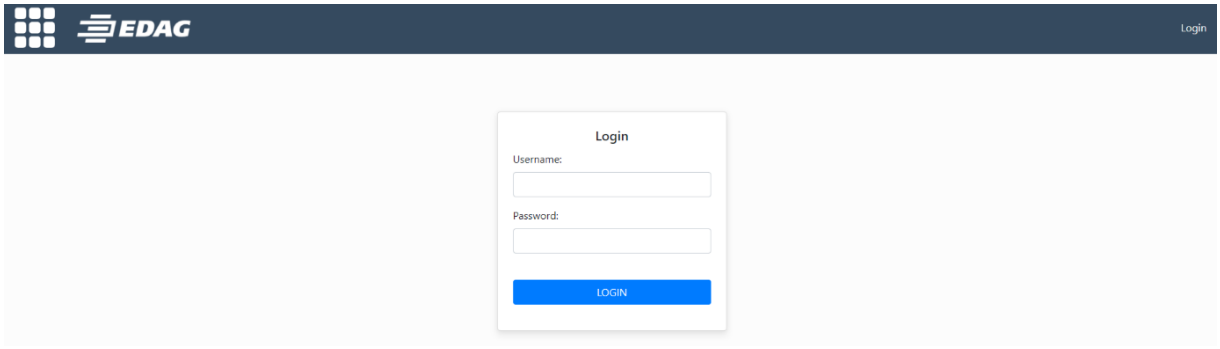
It is important to note that it is not a tool for calculating absolute values for the emissions of a component, but rather a tool for an estimated comparison of concepts. Such a use would represent misuse.

The sole purpose of the software is to estimate the CO2 emissions of materials, processes, transport routes and use phases in early development when comparing different concepts. The tool does not work according to norms.

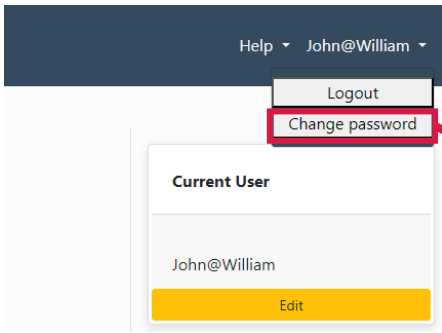
Absolute values according to a norm can be investigated via LCA-Software.

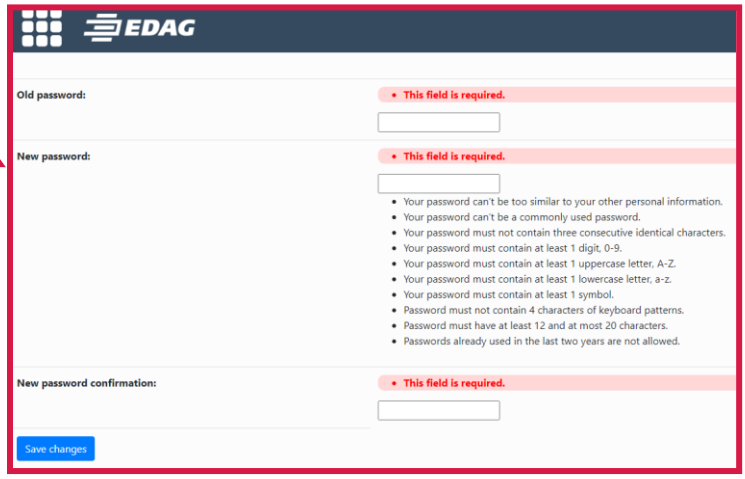
2.1 Getting started

Start the tool via the link provided.



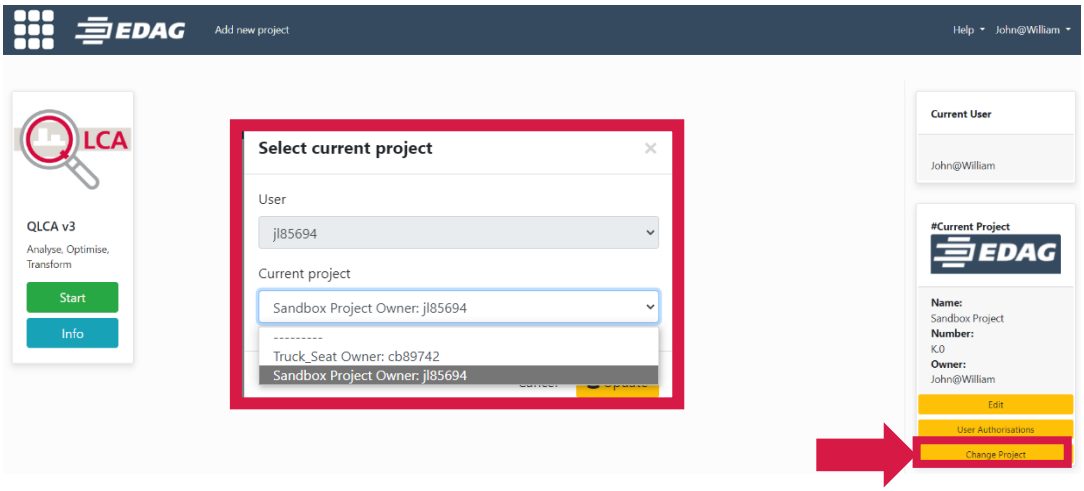
Login with your username and password provided. Then change your initial password to a personal password.



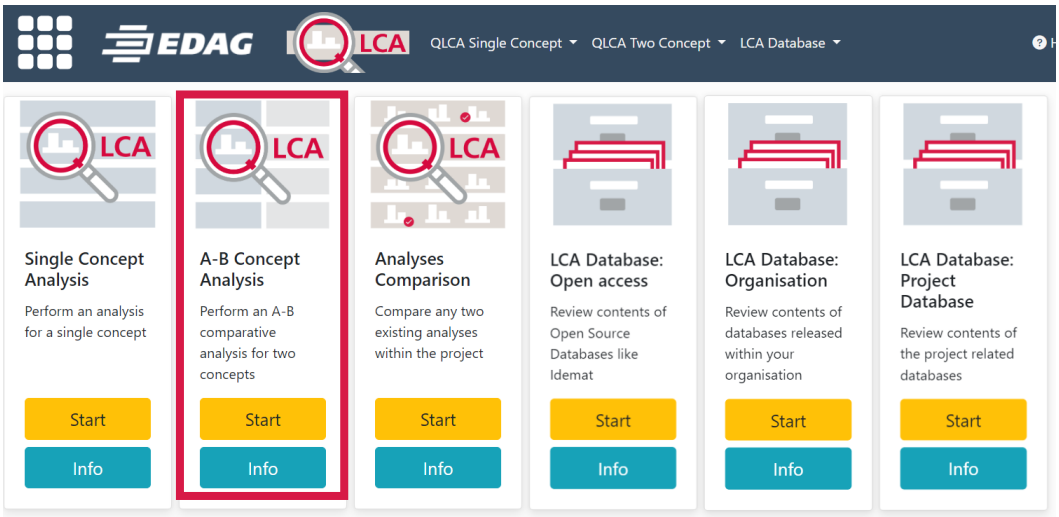


Once you have changed your password, you are now ready for login with your new password.

On the landing page you can now see The QLCA tool ("**QLCA v3**". If you press "Start" you will get to the next page). Before that, you can select the corresponding project by clicking “Change Project" on the right (if there already is a project). Creating an analysis is always related to a project. Created analyses are saved in the chosen project. You can only see analyses from the project you have selected



There are **six** options to choose from:



Single Concept Analysis allows you to perform an analysis for a single concept.

A-B Concept Analysis allows you to perform an A-B comparison analysis for two concepts.

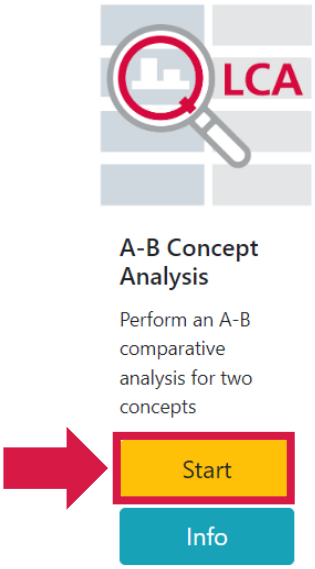
Analyses Comparison allows you to compare any two **existing** analyses within the project.

LCA Database: Open access enables exact viewing of Open-Source Databases like Idemat with which the QLCA tool works.

LCA Database: Organisation enables the exact viewing of the databases from your organisation.

LCA Database: Project Database enables the exact viewing and editing of project databases specific to one's own or other projects.

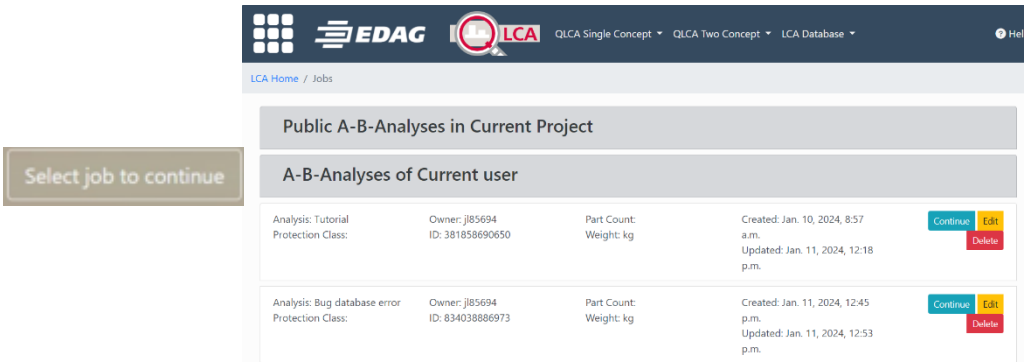
Select **Quick Lifecycle Analysis (QLCA): Two Concept**



Now there are four options in this menu:

Continue your last job opens the last QLCA comparison/job you worked on

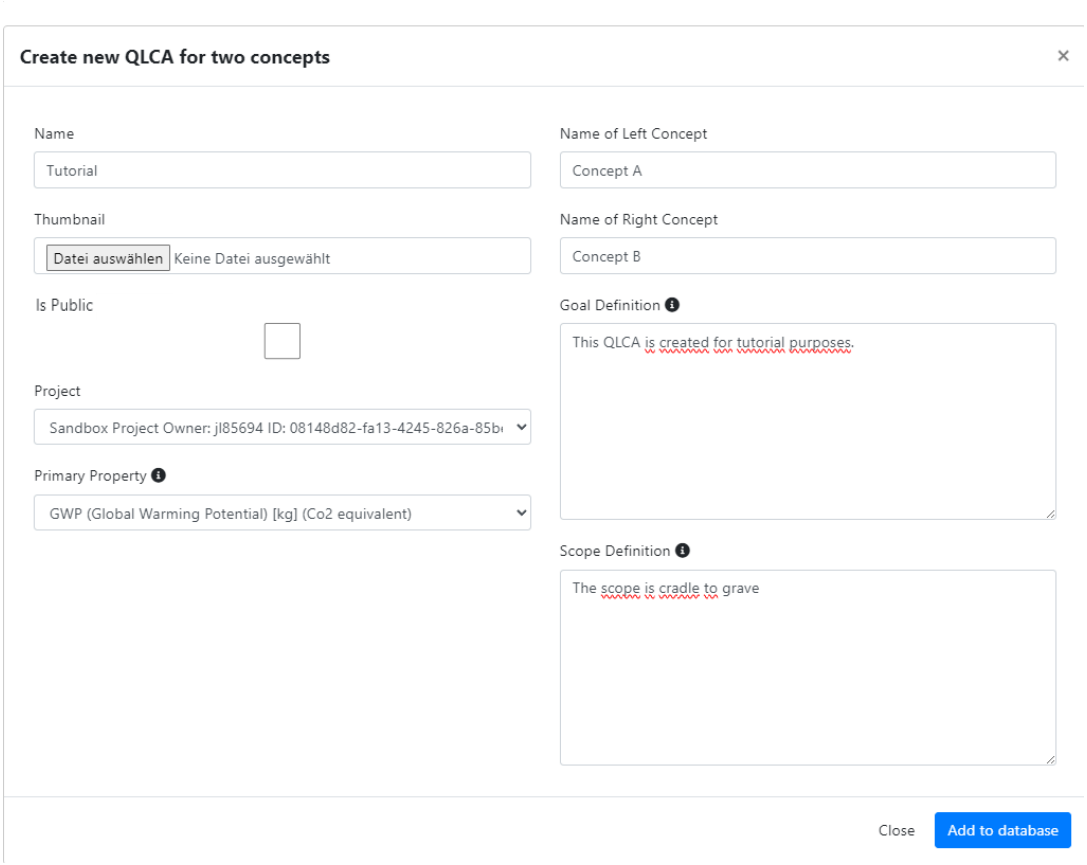
Select job to continue opens a menu where you can edit or continue one of your previous comparisons/jobs.



Tutorial shows this tutorial on the QLCA tool.

Start new job starts a new comparison.

Select **Start new job**



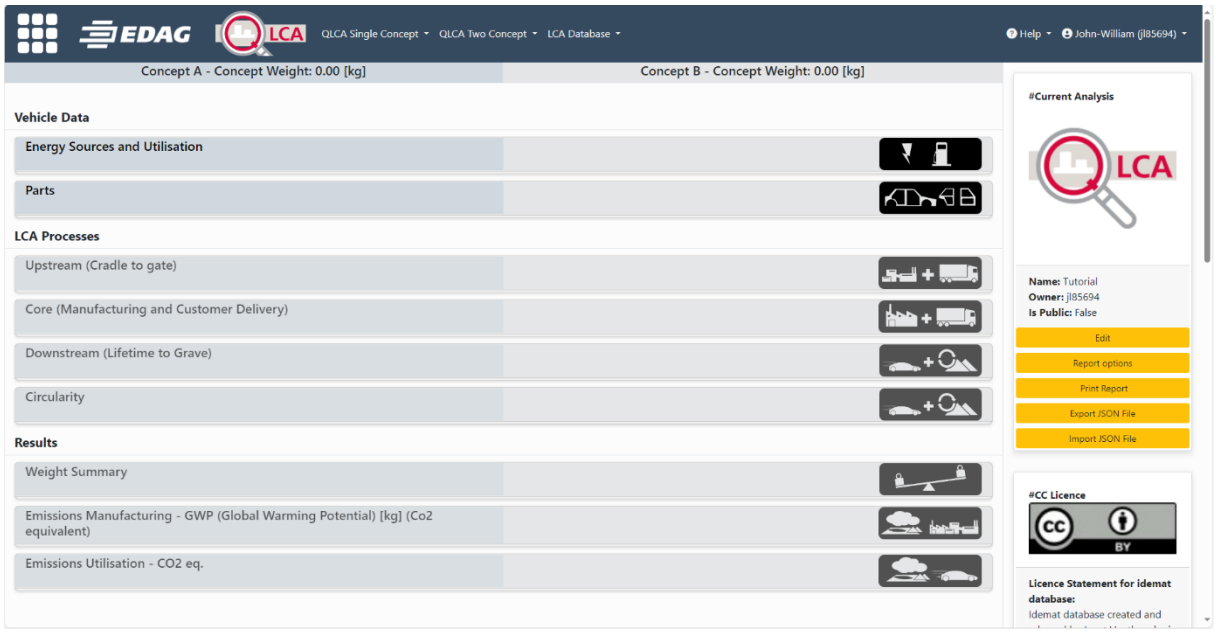
If you select "**Start new job**", you can now create your first QLCA. To do this, you give this QLCA a name. For the tutorial we name our QLCA "Tutorial". Furthermore, the following things can be edited:

- Thumbnail
- Is it public? (So that others in the project can see it)
- Primary Property (For CO_2 analyses: GWP)
- Name of the left concept (e.g. "Concept A")
- Name of the right concept (e.g. "Concept B")
- Goal Definition
- Scope Definition

With "**Add to database**" you start the analysis.

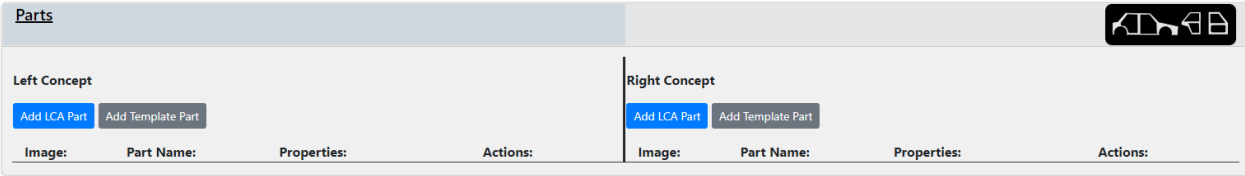
2.2 QLCA – Overview

After you have created your QLCA, this overview is displayed. The tool is divided into exactly three groups and a total of nine subgroups, which are explained on the following pages.



3 Parts

When creating the QLCA, it is best to start with “Parts” under "Vehicle Data". If you press this tab, you will see the following menu:



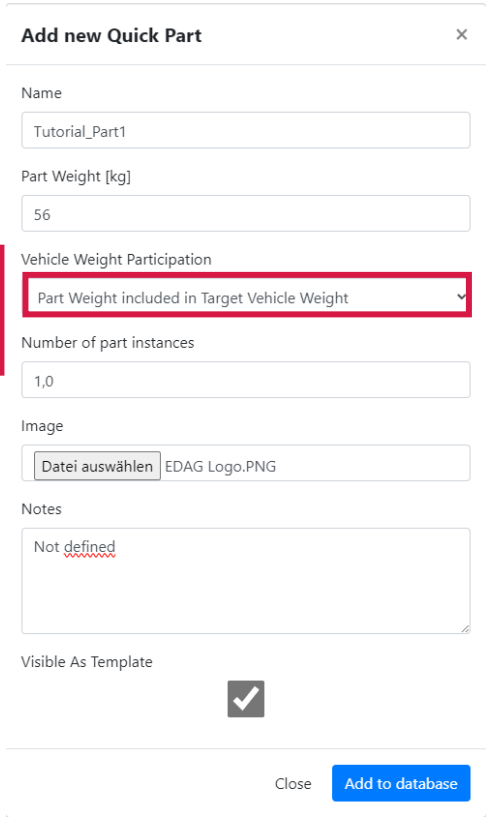
There is a window on the right and on the left for the creation of individual parts. This is for an A-B comparison. You have two possibilities to add parts:

With **Add LCA Part** a new part can be created. Here you can classify object specific data in the menu.

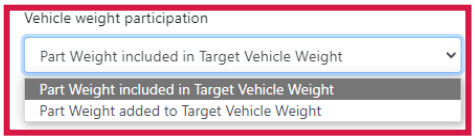
With **Add Template Part** you can add a previously created template part.

3.1 Add LCA Part

If you now click on **"Add LCA Part"**, you will be taken to this menu. Here you can enter the name of the part and the weight of that part. The weight should be the target weight, i.e. the value after all processes and possible weight losses.



Under the **"Vehicle weight participation"** tab, you can also specify whether the weight of the part should already be included in the target weight of the vehicle in a possible utilisation phase calculation, or whether it should be added to it. However, this point is irrelevant when only material and processing are considered.



You can also specify how many pieces of that specific part should be included in the comparison.

With “Image” it is possible to upload an image of the part.

A part can also be created as a template by ticking **"Visible As Template**" to reuse it later. To do this, click on the check box.

With **"Add to database"** the input is confirmed.

3.2 Different Functions / Options in the parts list

Once you have added a part to the concept, there are 5 options:

With this button you can edit the part

With this button you can clone the part and its whole process inventory

With this button you move the part to the other concept

With this button you can make a 1:1 bound duplicate, which is moved to the right side*

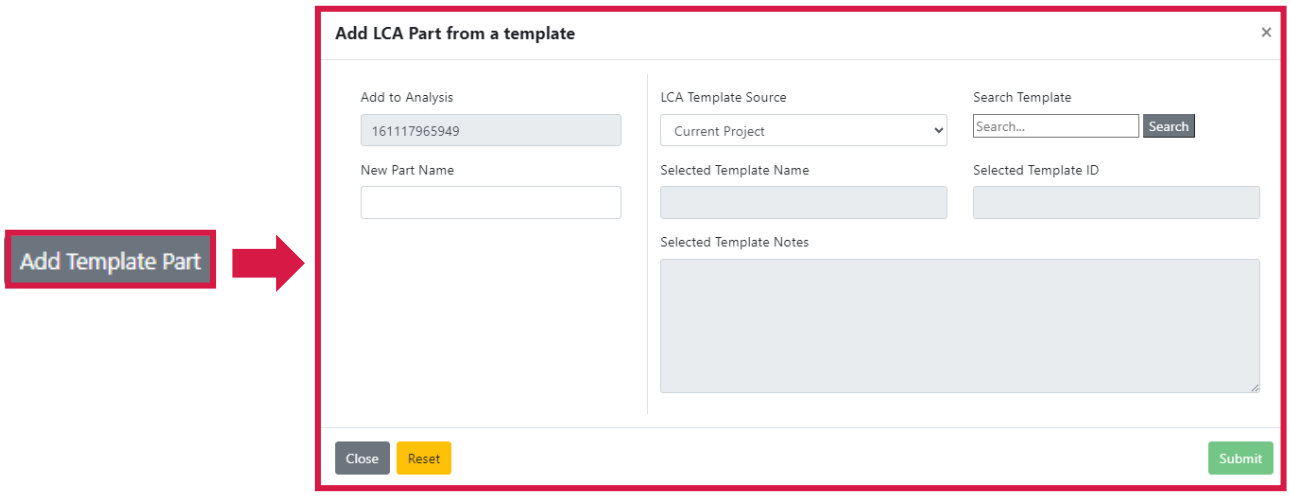
With this button you can delete the part

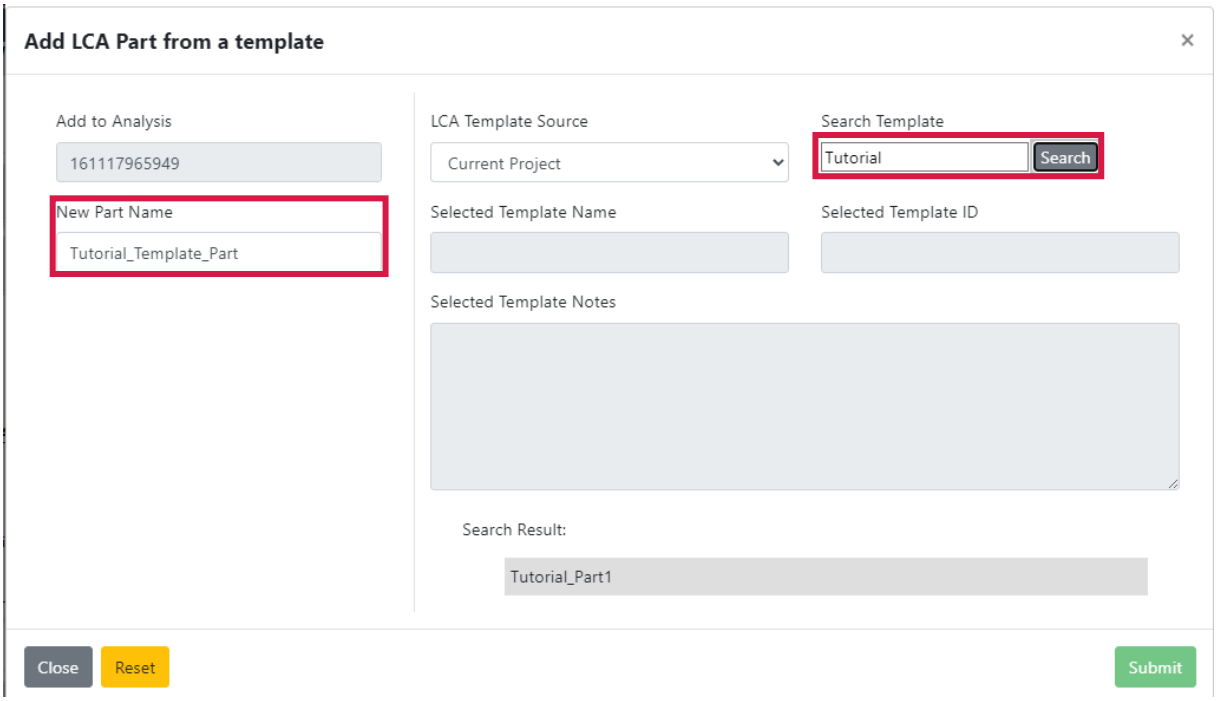
*Deleting a duplicate part on one site will also delete the original part

3.3 Add Template Part

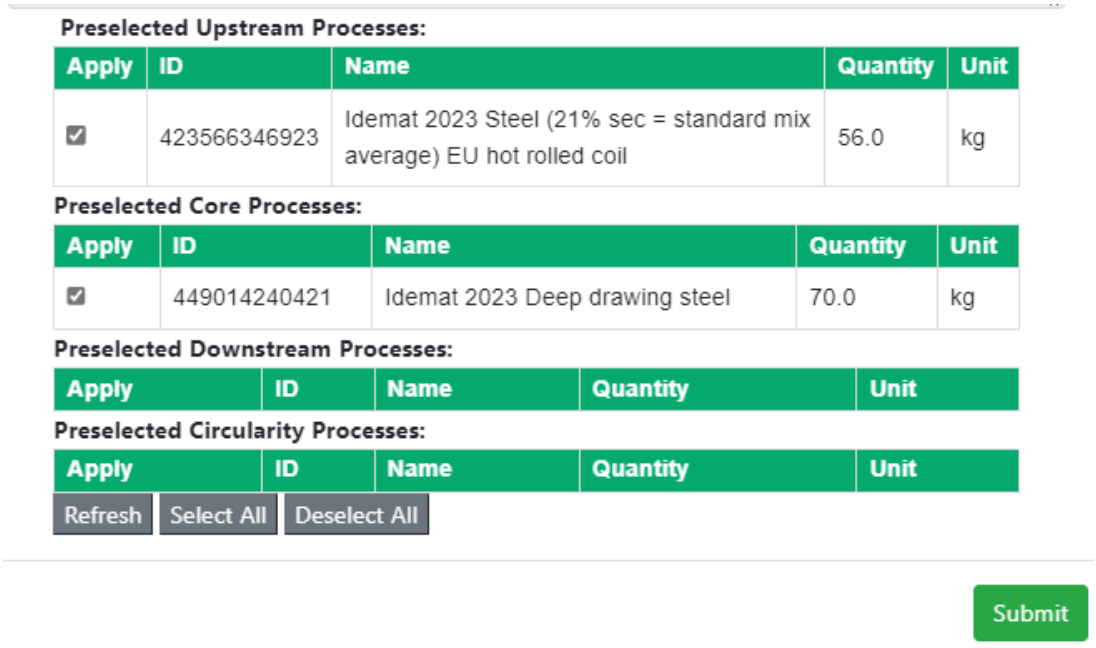
It is possible to add a template part after the desired part has been created. To use this function at least one part should have added processes to itself in the Upstream, Core, Downstream or Circularity. Add the processes you wish to copy. This function is very time efficient for parts that have a lot of processes in common e.g. deep drawn steel parts. If you're doing a QLCA for the first time, please skip to 4) Upstream and come back after you've added processes.

Clicking on "Add Template Part" will bring up the following window:

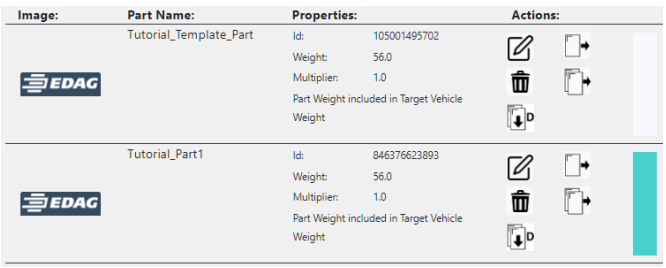




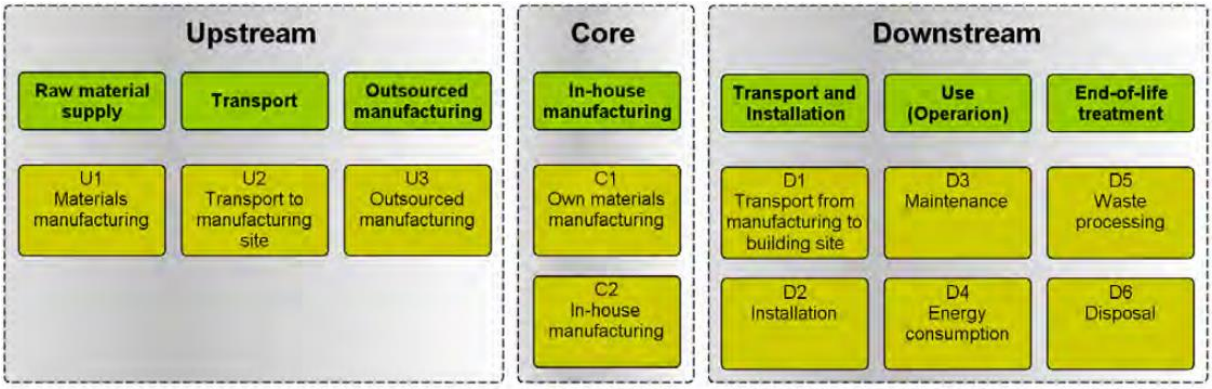
Enter your new part name and search for your template part. After clicking on the part, you have searched for you can select which processes to copy from your template part:



After clicking “Submit” the part will be successfully added. The weight and image will be copied from your template part. From here you can edit the part as you wish.



3.4 Short Introduction: Upstream, Core, Downstream



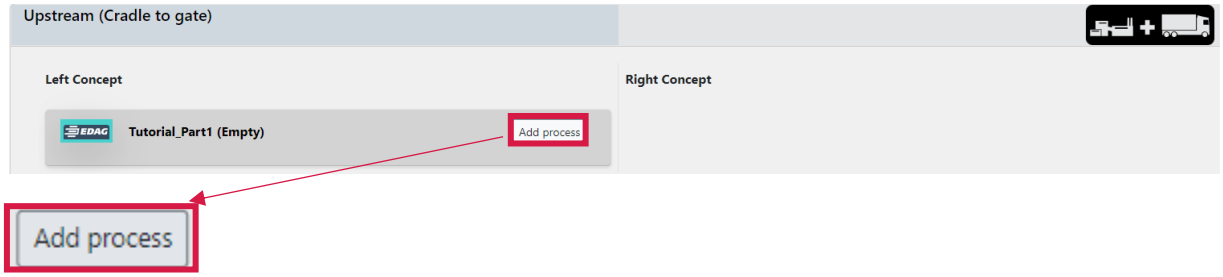
Source: Klaus Schafranietz, Lift Report 2018: „Konzeptionelle Überlegungen zur Ökobilanzierung aus Sicht eines Komponentenherstellers für Aufzugstüren“ (meiller-aufzugtueren.de)

Production and delivery are divided into **three** different **stages** in which CO2 is emitted: **Upstream, Core** and **Downstream**. In the graphic above you can see the different work processes within the three stages and get a good insight into the separation of the processes. On the following pages, the individual stages are explained together with the tool.

4 Upstream (Cradle to gate)

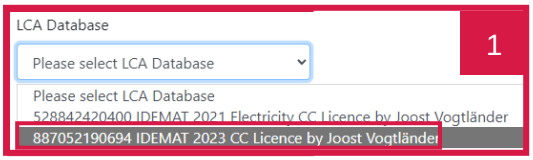
Upstream emissions are all emissions that occur on the way to the factory gates (cradle to gate). In other words, all emissions that occur before the company's own core production in its own factory. These are usually transport routes by container ship, truck or train to the company's own factory, which can be included in the calculation here. Prior material processing processes are also possible in the upstream before "core processing".

Click on “Upstream” and add a process by doing the following:

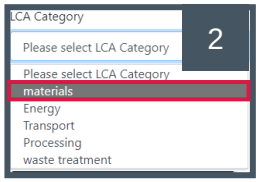


Materials, processes or transports can now be assigned via "**Add process**". First, we create a material.

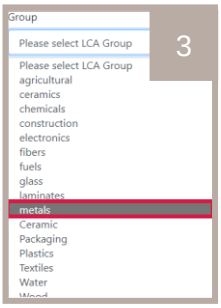
Step 1: First select the database you wish to work with (1). As a general database, the Idemat databases are very suitable.

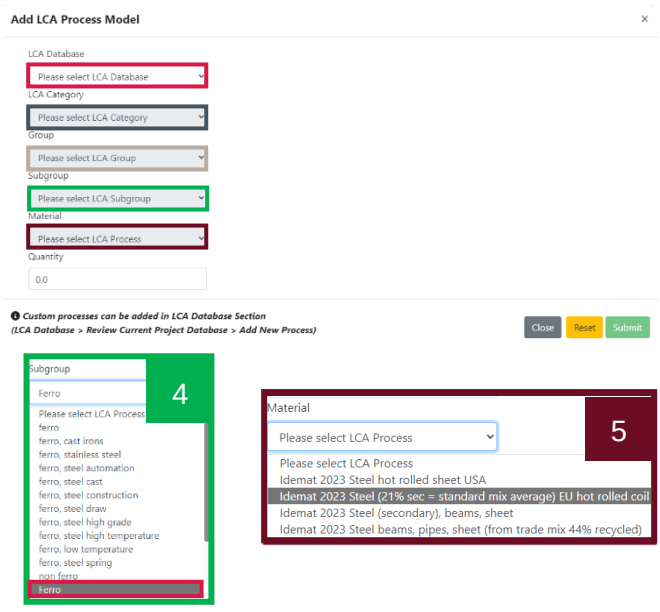


Step 2: Now select a category. As an example, we will go through a material assignment, which is why we select "materials".



Step 3: After selecting the category, we can now select a suitable material group. In our example it is a steel, which is why we select "metals".

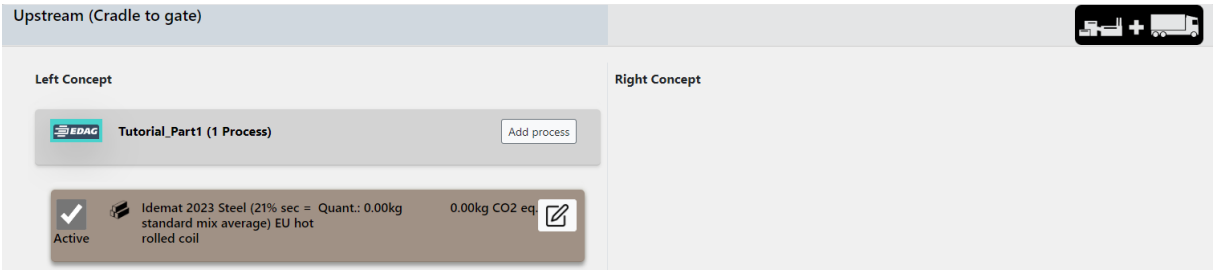




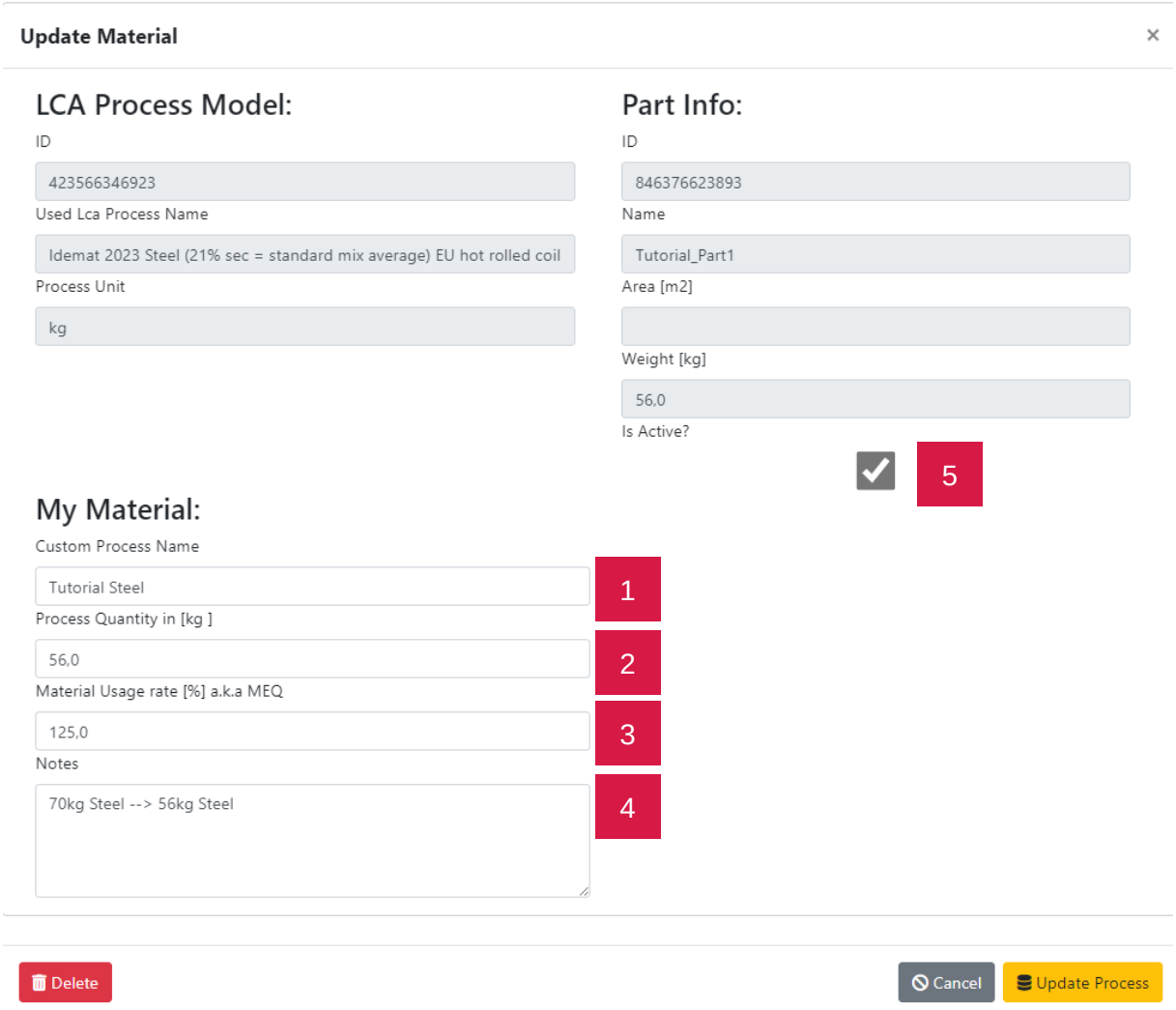
Step 4: Now we select "Ferro".

Step 5: We assign a 21% sec trade mix steel by selecting "Idemat2023 Steel (21% sec = trade mix average) […]”.

Now press **"Submit"** at the bottom right corner. You have successfully added the material.



Now we can edit the newly created material using the edit button and add values. The check mark indicates that the material/process is active.



Step 1: Create a process name. In our case, we name the material: "Tutorial Steel".

Step 2: Specify the weight of the material used. For the example we take 56kg.

Optional **Step 3:** With the Material Usage rate we can now define if a material loss has occurred that should be considered. This is the case if, for example, you had a waste and for 56kg target weight you need e.g. 70kg material. The difference and the resulting loss of 14kg of material can now be considered by specifying a percentage here. For the example, we would now enter 125 here (70/56=1.25).

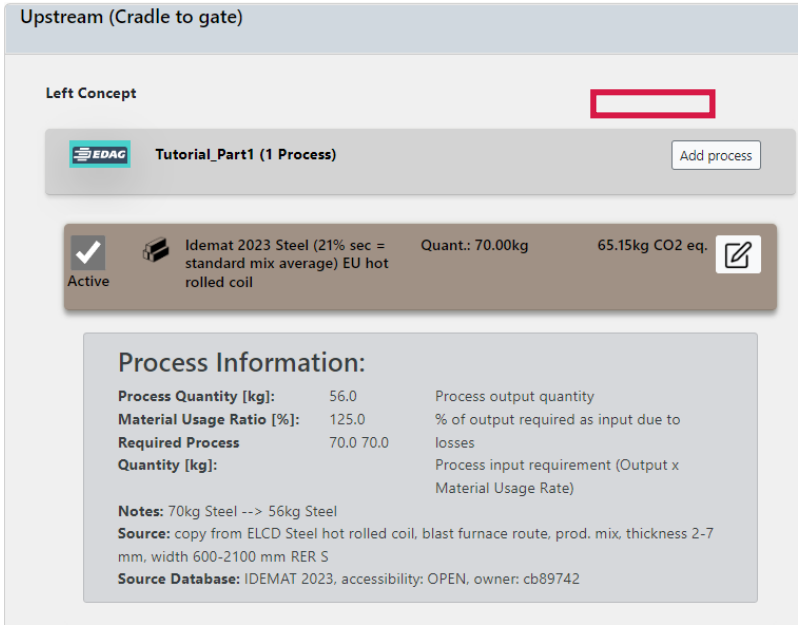
Optional **Step 4:** Here you can enter any notes you want to make. For example, it can be useful to describe under which conditions the process was considered to have a structured and complete QLCA available later.

Optional **Step 5:** With ticking “Is Active” the process is activated. If you remove this checkmark, you deactivate the process.

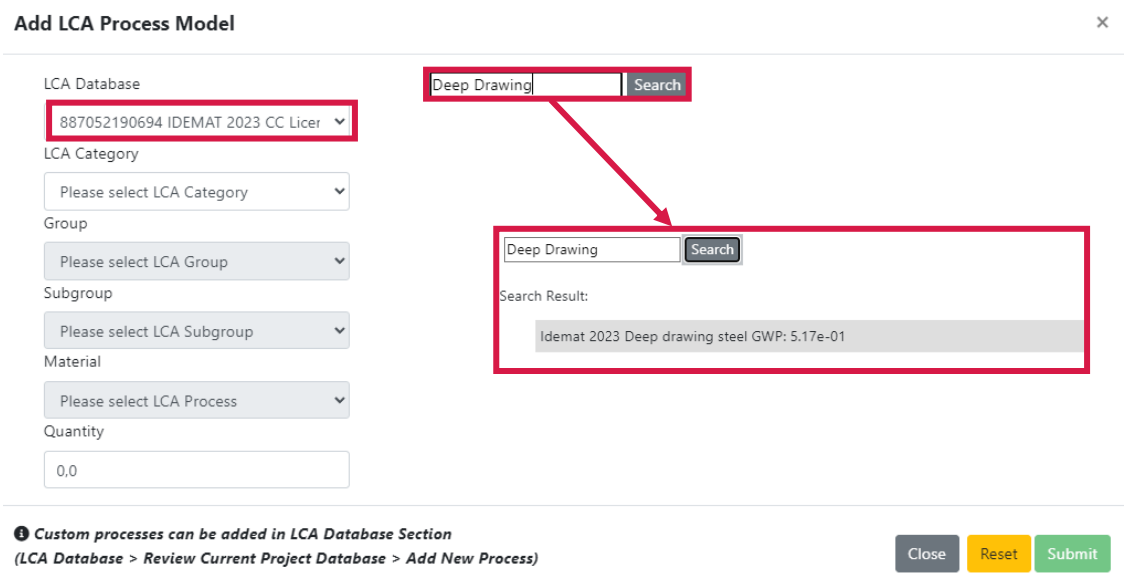
The entry can be confirmed via **"Update Process"**.

If you have now confirmed the input, the data is used for the calculation. If you click on the name of the material to expand this overview, you can double check if your input is correct. Also the CO_2 equivalent of the entered process/material is now displayed (CO_2-footprint / GWP-100). In our case, the steel has a carbon footprint of 65.15kg CO2 eq.

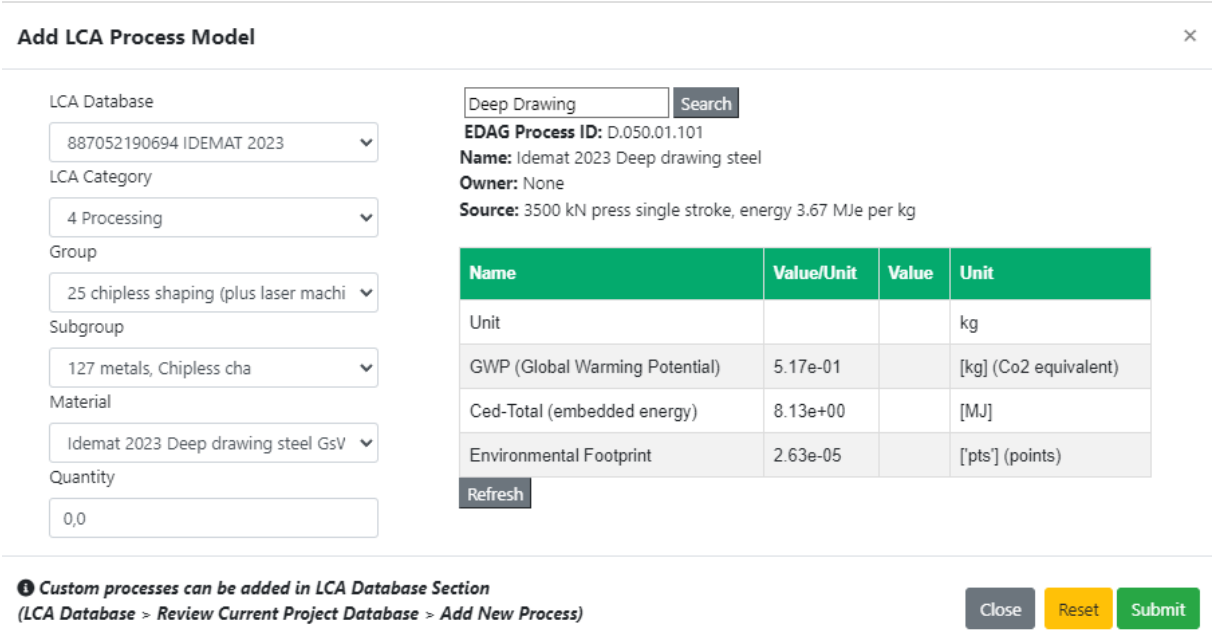
The creation of processes and transport routes works via the same mechanism as the creation of materials. There is also a search function for creating materials, processes and transport routes, which can save you a lot of time if you know which process you want to use.



The search function when adding an LCA process works as follows:

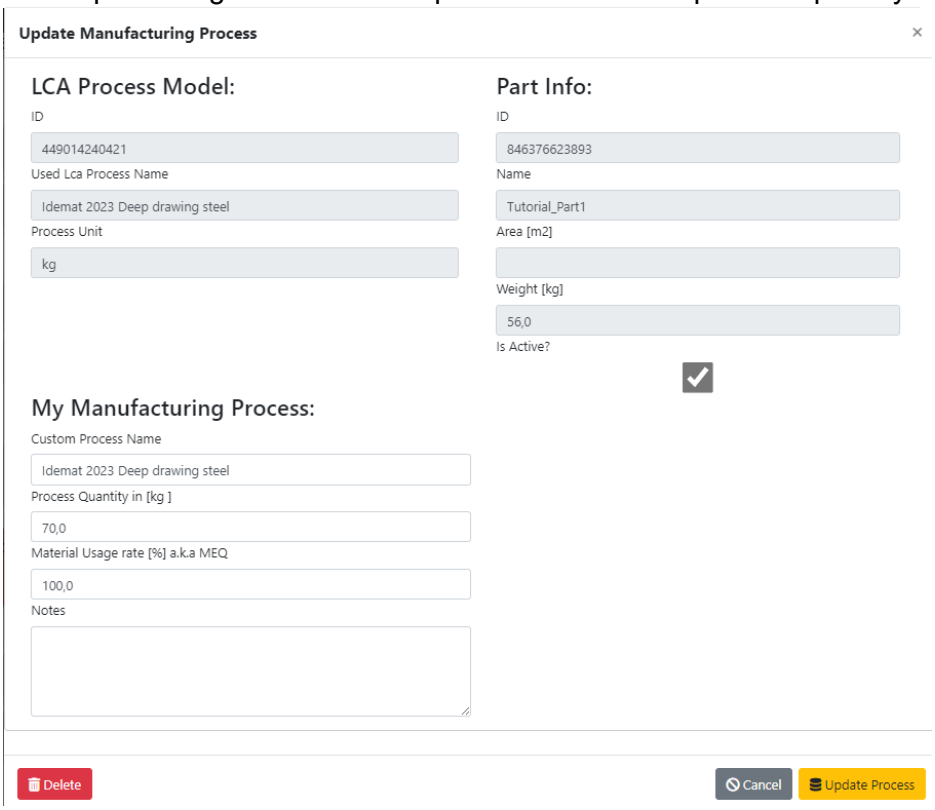


When adding processes, materials and transports, we simply select the Idemat database again. Within this window, the "Search" function can now be used to search for specific processes, materials and transports that are in the selected database. For our example, we search "Deep Drawing" and select the process.



After the selection, the various selection groups, which we had to select individually before, are filled in automatically. With "Submit" we can confirm the selection. Now we edit the newly created process again:

We can enter “Deep Drawing” as the custom process name. The process quantity is 70 kg



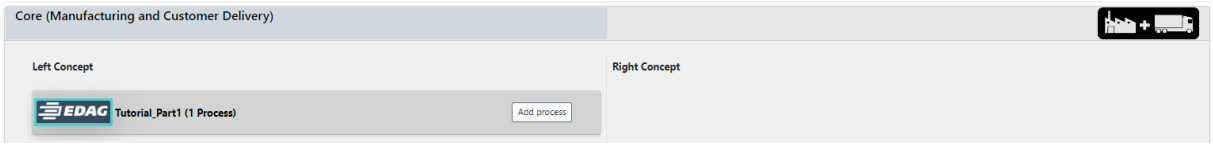
(deep drawing of the raw material leads to losses) - these 70 kg could now be further explained in the notes, for example. The material utilization rate remains at 100%. We confirm the entry with **"Update Process"**.

Note: In principle, creating transport processes works in the same way, but it should be noted that when creating them, the unit "tkm" is not stored under "Quantity". That's why it's important - just as with the examples just played through - to enter the kilometers in the edit menu after creating the process and not directly under "Quantity".

5 Core (Manufacturing and Customer Delivery)

This part of the tool is suitable for adding processes, which are executed at your own factory, whereas the Upstream part is about the processes which are executed before delivery to your own factory.

By separating upstream, core and downstream (explained in 4: Downstream), the CO_2 emissions can later be separated exactly into these three phases. This makes it easier to see in which production phase the most emissions are generated and how great one's own influence on the CO_2 value is.

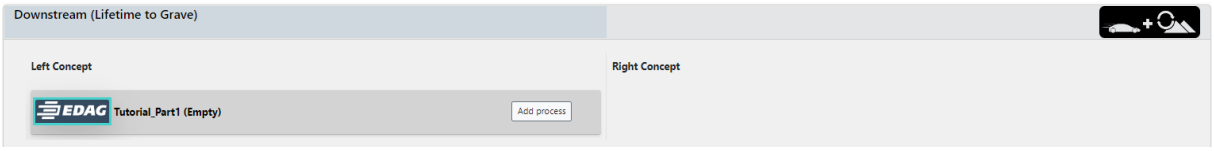


Adding processes here works the same as in the upstream, so no further explanation is necessary.

6 Downstream (Lifetime to Grave)

This part of the tool is about determining the CO_2 of the part until the end of its life: it is about the use phase.

This type of calculation can be particularly useful **if** a component **emits more CO2 during production**, **but then saves CO_2 in the use phase** through a higher degree of efficiency (e.g. better thermal insulation, so that less additional energy is required or less weight that has to be transported).

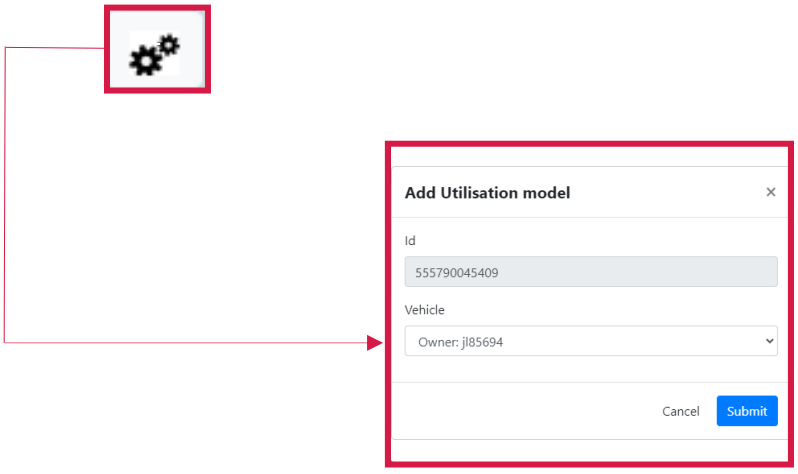


6.1 Add Use-phase/Utilisation

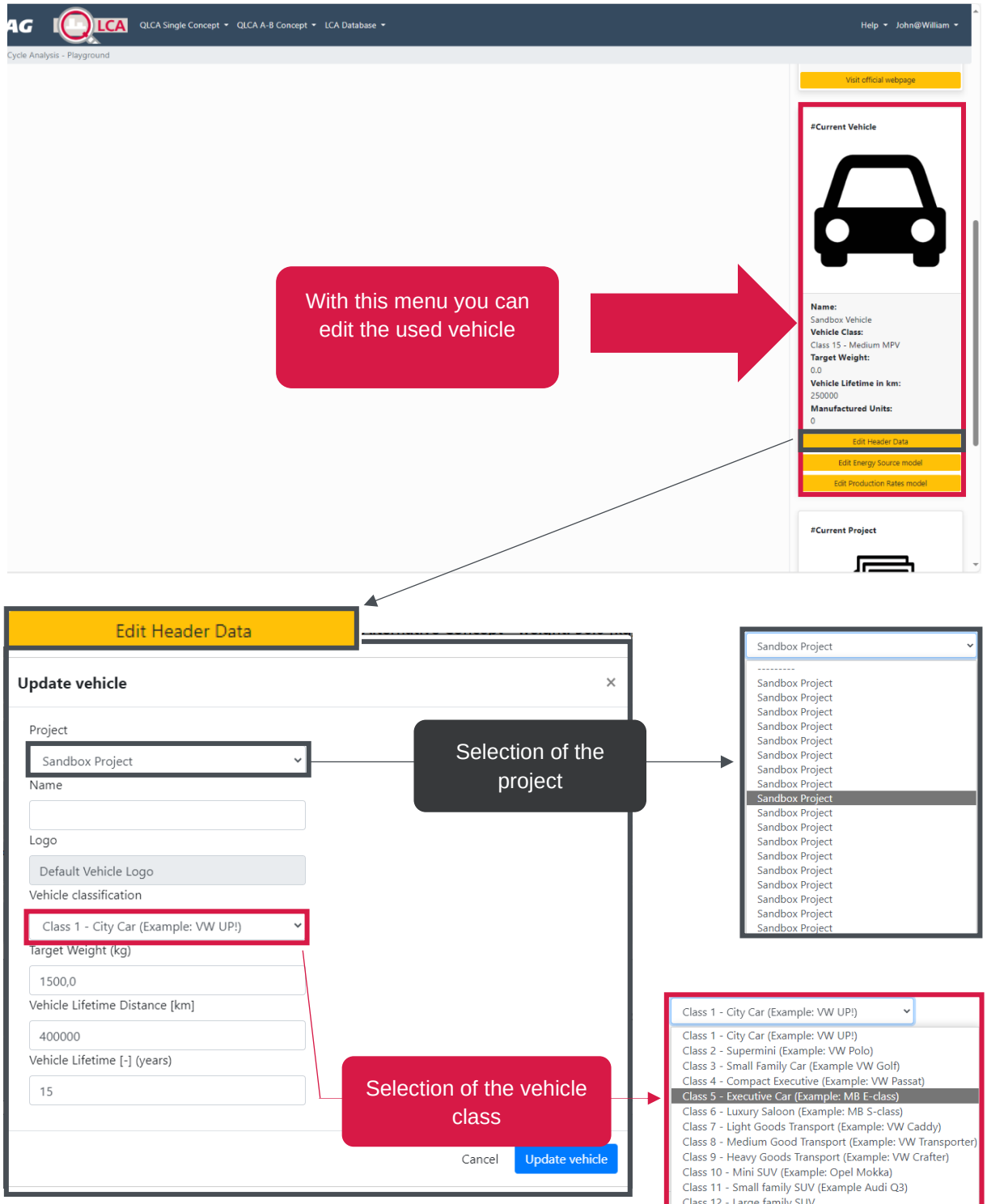
Now it's possible to add a use phase under the sub menu "Energy Sources and utilisation". Through this it's possible to evaluate a "Break-Even-Point". It is not necessary to create an Utilisation to solely consider material CO2 emissions, but it can be useful to analyze a component holistically. (See explanation above).

Through this Popup-Menu it's possible to add a vehicle with "submit". The tool has so far only been designed for vehicle-specific applications in the usage phase.

Before we continue, we will first define our vehicle in the next point.



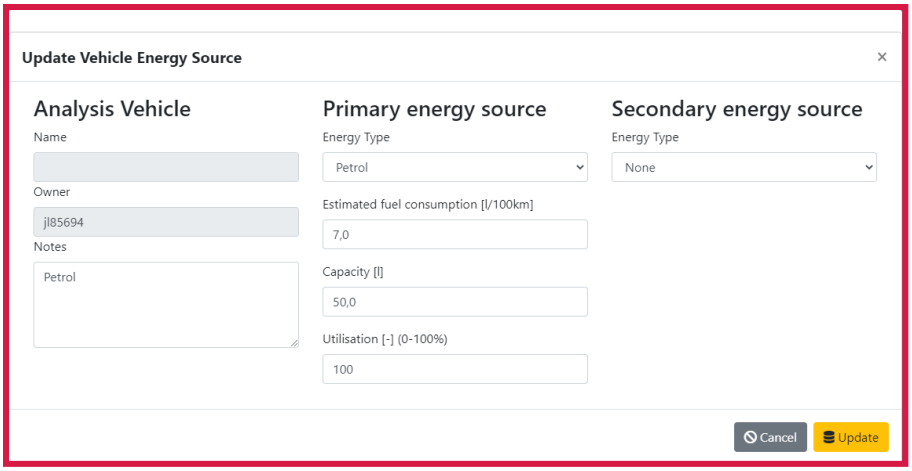
6.2 Adding a vehicle



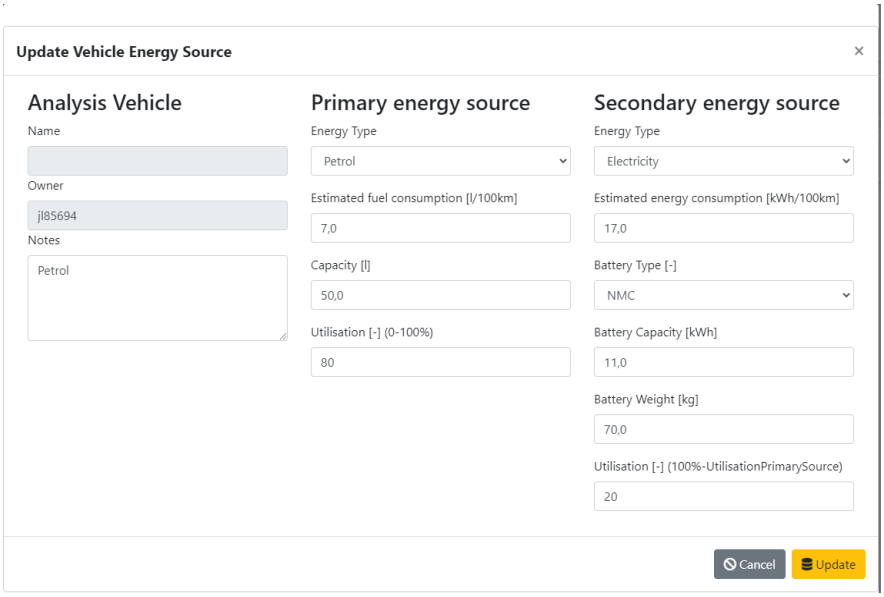
After selecting the project and the vehicle class, things such as the name of the vehicle, the target weight of the vehicle and the estimated lifespan of the vehicle [in kilometers and in years] can be specified.

The QLCA tool can now work with this data. In the next step, you only need to provide other vehicle-specific data. You then get the emissions graph for the usage phase. Confirm the entry with “Update Vehicle”.

6.2.1 Selection of the primary and secondary energy source



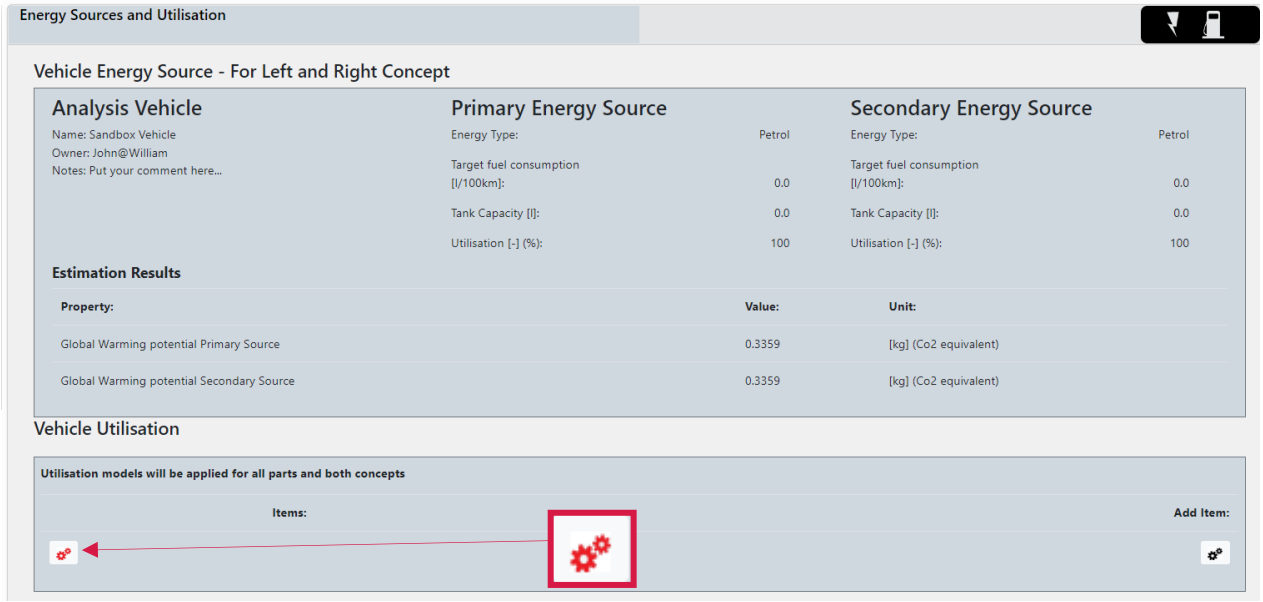
With „Edit Energy Source model" it's now possible to edit the energy source of the vehicle. It is possible to edit the **fuel consumption**, the **capacity of the tank**, and the **utilization**.
It is possible to edit the utilization because it's also possible to add hybrid drive systems with the second energy source. If you select "Electricity" from the second drop-down menu, it looks like this:

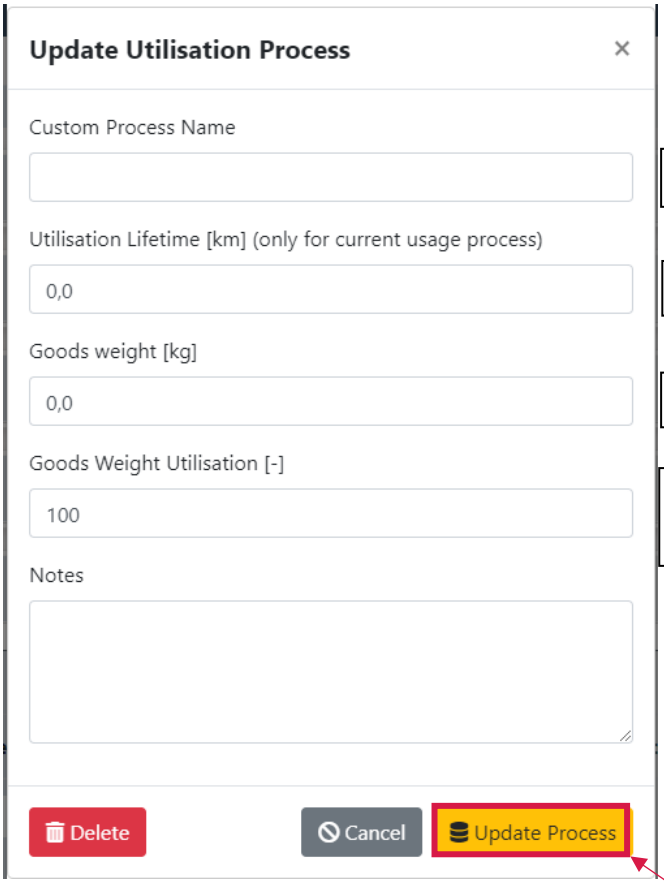


Energy consumption, battery type, battery capacity, battery weight and degree of usage can be specified here. Only the **energy consumption** in kWh is relevant for the calculation - the other data is optional.

In the example on the left we would have a vehicle with 80% utilization of the petrol engine and 20% utilization of the electric motor.

6.2.2 Finalize the Downstream: Utilisation





Name of the utilisation scenario

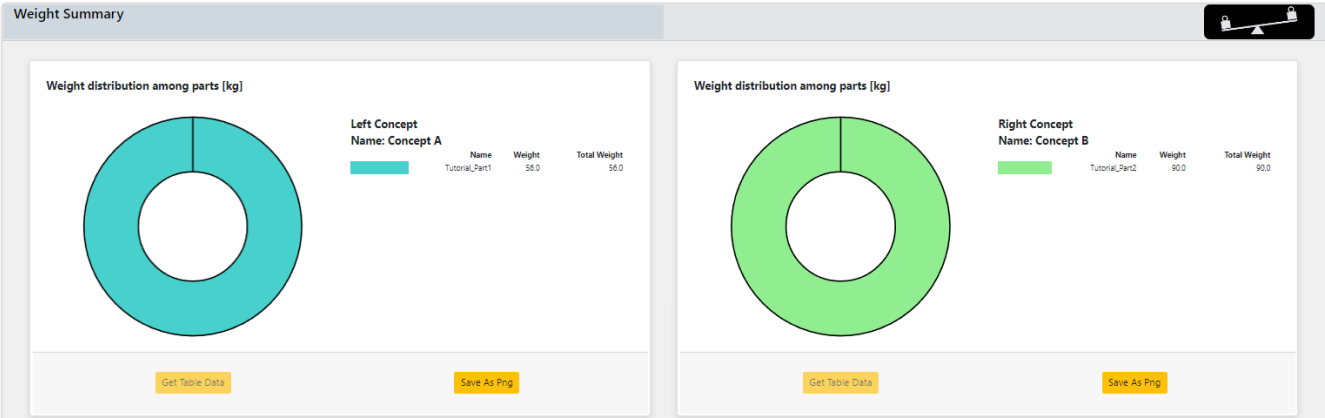
Liftime in km

Additional weight in kg

degree of utilisation (additional weight)

Now confirm the entry. The downstream is complete now.

7 Weight Summary

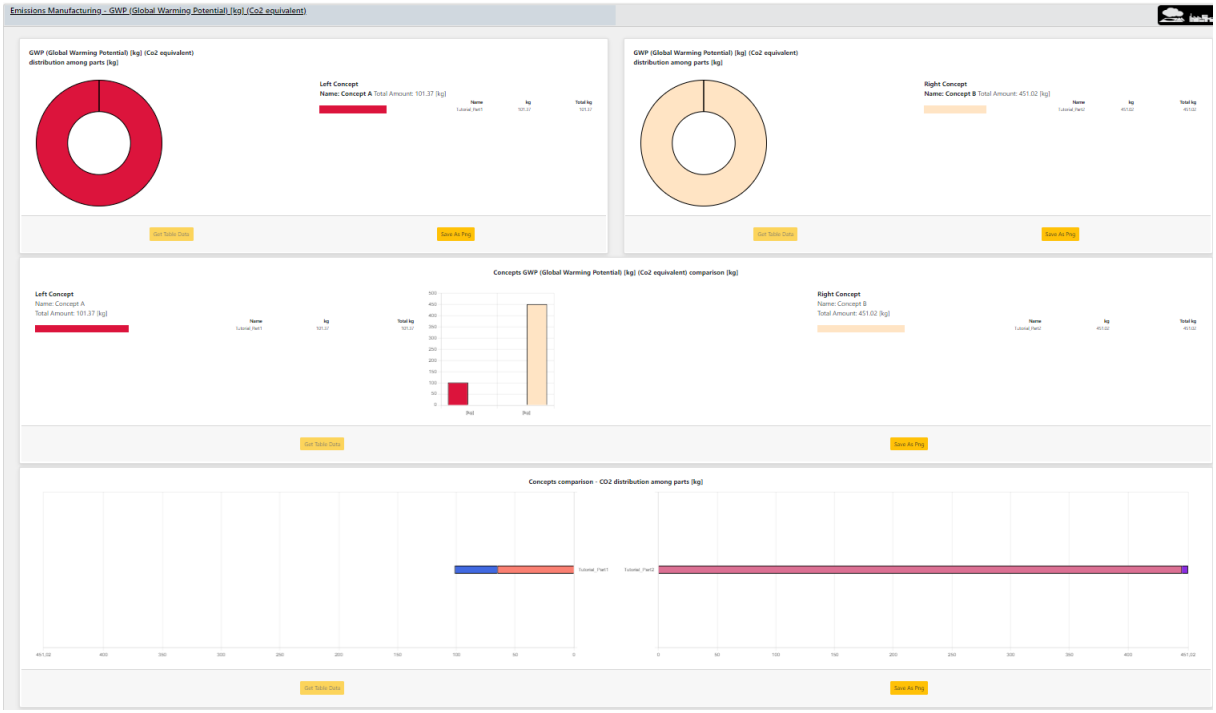


Under point 1 under "Results" we now have the weight data and a direct weight comparison between the two concepts is possible.

For multiple parts it could look like this:

8 Overall Emissions / Emissions Manufacturing

Now it's getting interesting: The evaluation of the CO2-emissions



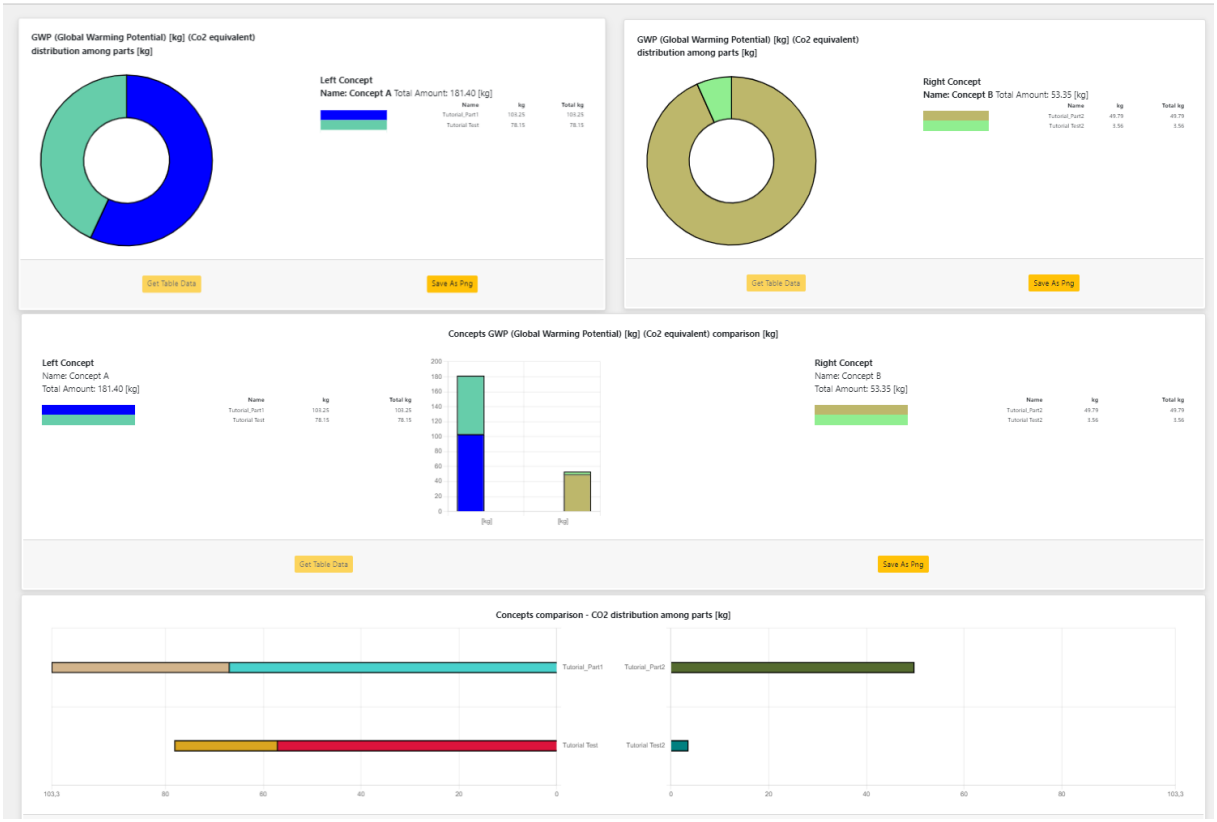
The data is evaluated in CO2 equivalents. In the left and right concepts, a CO2 distribution among the individual parts is shown by a pie chart. In the middle of it is the direct comparison of the total CO2 values - if you hover over the bars, you can see the exact values.

It is also possible to export the data as an image or Excel table using the respective buttons.

This feature is still under development and is not yet available for use.

Furthermore, below is a direct comparison of the two conceptual parts - this does not compare the individual parts in total values, but rather the individual production steps of the individual parts. This way you can quickly identify the biggest CO2 driver.

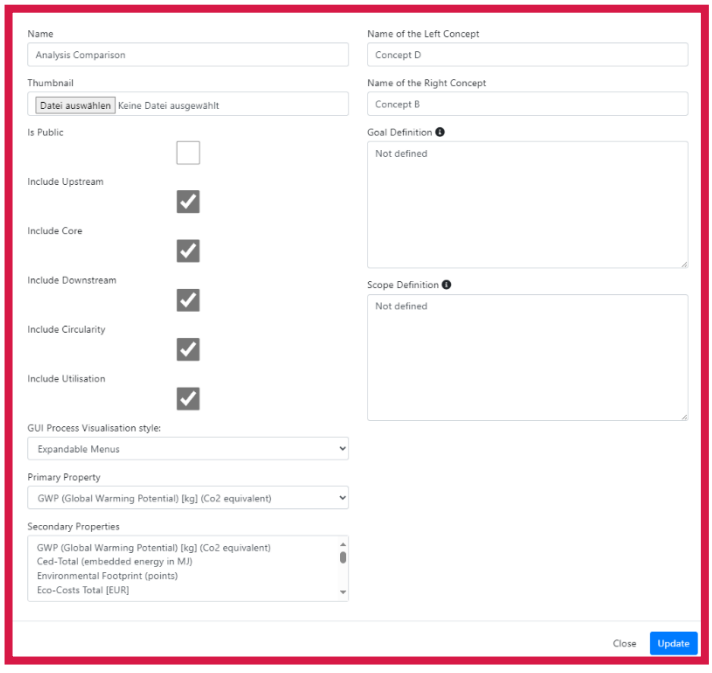
The following page shows another part with several parts for better understanding.



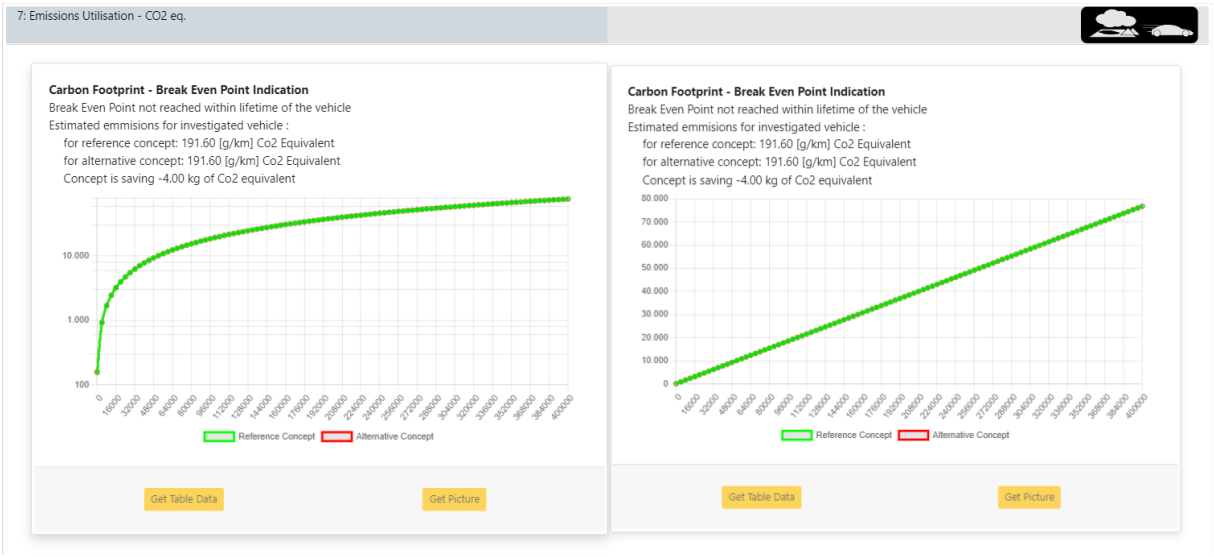
With the help of this data, it is now possible to create a holistic analysis of the analyzed product with possible suggestions for improvements in production, processing or transport routes.

The data provides a clear relationship with which you can quickly get the first indications as to where the greatest CO2 consumption lies and where improvements with a major impact would be appropriate.

To compare only certain product phases you can deactivate the ones you don’t need:



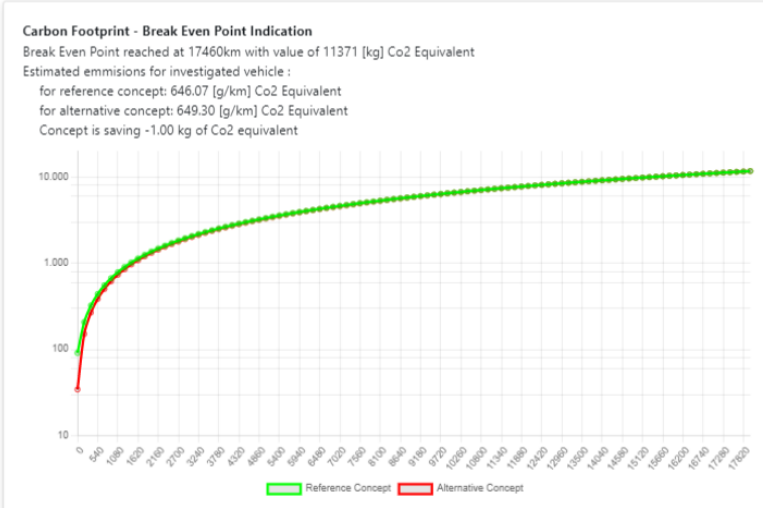
9 Emissions in the use phase / Break-Even-Point-indication

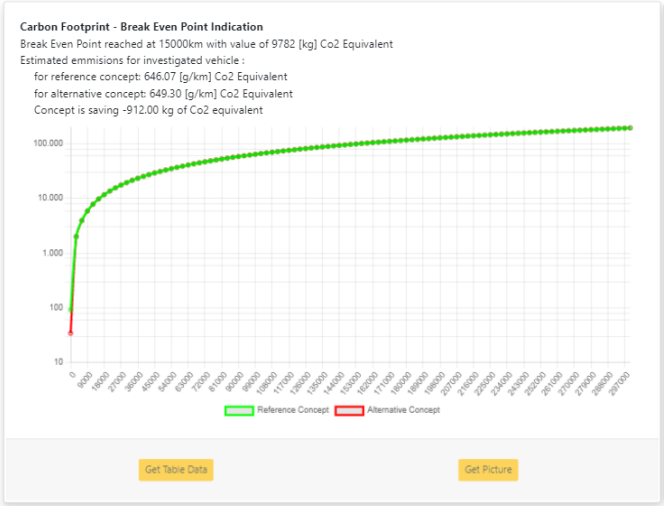


Under point 3: "Emissions Utilisation - CO2 eq.". a break-even point indication is now possible.

Here, for example, it can be calculated whether a lighter vehicle made of aluminium or a heavier one made of steel is worthwhile in terms of the CO2 value. Steel because it produces fewer emissions than aluminium purely because of the material. However, because aluminium weighs less, this also influences consumption and the associated CO2 footprint in the use phase.

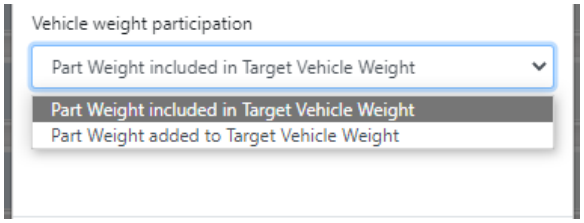
With the help of these graphs, it is then possible to determine after how many kilometres aluminium catches up with steel in the overall CO2 balance. In the present example, there is no break-even point because the vehicles to be compared have the same total weight (and therefore the slope m is the same). This can be changed in the following so that a break-even point can be determined as here:





9.1 Weight adjustments – Downstream calculation

If you go back to **"Parts"** and edit a part, you can also adjust the weight calculation under the item **"Vehicle weight participation"**:



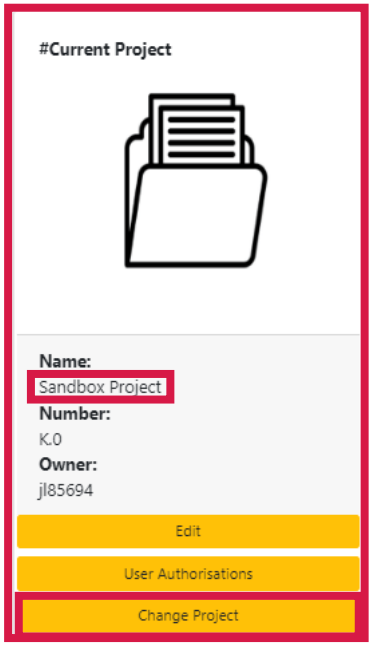
It will then be calculated as follows:

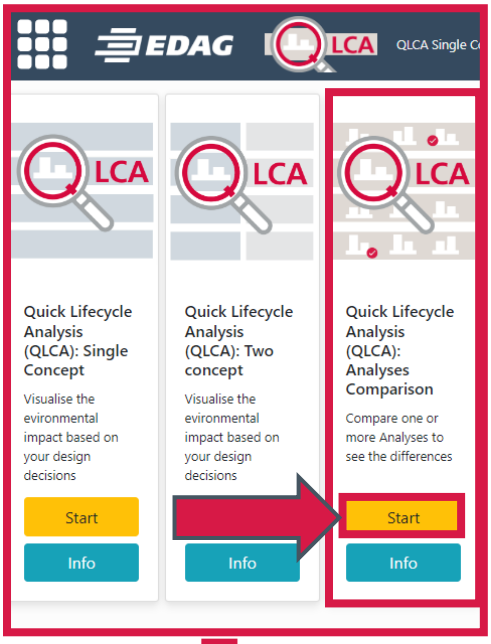
The weight difference resulting from the inclusion of one part and the exclusion of a reference part results in a different slope of the graph during the use phase: A change in the total weight of the vehicle also changes the CO2 emissions over the lifetime of the vehicle.

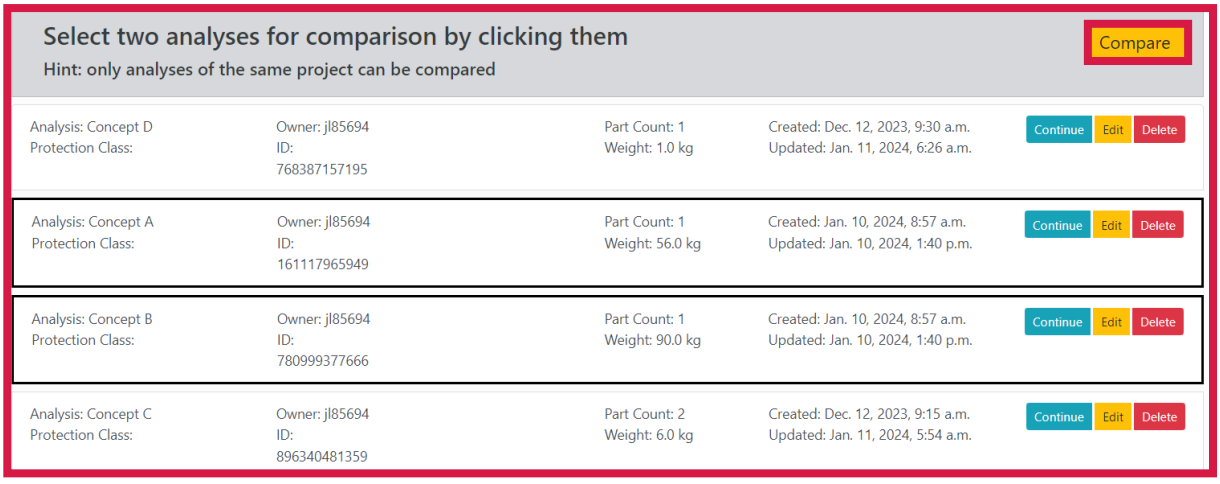
For this reason, it is always important to ensure that the weight distribution is correct when calculating the use phase.

10 Comparison of existing Analysis

It is also possible to compare any **existing** analysis with each other. Make sure you have selected the right project because the comparison of concepts is project related. After making sure to select the right project, you can now start the comparison by clicking on “Start”.





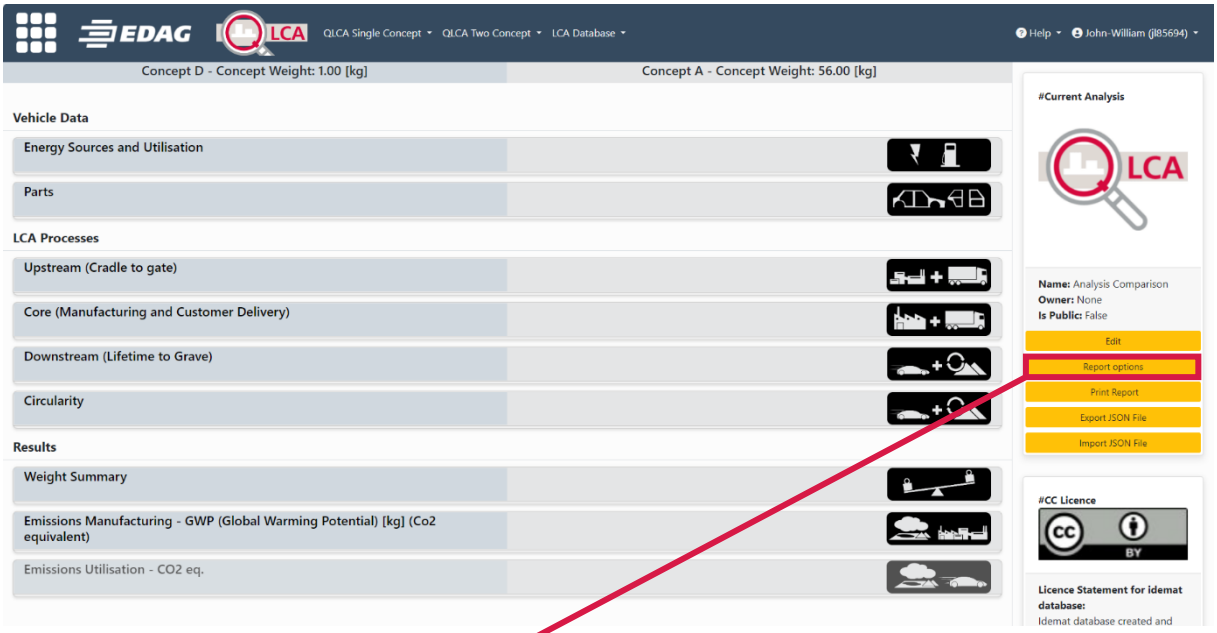


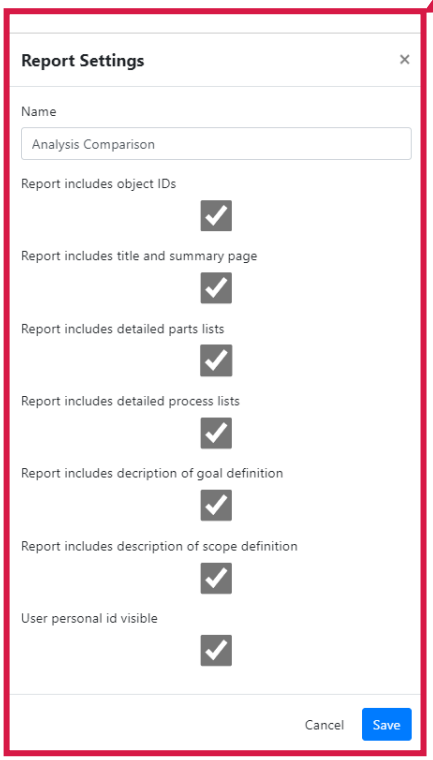
Every created analysis of the selected project is displayed on this page. Simply click on the analyses you wish to compare and then click on “Compare” to perform a comparison.

You can then compare the selected analyses as wished.

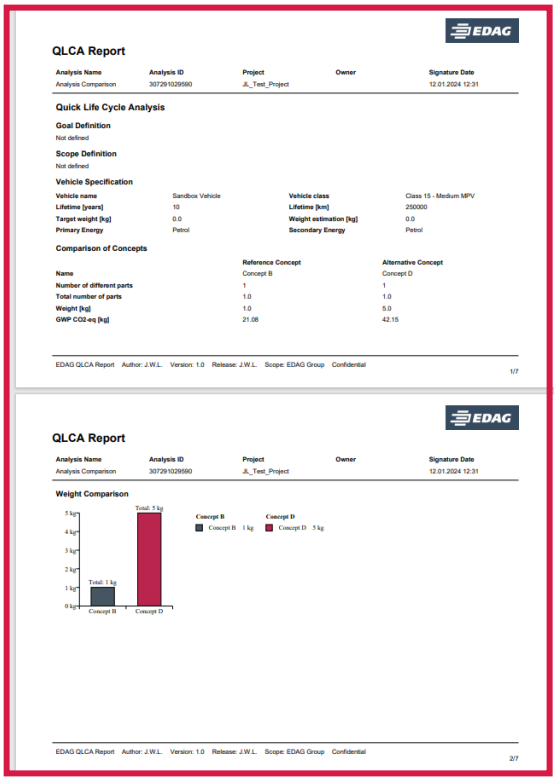
10.1 Printing a report

When you've finished your analysis, then you can also print a PDF-report. Simply do this by clicking on "report options" first.





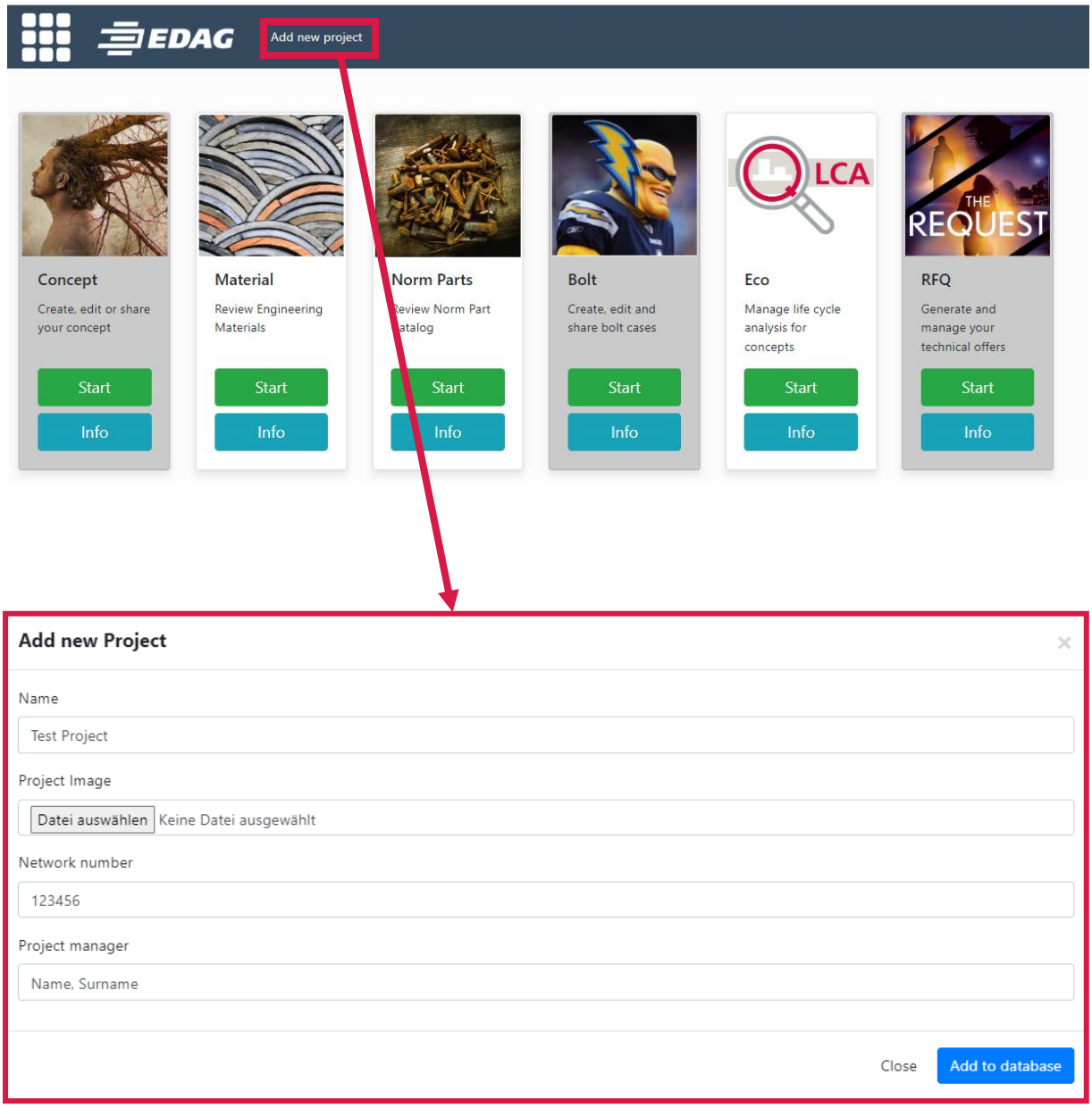
In this window you can decide what should be shown in the report. After confirming your report settings go to "Print Report". A report will be created for you:



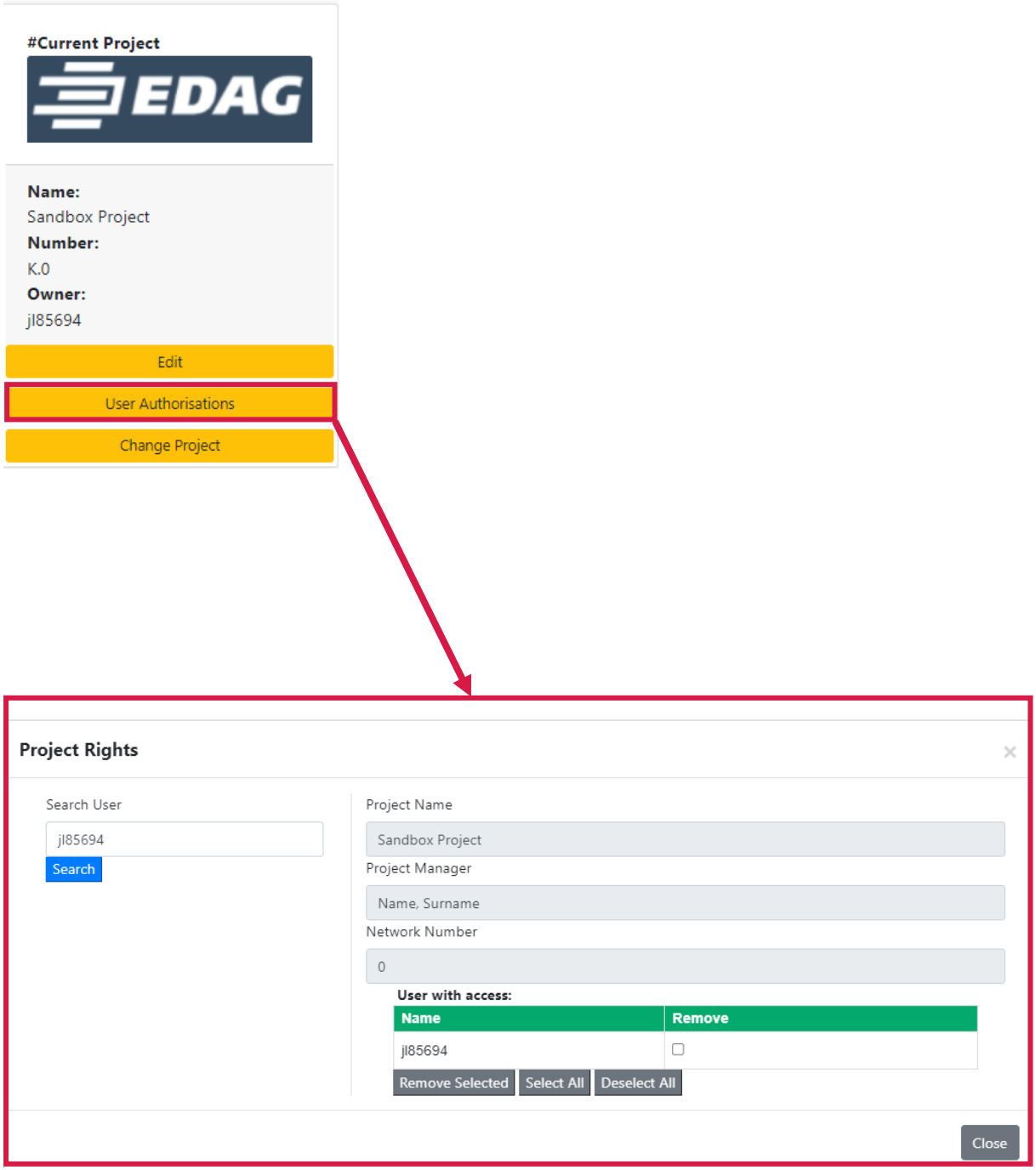
11 Projects

The QLCA-Tool works always works with projects. Creating different projects can be very useful to differentiate between all your created analyses. You can always only see and work on the analyses of the project you are in.

11.1 Adding a project



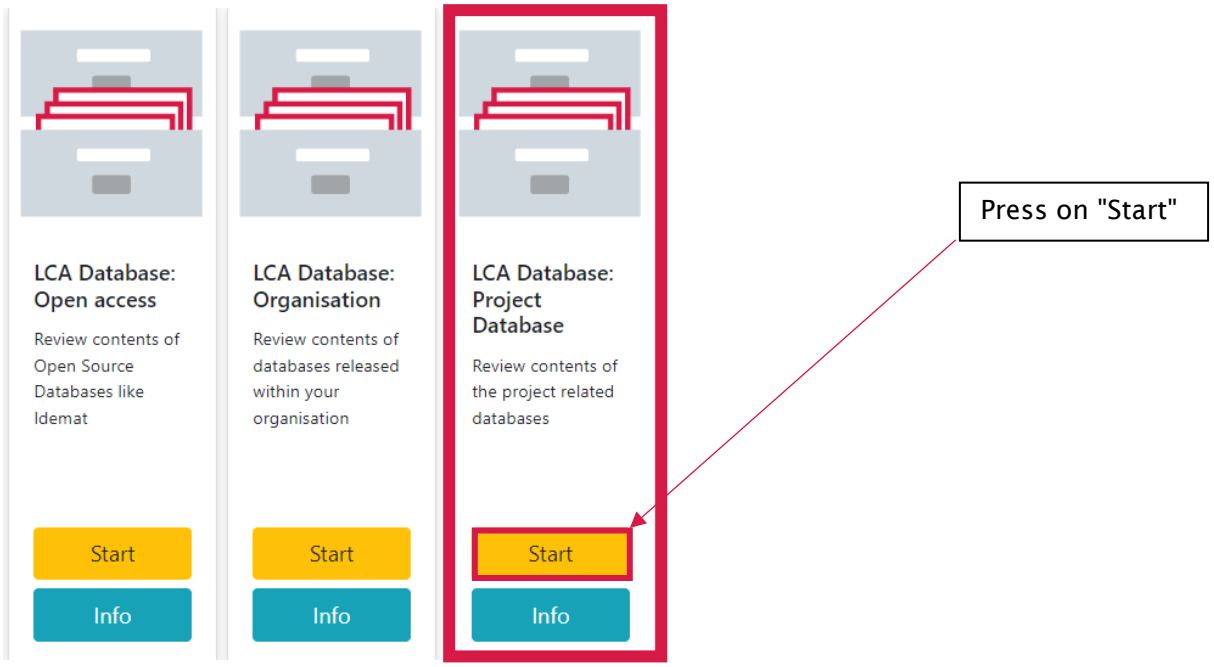
11.2 Editing user authorisations



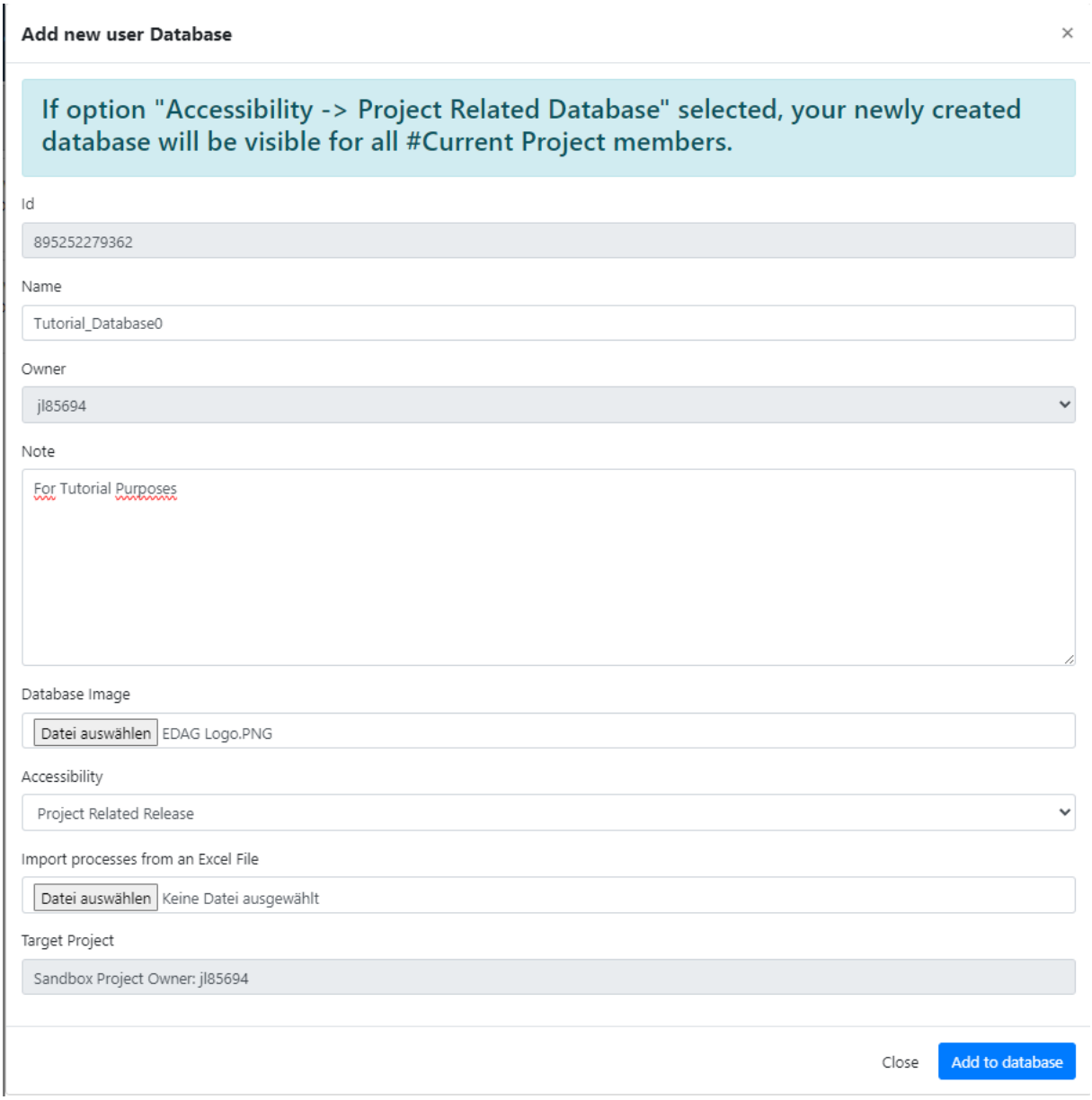
In this menu you can add users to your project and allow them to work in your project. You can also remove users from the access list.

12 Databases and how to use them

The QLCA-tool also allows you to make changes to the existing project database or add new processes/materials to a new database. In this way, you can also incorporate your own process data or raw material data into the QLCA analysis.



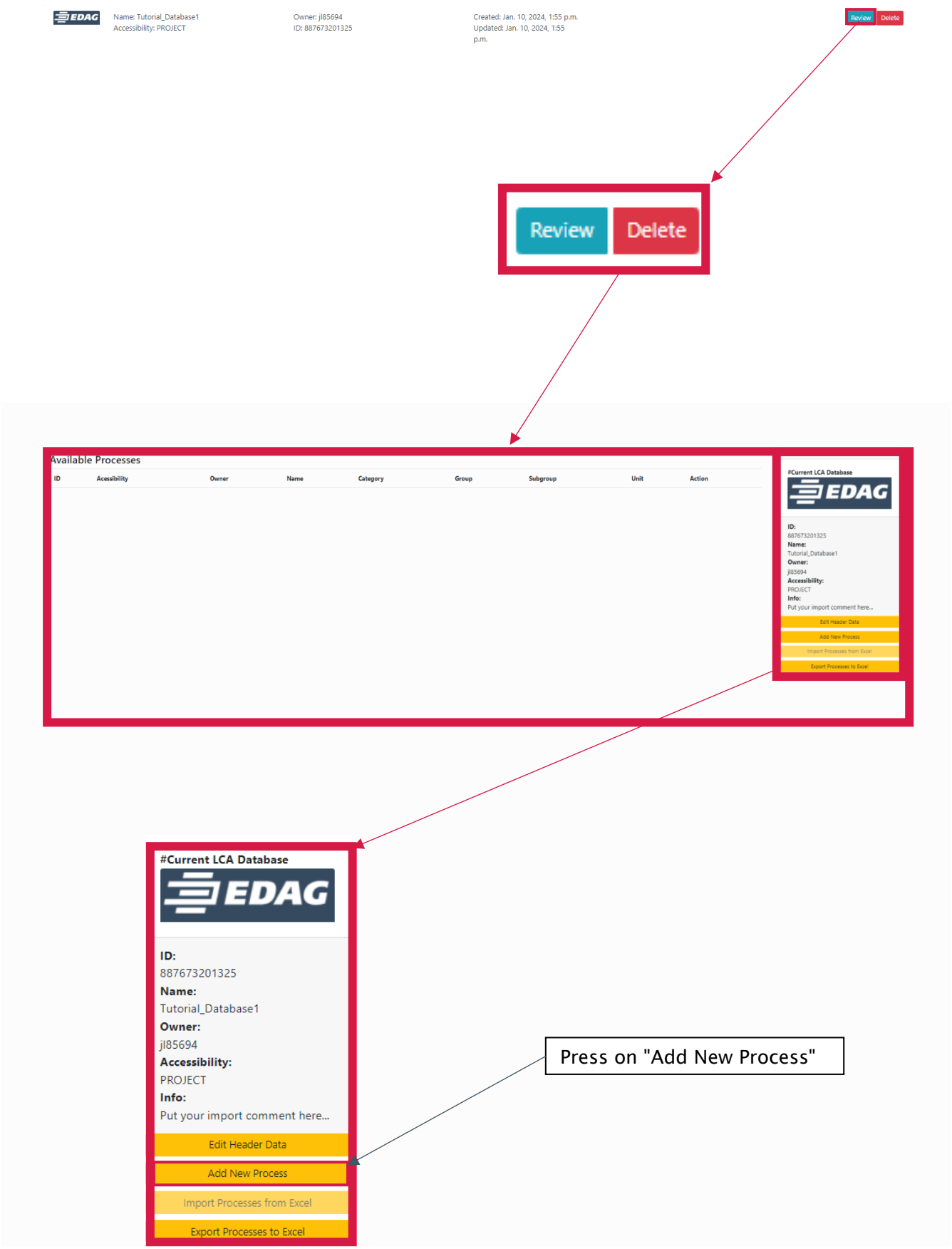
Now you can see the current project databases and your own databases. Through the dropdown menu "LCA database" it's possible to create a new database, which is then added to your active project:

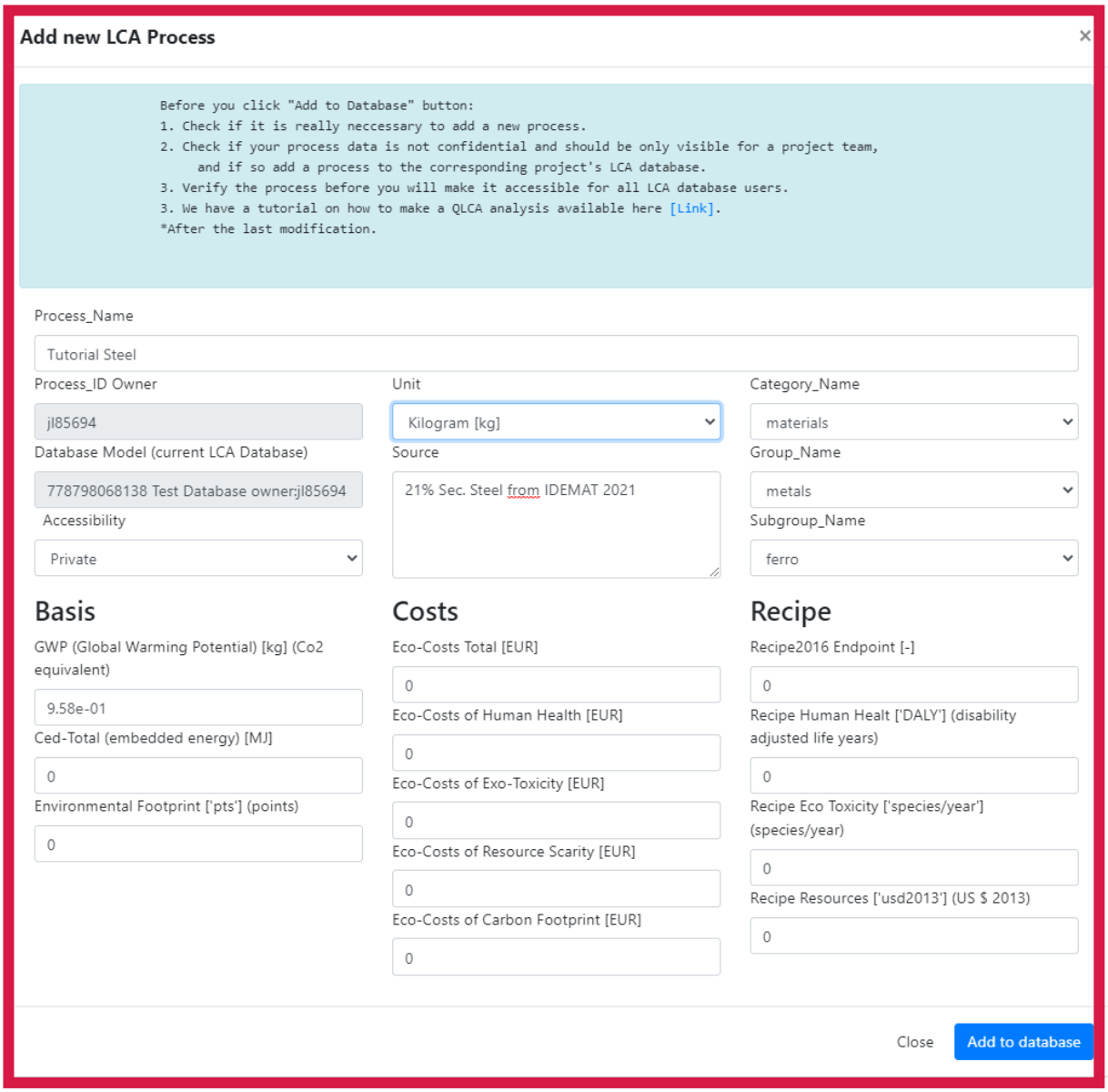


Now you can edit the following:
- Name of the database
- Notes to the database
- Accessibility for others

It's also possible to import processes from an Excel File. For Importing an Excel File it is necessary to follow a certain format, which can be downloaded, filled and then uploaded in through this window.

12.1 Adding processes to the database



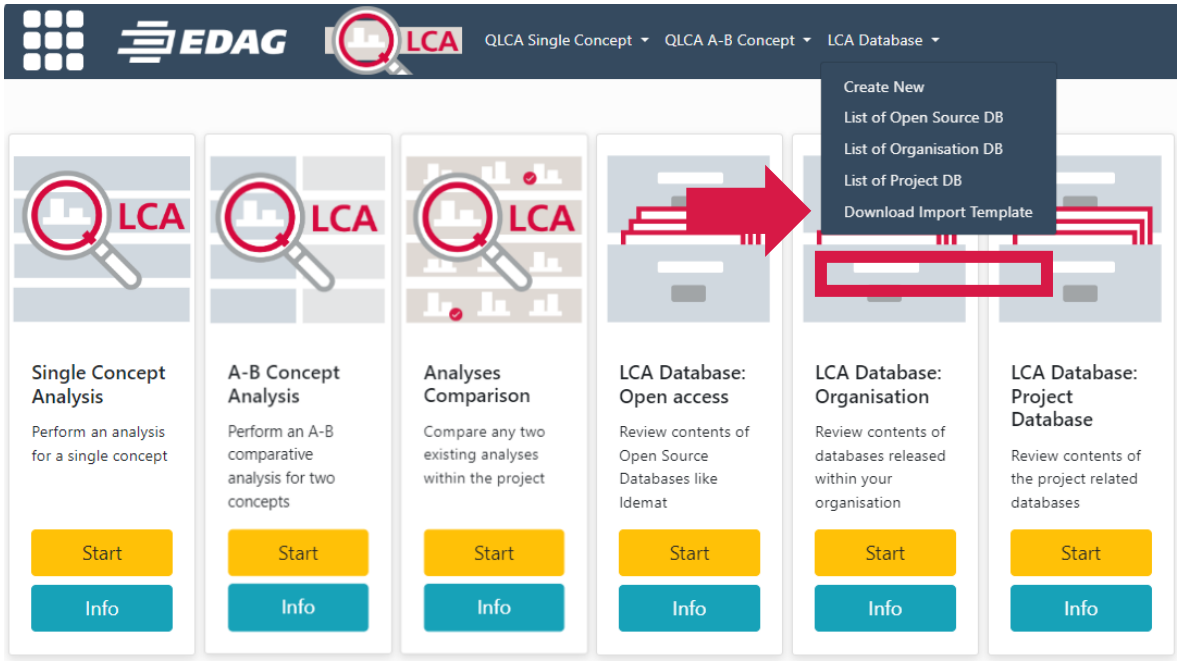


When adding a process, you should at least enter the following:

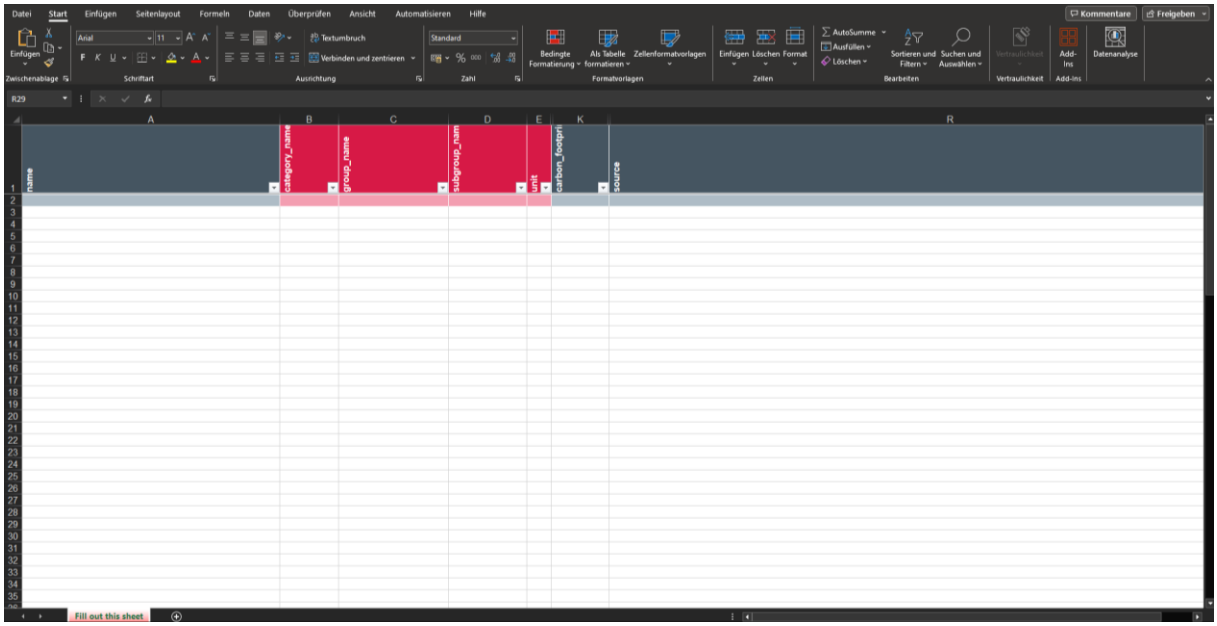
- The Process Name
- Accessibility (private or for all database users)
- GWP (Global Warming Potential / CO2 equivalent)
- Functional Unit [e. g. "kg", "m", "MJ" etc.)
- Source
- Category Name
- Group Name
- Subgroup Name

If that is done it's possible to use that process in your project via this database.

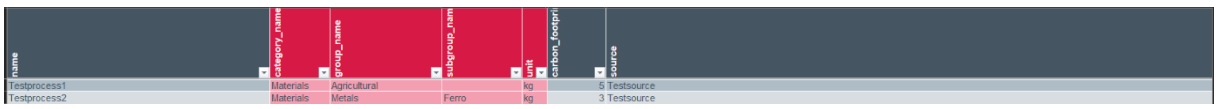
12.2 Importing a database



Click on “Download Import Template”. You’ll receive an excel which you then can fill out and import. The Excel looks like this:



Simply fill it out by typing in the name for the processes you want to add. Continue with using the dropdown menus of the red cells. If a dropdown menu does not show any options to select, please leave it empty. It should then look something like this:



When you're finished, save the Excel file and use the Import Upload feature while creating a database.

12.3 The Idemat Database

“IDEMAT (short for Industrial Design & Engineering MATerials database) is a compilation of LCI data of the Sustainable Impact Metrics Foundation, SIMF, a non-profit spinn-off of the Delft University of Technology. It is designed for the need of designers, engineers and architects in the manufacturing and building industry.

The dataset has been developed to educate approx 500 students each year on how to apply LCA in the fuzzy front end of Industrial Design Engineering. The aim was to provide students with:
(1) extra data on plastics, alloys, and wood species (that were missing in Ecoinvent)
(2) extra data on end-of-life credits for recycling and combustion with heat recovery, to give students a better understanding of material and system choices in regard with circular design.

Until 2014 the dataset was based on Ecoinvent Version 2 LCIs, but after the introduction of EI Version 3, there wase a growing dissatisfaction on the lack of sufficient transparency (which was excellent in the EI Version 2)

and the inaccuracies of data on e.g. electricity (see Electricity in LCA) and transport (data seemed to be outdated). At that time it was decided to build a new dataset based on peer reviewed literature and measured data. The aim was to achieve:
(3) a better accuracy than Ecoinvent for the main emissions (CO2, SO2, NO2, PM2.5, etc.) in relation to electricity and transport,
(4) provide a good transparency of the source of LCI data (better than than e.g. Ecoinvent)

Idemat data are based on peer-reviewed scientific papers (472), plus additional LCI’s made by Delft University of Technology (652), and Plastics Europe (40). The remaining background processes (74) are from Probas (25), USLCI (20), ELCD (16), CESedupack (7), Univ Chalmers (4) and EI (2). SIMF has the aim is to replace these remaining background LCIs by processes from scientific literature as soon as it becomes available in peer reviewed papers, since many of these background databases appear to be highly inaccurate (outdated, or based on generic statistics, the so called Input-Output tables, rather than process flows).“ (Source: Sustainability Impact Metrics, https://www.ecocostsvalue.com/data-tools-books/idemat-calculation-rules/)