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BIM-LCA Construction Project

Title: LCA applied to Elements in Construction. Granta and OneClick

1 – Aims

The objectives of this LCA tutorial are as follows:

Learning about the LCA.

Knowing about several uses of LCA applied to construction.

Efficiently organize the LCA in a BIM project.

2 - Learning methodology

The teacher will give an explanation about LCA of about 30 minutes.

Students will read this tutorial and follow the steps shown in the tutorial, namely:

- LCA overview
- Project information
- Project LCA Goals and LCA Uses
- LCA process and strategy
- LCA exchange protocol and submittal format
- Project deliverables
- Collaboration Procedures

In order to evaluate the success of the application, a questionnaire will be held for the students.

3 - Tutorial duration

The implementation described in this tutorial will be implemented through the BIMVET3 platform by self-learning.

4 lesson hours are suitable for this training.

4 – Necessary teaching recourses

Computer room with PCs with internet access.

Required software: GRANTA EduPack, OneClickLCA

5 – Contents & tutorial

5.1 – Introduction

To efficiently organize the LCA implementation process on a BIM project, the definition and design of the element should be addressed in first place. Therefore, the following items should be discussed:

- Element/part of the building to be analyzed.
- List of materials of the element.
- Lifetime of the element.
- Content of recycled materials.
- Potentially recycling materials.

5.2– LCA short overview

5.2.1. What is LCA.

The large focus on sustainability and transition to a low carbon society is making it necessary for more companies to have a proactive sustainability strategy. For large companies, this task can be managed by separate directors, departments, and staff. The use of quantitative reporting of climate performance has increased in the later years and are moving from market based voluntary requirement to regulatory requirements. For instance, environmental product declarations (EPD) have been available since the mid-1990s and are based on life cycle assessment (LCA). LCA is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service. LCA aims to identify, quantify, check, and evaluate information in terms of environmental indicators. The outcome of the interpretation phase is a set of conclusions and recommendations for the study.

5.2.2. Major LCA Goals / Objectives

To create an effective LCA, it is very important to consider the benefits that the report can bring to the project and define the goals we aim to achieve on this basis. This information can be used in two different ways:

1. LCA shows the energy and carbon footprint of an element or product. Therefore, this information is the basis for the elaboration of EPDs.

2. The report also shows the difference between the phases of the LCA. The identification of the most contaminating phase is helpful to design the strategies to efficiently decrease the environmental impact of the product.

5.2.3. EPDs

EPDs is a transparent strategy to report the commitment to measuring and reducing the environmental impact of a product or service. The environmental performance of the product shall be described from a life cycle perspective by carrying out a life cycle assessment of the product. The results of the LCA study and other information mandated by the reference shall be compiled in the EPD reporting format. The EPD shall then be verified by an approved independent verifier before being registered and published at the International EPD System.

The International EPD® System is a global programme for Environmental Declarations. Environmental Product Declarations present transparent, verified, and comparable information about the life-cycle environmental impact of products and services.

The main challenges in creating EPDs are the diversity of range of the product category rules, complexity and inconsistencies in databases, lac of satisfactory and acceptable third-party critical review, financial constraints and incomplete formation and interpretation of results.

Focusing in the Construction and Building Technologies, the International Green Construction Code (IgCC) is a model to include sustainability measurements for an entire construction project and its site. As an overlay code, it establishes minimum green requirements for buildings by exceeding the companion classical ICC model codes in the areas of energy efficiency, water usage and waste reduction, as well as focusing attention on health, safety, and community welfare.

Green buildings necessarily require careful product and material selection criteria. Understanding a product's environmental footprint increasingly considers all attributes across all of the phases of a product's life, including parameters such as energy consumption during manufacturing, waste impacts during installation and the product's maintenance requirements. And this approach, importantly, considers potential energy savings the product may offer during the long "use" phase as well as outcomes at its end of life disposition. The International Organization for Standardization, called ISO standards, explains how to apply these multi-attribute, life cycle approaches.

While ISO offers standards and guidance that help companies conduct life cycle assessments of their products, ISO standards can do even more than that. For companies that choose to develop an Environmental Product Declaration (EPD) under the ISO 14025 standard, the first step before an EPD is written (in general) is for an industry group to develop and establish a set of Product Category Rules (PCRs) for doing EPDs that contain LCAs. A PCR is a pre-requisite for conducting an EPD – this is covered in the ISO 14025 standard. The standard Product Category Rules (PCRs) are standardized rules for collection and reporting of environmentally-relevant information in an entire product category (like insulation or pipe). Within these rules, a company can better develop an ISO-compliant Life Cycle Assessment (LCA) on its product, which measures the product's impact upon the environment across multiple attributes throughout its life cycle. Then, a company can prepare a report called an Environmental Product Declaration (EPD) if they so choose, following the rules set out in this ISO 14025 standard.

EPDs are becoming more available and are increasingly being used to address a growing market demand for quantified environmental information. EPDs make decisions and judgments more informed and more defensible for code officials making an approval determination.

Including EPDs in the model code gives builders more compliance options and more choices. The IgCC still includes single attribute materials and resources compliance pathways, EPDs would provide additional compliance choices to builders.

EPDs report environmental impacts over the lifespan of a product, so they function as a useful tool to support product evaluation. They do not require builders to select any particular product, since they are not comparative by nature. The cost of developing EPDs is borne by product manufacturers and does not fall upon builders.

One of the virtues of an EPD is that it provides information about energy use/savings delivered by the product during its use phase. Given that many buildings are constructed with a 100 year life span, and that energy consumption in buildings is a huge part of their environmental footprint, inclusion of this attribute is highly valuable to an accurate understanding of a product's full environmental footprint.

Consumers and businesses increasingly recognize the value of products that lower their monthly energy bills and lighten their home's environmental footprint not only on the day they move in but for the period of their occupancy and beyond.

EPDs are not a comparable claim of superiority – and are by their nature product and material neutral, since every company that wants to prepare an EPD has to use the same standards and rules for collecting and reporting information.

5.2.4. LCA and BIM. A synergetic collaboration.

In the later years, EPD and carbon footprint of building materials has been introduced as building code requirement in countries such as Netherlands, Sweden, Denmark, Finland, France, and Norway. In regulation terms, the European Commission has a new directive on sustainability reporting of corporations, including requirements for indicators on climate performance according to Paris Agreement.

Currently, LCA for whole buildings is an exhaustive work due to the repetition of parameters extracted from BIM. Additionally, the complexity of LCA tools is another reason that keeps professionals away from the LCA in construction. Therefore, the integration of LCA in tools in BIM software will lead to an integral vision of the Civil Engineering with commitment to the environment.

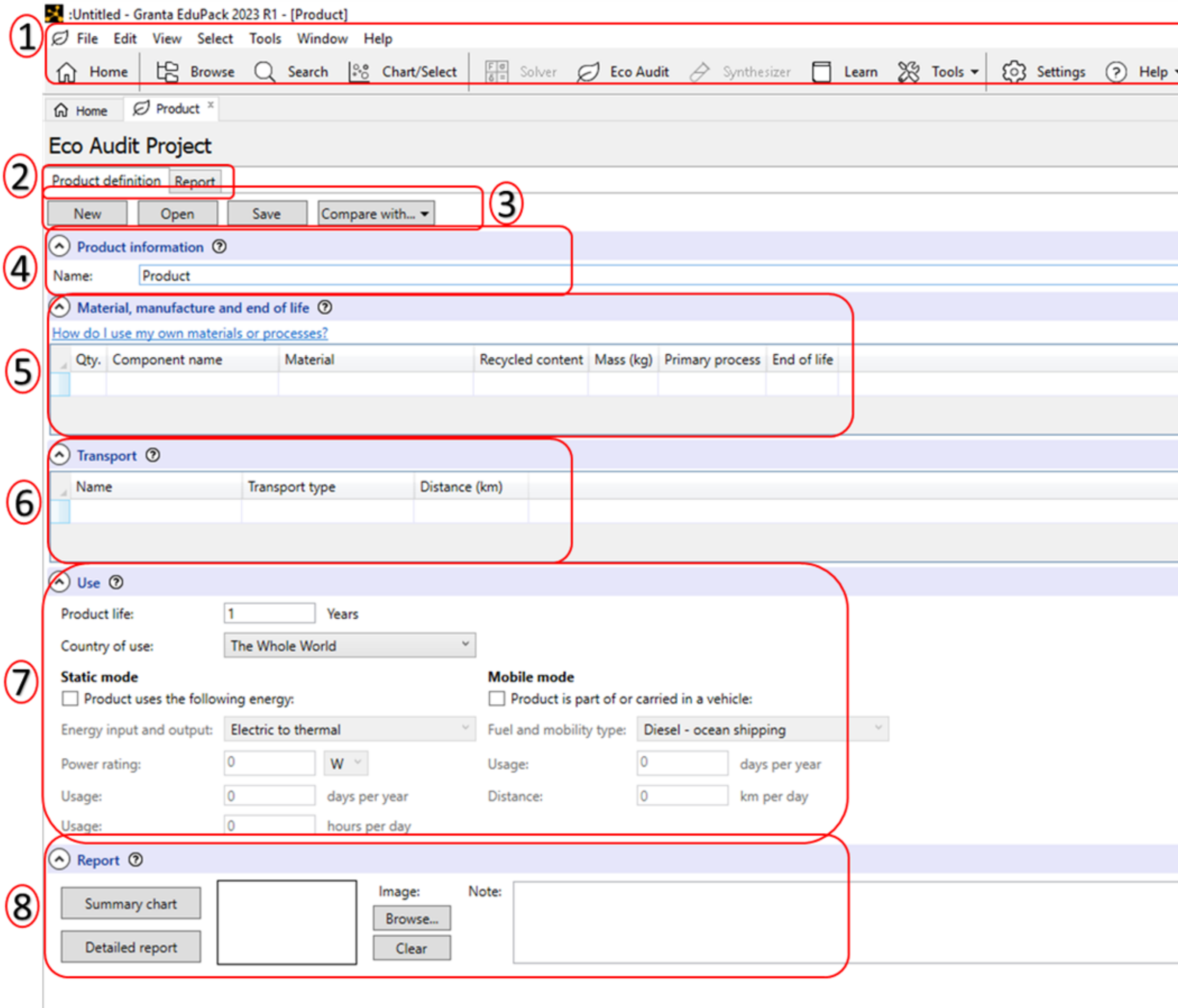
5.3. GRANTA EduPack. Eco Audit Tool.

Ansys Granta EduPack—formerly CES EduPack—is a unique set of teaching resources that help academics enhance courses related to materials across engineering, design, science and sustainable development.

The Granta EduPack Eco Audit Tool enables the first part of a two-part strategy for selecting materials for eco-aware product design. The second part of the strategy is implemented through the Granta EduPack selection software. The Eco Audit Tool draws on the same database of material and process properties as Granta EduPack, ensuring consistency. The approach described provides an excellent basis for teaching students key eco design concepts.

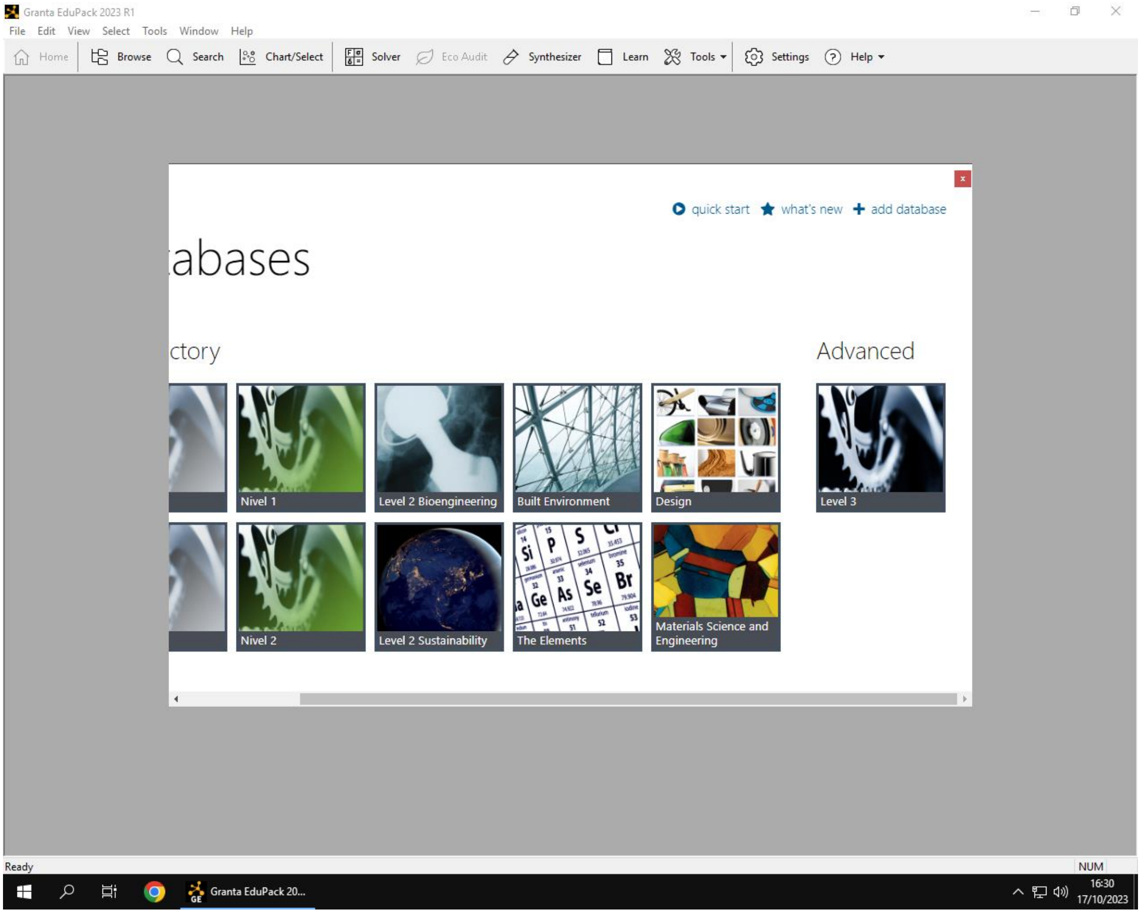
5.3.1. EcoAudit Tool Interface.

1. Tabs.
2. Navigation bar.
3. Project Browser.
4. Panel for product/element information.
5. Panel for material information (type, recycled fraction, manufacturing, mass and end of life).
6. Panel for transport information.
7. Panel for use information (static or mobile mode).
8. Panel for report.

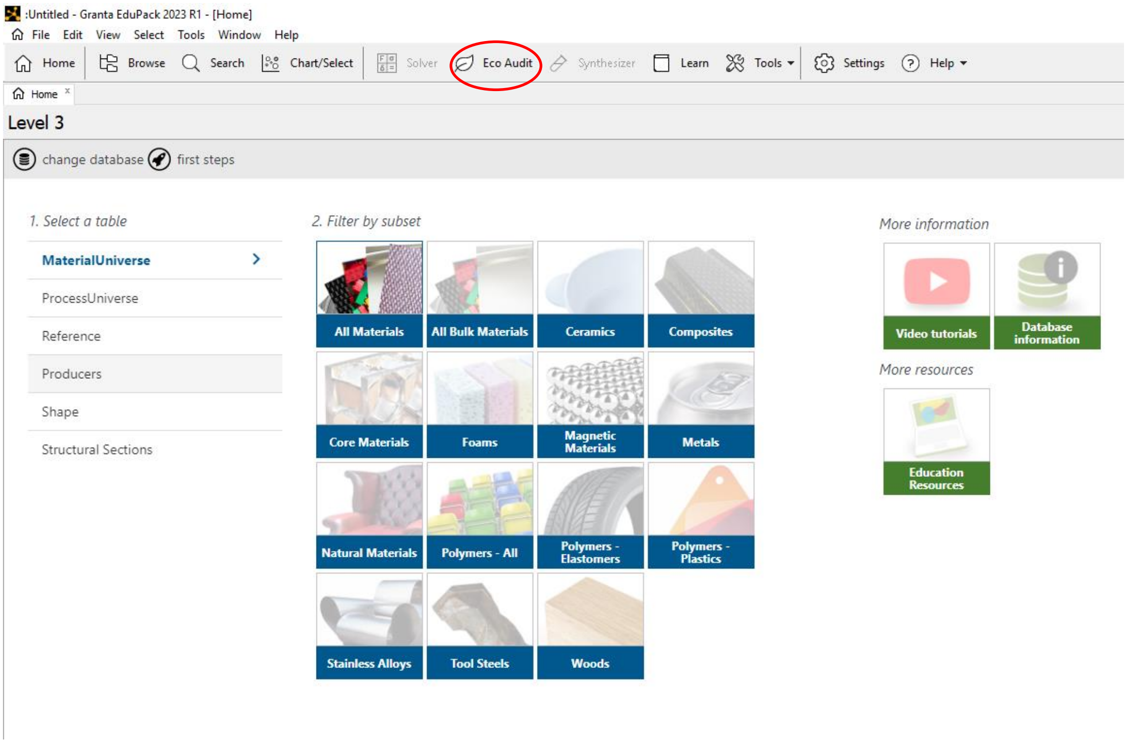


5.3.2 – Starting a project with EcoAudit.

After opening the program, different libraries are open. Eco Audit Tool is available in Levels 2 and 3, but it is highly recommended to use Level 3 (Advanced) for a better understanding and accuracy of data.

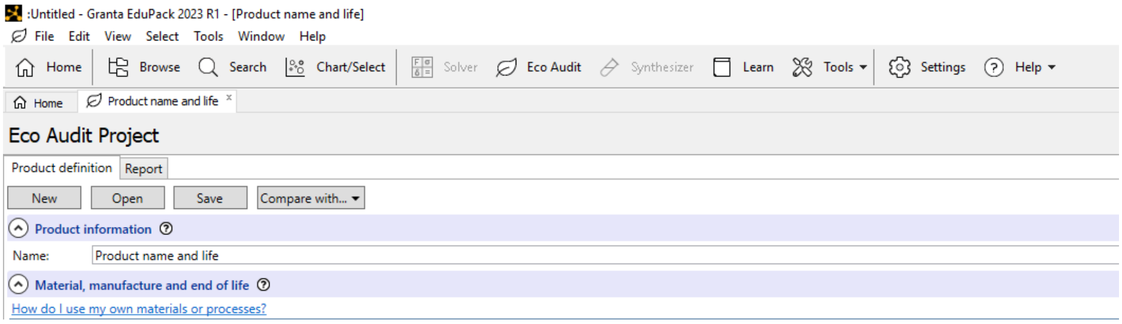


When the library is open, the tool Eco Audit will appear in the navigation bar.



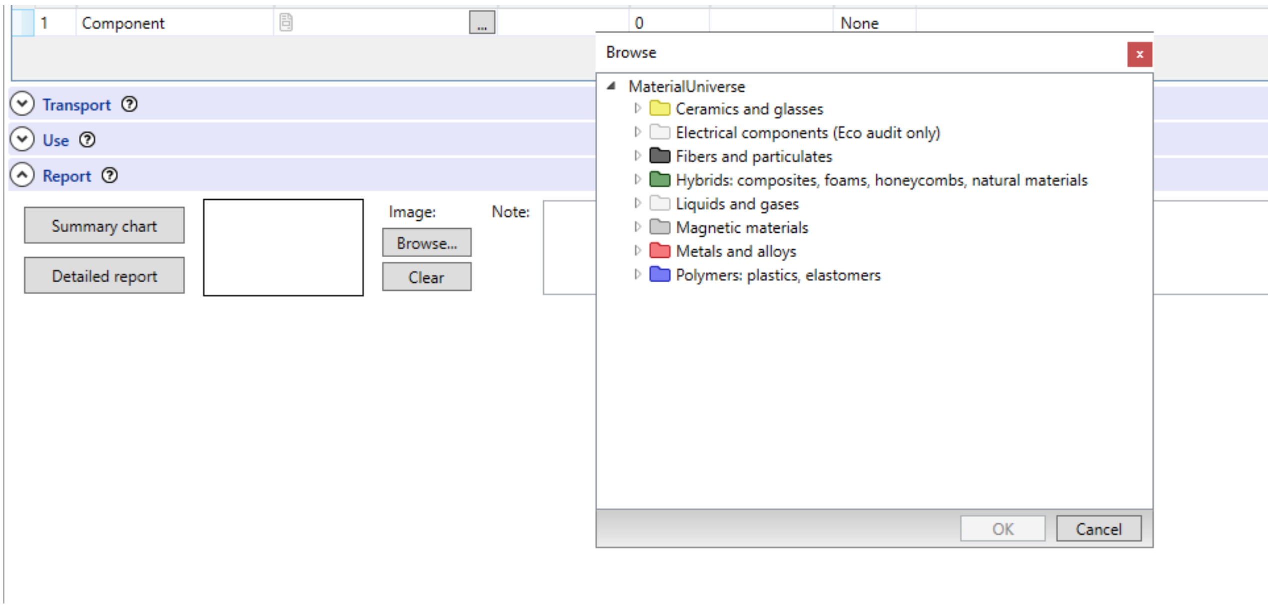
After Eco Audit Tool is open, we can start to introduce the data of our project. We can divide the project into five different actions.

Action 1. Enter product name and life.

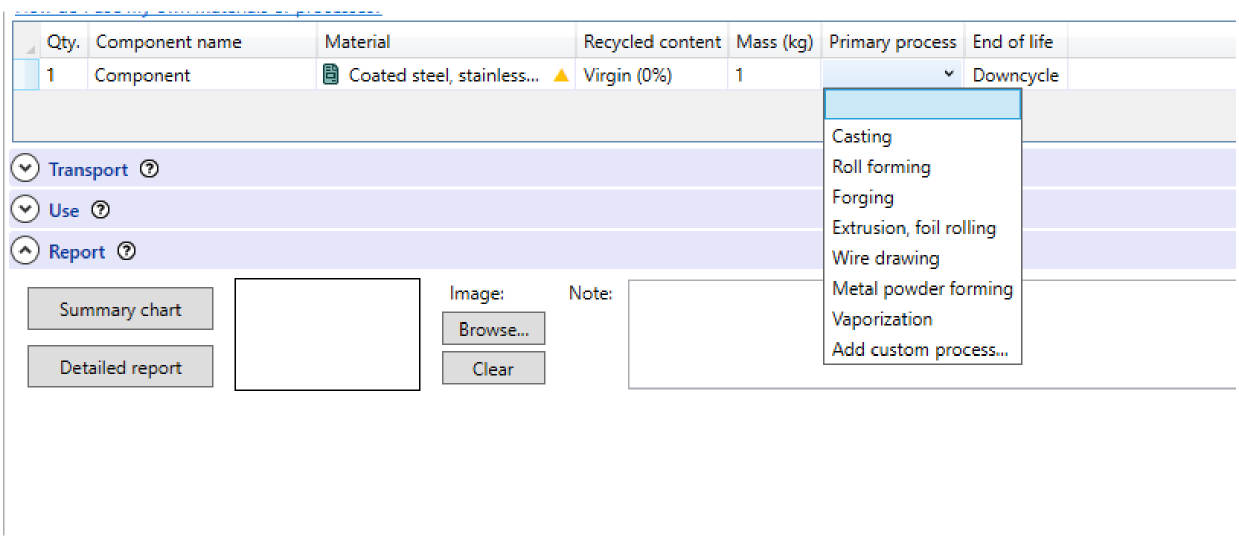


Action 2. Enter component name. Select material and process. Enter mass and end of life.

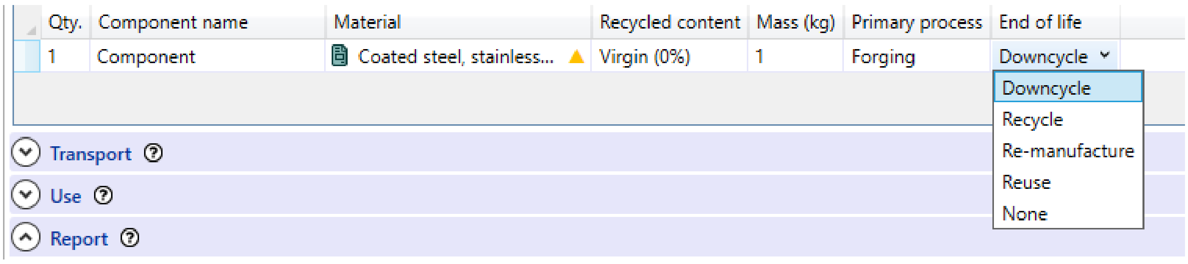
1. After entering the name of our component, it is necessary to select the material from the data base. A browser is open, and we can select the material from the Material Universe Library. In Level 3 a quite detailed library, containing more than 4000 entries, is available.



2. Once the material is selected, we can add the recycled content. We can select three options (virgin, typical or reused) but it is also possible to add a specific quantity.
3. An easy, but critical point is to add the mass of the material.
4. Then the manufacturing process must be selected. The different options are the most common fabrication processes for the selected material. However, it is also possible to add a custom process.



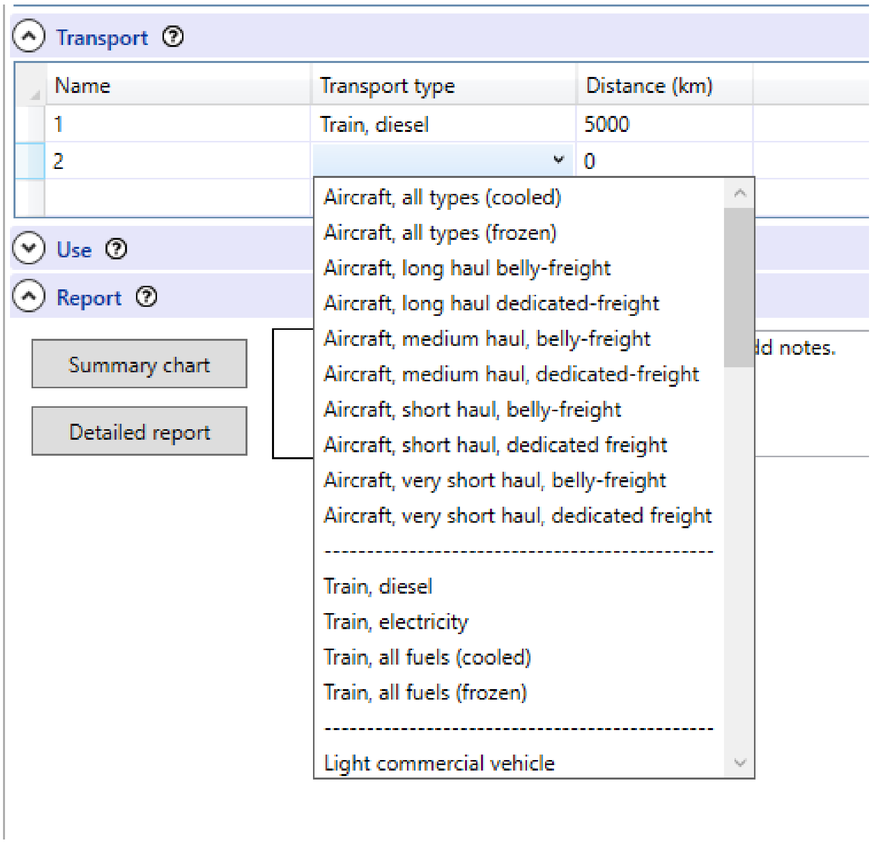
5. Finally, the End of Life is defined from a list of the possibilities for these specific materials.



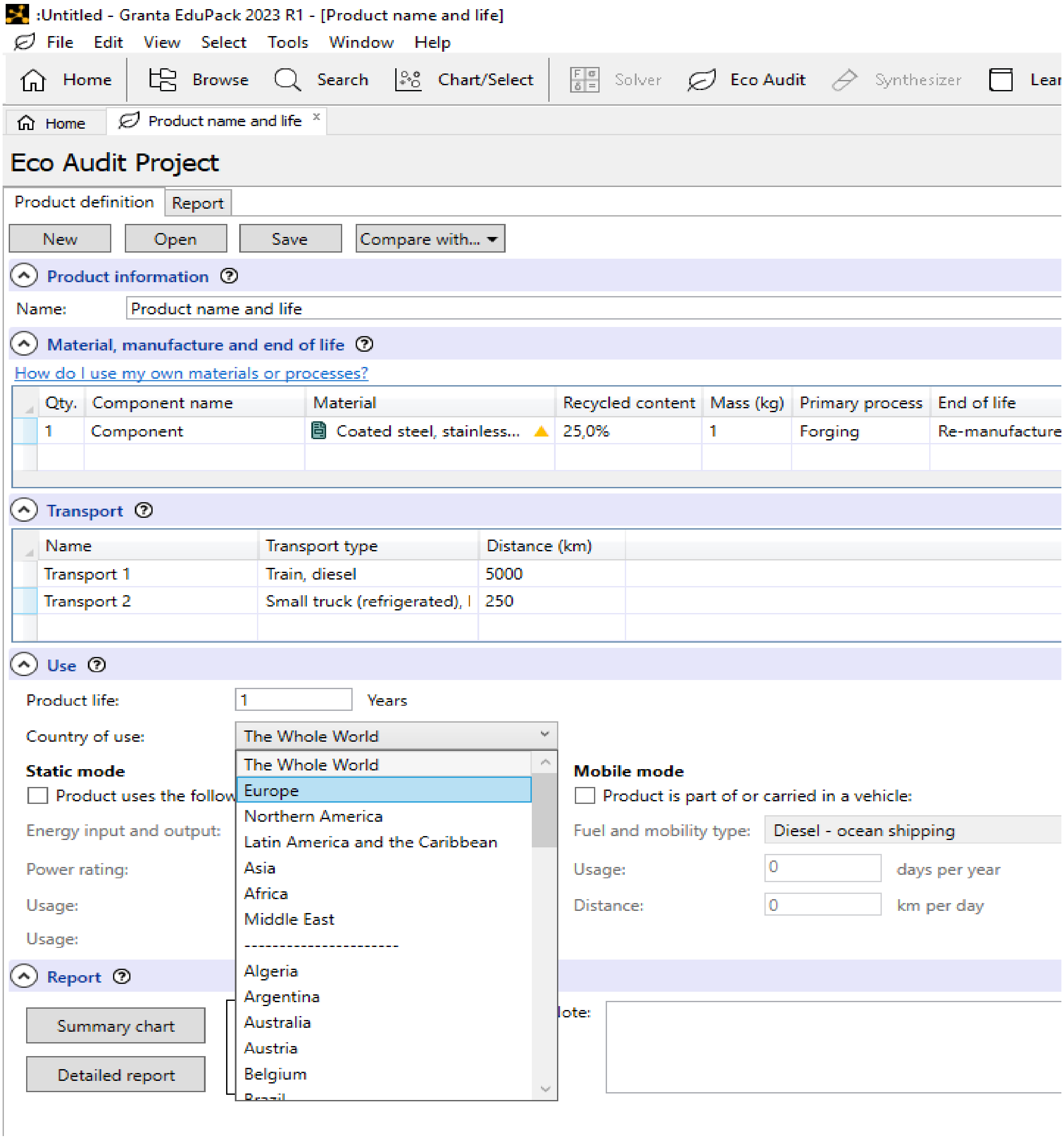
After all the information about one of the components is added, we can add as much materials or components as we need to. At the end, we introduce a list of materials with the manufacturing, mass and end of life.

Action 3. Enter transport.

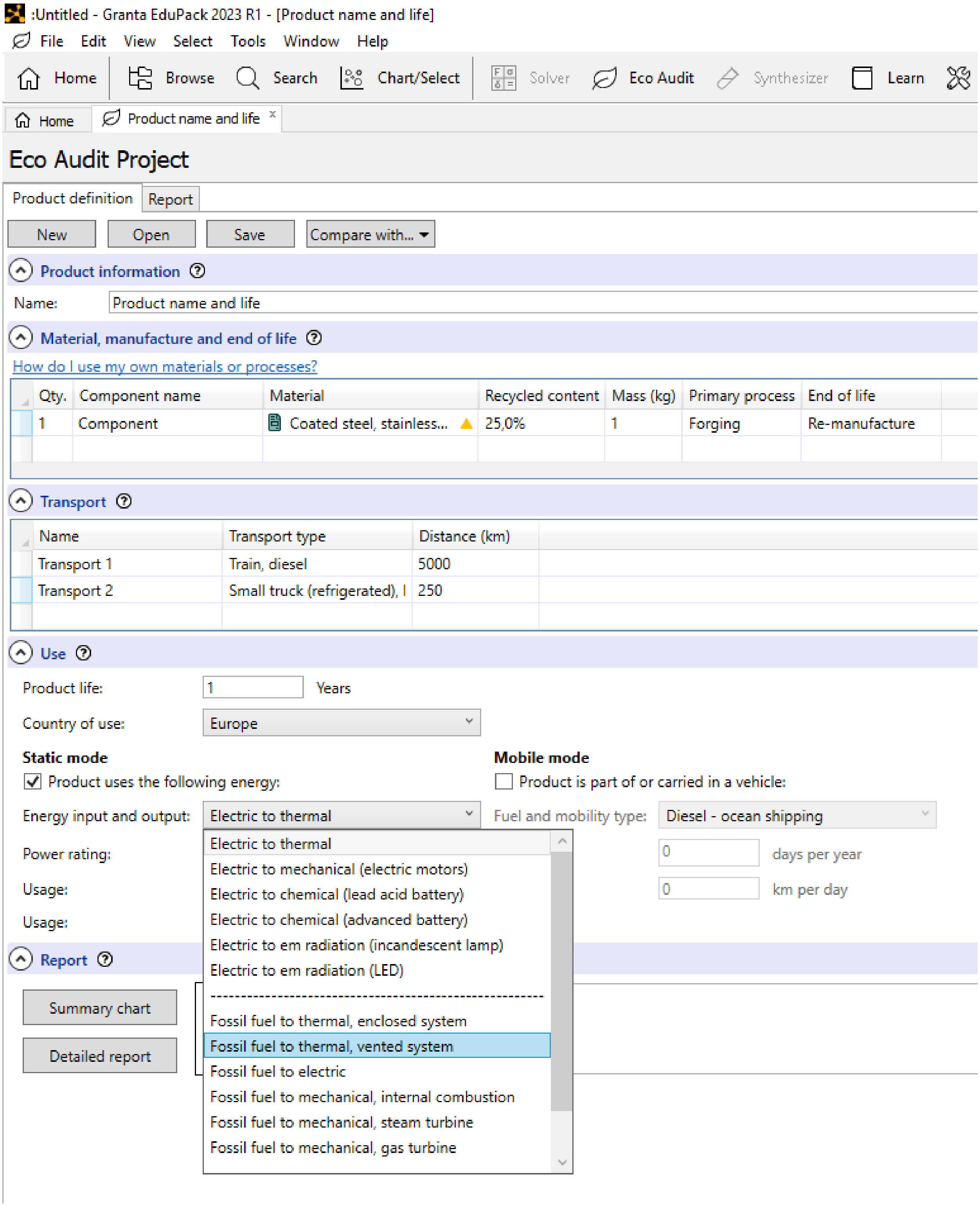
Select transport mode from the browser and enter distance. We can add as much transport as necessary.



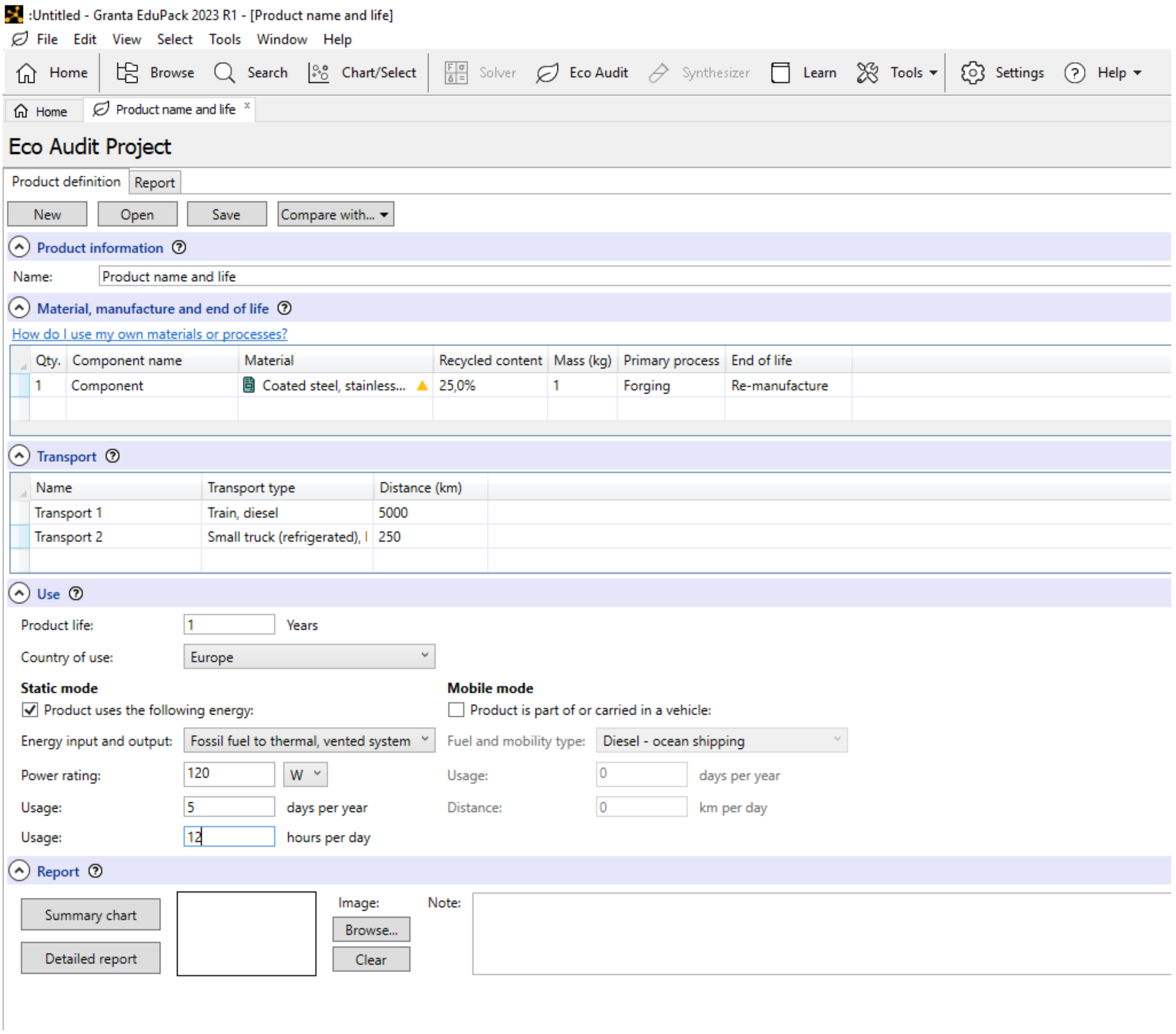
Action 4. Enter product life. Select static mode if product does not move (energy in and out, power and usage). Select mobile mode if product moves (select fuel and type of mobility).



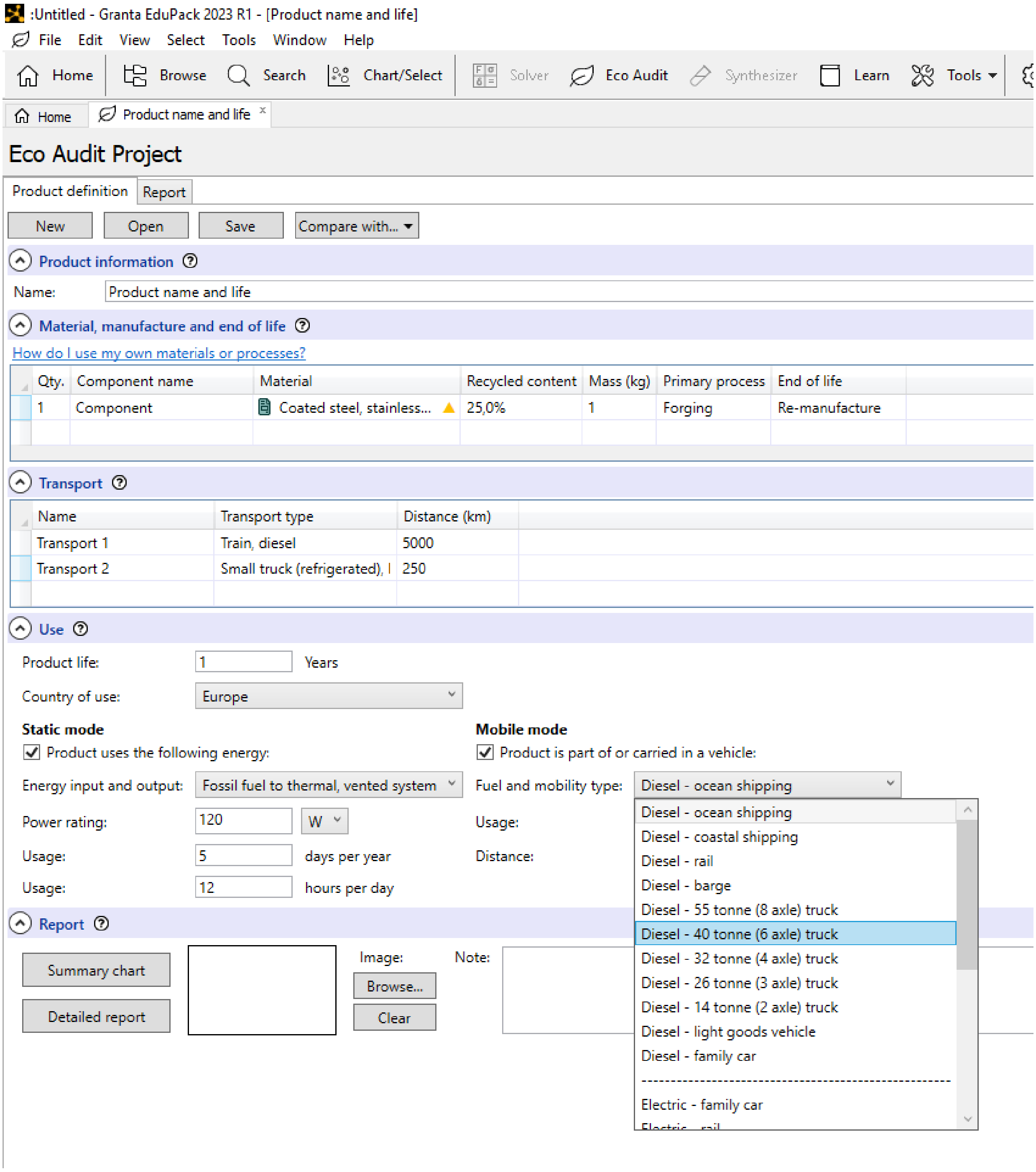
The power supply changes from one region to other. Therefore, we need to select the country of use.



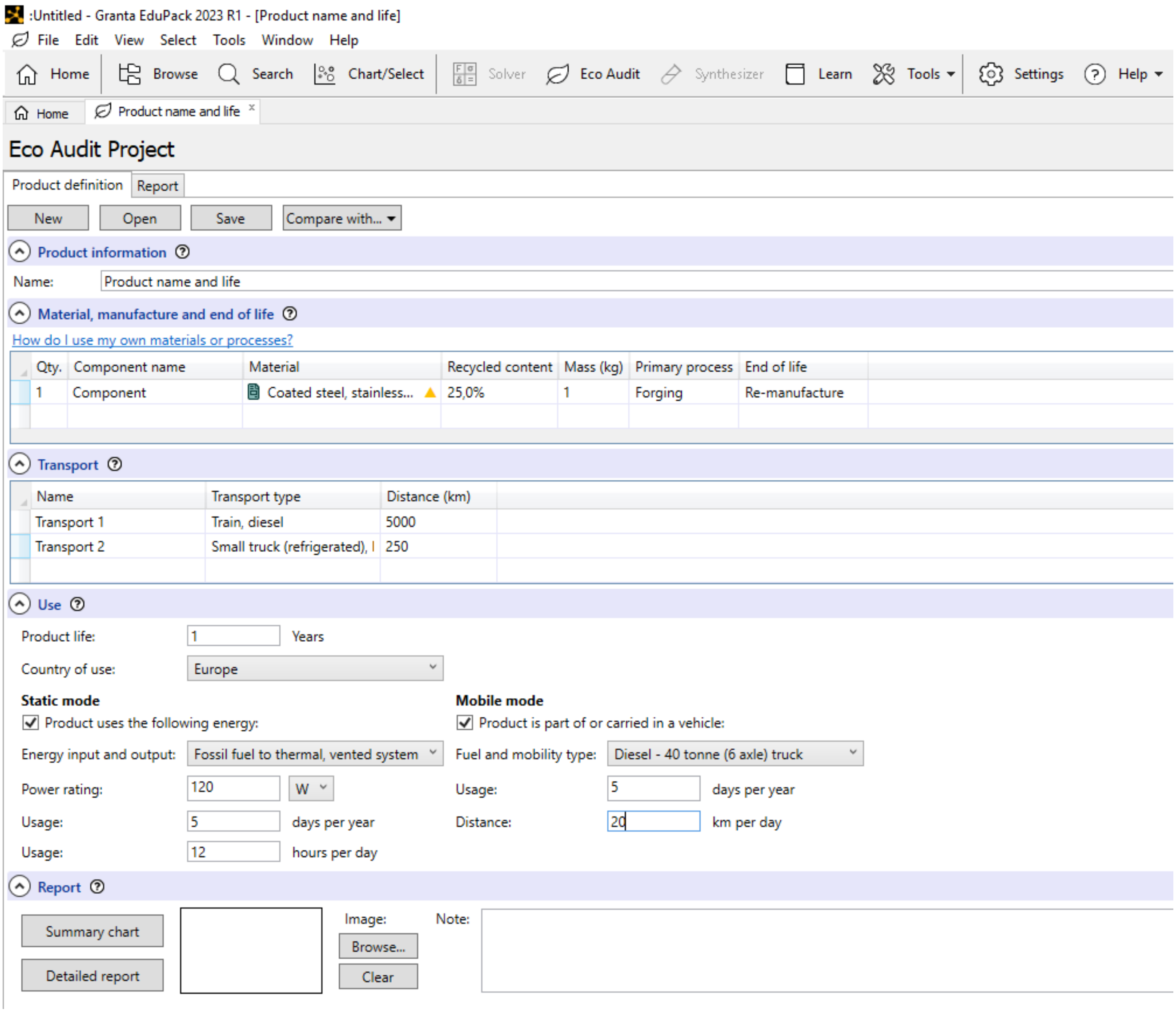
In the static mode (the product does not move), we select the energy input and output. For example, a heater is electric to thermal.



After the selection of the input/output of energy, the power and time of usage should be selected.



If the product moves, we have to select the mobile mode and then the fuel and mobility type should be selected from a browser.

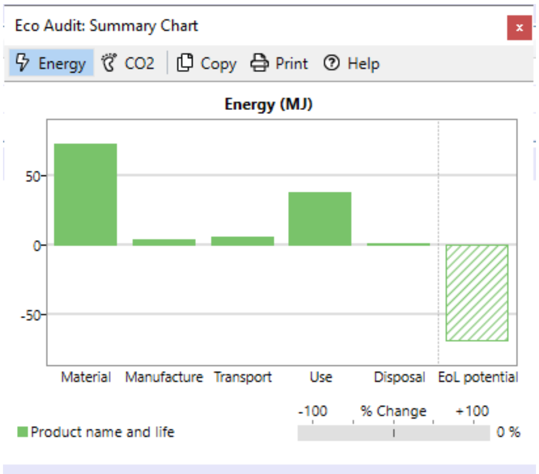


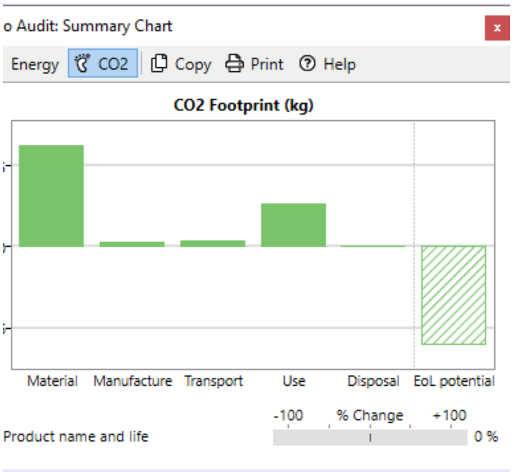
Finally, we select the usage and distance.

Action 5. Enter notes and images. The software allows the insertion of notes and images in the report.

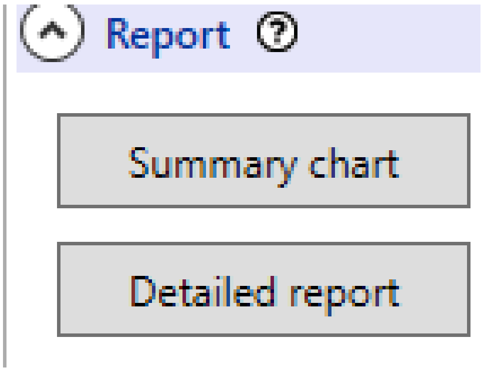
Action 6. Summary Chart.

This option is a quick evaluation of the LCA. A chart of either energy or carbon footprint appears. These charts are useful to check if there is any information missing and which are the phases of the LCA with more and less impact.





Finally, press “Detailed report”.

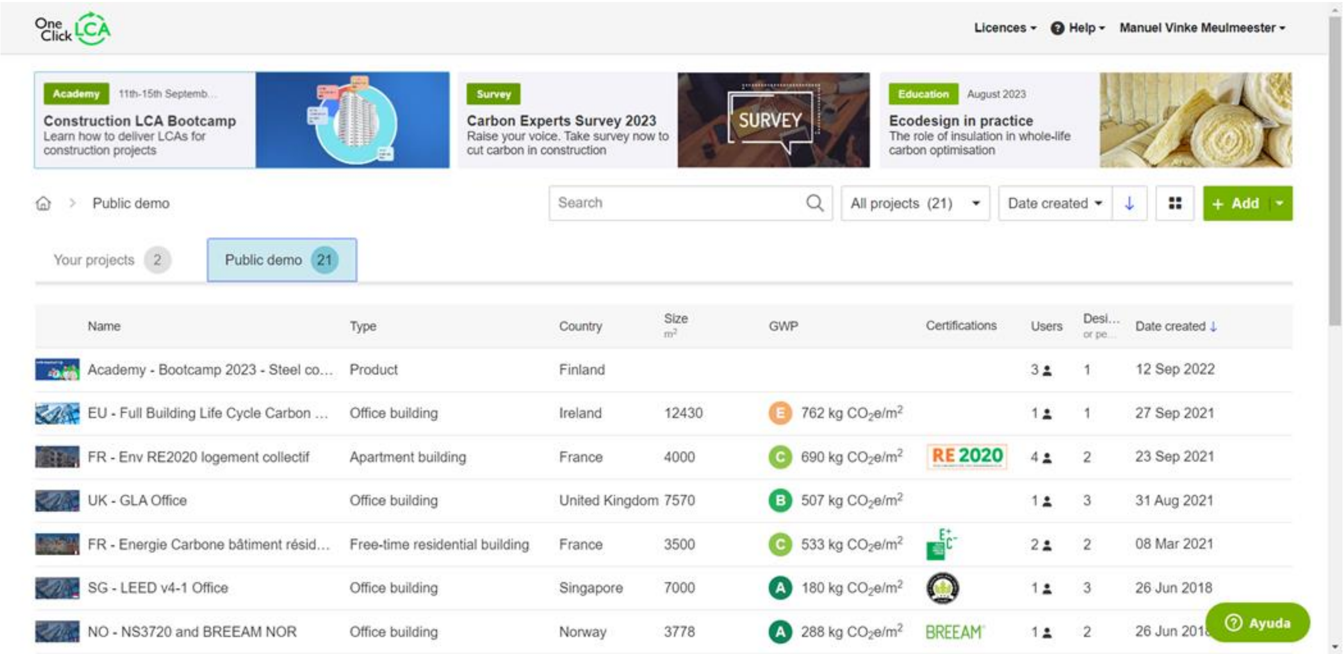


5.4. OneClick LCA.

OneClick LCAis a tool to assess and manage the sustainability of Buldings and Construction projects. It contributes to the reduction of the environmental impacts and to the development of greener edification. This tool assists to the design of low carbon footprint projects and acquire certifications. The inventory of this tool integrates data from available EDPs platforms, following EN 15804 and ISO 14025 standards.

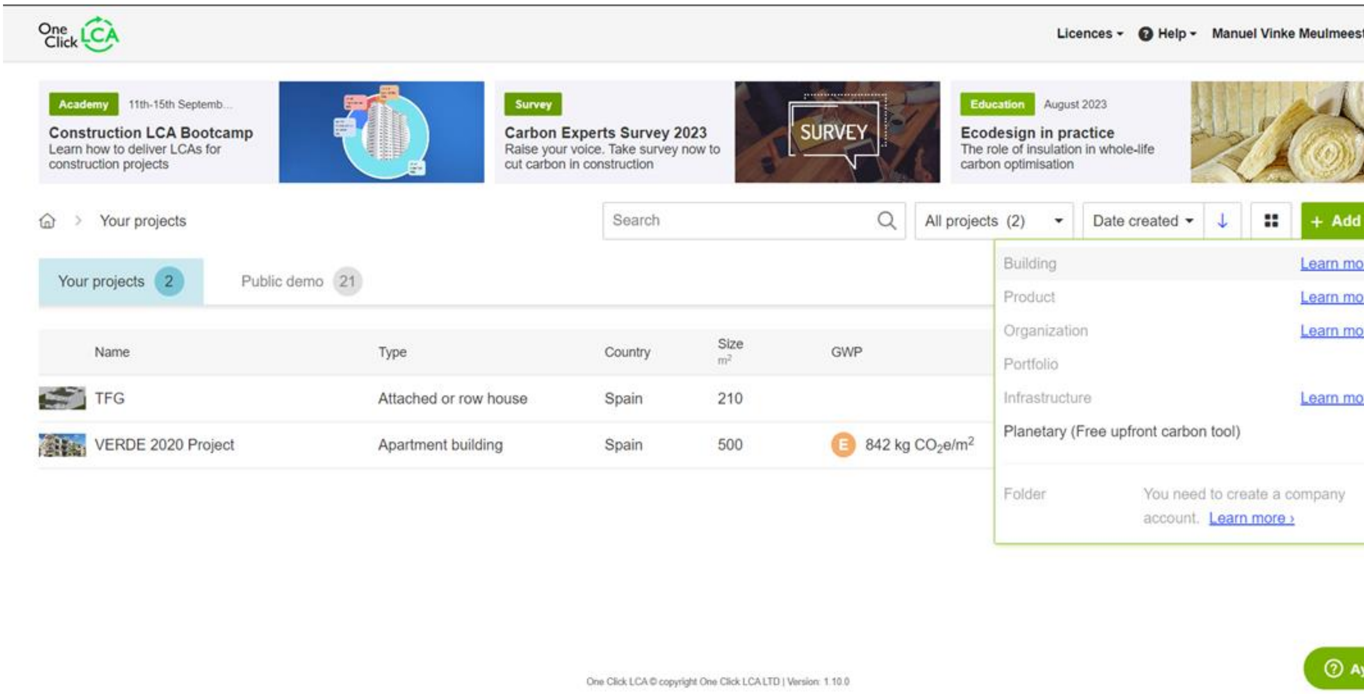
5.4.1. Oneclick LCA interface.

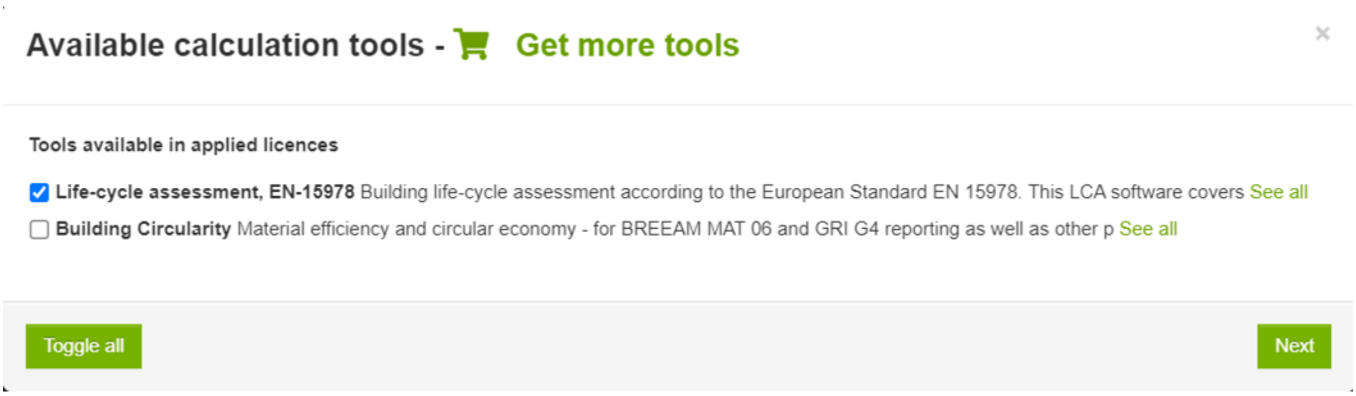
The following figure is a main menu of the software, which includes both own projects and demos.



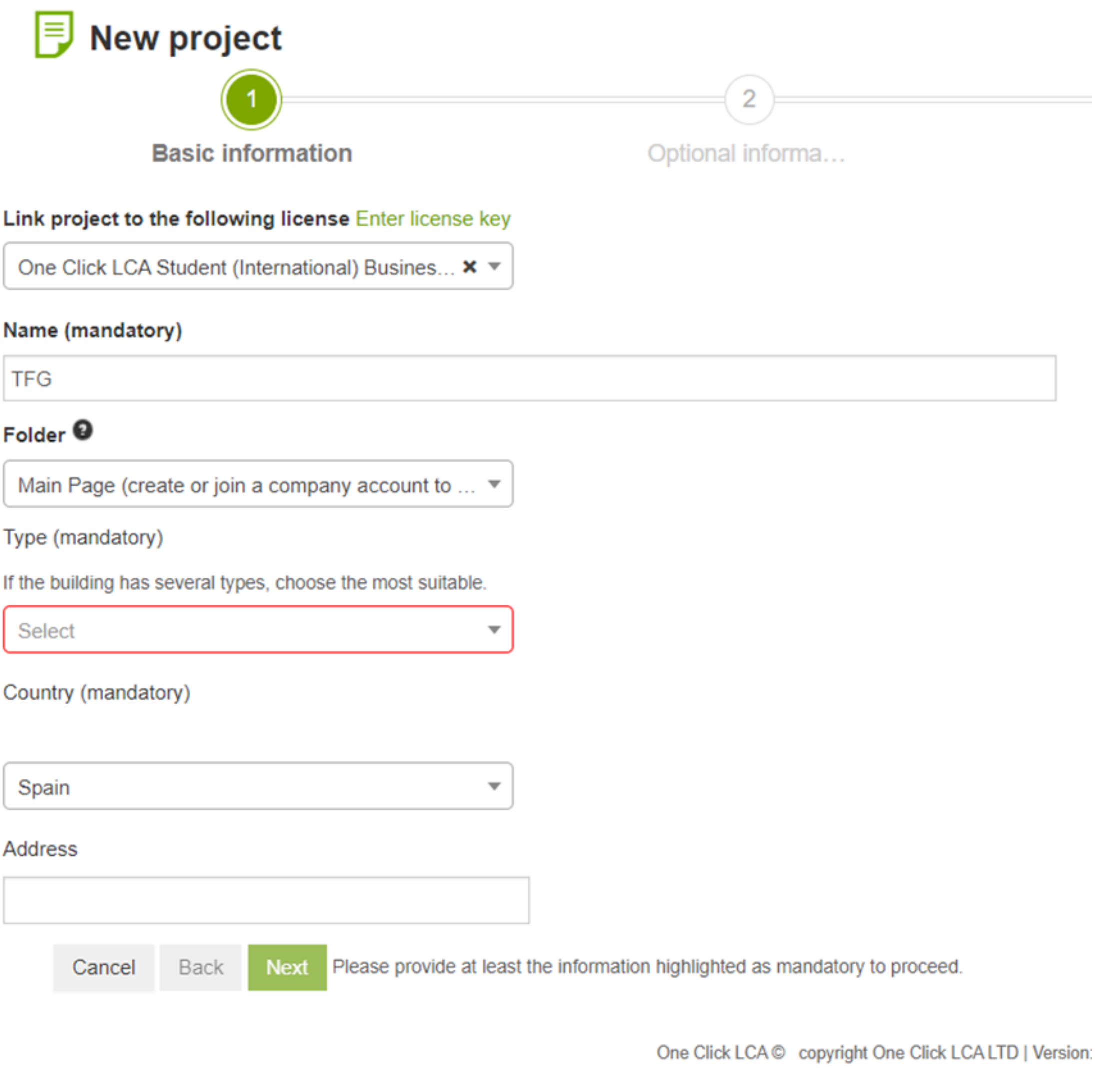
5.4.2. Starting a project with OneClick LCA.

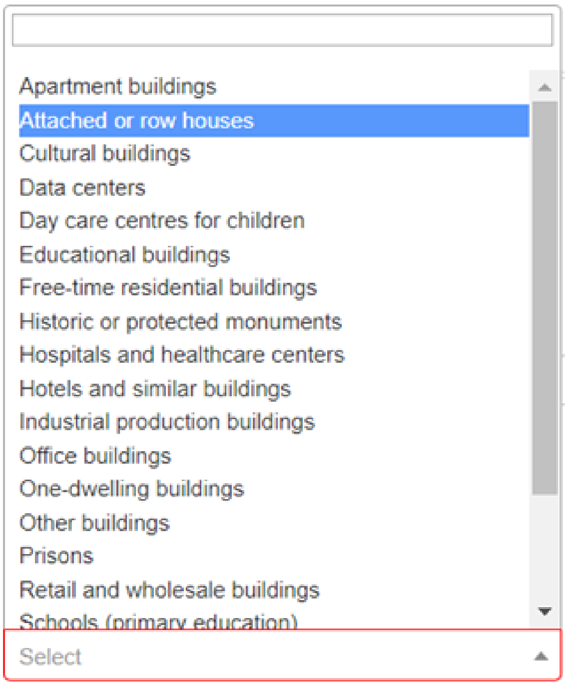
To start a project with OneClick LCA, we have to select “Your Projects” and add “Building”. Then, the software requires the tool which depends on the license. In our case we select Life-cycle assessment, EN-15978.



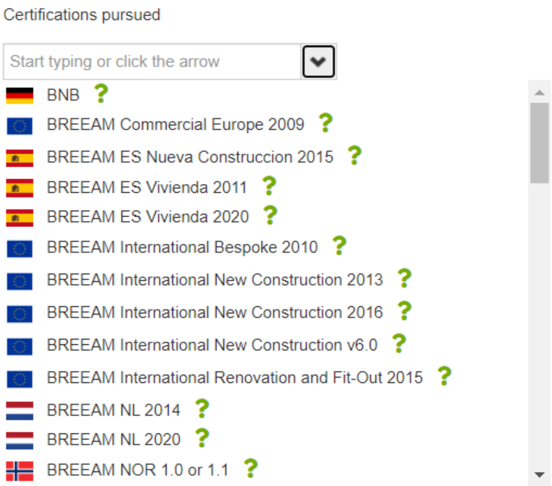


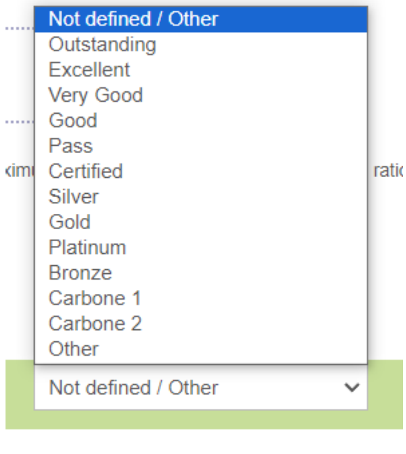
After adding the new building, a series of data should be included regarding the basic information of the project: license number, name of the project, type of building and country. Then, we have to choose the type of building closer to our design.





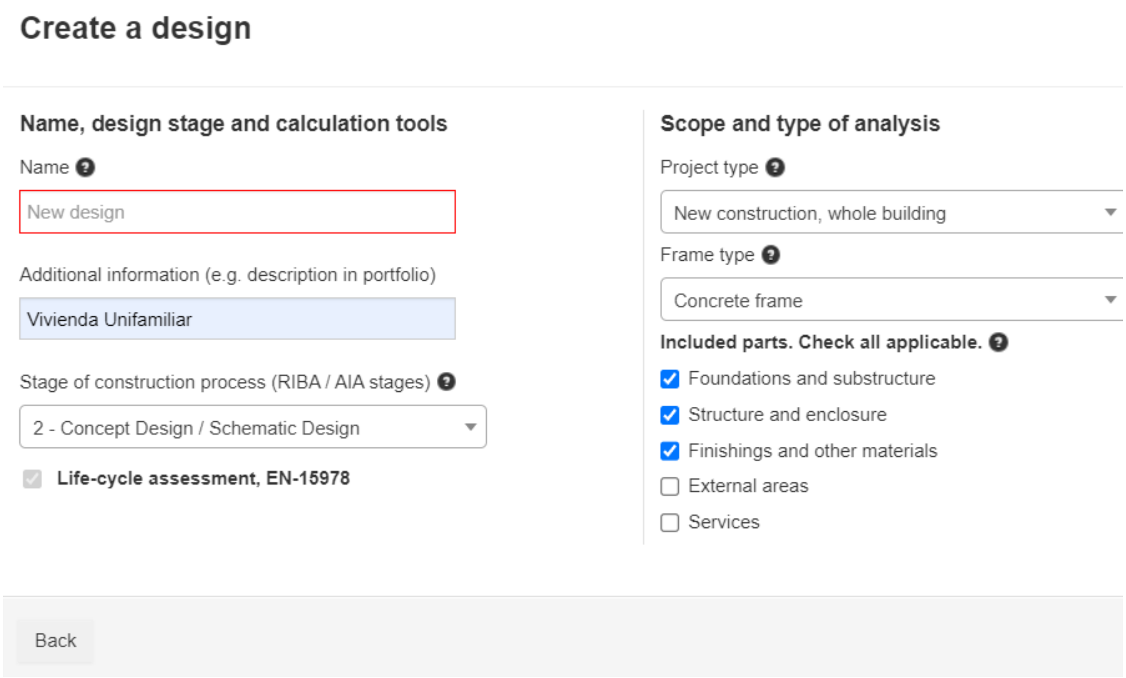
New Project – optional information. In this section recommended, but not compulsory, information shall be added, such as: surface, number of floors, structure, images and the final certification to be acquired. In our case, the certification is BREEAM ES Vivienda 2020, which is a methodology to assess the sustainability of edification.



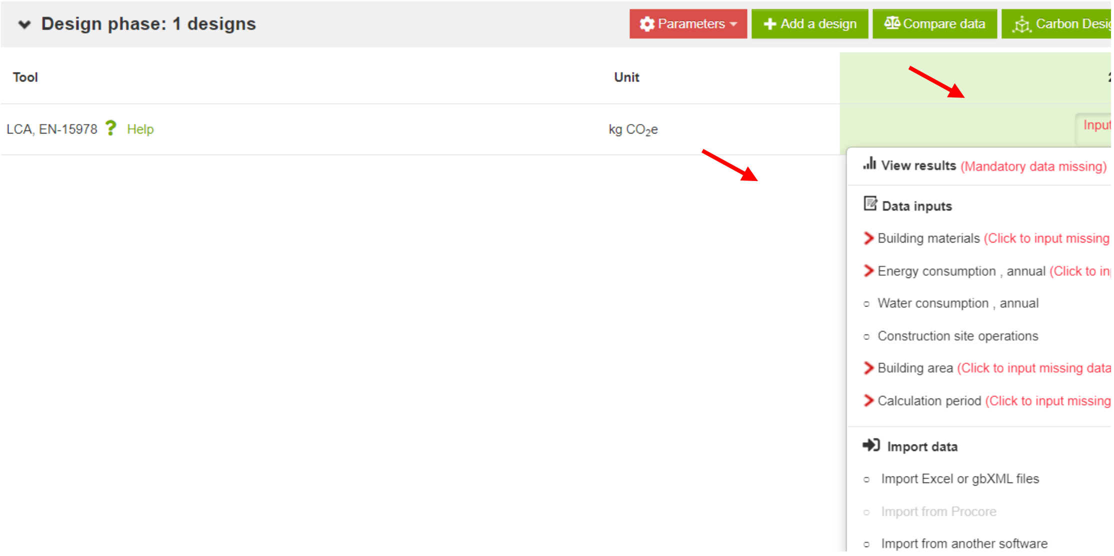


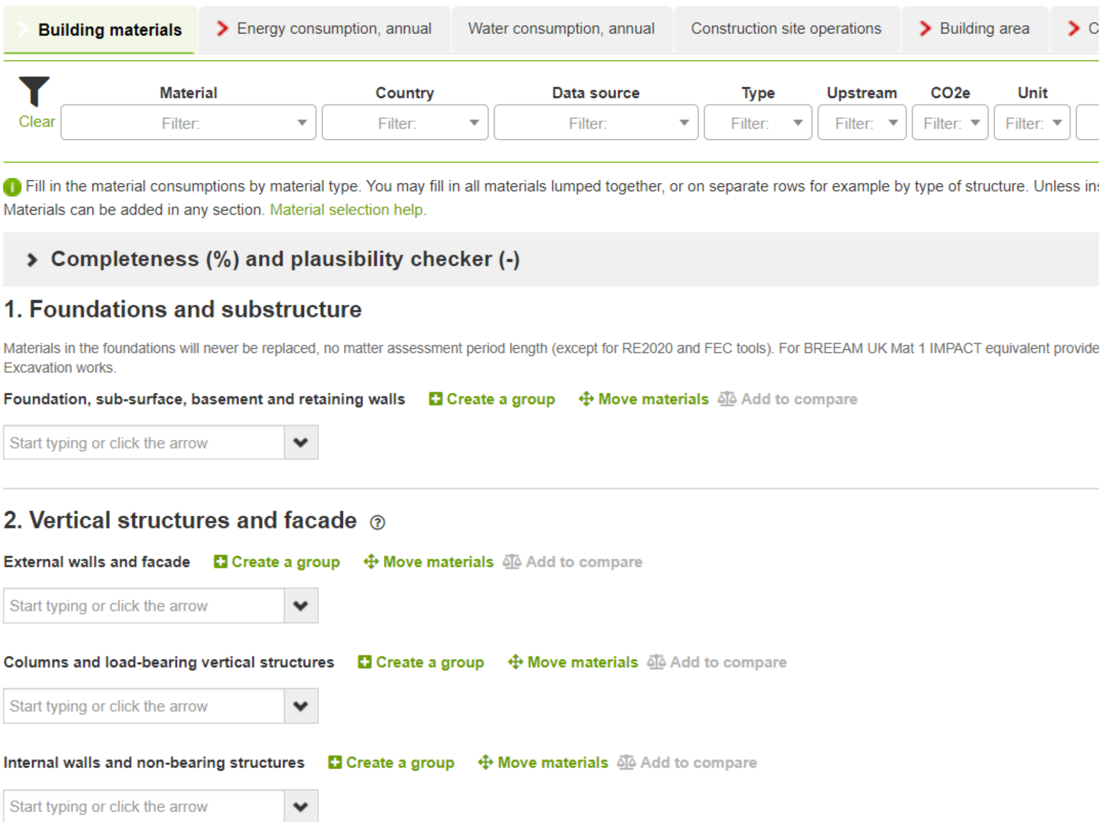
Design.

From now on, we will add the data of our design: name, description, phase of the project, type of project (new construction, refurbishment, etc.), structure and parts of the design.



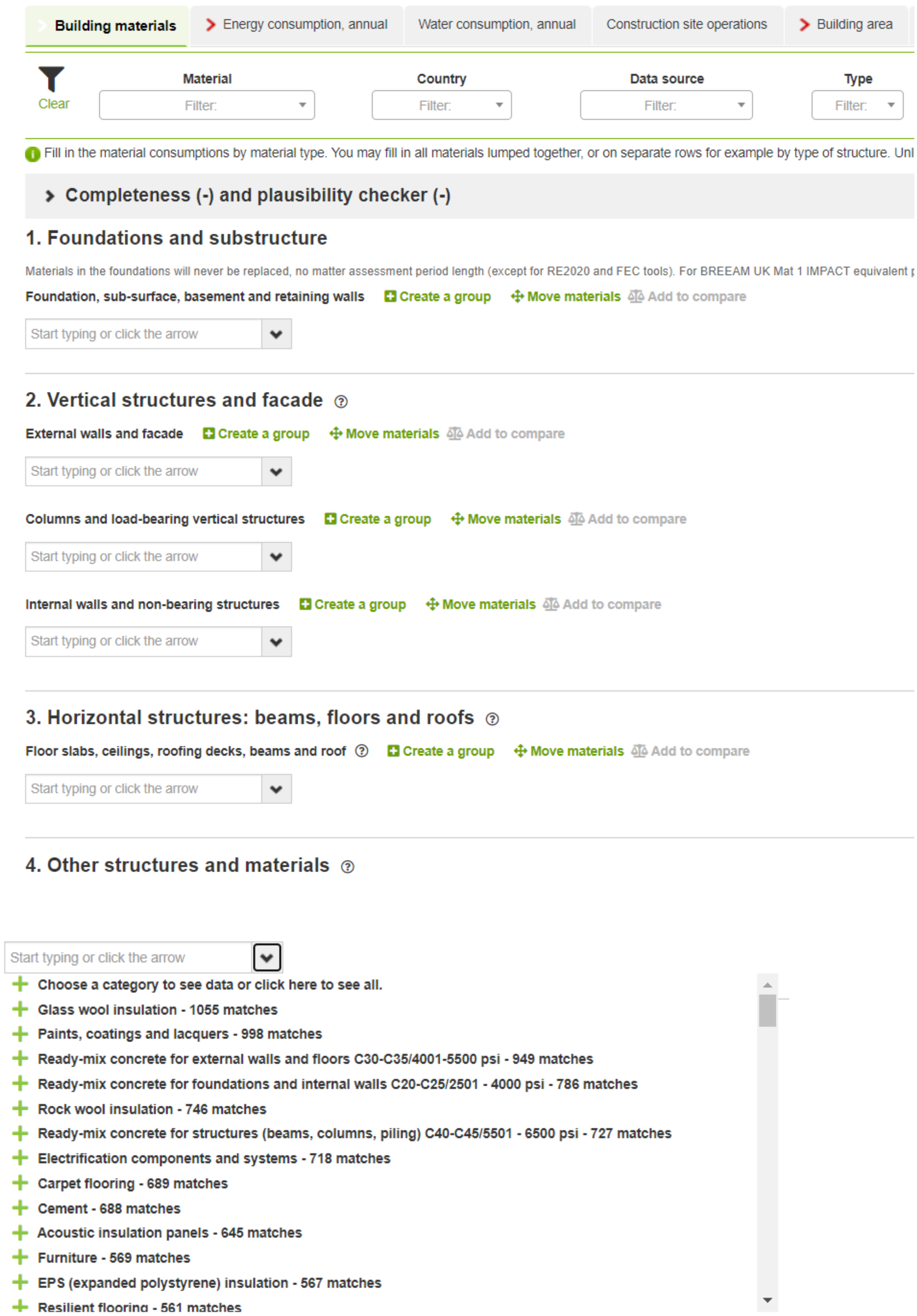
Then we start the design phase. To carry out the LCA, we shall input our data from the browser "Input data → Building materials".





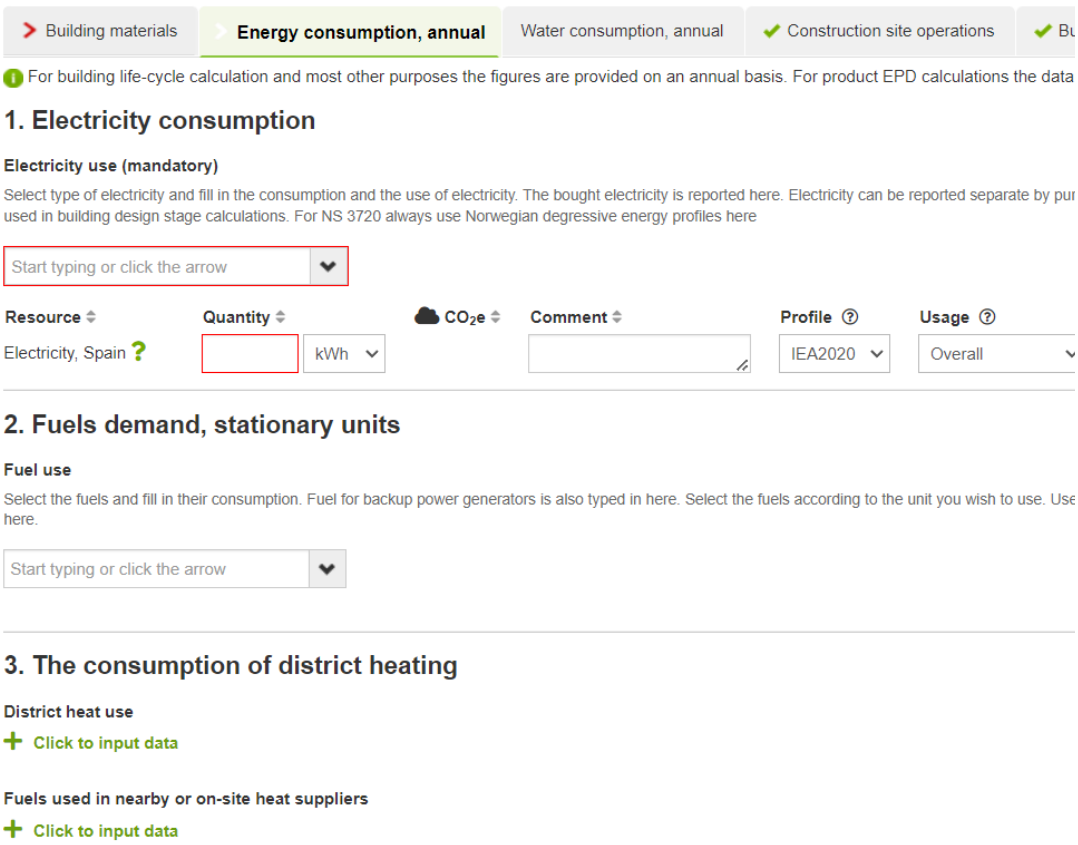
The required information is:

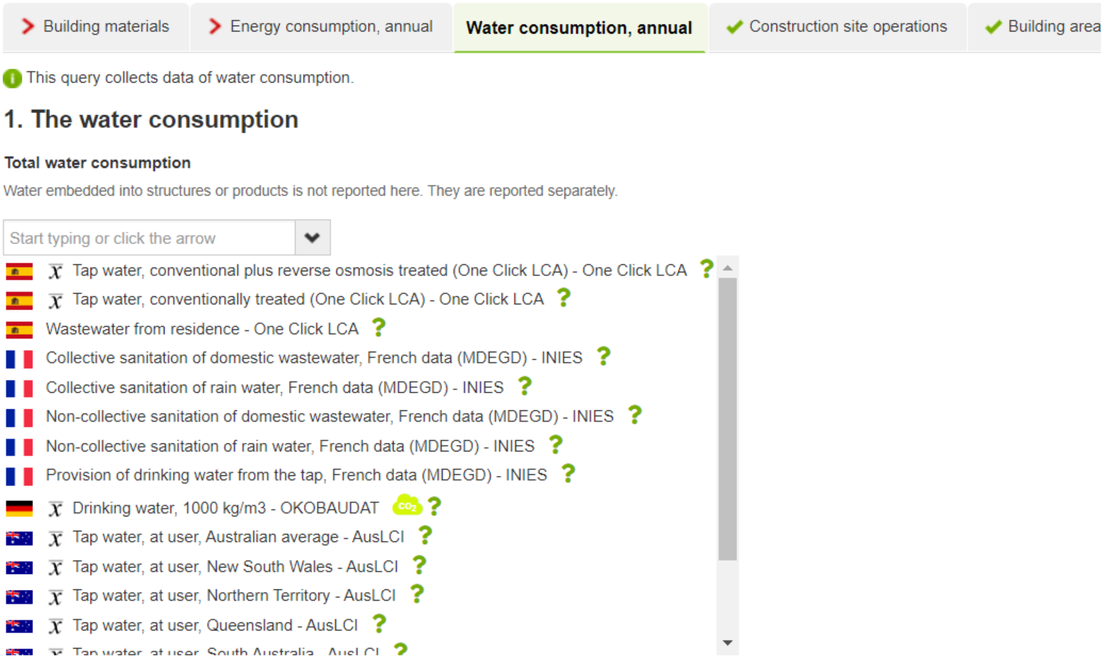
- **Building materials.** Foundations and substructure, vertical structures and fachada, horizontal structures (beams, floors and roofs). The data base contains more than 30,000 materials divided in 127 material categories according to their functional properties.



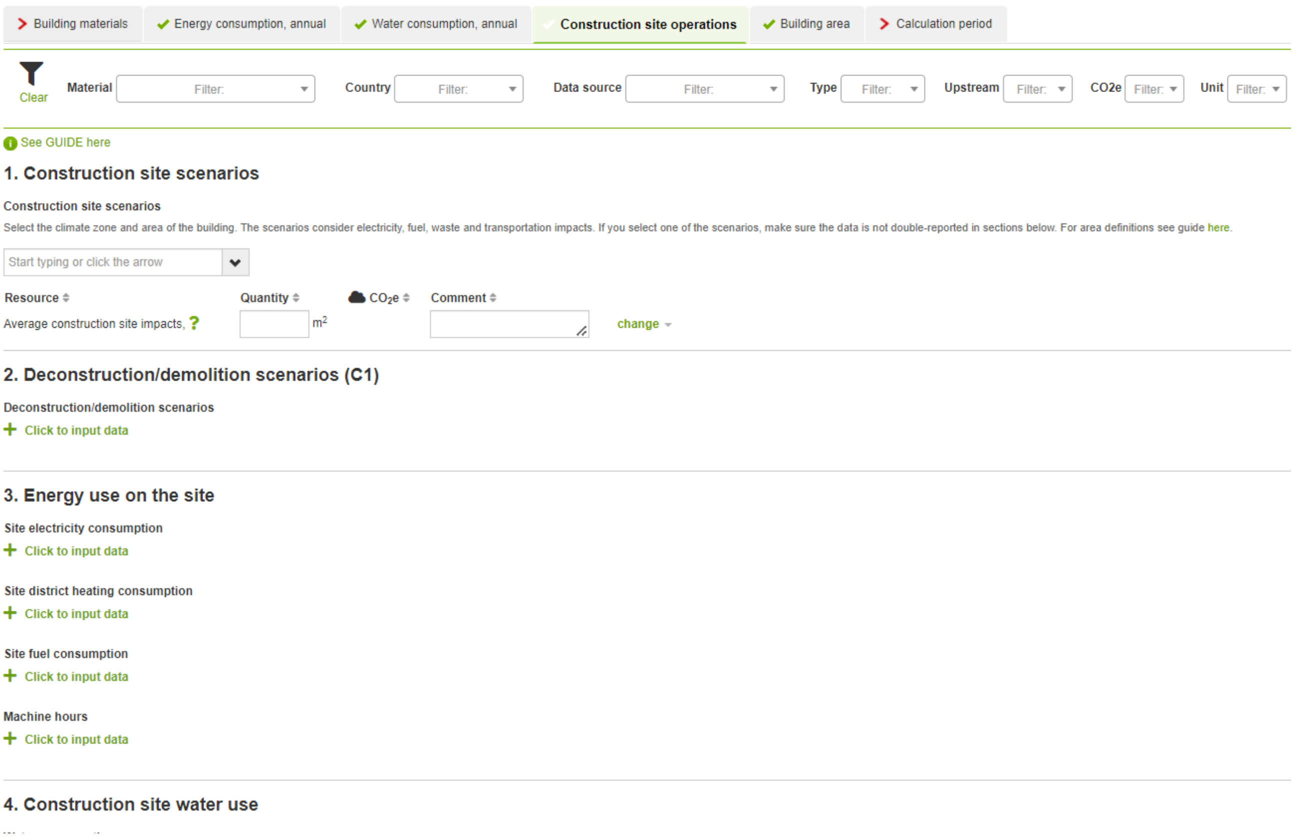
When the material is added to the design, we shall select the units (kg, ton, m^3, m^2, ud, m). The software gives default values for the transport and distance, but they can be manually modified. Finally, the end of life is required.

- **Energy and water consumption.** These data depend on the kind of building, location, climate conditions, energetic efficiency and habits of the inhabitants.

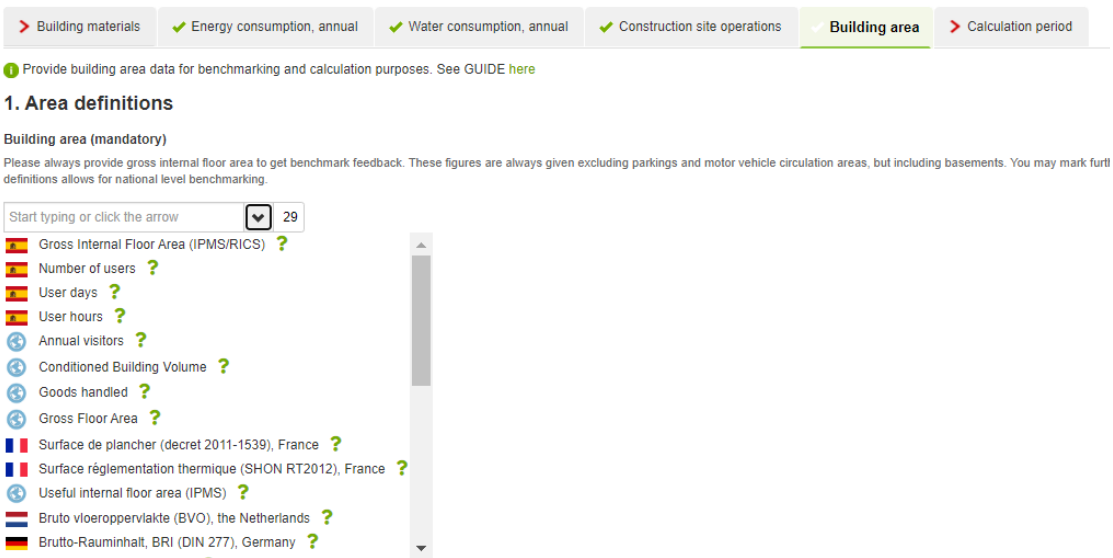




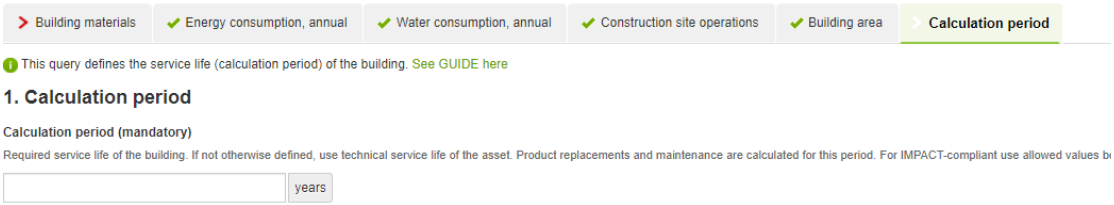
- **Construction scenarios.** In this case the impact of the usage of electricity, water, and fuel during the construction is considered. The waste materials and the transport are also taking into account. This information depends on very specific data from the Project, however, OneClick LCA is able to give an estimation based on the area and Surface.



- **Area definitions**. The building area is denominator of the results, including basements but excluding parking and motor vehicle circulation areas.



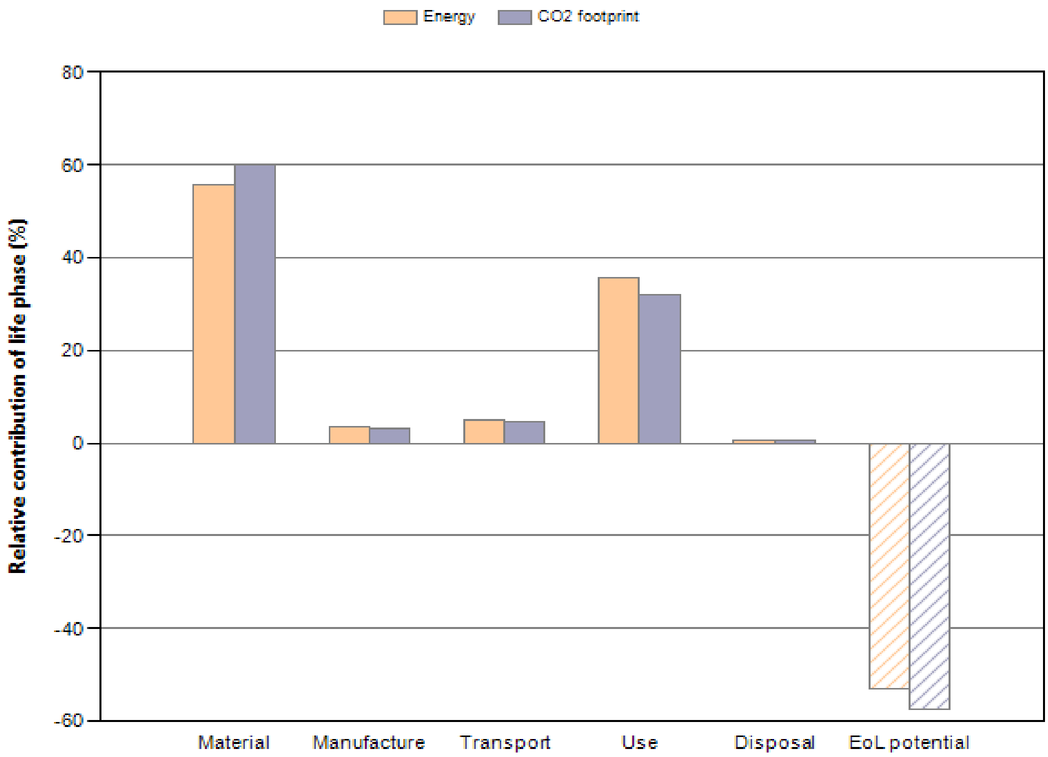
- **Calculation period.** This is the required service life of the building.



5.5 - The results.

5.5.1 – The report. EcoAudit.

The report form EcoAudit consists of a chart with the relative contribution of life phase in percentage of the different phases: material, manufacture, transport, use, disposal, and potential end of life. In this first graph the information in Energy and Carbon footprint is shown useful for a preliminary assessment.



A table with the data in Energy (MJ and %) and Carbon Footprint (kg and %) is added to the report.

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	58,3	55,8	5	60,0
Manufacture	3,57	3,4	0,268	3,2
Transport	5,35	5,1	0,376	4,5
Use	37,1	35,5	2,67	32,1
Disposal	0,2	0,2	0,014	0,2

Total (for first life)	**105**	**100**	**8,32**	**100**
End of life potential	-55,3		-4,79	

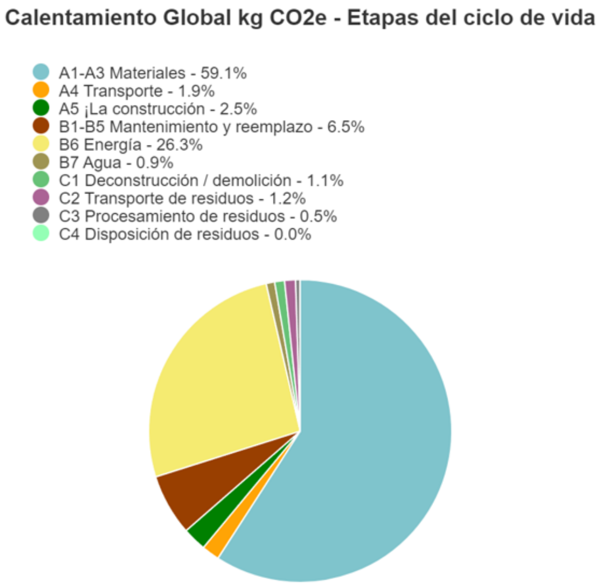
In appendix 1, a total report is shown. After this first page, the information in depth for Energy (page 2) and Carbon Footprint (page 3) is shown, with the corresponding values for each material and phase of the LCA.

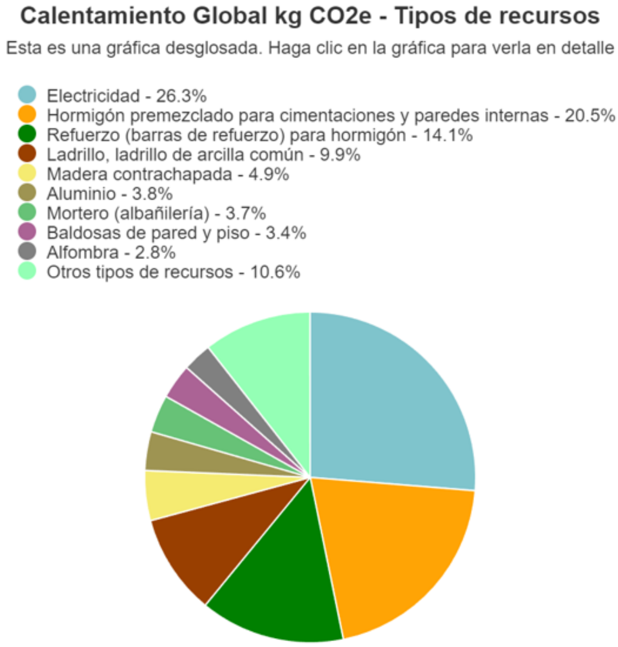
5.5.2 – The report. OneClick LCA.

The first information from the report is a quick overview with the values of CO2 emissions and the social cost. In depth, we can evaluate the different phases of the LCA and the contribution to different environmental impacts: global warming, acidification, eutrophication, ozone depletion, ozone formation, primary energy, and biogenic CO2 storage. All these data can be visualized in pie-charts and Sankey diagrams.

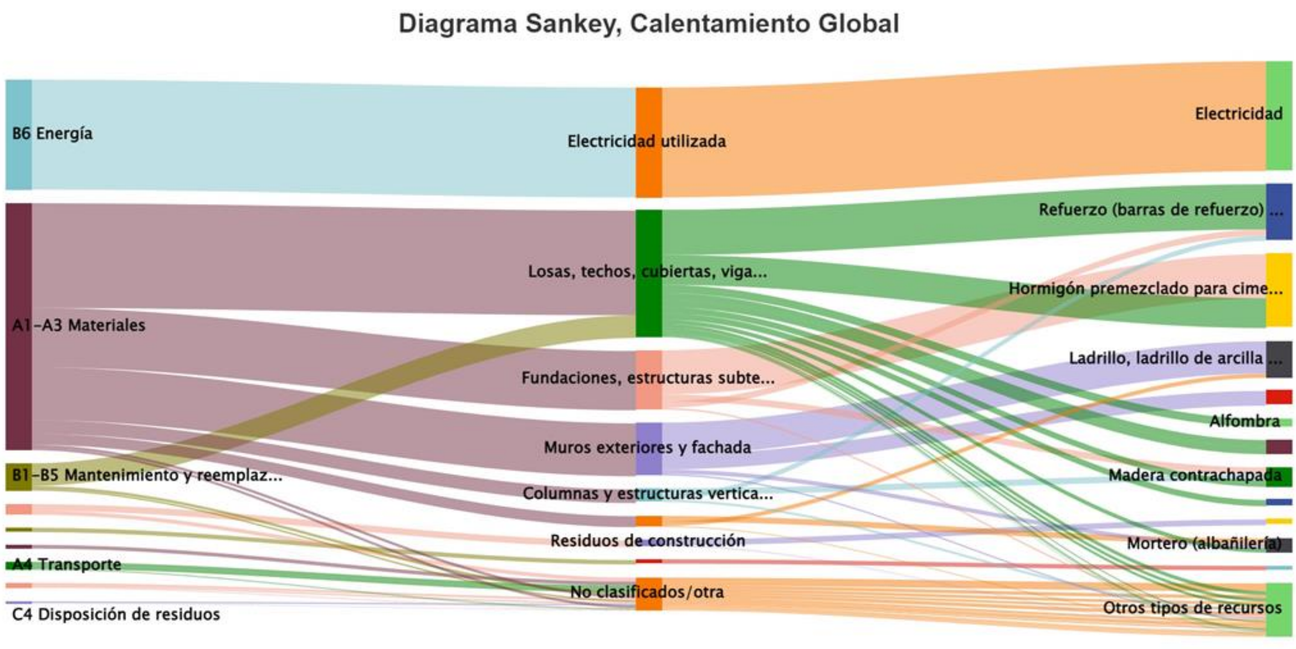
247 Toneladas CO_2e | 23,51 kg CO_2e / m^2 / año | 12 345 € Costo social del carbono

	Categoría de resultados	Calentamiento Global kg CO_2e	Acidificación kg SO_2e	Eutrofización kg PO_4e	Agotamiento de la capa de ozono kg CFC11e	Formación de ozono en la baja atmósfera kg Ethenee	Uso total de energía primaria excluyendo materias primas MJ	Almacenamiento de carbono biogénico kg CO_2e bio
A1-A3	Producto de construcción	146 006,19	445,82	2 264,21	0,01	44,3	3 414 405,67	11 480,11
A4	Transporte a la construcción	4 666,17	9,88	2,08	0	0,61	83 980,24	
A5	Proceso de instalación/construcción	6 287,38	32,6	8,31	0	0,73	76 019,07	
B1-B5	Mantenimiento y reemplazo del material	16 155,63	60,24	10,64	0	4,18	313 832,18	
B6	Consumo de energía	64 894,57	248,98	55,26	0,01	11,58	3 725 050,32	
B7	Uso de agua en servicio	2 222,62	15,21	3,54	0	0,53	36 497,58	
C1-C4	Fin de vida	6 666,68	27,34	7,71	0	1,02	146 122,42	
D	Impactos externos (no incluídos en el total)	−39 521,07	−134,54	−16,03	−0	−17,73	−478 779,52	
	Total	**246 899,22**	**840,07**	**2 351,74**	**0,02**	**62,96**	**7 795 907,49**	**11 480,11**
	Resultados por denominador							
	Por área de superficie interna bruta (IPMS/RICS) 210.0 m^2	1 175,71	4	11,2	0	0,3	37 123,37	54,67





Saneky diagrams are especially useful in LCA. This type of graphs depicts the ammount and direction of the flow in a process or systems, identifying the loss, inefficiencies and optimization of resources..



5.6 Getting more sustainable in the Construction and Building Technology.

Perspective 1 – Embodied carbon: Moving towards a holistic life cycle approach.

Over the last 30 years, the building industry has prioritized energy savings, and these efforts will intensify in the coming years. This means that as operating efficiency grows, the focus will naturally shift to the carbon footprint stored in the building itself.

In the Embodied Carbon topic session, participants agreed that digital models will play an important role in defining the CO2 footprint of the materials used and simplify the selection of materials that embody less carbon. Low-carbon technologies and materials will also become a more active consideration in investment decision-making.

The construction industry still falls short in planning and building according to circular principles and in taking a life cycle assessment (LCA) approach to the design of buildings. Achieving net zero embodied carbon by 2050 is an aim that is in line with the Paris agreement goal of limiting the temperature rise to 1.5°C. The biggest challenge here is making the existing progress towards the goal visible and fact-based.

Establishing waste and material cycles, repurposing raw materials before building demolition begins, and even maintaining portions of existing buildings are all useful practices in reaching the net zero goal. Integrating locally available sustainable energy sources like wind or sun will also contribute to achieving a net-zero carbon footprint.

Perspective 2 - Upfront carbon: Mindset shift to reduce CO2 in material production and construction

The expression upfront carbon means the CO2 emissions triggered by the sourcing and processing of the raw materials, as well as what's emitted during the actual construction process. Participants do see some positive indicators of growing sustainability by the year 2030. The industry is already making an effort to source materials with a low CO2 footprint, whether they are organic or recycling-based. And likewise, CO2 classification systems for buildings will lead to new design concepts.

What are still likely to be missing in 2030 are extremely detailed, widely accessible, interlinked databases of materials, their properties, and their carbon footprints. Participants see filling this gap as critical and argue that building material databases and building information modelling (BIM) systems should employ artificial intelligence (AI) to analyse the material mix and optimize planning during construction. These databases should also reflect regional differences in materials and architectural styles and encourage building methods that minimize environmental impacts.

Overall, the challenge for embodied carbon is to achieve a mindset shift, incorporating upfront carbon into a holistic life cycle philosophy. Decisions made in the design and construction phase will have a knock-on effect on the carbon emission footprint over the entire life of a building.

Perspective 3 - Use phase embodied carbon: Enhance efficiency and circularity during operation

Owners and operators are typically the customers for new construction and renovations. Workshop participants believe that the industry will therefore naturally tend to optimize design to suit these clients, which means achieving the lowest possible running costs and CO2 footprint for the operation and maintenance phase.

Recent advances in heating technology, building insulation, and overall energy efficiency have reduced CO2 emissions and increased sustainability during the use phase. But by 2030, participants expect the industry to embody less carbon thanks to improved practices including the increased use and reuse of modular, detachable, and recyclable building components.

For the use phase, participants see the biggest short-term win in increasing circularity and conserving resources. Logistics for handling construction waste recycling should be established, enabling further use of the building fabric. Introducing a resource passport would boost material transparency, enabling more effective, detailed EPDs. Creating energy efficiency incentives, capturing, and reading energy consumption digitally will contribute to a more sustainable use phase. Integrating more renewable energy sources directly into building elements can also help lower environmental impact in the short term.

Perspective 4 - End-of-life carbon: Build for deconstruction, standardize low carbon building codes

The end-of-life stage of a building offers huge potential for reducing the CO2 footprint. Workshop participants noted that there is already a lot of experimentation and testing of circular solutions for deconstruction. On-site recycling of old materials already takes place in some areas, particularly in road construction. Metal materials are often recycled. The exchange of building parts is already possible.

Unfortunately, sustainable practices at the end of a building’s life are the exception, not the rule. Demolition/tear-down and new building almost always take priority over recycling and reuse. There is an urgent need to shift to more recycling and reuse of materials, basic knowledge sharing, and for buildings where disassembly is baked into the design from day one. Recycled materials from other industries should be also included in the service catalogue as building materials. A

CO_2 tax and introduction of a demolition permit could also incentivize low carbon deconstruction practices.

The end-of-life solution is to build more simply and flexibly up front, with deconstruction as part of the original plan. Prefabricated building modules can be planned for dismantling and separation of their materials according to type. In parallel, adapting building and planning regulations to accommodate climate protection measures should be a high priority, while also simplifying them and standardizing them across regions. Participants in the workshop agreed they have a role to play in this transformation, with a responsibility to discuss, visualize and create “lighthouse” projects as an inspiration for wider change.

5.7 LCA project.

To face the LCA project it is necessary to define 4 main deliverables.

Goal definition. In this part we have to set the limits of our aims and objectives. For this, the System Boundary Definition should be marked within the coverage, scope and signification of the analysis. It is also important to describe the functional unit and the reference flow.

Inventory Analysis. A difficult part of the project is to define the data collection, quality and validation with a secure and accurate inventory.

Impact Analysis. In this part of the project, we carry out the quantitative analysis of data and the data normalization.

Life Cycle Interpretation. Finally, we verify the results for consistency and completeness and derive the recommendations.

5.7.1. Project deliverables

At each phase of the Design and Construction process, the delivery of the model could be required, along with electronic versions of hardcopy submissions and other files that support the intent of the project.

Table 12 and 13 present an example of file types for Design and Construction deliverables.

Phase	Submission requirements
Goal definition.	Narrative Project Execution Plan Existing Condition Model(s)
Inventory Analysis.	Narrative Materials

Phase	Submission requirements
	Energy Carbon Footprint
Impact Analysis.	Energy Carbon Footprint Ecoindicators Toxicity Water Footprint Solid Waste Biodegradability
Life Cycle Interpretation.	Essential contributions Inventory parameters Impact category indicators

Table 1: Example of deliverables.

5.7.2. LCA Coordination.

It is necessary to document the type and frequency of meetings related to the elaboration of the project. Table 2 depicts the typical project meetings including the type, deliverable, frequency, participants and location.

Table 2: LCA Coordination meetings

Meeting Type	Deliverable	Frequency	Participants	Location

5.7.3. Worksets.

Worksets is a way to separate a set of elements in the project model into subsets for “worksharing”. During the development of LCA projects, users should be aware of the active workset. Each new element added or assessed into the project will be placed in the active workset. Different information could be added to the Workset (materials, manufacturing, recycling, etc.).

Table 3: Example of workshets for different elements/parts added to a project.

Workset name	Elements	
	Parts	Materials
Window	Frame, glass	Al2024, silica glass
Piping	Pipes, valves	PVC, AISI 316

6 - Deliverables

To evaluate the success of the application, students will have to answer an online questionnaire.

7- What we have learned

How to prepare LCA projects.

Why is the LCA prepared.

What are the LCAExecution Plan components.

8- Appendix 1. Eco Audit Report.

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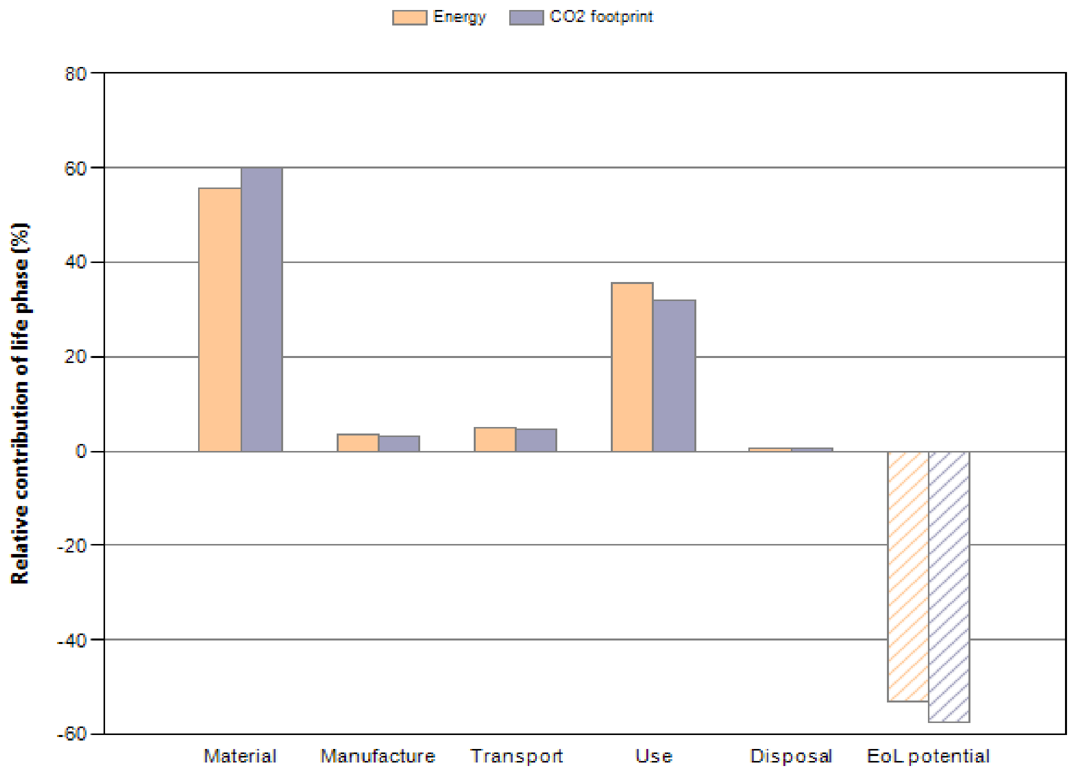
Eco Audit Report

Product name	Product name and life
Country of use	Europe
Product life (years)	1

Summary:



Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	58,3	55,8	5	60,0
Manufacture	3,57	3,4	0,268	3,2
Transport	5,35	5,1	0,376	4,5
Use	37,1	35,5	2,67	32,1
Disposal	0,2	0,2	0,014	0,2
Total (for first life)	**105**	**100**	**8,32**	**100**
End of life potential	-55,3		-4,79	

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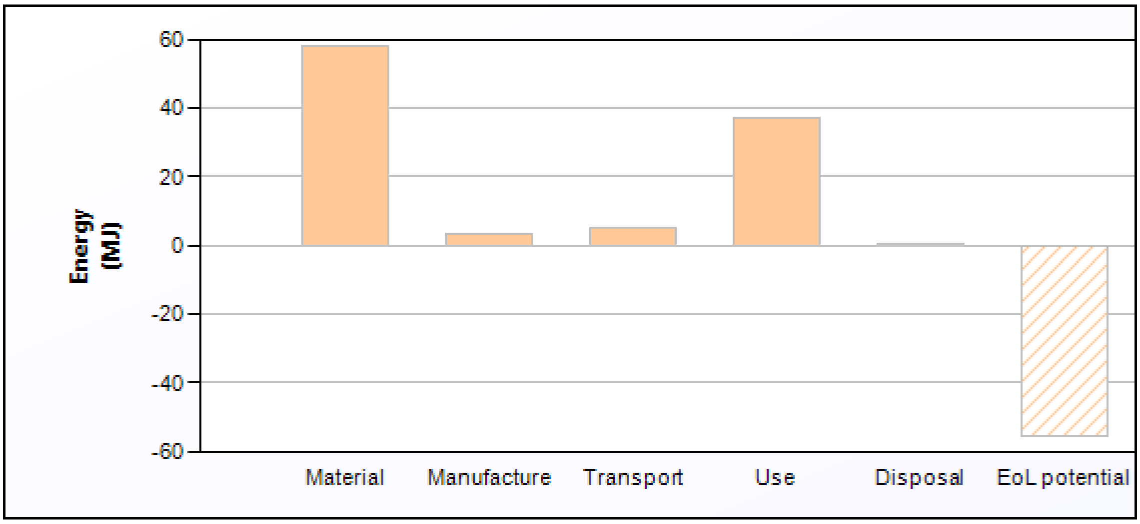
Eco Audit Report

Energy Analysis

Summary



	Energy (MJ/year)
Equivalent annual environmental burden (averaged over 1 year product life):	105

Detailed breakdown of individual life phases

Material:

Summary

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass (kg)	Energy (MJ)	%
Component	Coated steel, stainless steel, terne coated	25,0%	1	1	1	58	100,0
Total				**1**	**1**	**58**	**100**

*Typical: Includes 'recycle fraction in current supply'

***User-defined material

Manufacture:

Summary

Component	Process	Amount processed	Energy (MJ)	%
Component	Forging	1 kg	3,6	100,0
Total			**3,6**	**100**

Transport:

Summary

Breakdown by transport stage

Stage name	Transport type	Distance (km)	Energy (MJ)	%
Transport 1	Train, diesel	5e+03	3,9	72,0
Transport 2	Small truck (refrigerated), EURO 6	2,5e+02	1,5	28,0
Total		**5,3e+03**	**5,3**	**100**

Breakdown by components

Component	Mass (kg)	Energy (MJ)	%
Component	1	5,3	100,0
Total	**1**	**5,3**	**100**

Use:

Summary

Static mode

Energy input and output type	Fossil fuel to thermal, vented system
Country of use	Europe
Power rating (W)	1,2e+02
Usage (hours per day)	12
Usage (days per year)	5
Product life (years)	1

Mobile mode

Fuel and mobility type	Diesel - 40 tonne (6 axle) truck
Country of use	Europe
Product mass (kg)	1
Distance (km per day)	20
Usage (days per year)	5
Product life (years)	1

Relative contribution of static and mobile modes

Mode	Energy (MJ)	%
Static	37	99,8
Mobile	0,082	0,2
Total	**37**	**100**

Breakdown of mobile mode by components

Component	Energy (MJ)	%
Component	0,082	100,0
Total	**0,082**	**100**

Disposal:

Summary

Component	End of life option	Energy (MJ)	%
Component	Re-manufacture	0,2	100,0
Total		**0,2**	**100**

EoL potential:

Component	End of life option	Energy (MJ)	%
Component	Re-manufacture	-55	100,0
Total		**-55**	**100**

Notes:

Summary

Add notes

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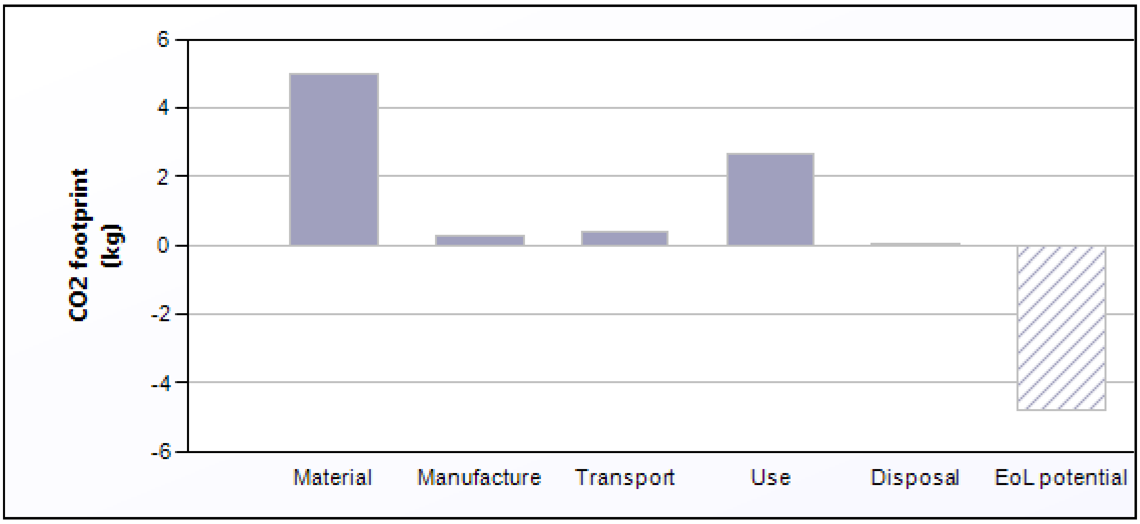
Eco Audit Report

CO2 Footprint Analysis

Summary



	CO2 (kg/year)
Equivalent annual environmental burden (averaged over 1 year product life):	8,32

Detailed breakdown of individual life phases

Material:

Summary

Component	**Material**	**Recycled content* (%)**	**Part mass (kg)**	**Qty.**	**Total mass (kg)**	**CO2 footprint (kg)**	**%**
Component	Coated steel, stainless steel, terne coated	25,0%	1	1	1	5	100,0
Total				**1**	**1**	**5**	**100**

*Typical: Includes 'recycle fraction in current supply'

***User-defined material

Manufacture:

Summary

Component	**Process**	**Amount processed**	**CO2 footprint (kg)**	**%**
Component	Forging	1 kg	0,27	100,0
Total			**0,27**	**100**

Transport:

Summary

Breakdown by transport stage

Stage name	Transport type	Distance (km)	CO2 footprint (kg)	%
Transport 1	Train, diesel	5e+03	0,28	73,2
Transport 2	Small truck (refrigerated), EURO 6	2,5e+02	0,1	26,8
Total		**5,3e+03**	**0,38**	**100**

Breakdown by components

Component	Mass (kg)	CO2 footprint (kg)	%
Component	1	0,38	100,0
Total	**1**	**0,38**	**100**

Use:

Summary

Static mode

Energy input and output type	Fossil fuel to thermal, vented system
Country of use	Europe
Power rating (W)	1,2e+02
Usage (hours per day)	12
Usage (days per year)	5
Product life (years)	1

Mobile mode

Fuel and mobility type	Diesel - 40 tonne (6 axle) truck
Country of use	Europe
Product mass (kg)	1
Distance (km per day)	20
Usage (days per year)	5
Product life (years)	1

Relative contribution of static and mobile modes

Mode	CO2 footprint (kg)	%
Static	2,7	99,8
Mobile	0,0059	0,2
Total	**2,7**	**100**

Breakdown of mobile mode by components

Component	CO2 footprint (kg)	%
Component	0,0059	100,0
Total	**0,0059**	**100**

Disposal:

Summary

Component	End of life option	CO2 footprint (kg)	%
Component	Re-manufacture	0,014	100,0
Total		**0,014**	**100**

EoL potential:

Component	End of life option	CO2 footprint (kg)	%
Component	Re-manufacture	-4,8	100,0
Total		**-4,8**	**100**

Notes:

Summary

Add notes