life SUPERHERO

SUPERHERO Software Tool
User Manual

Co-funded by the European Union

LIFE SUPERHERO LIFE19 CCA/IT/001194

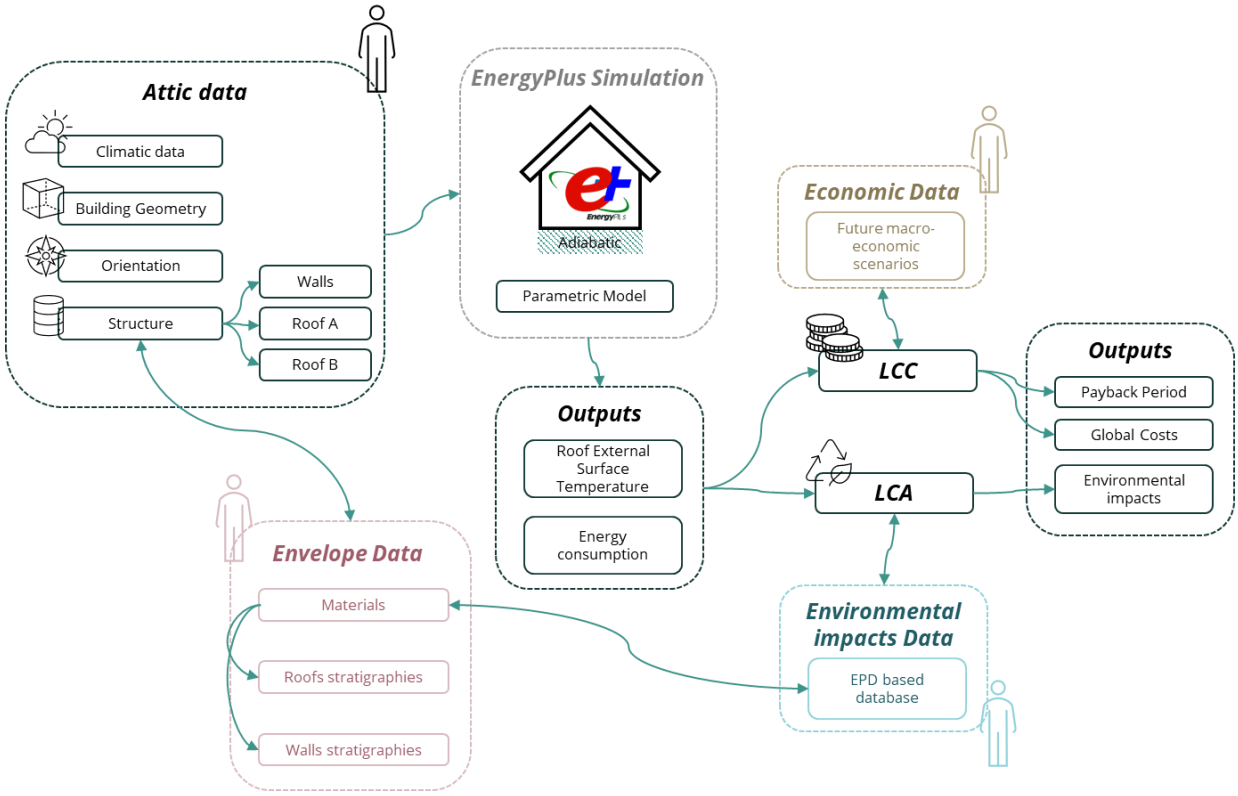
Content

1. SUPERHERO software general concept

SUPERHERO software is able to easily assess the following results for a new roof, including an HBR, also in comparison with another reference roof:

- the dynamic heating and cooling energy performance, considering the roof installed on an attic space;
- the external roof covering maximum temperature;
- Global Costs, Cumulative Discounted Cash Flows and Payback Period, considering the initial, maintenance and energy costs difference among the two roofs;
- the environmental impacts of the new roof based on product and operational cooling energy use stages.

The figure provides the general software architecture.



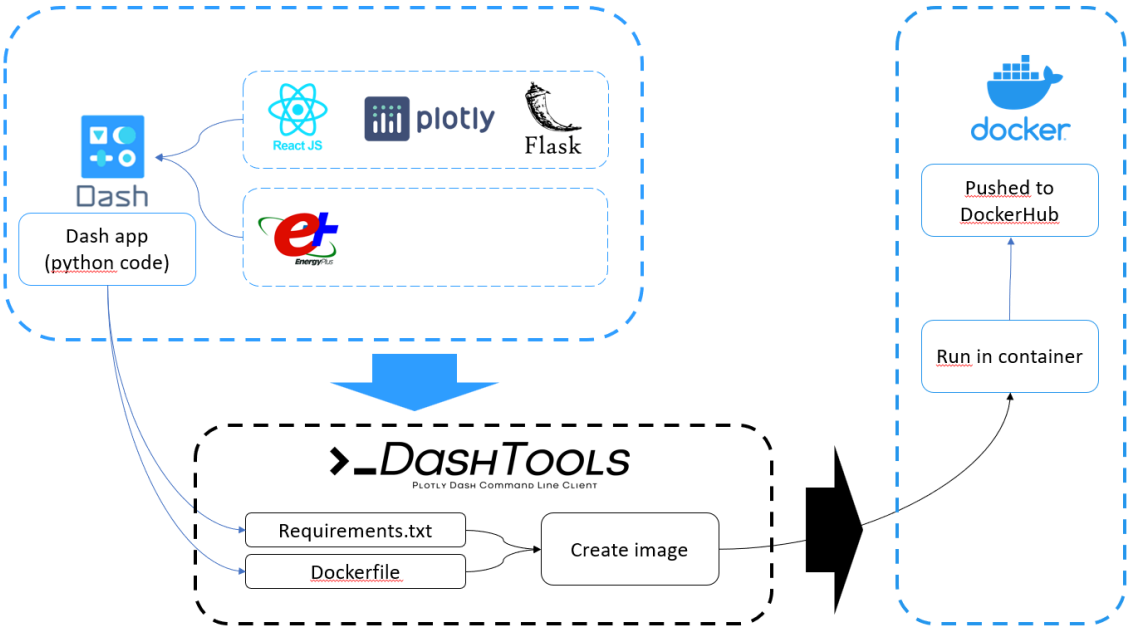
In 4 specifically developed modules, the user inserts input data or modifies data already included in databases.

The user selects the attic location, geometry, orientation and features of walls, windows and roofs (for the design roof and the reference roof). He/she can use the materials' data stored in databases or create new materials and stratigraphies. These inputs dynamically modify a parametric model in Energy Plus Software, then the energy performance is assessed, and the roof external surface temperature also obtained.

The calculated energy consumption is needed to assess the costs and impacts during the building use phase. For LCC, the user specifies economic data inputs to obtain the Global Cost and Payback Period.

The environmental data can be inserted in a specific module, and the user can upload EPDs for specific materials in XML format.

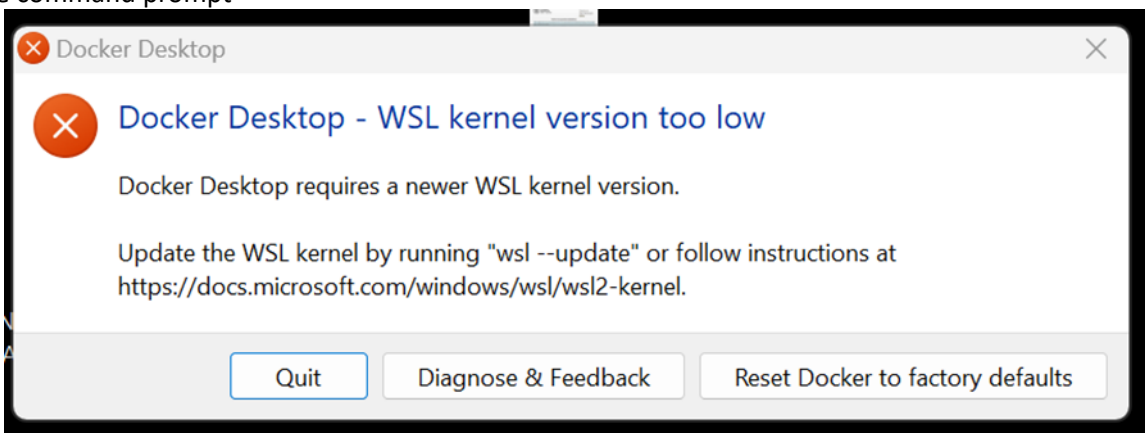
The software code is written in python language and the visual interface provided by a Dash web app. Energy Plus simulations are run inside the code after updating a parametric file with input data defined by users (next figure).



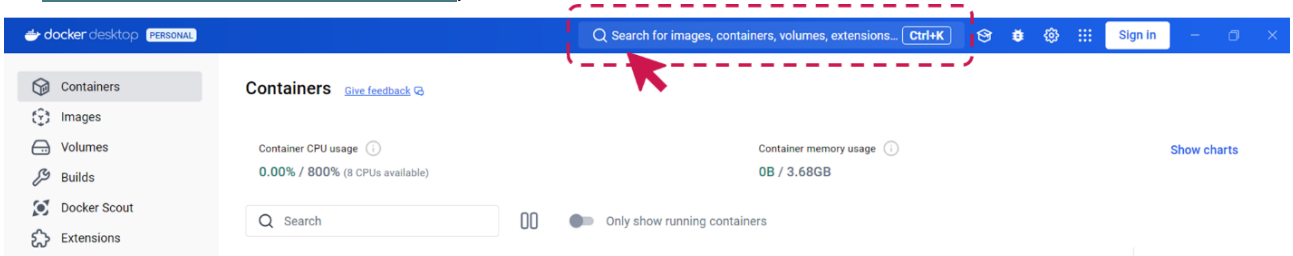
2. Installation and run of the software tool

a. Install docker desktop software: *Install Docker Desktop on Windows | Docker Docs*

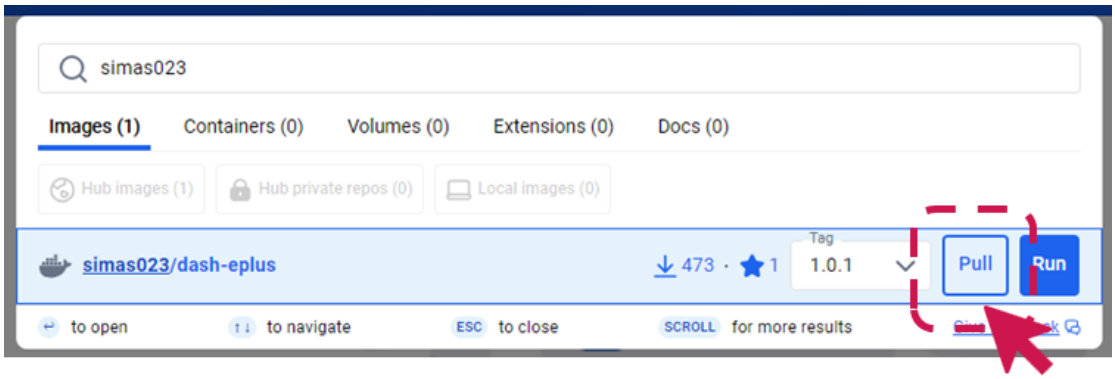
b. Once installed, launch the software and if this window appears at startup, type the suggested string in the command prompt



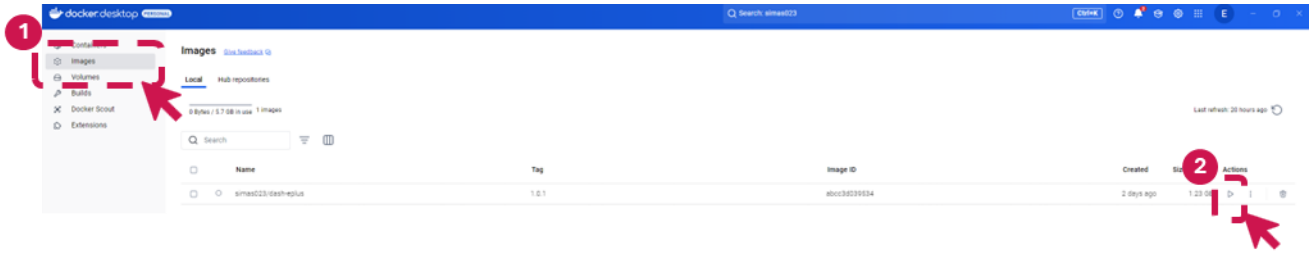
c. In the "**Search**" bar above, search for the user **simas023** (or direct link from browser: simas023/dash-eplus - Docker Image | Docker Hub)



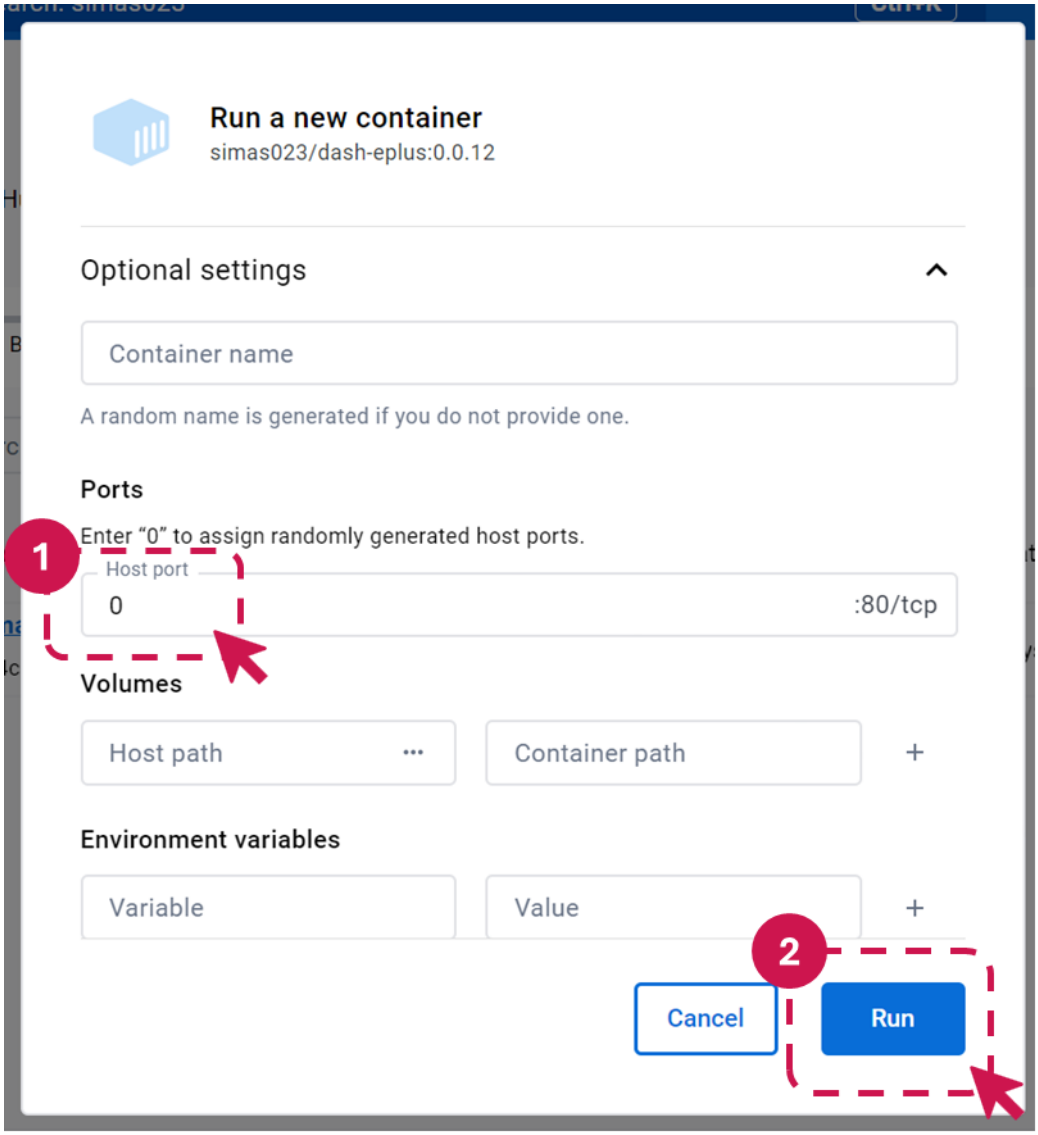
d. Press “**Pull**” to load the software image among your images within your Docker Desktop



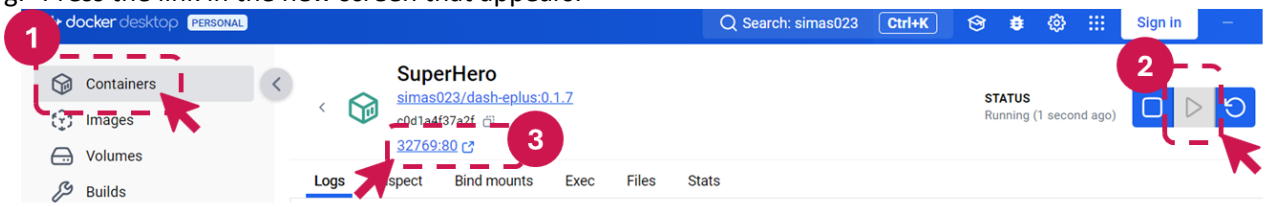
e. click on “**Images**” on the left, the “*simas023/dash-eplus*” image will appear. Press “**play**” (on the right, under “Actions”)



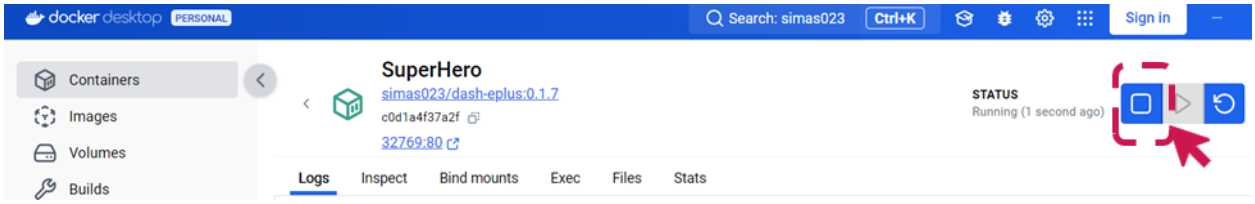
f. In the “**Optional settings**” screen, type 0 on “**Ports**”


Run a new container
simas023/dash-eplus:0.0.12
Optional settings
Container name
A random name is generated if you do not provide one.
Ports
Enter "0" to assign randomly generated host ports.
1
Host port
0
:80/tcp
Volumes
Host path
Container path
Environment variables
Variable
Value
2
Cancel
Run

g. Press the link in the new screen that appears:

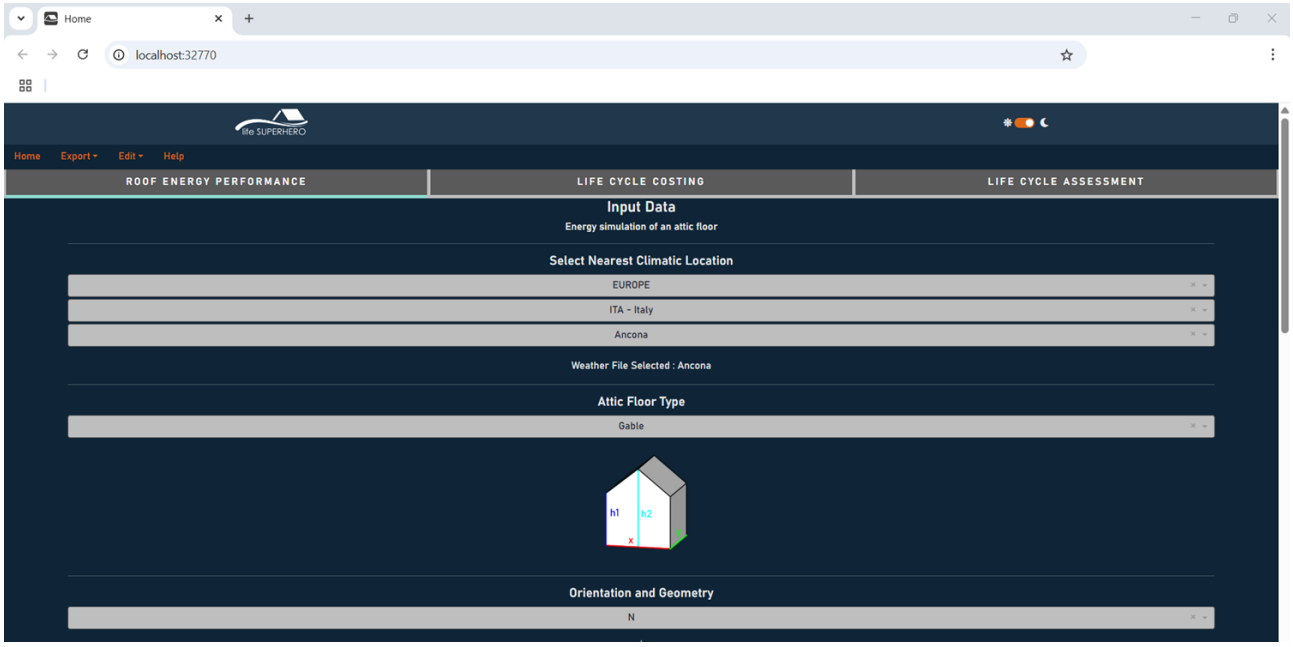


h. To end use, press "**stop**".



3. Use Guide

Once the App is launched, the internet browser opens, and the **home page** appears.



3.1 Menu

A. The tool web interface contains the menu on the top left with the following items: *Home*, *Export*, *Editing*, *Edit*, *Help*.

B. To switch between a light (day) and dark (night) theme, you will need to adjust the button on the top right.

3.2 Home

The **home page** contains the main menu with the following items:

A. ROOF ENERGY PERFORMANCE: to perform an energy simulation of an attic floor

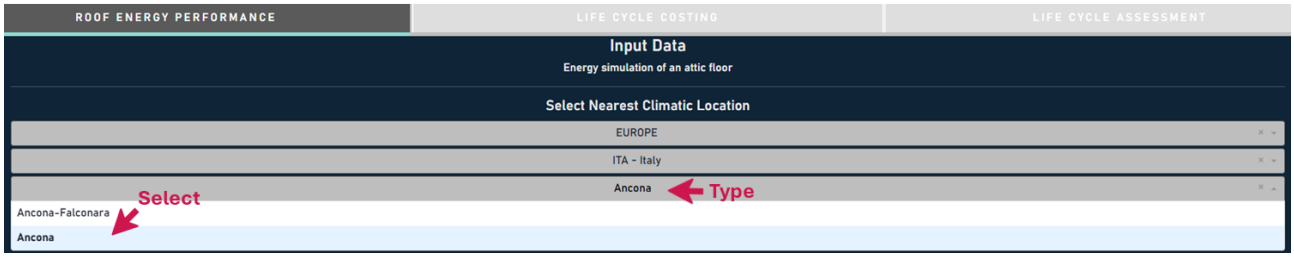
B. LIFE CYCLE COSTING: to carry out a life cycle assessment of the economic performance based on cooling energy benefits of the new roof

C. LIFE CYCLE ASSESSMENT: to perform an environmental impact assessment of the new roof based on product and operational cooling energy use stages

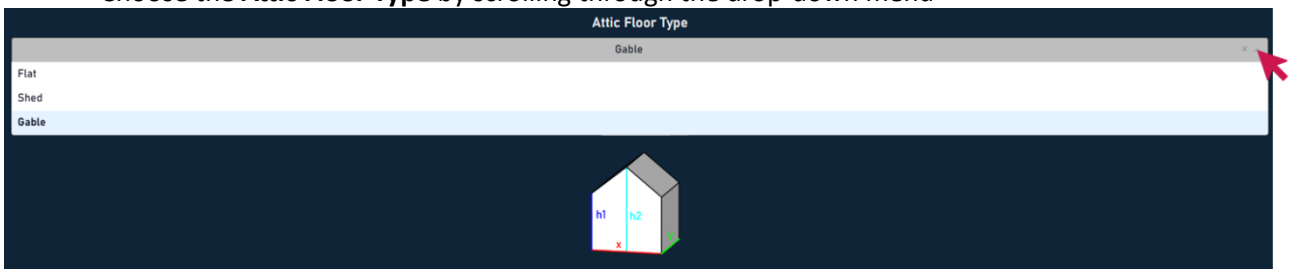
3.2.1 Roof Energy Performance

In the Roof Energy Performance page, the first section is the **Input Data** where it is possible to:

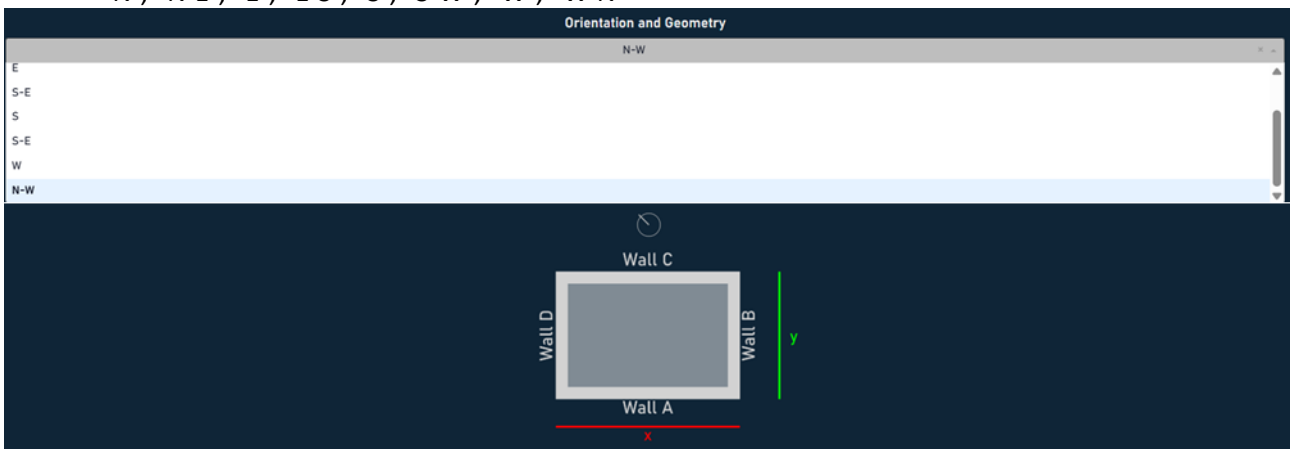
- Choose the **Climatic Location** by either scrolling through the drop-down menu or typing the city name directly



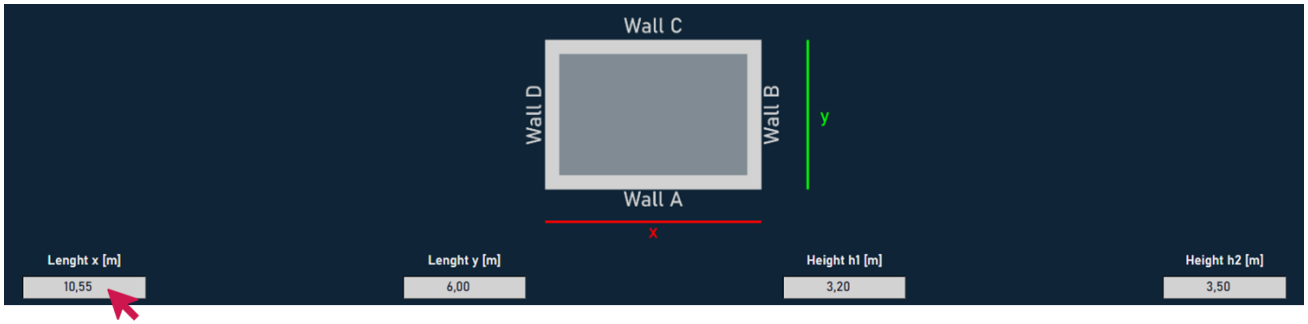
- Choose the **Attic Floor Type** by scrolling through the drop-down menu



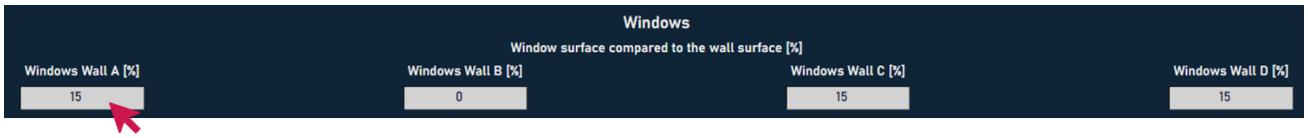
- Select the building's plan **Orientation** by scrolling through the drop-down menu or typing “N”, “N-E”, “E”, “E-S”, “S”, “S-W”, “W”, “W-N”



- Specify the walls **Geometry** by entering the length [m] and height [m] of walls in the designated fields



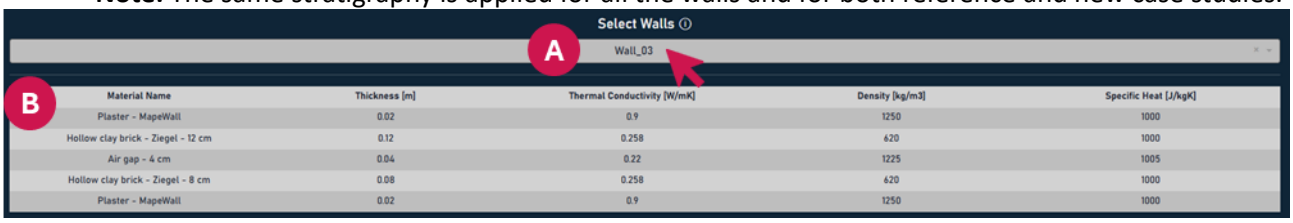
- In the designated fields specify the **window surface**, for each wall, as a percentage [%] of the total wall surface



- Then the user can define the wall stratigraphy in the "**Select Walls**" section.
  A selection of predefined wall types is available in drop-down menu (**A**).
  Once a wall is selected, its stratigraphy will be displayed in table (**B**).

  Alternatively, the user can create a custom stratigraphy on the ***Edit > Walls*** page (see guide Section ***3.4.3 Edit > Walls***).

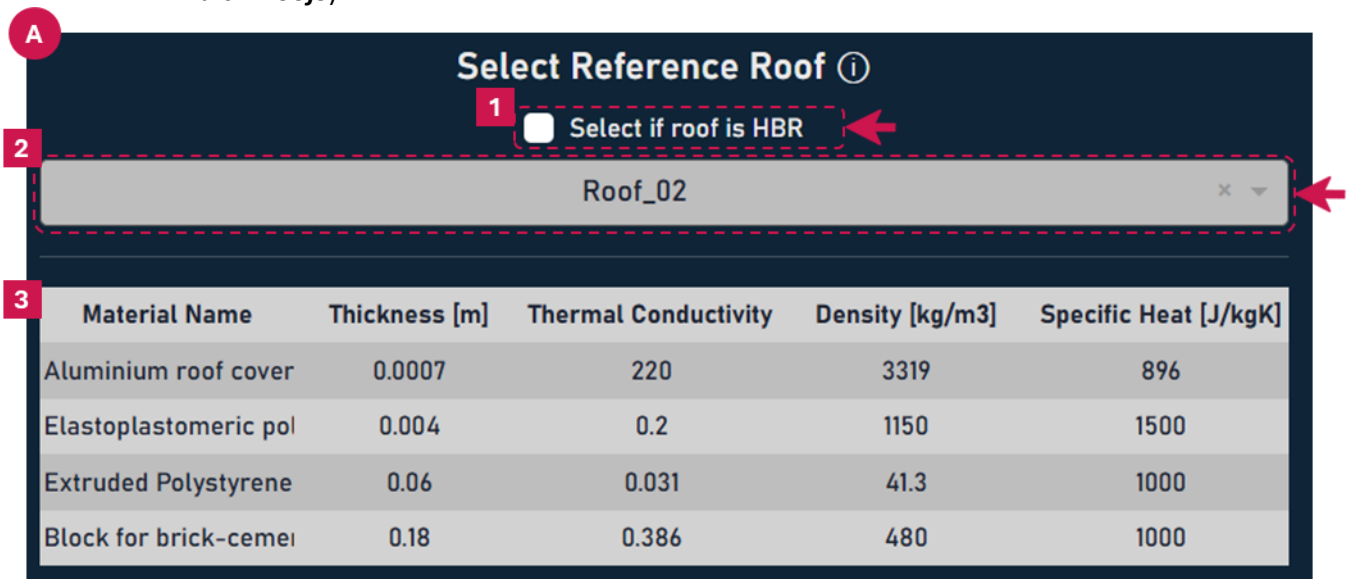
  Note: The same stratigraphy is applied for all the walls and for both reference and new case studies.

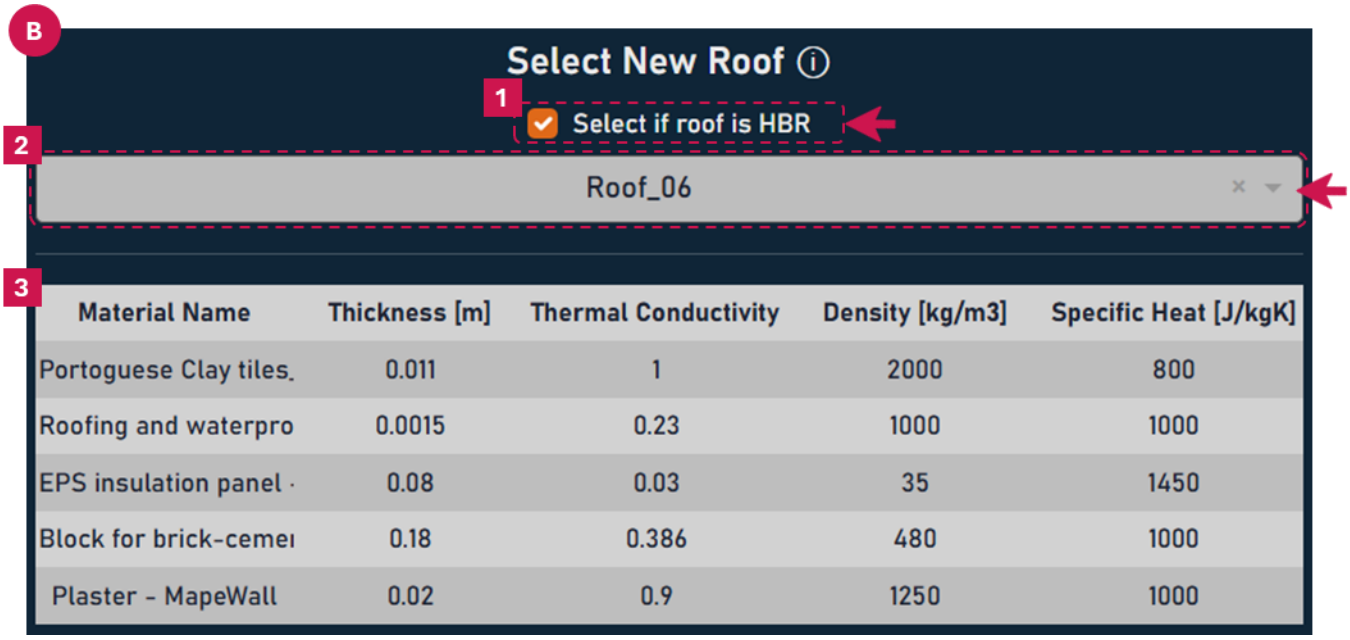


- The user can define the roof stratigraphy separately for the reference roof (i.e., the original roof before the renovation, or a first roof option) in the "**Select Reference Roof**" section (**A**), and for the new roof (i.e., the roof after renovation, or a second roof option) "**Select New Roof**" section (**B**).

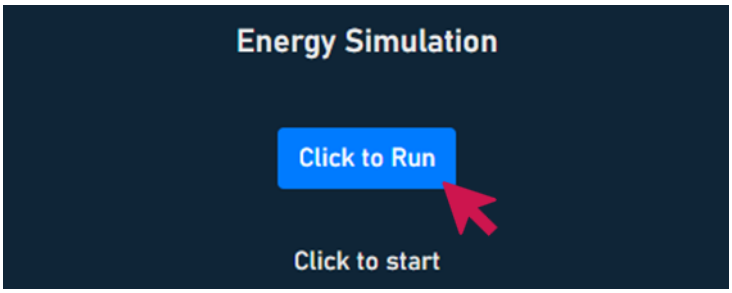
In particular, the user can specify whether the roof is a HEROTILE-Based Roof (HBR) by checking the appropriate box (**1**) and select a predefined roof type in drop-down menu (**2**). Once a roof is selected, its stratigraphy will be shown in table (**3**).

Alternatively, a custom stratigraphy can be created on the ***Edit > Roofs*** page (see guide Section ***3.4.2 Edit > Roofs***).



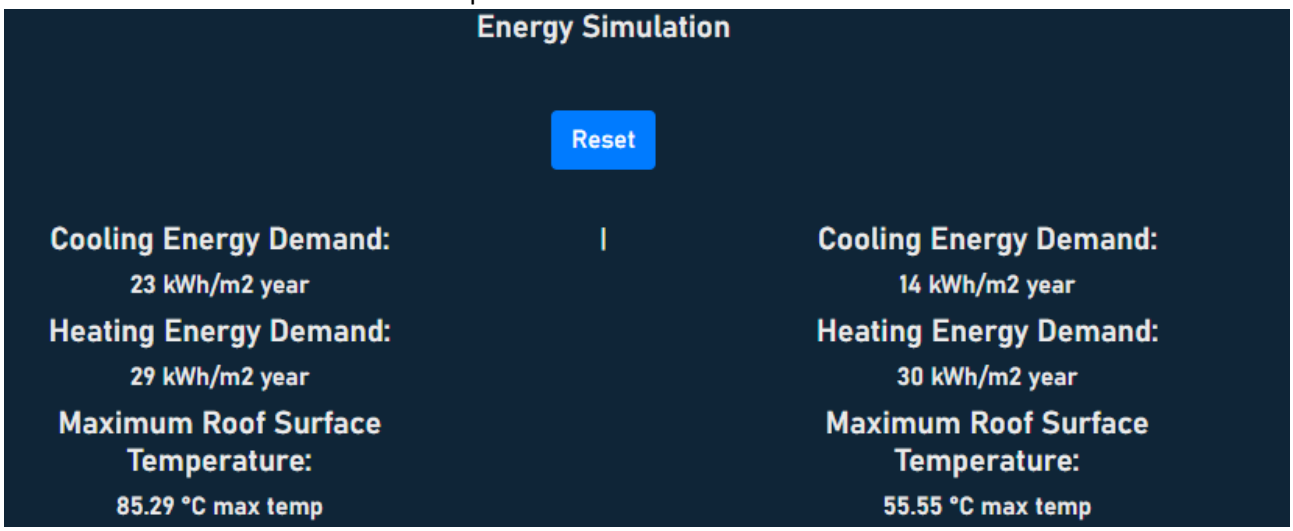


Once the Input Data phase is complete, click the **Run** button to perform the energy simulation of the attic floor for both the *reference* and *new roof configurations*.



For both the solutions the user is now able to read:

- the cooling energy demand
- the heating energy demand
- the maximum roof surface temperature

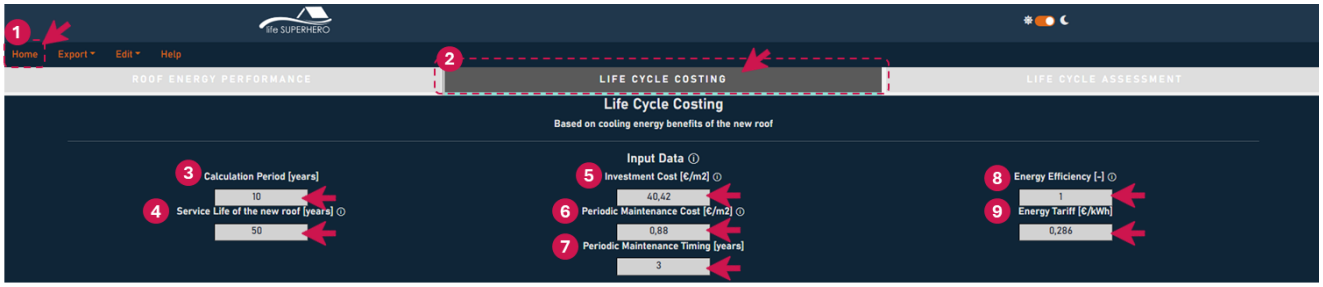


3.2.2 Life Cycle Costing

From the **Home** (1), in the **LIFE CYCLE COSTING** page (2), the user selects the Input Data in order to perform the LCC based on cooling energy benefits of the new roof and o the macroeconomic input data (Nominal Interest Rate, Inflation rate, Nominal Wage GDP, Electricity Price growth) that can be modified in Edit/Economic data (see guide Section ***3.4.4 Edit > Economic data***).

In particular, the user can choose:

- Calculation Period [years] (3)
- Service Life of the new roof [years] (4) for the calculation of the replacement cost and of the residual value of the roof at the end of the calculation period
- Investment Cost [€/m^2] (5), i.e., extra-cost compared to building the 'reference roof'. Cost savings can be considered by using negative values.
- Periodic Maintenance Cost [€/m^2] (6), i.e., extra-cost compared to maintaining the 'reference roof'. Cost savings can be considered by using negative values
- Periodic Maintenance Timing [years] (7)
- Cooling Energy Efficiency [-] (8), i.e., Coefficient of Performance for the electric cooling system
- Energy Tariff [€/kWh] (9)



The calculation may take a few seconds. Once finished, results will appear. They are:

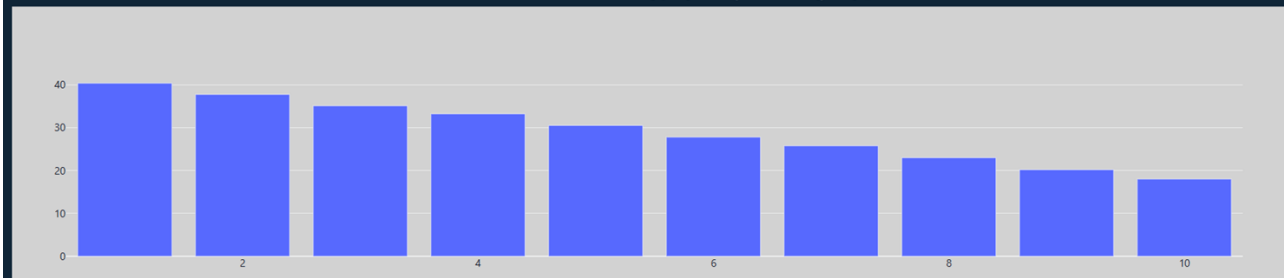
- Global costs at the end of calculation period [€/m^2] (A), considering the initial investment extra-cost, the energy savings compared to the reference roof, the maintenance extra-cost and the residual value of the new roof at the end of the calculation period.
- Cumulative Discounted Cash Flows [€/m^2] and Payback Period [years] (B). The Payback period, if any, is obtained in the year when cash flows reach a negative value.
- Present Values (C) for each year of the calculation period, including:
  - Cooling energy cost of the reference roof [€/m^2]
  - Cooling energy cost of the new roof [€/m^2]
  - Cooling energy savings [€/m^2]
  - Maintenance cost [€/m^2]
  - Replacement cost [€/m^2]

A

Global Cost [€/m2] ⓘ

52.46

Cumulative Discounted Cash Flows [€/m2] and Payback Period [years] ⓘ



B

Years	Cumulative Discounted Cash Flows [€/m2]
1	40.42
2	37.796
3	35.147
4	33.256
5	30.555
6	27.829
7	25.794
8	23.015
9	20.21
10	18.034

C

Present Values

Years	Cooling energy cost of the reference roof [€/m2]	Cooling energy cost of the new roof [€/m2]	Cooling energy Savings [€/m2]
1	6.641	4.042	2.599
2	6.705	4.081	2.624
3	6.77	4.121	2.649
4	6.835	4.16	2.674
5	6.9	4.2	2.7
6	6.967	4.241	2.726
7	7.034	4.281	2.752
8	7.101	4.323	2.779
9	7.17	4.364	2.806
10	7.239	4.406	2.832

Years	Maintenance Cost [€/m2]	Replacement Cost [€/m2]
1	0	0
2	0	0
3	0	0
4	0.783	0
5	0	0
6	0	0
7	0.717	0
8	0	0
9	0	0
10	0.657	0

3.2.3 Life Cycle Assessment

Environmental impact assessment of the new roof based on product and operational cooling energy use stages can be performed from the Home (1), in the LIFE CYCLE ASSESSMENT page (2).

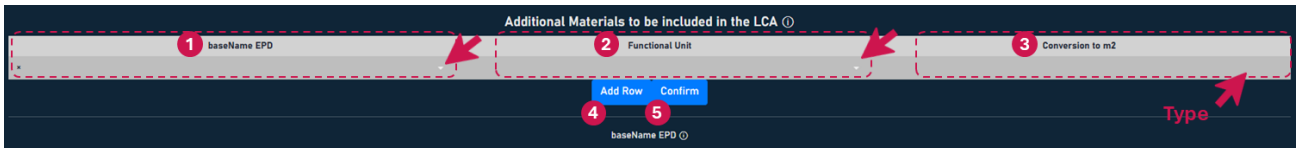
The user has the option to include, within the already defined roof stratigraphy (see guide Section ***3.2.1 Roof Energy Performance***), additional materials that are part of the roof but do not contribute to the energy calculation (e.g., battens, special components, etc.).
The user should provide the following information:

- **baseName EPD** - Material for which an EPD or Impact Table already exists in the tool database (1)
  Note:
  - Check if the material exists (see guide Section ***3.4.1 Edit > Materials***)
  - Upload existing EPD in. xlml format (see guide Section ***3.4.5 Edit > Database of EPD***)
  - Or create a new Impact Table (see guide Section ***3.4.6 Edit > Create a new Impact Table***)

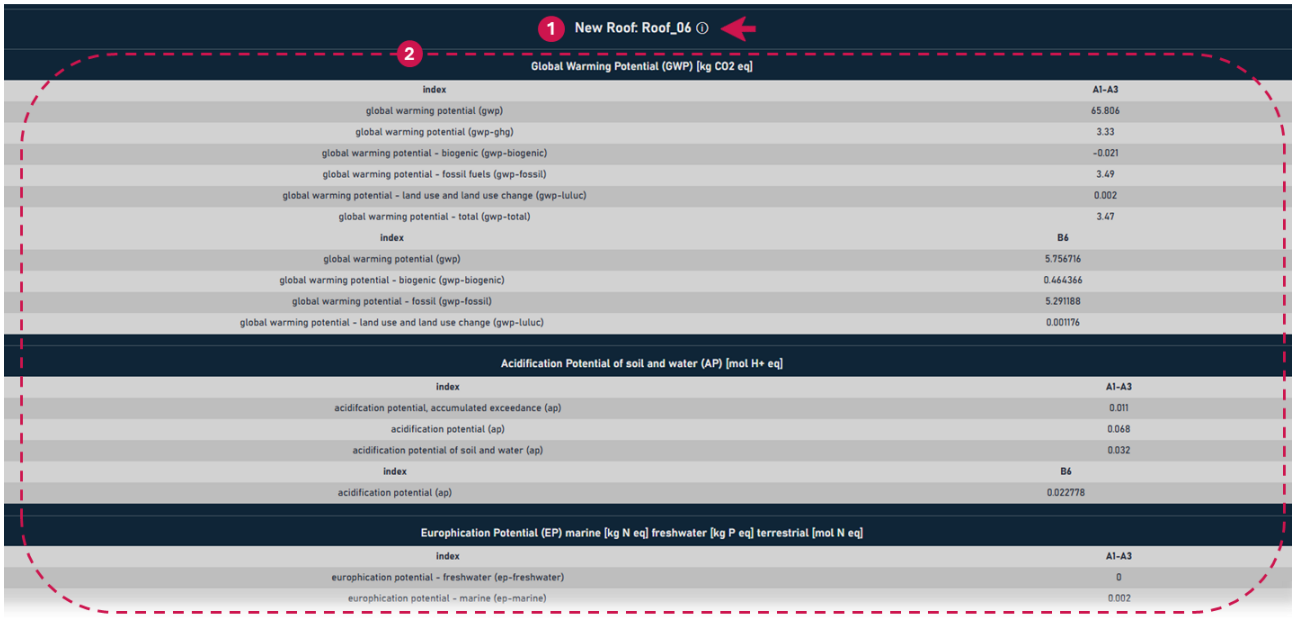
- **Functional Unit** – as reported in the EPD or in the Impact Table (2)

- **Conversion Factor** - to relate the functional unit to 1 m^2 of roof surface (3)

The user can add as many materials as needed by inserting new rows (4) and then confirming the selection (5).



The user can check the name of the new roof selected (1) (see guide section ***3.2.1 Roof Energy Performance***). The calculation may take a few seconds. Once finished, results will appear (2).



Global Warming Potential (GWP) [kg CO2 eq]

index	A1-A3
global warming potential (gwp)	65.806
global warming potential (gwp-ghg)	3.33
global warming potential - biogenic (gwp-biogenic)	-0.021
global warming potential - fossil fuels (gwp-fossil)	3.49
global warming potential - land use and land use change (gwp-luluc)	0.002
global warming potential - total (gwp-total)	3.47
index	**B6**
global warming potential (gwp)	5.756716
global warming potential - biogenic (gwp-biogenic)	0.464366
global warming potential - fossil (gwp-fossil)	5.291188
global warming potential - land use and land use change (gwp-luluc)	0.001176

Acidification Potential of soil and water (AP) [mol H+ eq]

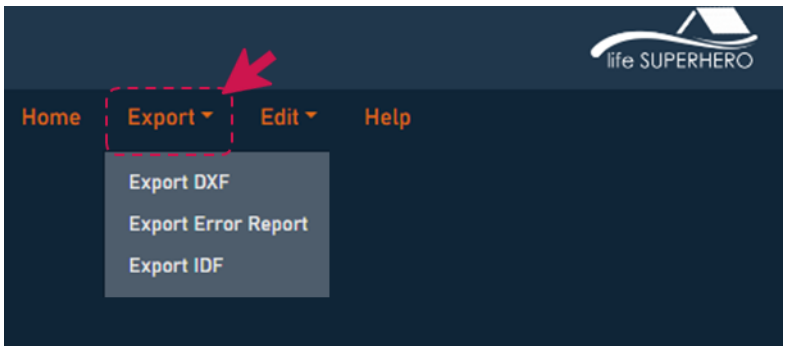
index	A1-A3
acidifcation potential, accumulated exceedance (ap)	0.011
acidification potential (ap)	0.068
acidification potential of soil and water (ap)	0.032
index	**B6**
acidification potential (ap)	0.022778

Europhication Potential (EP) marine [kg N eq] freshwater [kg P eq] terrestrial [mol N eq]

index	A1-A3
europhication potential - freshwater (ep-freshwater)	0
europhication potential - marine (ep-marine)	0.002

3.3 Export

Once the calculation is performed, energy model results can be saved as .dxf file or .IDF files with the Export menu. It also possible to download an Error log file .err



3.4 Edit

In the **Edit page** user can check or modify the database of:

- MATERIALS
- ROOFS
- WALLS
- EPD and Impact Tables
- Energy use conversion factor

3.4.1 Edit > Materials

To create a new material, the user must go to Edit (1) and select Materials (2)
The user should provide the following information:

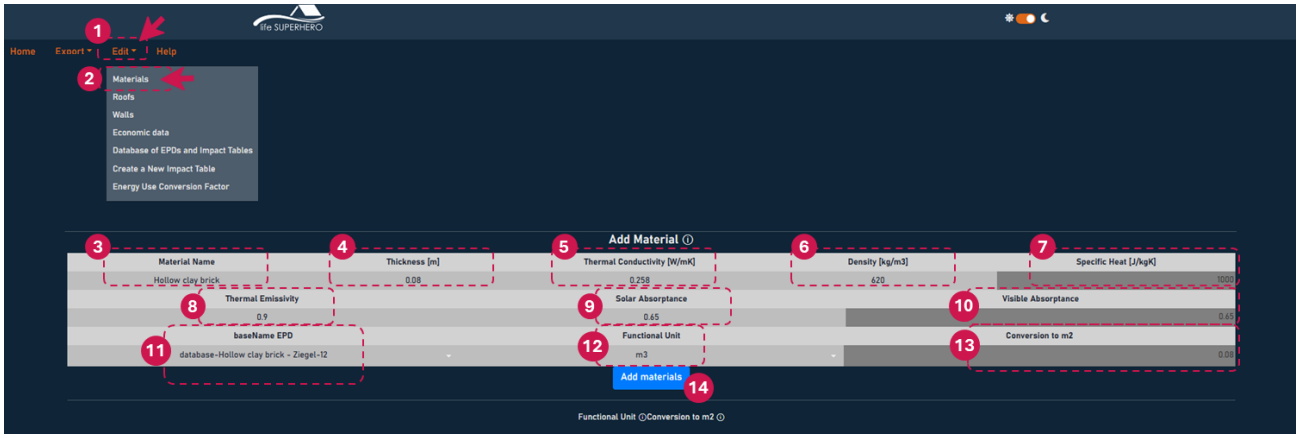
- **Material Name** (3)
- **Thickness** [m] (4)
- **Thermal Conductivity** [W/mK] (5)
- **Density** [kg/m3] (6)
- **Specific Heat** [J/kgK] (7)

For materials used in the building envelope (walls and roofs), optical properties must be specified to enable energy calculations:

- **Thermal Emissivity** (8)
- **Solar Absorptance** (9)
- **Visible Absorptance** (10)

Note:
The user must then assign an **EPD or Impact Table** from those available in the software (**11**); or create a new one (see guide Section **3.4.6 Edit > Create a new Impact Table**); or upload an EPD in. xlml format (see guide Section ***3.4.5 Edit > Database of EPD and Impact Tables***).

Additionally, the user must provide: **Functional Unit** as reported in the EPD or in the Impact Table (**12**), and a **Conversion Factor** to relate the functional unit to 1 m^2 of roof surface (**13**).
Once all required information is entered, click Add Materials (**14**) to confirm.



The user can review the available materials in the tables below and modify existing properties by entering new values. To save the changes, click the appropriate confirmation buttons.

Edit Materials

	Material Name	Thickness [m]	Thermal Conductivity [W/mK]	Density [kg/m3]	Specific Heat [J/kgK]
×	Glass Wool Insulation	0.09	0.0375	19	1000
×	Aluminium roof covering	0.0007	220	3319	896
×	Elastoplastomeric polymer bitumen membr	0.004	0.2	1150	1500

Confirm materials

Material's Optical Properties ⓘ

	Material Name	Thermal Emissivity	Solar Absorptance	Visible Absorptance
×	Glass Wool Insulation	0.9	0.7	0.7
×	Aluminium roof covering	0.4	0.8	0.8
×	Elastoplastomeric polymer bitumen membrane	0.9	0.6	0.6

Confirm materials

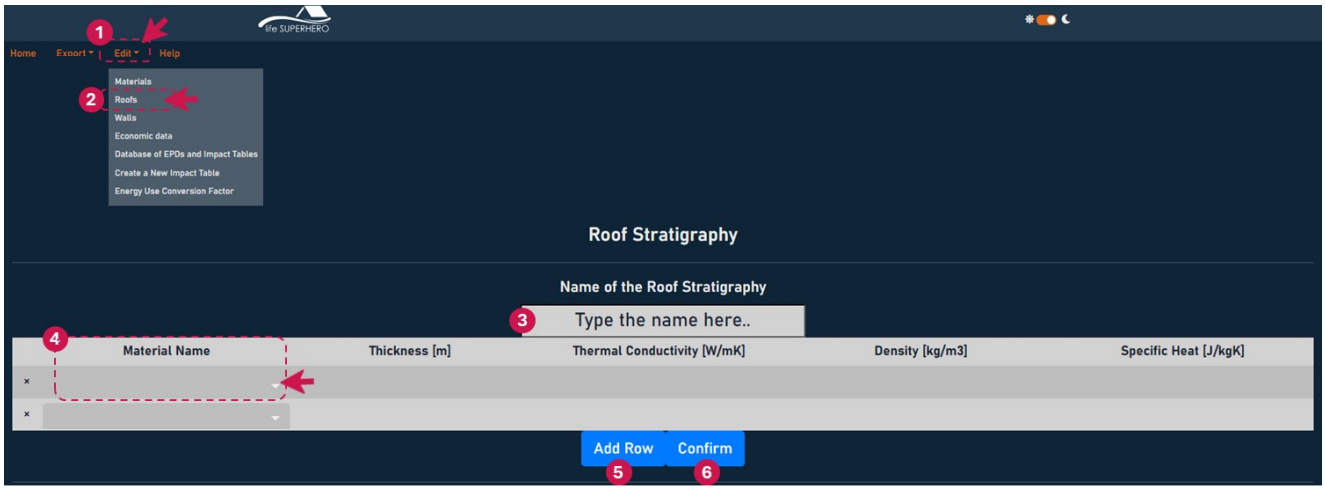
The user can check the available Environmental Impact Data in the table below:

Environmental Impacts Data

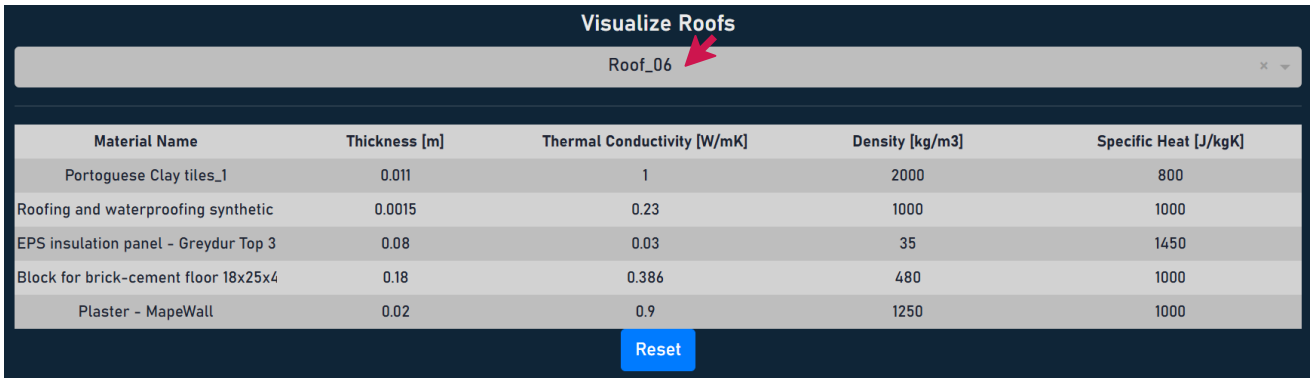
Material Name	Functional Unit	baseName EPD	Conversion to m2
Portoguese Clay tiles_1	t	Tegola portoghese tipo UNICOPPO e TE.SI	0.049225
Portoguese Clay tiles_2	t	Tegola portoghese tipo UNICOPPO e TE.SI	0.049225
Glass Wool Insulation	m2	S-P-06611 Isover Standard 90 mm	1
Aluminium roof covering	m2	S-P-06249 Coperture metalliche & rivestimenti di facci	1
Expanded Polystyrene Insulation (EPS)_1	m3	ECO-DUR ZETA	0.1
Elastoplastomeric polymer bitumen membrane	m2	S-P-06507 Polyflex Light Evolution P	1
Marsilleise Clay tiles_1	t	Tegola marsigliese rossa in laterizio	0.042
Expanded Polystyrene Insulation (EPS)_2	m3	Eco Espanso 100	0.1
Roofing and waterproofing synthetic membrane	m2	S-P-00906 Mapeplan T TPO/FPO Waterproofing Membr	1
Steel Profiles	m2	S-P-06895 Building Steel Profiles	1
Roofing and waterproofing PVC-P membrane	m2	S-P-00691 DANOPOL PVC Waterproofing sheet	1
Extruded Polystyrene Insulation (XPS)_1	m2	S-P-07847 Sopra XPS	1

3.4.2 Edit > Roofs

To create a new Roof Stratigraphy, the user must go to Edit (1) and select Roofs (2).
Next, the user should enter a name for the new roof in the designated field (3) and select the first material (4).
Additional materials can be added as needed by inserting new rows (5) and then confirming the selection (6).
The material properties will be automatically populated based on the information provided in the **Edit > Materials** section.

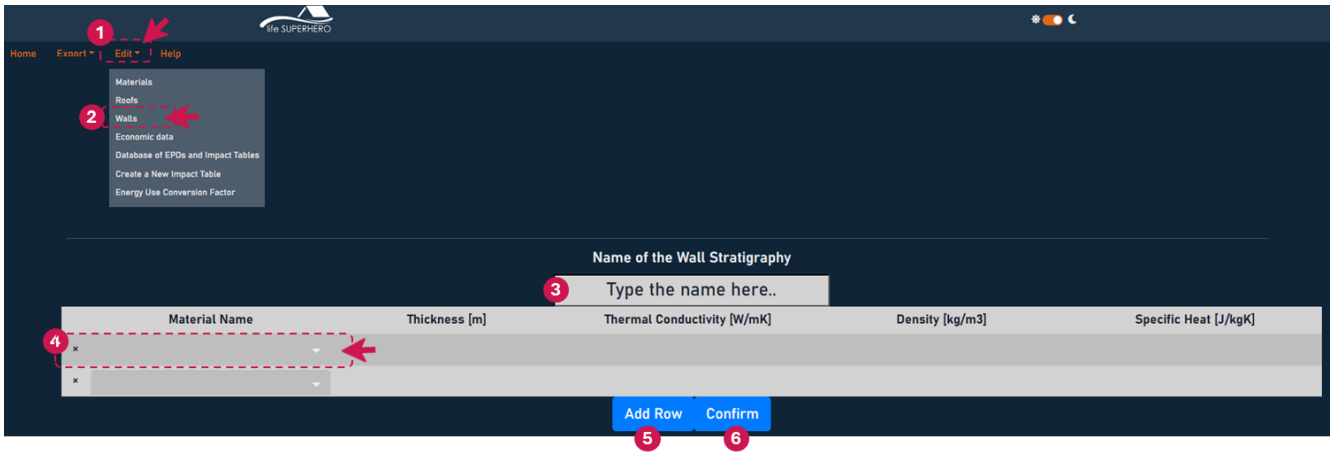


The user can view existing roofs stratigraphy in the table below by selecting a roof from the list:



3.4.3 Edit > Walls

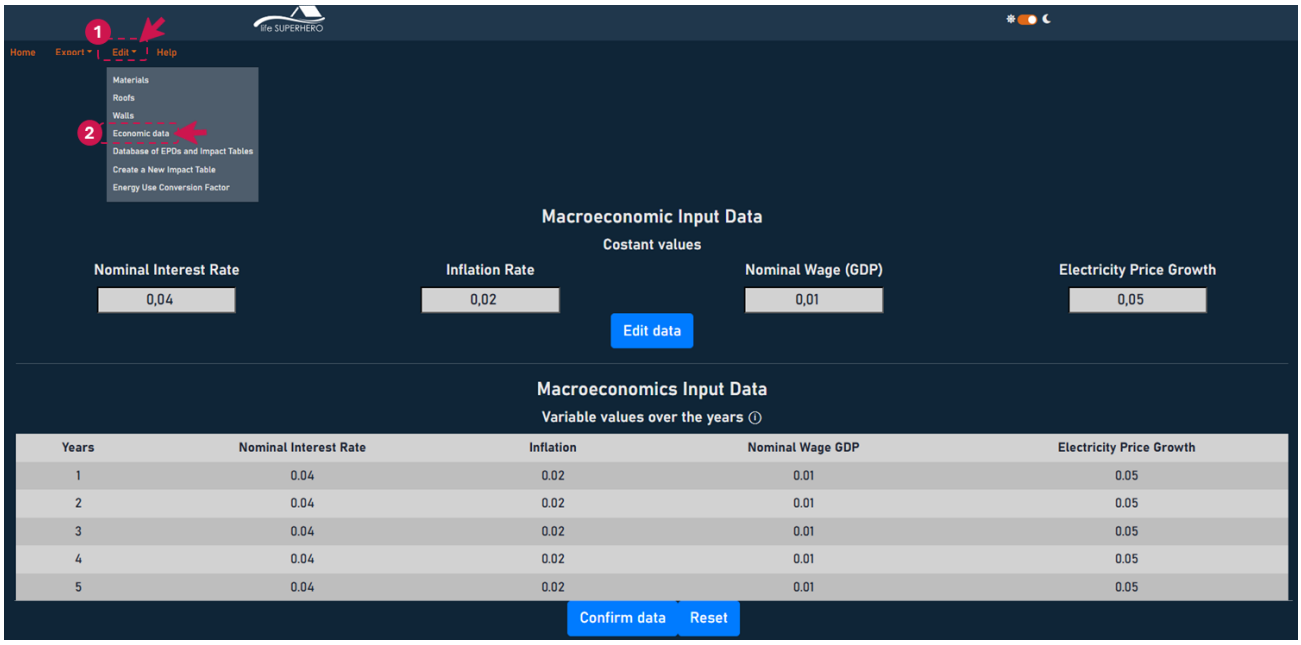
To create a new Wall Stratigraphy, the user must go to Edit (1) and select Walls (2).
Next, the user should enter a name for the new wall in the designated field (3) and select the first material (4).
Additional materials can be added as needed by inserting new rows (5) and then confirming the selection (6).
The material properties will be automatically populated based on the information provided in the **Edit > Materials** section.



The user can view existing walls stratigraphy in the table below by selecting a roof from the list:

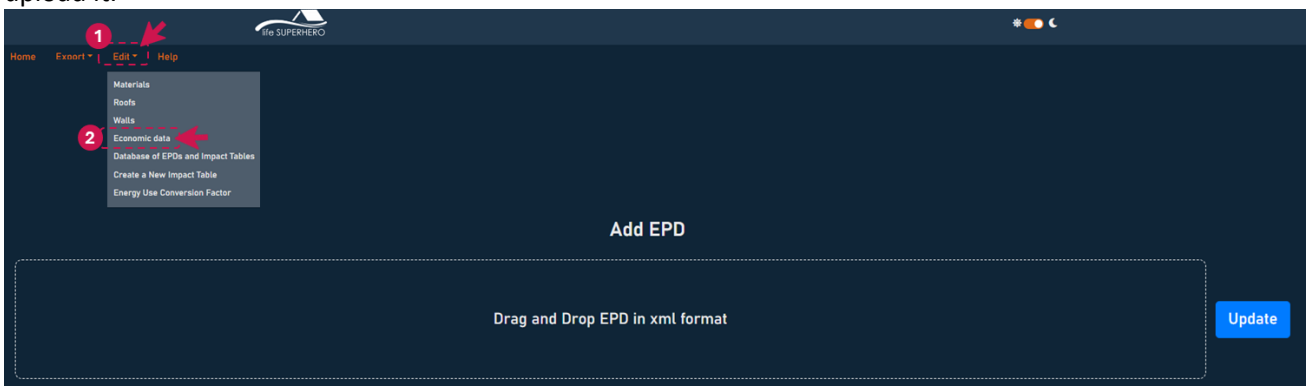
3.4.4 Edit > Economic data

By going to Edit (1) and selecting Economic data (2), the user can modify all macroeconomic constants and/or year-by-year variable values. Once the edits are complete, confirmation is required by clicking the designated button.



3.4.5 Edit > Database of EPD and Impact Tables

To create a new EPD the user must go to **Edit** (1) and select **Database of EPD and Impact Tables** (2).
The user can then drag and drop a new EPD file in .xml format into the designated area and click **Update** to upload it.



On the same page, it is possible to view the list of the existing uploaded EPDs.

Uploaded EPDs List

baseName EPD	UUID
database-Greydur Top B_100% recycled-1	epd-database-pdf-1
database-Greydur Top B-0	epd-database-pdf-0
database-Sopro Fliesenfest extra FF 450-2	epd-database-pdf-2
database-Mapei Polyglass ANTIRADICE LIGHT P-7	epd-database-pdf-7
S-P-00691 DANOPOL PVC Waterproofing sheet	6b7911c8-7933-42ea-9309-41f907f28939
Tegola portoghese tipo UNICOPPO e TE.SI	07ab1c07-ee4e-44c5-9c83-959fb0446bb4
database-MR_Rothoblaas Transpir Evo Seal 200-3	epd-database-pdf-3

On the same page, it is also possible to view the Life Cycle Impact Assessment (LCIA) results of a specific material across its entire life cycle, quantified by specific environmental impact categories, and export the data.

LCIA Results Select

database-Greydur Top B-0

Export

Global Warming Potential (GWP) [kg CO2 eq]

database-Greydur Top B-0	global warming potential (gwp)
A1-A3	127
C2	0.15
C3	81.2
D	-33.7

Export

Acidification potential of soil and water (AP) [mol H+ eq]

database-Greydur Top B-0	acidification potential (ap)
A1-A3	0.135
C2	0
C3	0.007
D	-0.045

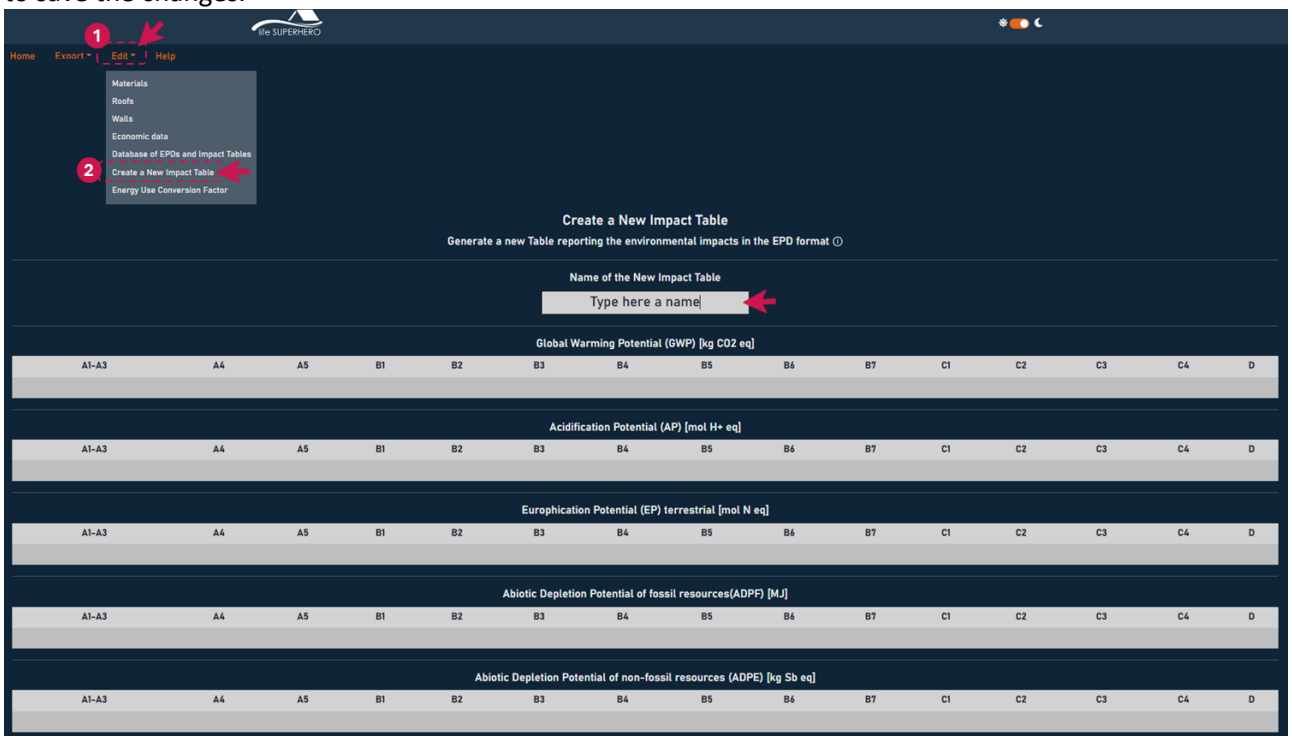
Export

Europhication Potential (EP) marine [kg N eq] freshwater [kg P eq] terrestrial [mol N eq]

database-Greydur Top B-0	eutrophication potential (ep)
A1-A3	0.451
C2	0.001
C3	0.034
D	-0.137

3.4.6 Edit > Create a new Impact Table

In **Edit** (1) > **Create a new Impact Table** (2). The user can generate a new table reporting environmental impacts in the EPD format. To do so, edit the values directly in the table rows and then click the Update button to save the changes.



3.4.7 Edit > Energy Use Conversion Factors

In **Edit** (1) > **Energy Use Conversion Factors** (2), the user can modify values directly in the table rows and then click the *Confirm Data* button to save the changes. These values are calculated based on: *1 kWh Electricity, low voltage – UNI EN 15804 + A2 (adapted), Version 1.00 / EF 3.1 normalization and weighting set, October 2023.*