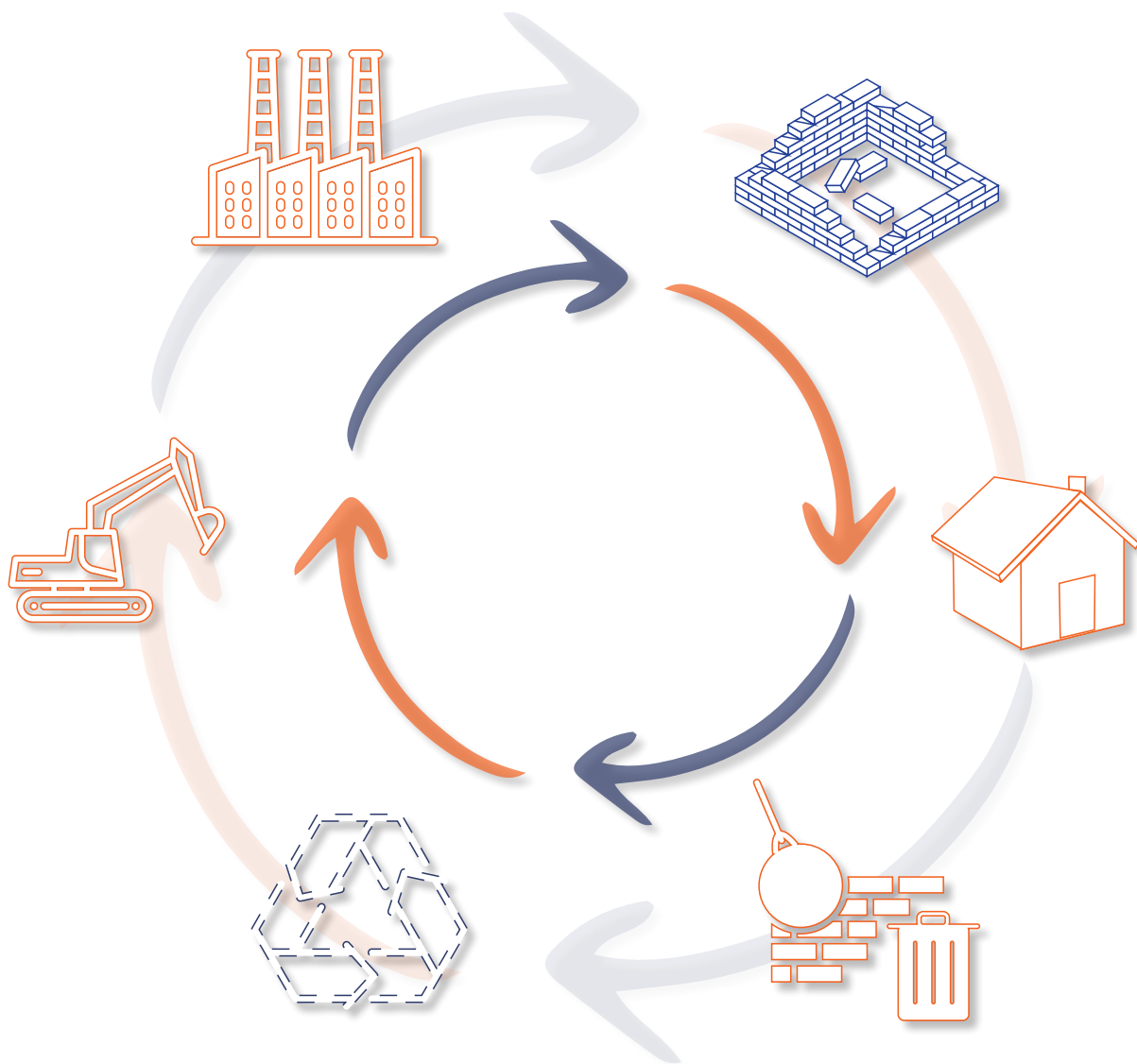


GRAPHISOFT® | CENTER

MANUAL:  
**DesignLCA 4.0**



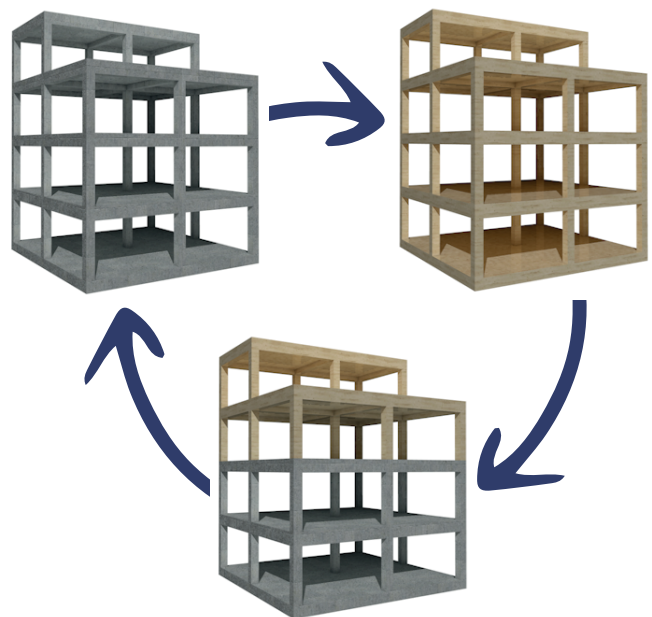
**LCA IN THE EARLY DESIGN PHASE**

Sustainability in the building sector has become a major topic worldwide and multiple European countries are working on implementing regulations. This means that we must investigate new ways to assess a building's climate impact already from the early stages. LCA is a detailed method for assessing a building's footprint and is still undergoing rapid development in line with increasing demand. However, it is a method that requires a large amount of data on included processes.

It is crucial to be able to consider the environmental impact in the initial phases of a project, so that you can continuously see how the geometry and choice of materials can affect the final result. For example, testing different material compositions on e.g. the load-bearing structure, facades, roof, etc. This saves both architects and engineers time, as it provides a better prerequisite for achieving the desired results in the final design LCA.

That is why Graphisoft Center Danmark has developed an Add-on, DesignLCA, for Archicad to estimate impacts from any construction along with the modelling.

The Add-on enables you to compare different solutions as well as getting an estimate of the whole performance of your building throughout its life cycle.



Product stage			Construction process		Use stage							End of life				Beyond system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction, installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/demolition	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling potential
<b>A1</b>	<b>A2</b>	<b>A3</b>	<b>A4</b>	<b>A5</b>	<b>B1</b>	<b>B2</b>	<b>B3</b>	<b>B4</b>	<b>B5</b>	<b>B6</b>	<b>B7</b>	<b>C1</b>	<b>C2</b>	<b>C3</b>	<b>C4</b>	<b>D</b>

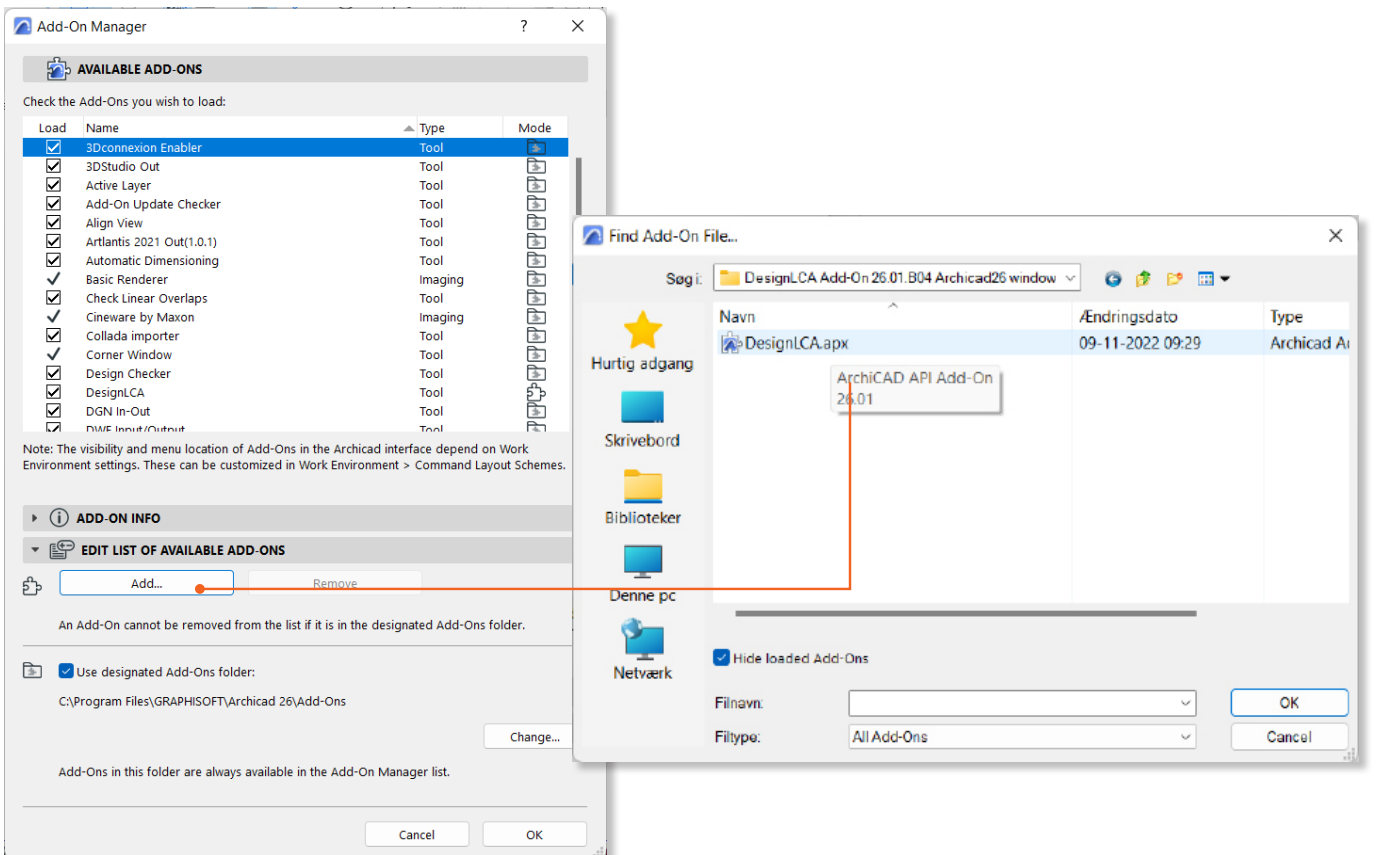
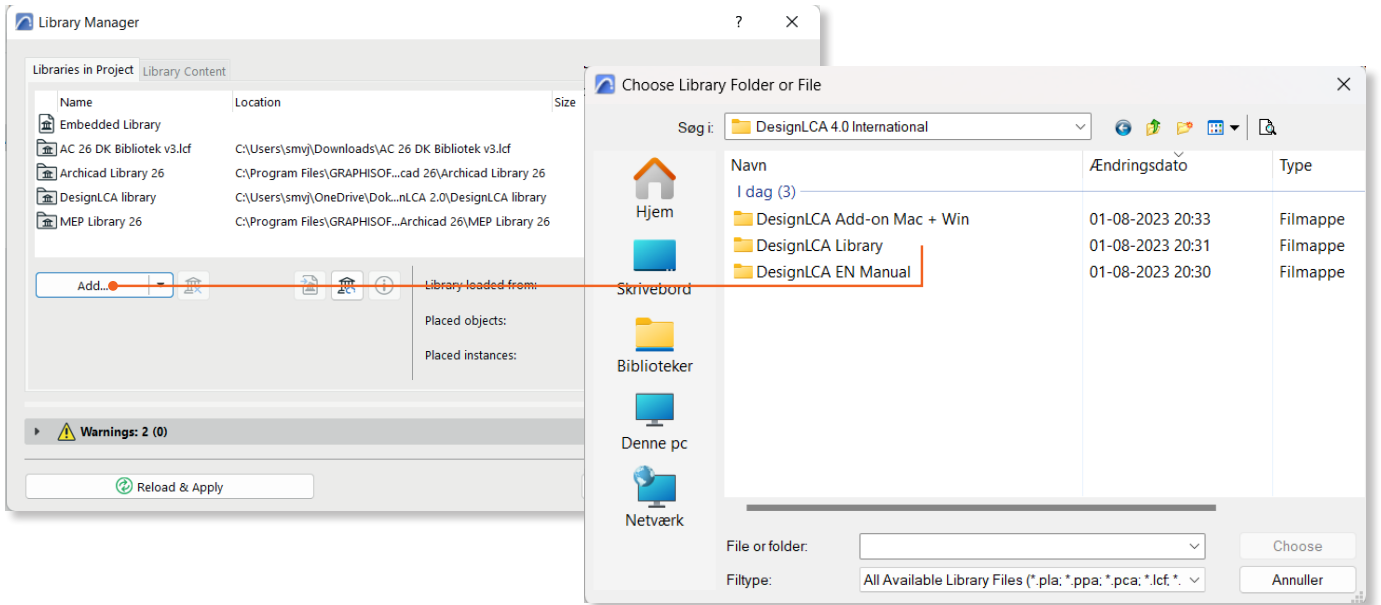
 Modules included in DesignLCA

**DESIGNLCA ADDON IMPORT - LIBRARY AND ADDON**

DesignLCA is an add-on that is downloaded as a bundle with this manual an XML-file with properties for windows and doors and a Library Container File (.lcf).

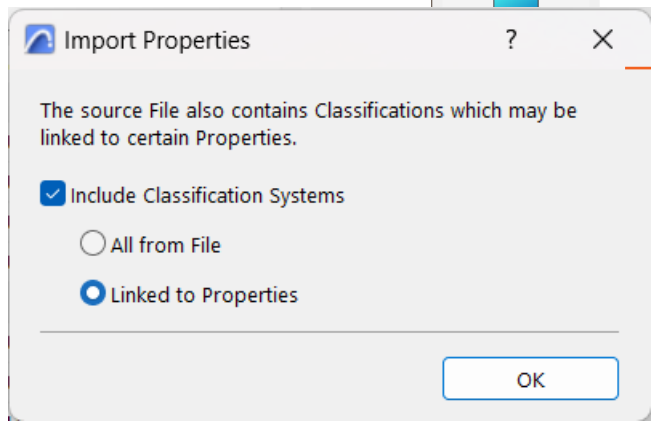
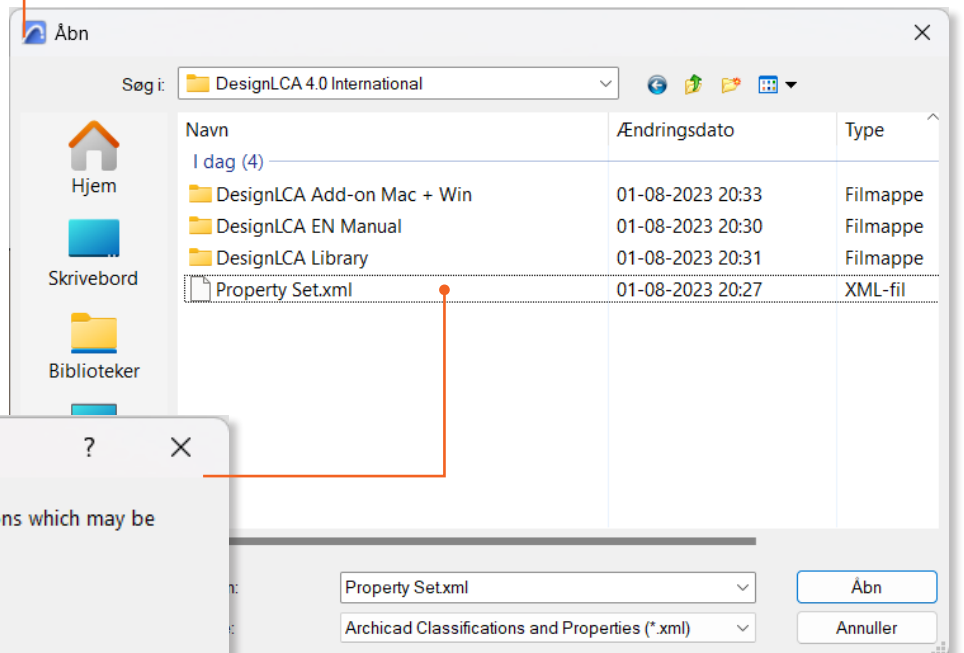
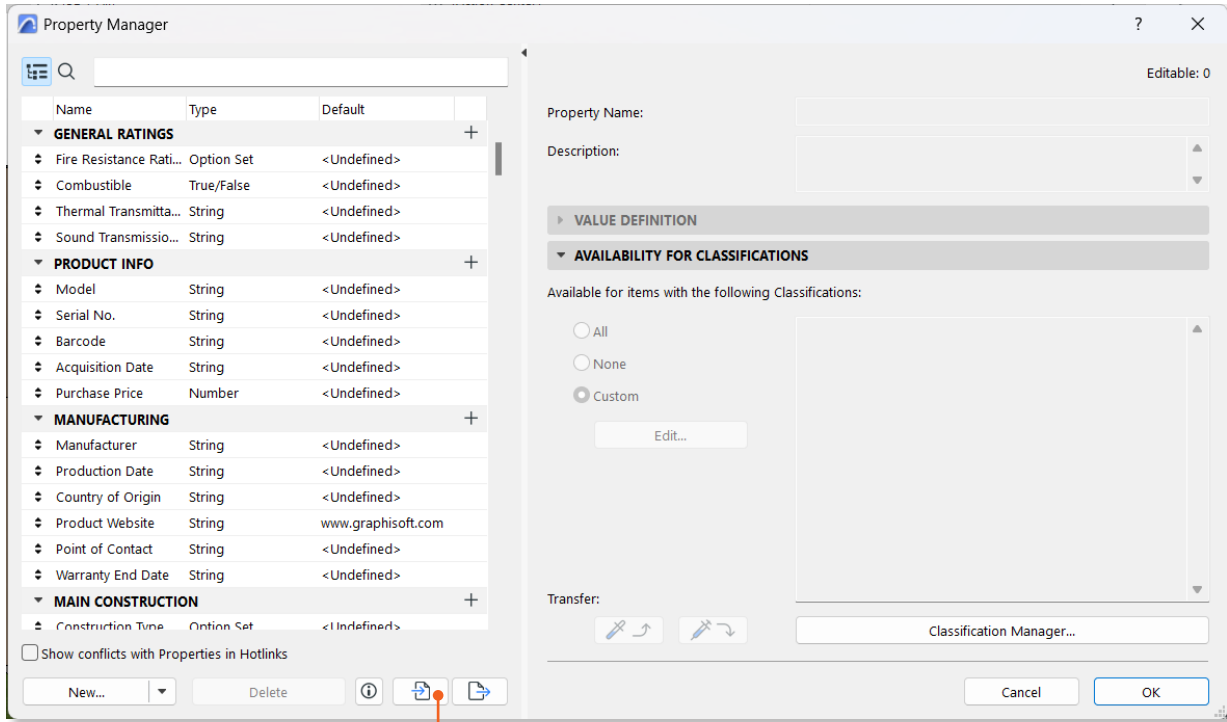
Formfaktor ApS and GRAHISOFT Center Danmark make DesignLCA available free of charge, but do not take responsibility for any errors in the product or in the calculations performed with DesignLCA. Always make sure to adjust all parameters in Archicad and DesignLCA to match your project.

The addon is imported via Options > Add-on Manager. Then DesignLCA is added to the list via 'Add'. When this is done, Archicad must restart, after which a new tab will appear in the toolbar of Archicad's window. It's important to have the latest version of Archicad 26 (Build 4019 or later) in order to use the addon.



### DESIGNLCA ADDON IMPORT - PROPERTIES

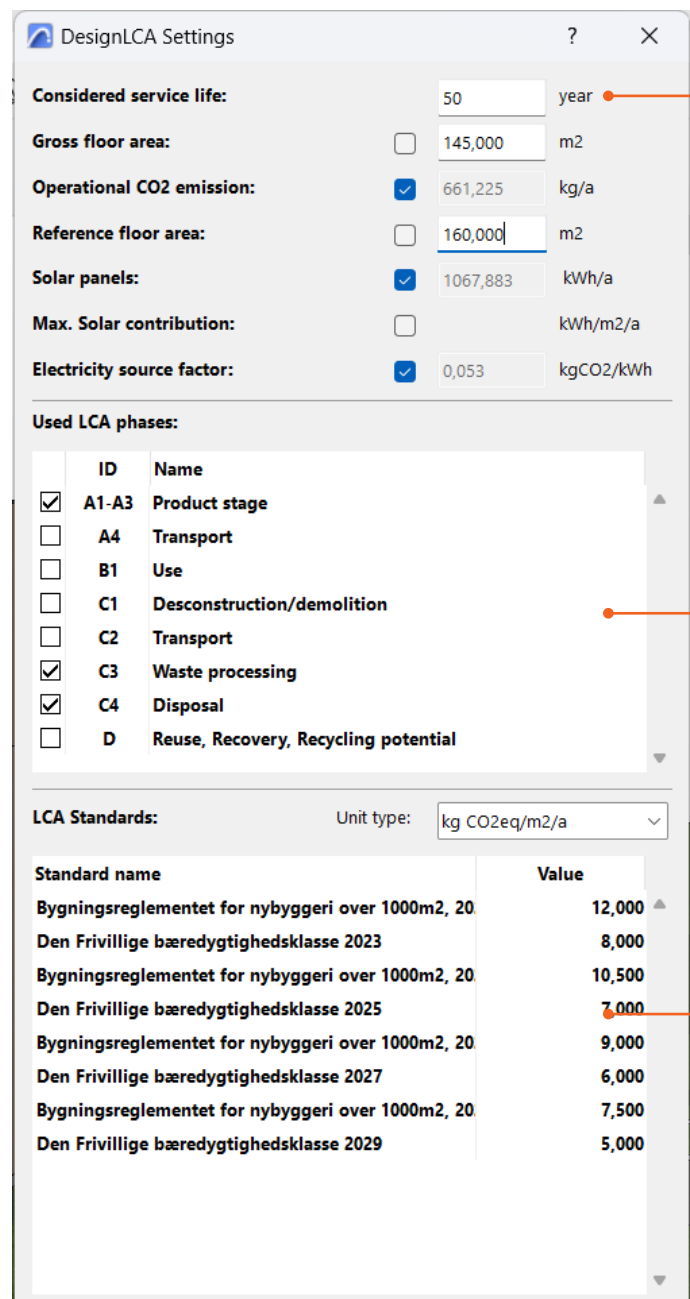
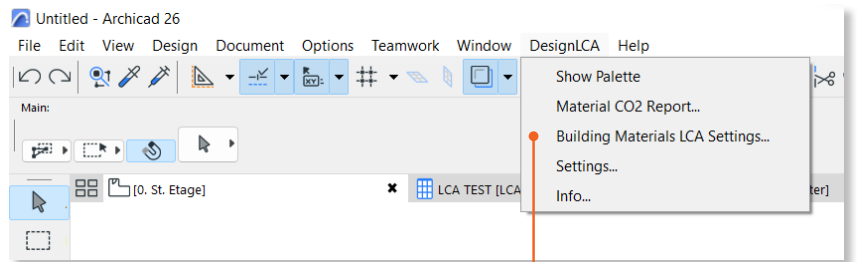
The XML-file with the properties for windows and doors are imported in Options > Property Manager. Make sure only to include the classifications linked to the properties in the file.



DESIGNLCA SETTINGS

As the first step after importing DesignLCA, a decision must be made about the framework for the LCA calculations in DesignLCA's settings.

The Add-on contains four menus: the Palette which shows the results, the Building Materials LCA Settings, which is where data from EPD's needs to be input, the Settings with the overall settings for the calculations and lastly the Info which sends you to the DesignLCA website. These menus will be explored throughout the manual.



The consideration period has 50 years as a default value according to the Danish requirements, but can be changed, if needed. If the boxes in 'Gross floor area', 'Operational CO2 emissions' and 'reference floor area' are ticked, the data will be obtained from the Eco Designer STAR export. However if you want to use your own data, simply tick them off and put in the values manually. The gross floor area is in relation to the Operational CO2 and the reference area is in relation to the materials.

In this field, the stages in the life cycle of the materials can be added and removed as desired. When a module is added, there will be an additional data field in 'Building Materials LCA Settings'. It is preset according to the Danish regulations.

In 'LCA Standards', thresholds can be added that can be used as a reference in relation to the modeled building in DesignLCA's palette.

Here, the Danish standards are entered with the current and upcoming Danish threshold values.

**ARCHICAD – BUILDING MATERIALS**

As illustrated in the image below, there is an overview of the various Building Materials in Archicad. Here you can access the data used for Energy calculation for each material under 'Physical Properties'. Make sure to ensure that these values comply with the national standard of your country. Furthermore you can access the default climate impact from all impact categories for each material with a link to the relevant EPD. These are for reference only and are not used for calculation.

The screenshot shows the 'Building Materials' window in Archicad. The left pane lists various materials, with 'CLT' selected. The right pane displays the properties for 'CLT', categorized into 'ENVIRONMENTAL' and 'PHYSICAL PROPERTIES'.

ENVIRONMENTAL	
Global Warming Potential (GWP)	1,787
Ozone Depletion Potential (ODP)	0,000
Photochemical Ozone Creation Pot...	-0,001
Acidification Potential (AP)	0,004
Eutrophication Potential (EP)	0,001
Abiotic Depletion Potential (for no...	0,000
Abiotic Depletion Potential (for fos...	23,955
Data Source	<a href="https://www.oekobaudat.de/OEKOBAU.DAT/resource/pr...">https://www.oekobaudat.de/OEKOBAU.DAT/resource/pr...</a>

PHYSICAL PROPERTIES	
Load from Catalog	Open Catalog...
Thermal Conductivity	0,250 W/mK
Density	840,000 kg/m <sup>3</sup>
Heat Capacity	1000,000 J/kgK

When you create a composite, Archicad itself calculates how the composition has an influence on e.g. the building's energy performance, which is important when you have to consider the climate impact during the operational phase.

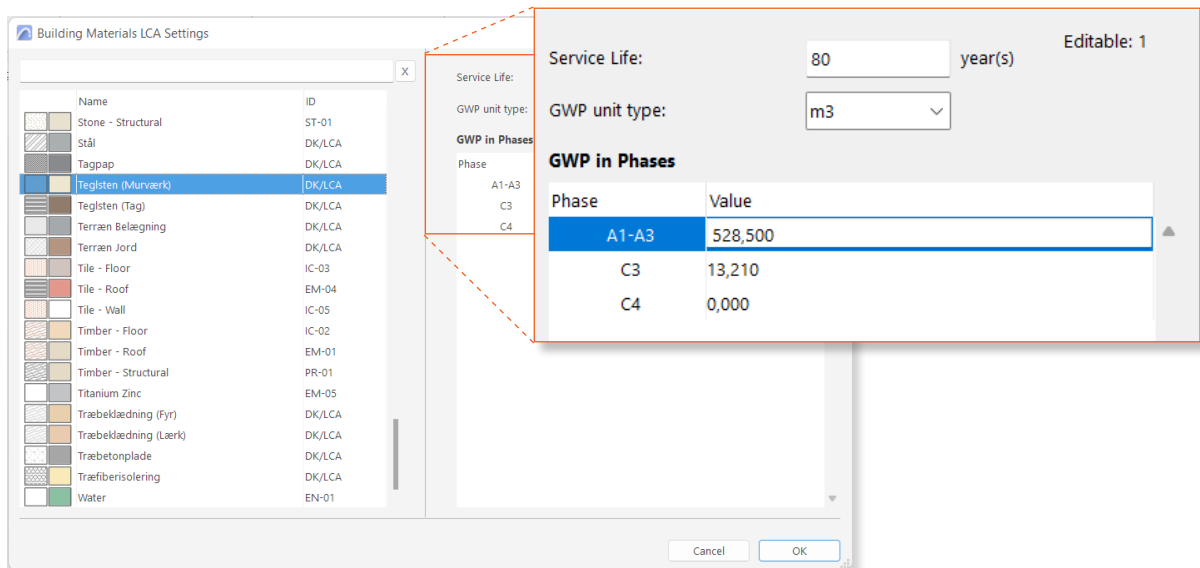
The screenshot shows the 'Energy Model Review - Structures' window. The 'Structure Properties' panel is expanded, showing details for a 'Wall' structure.

Structure Properties	
Type	Wall
Orientation	South
Category	External
Thermal Block	001 Ophold
Name	_DK_LCA_Tegl gasbeton
Area	1,00 m <sup>2</sup>
Thickness	410 mm
U-value	0,16 W/m <sup>2</sup> K
Infiltration	1,10 l/sm <sup>2</sup>
Solar Absorptance	85,00 %



DESIGNLCA – MATERIALS

In addition to the thermal properties of the materials, data on the CO<sub>2</sub>eq emissions of the same materials must be applied. This is done in DesignLCA's 'Building Materials LCA Settings'. You can either use the EPD's from the International Archicad 26 template which is to be found in the 'Environmental Properties' as shown on the first image on page 6. You can also apply data from a local EPD-database. Remember to ensure that the GWP unit type is corresponding with the declared unit in the EPD you use. The service life of a material is usually not declared in the EPD, but should be accessible in national standards.



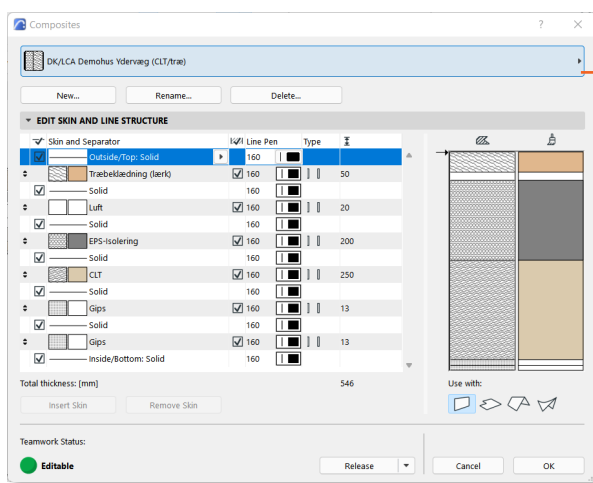
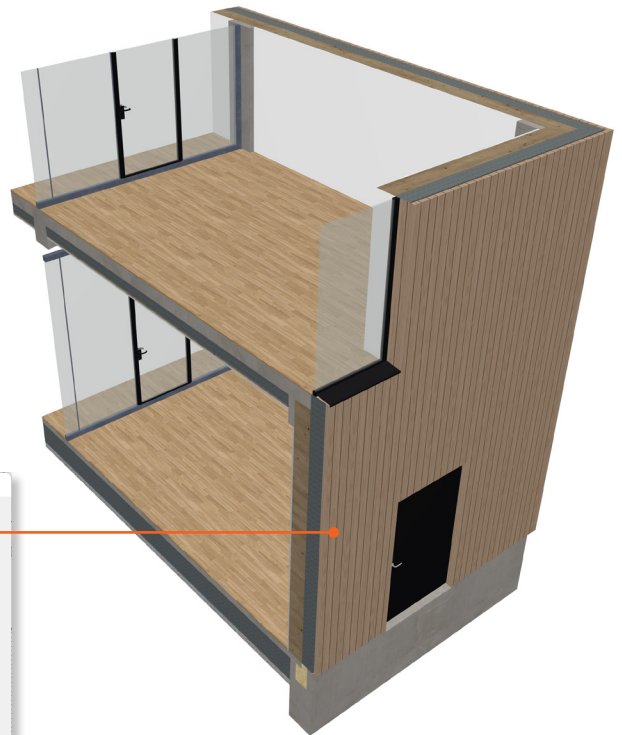


### Building Information Modeling

On the following pages there is a rundown of what the model should contain in order to use DesignLCA adequately. Be aware that the Calculation Units should be in metres in order to match the DesignLCA units.

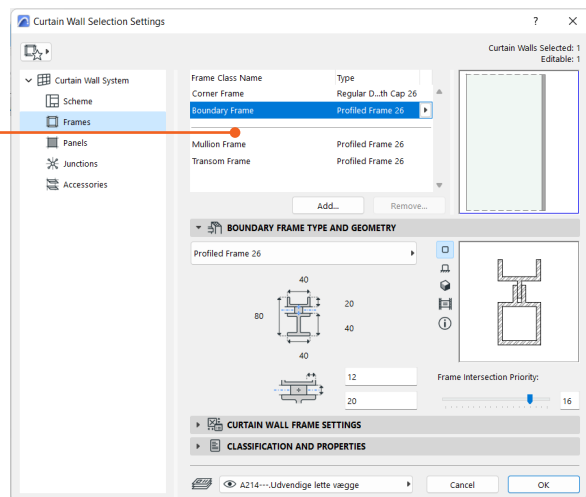
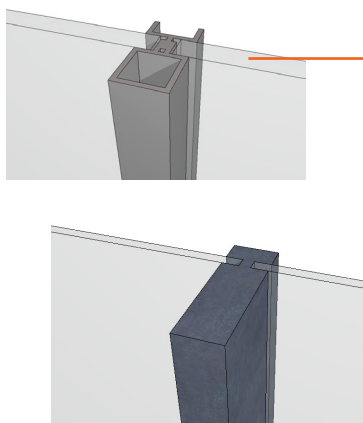
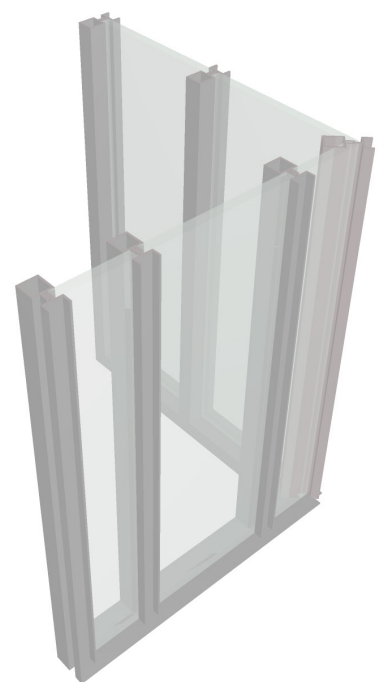
### Modeling the building components

As mentioned, all building components must be assigned a material composite. Make sure to only use composites with materials containing both thermal properties and GWP-data in DesignLCA. The more detailed you model, the more precisely Archicad will produce a quantity extraction and thus a more precise estimate of the building's CO<sub>2</sub> emissions. This means that in addition to modeling walls, decks and roofs, you should model columns and beams with an assigned material.



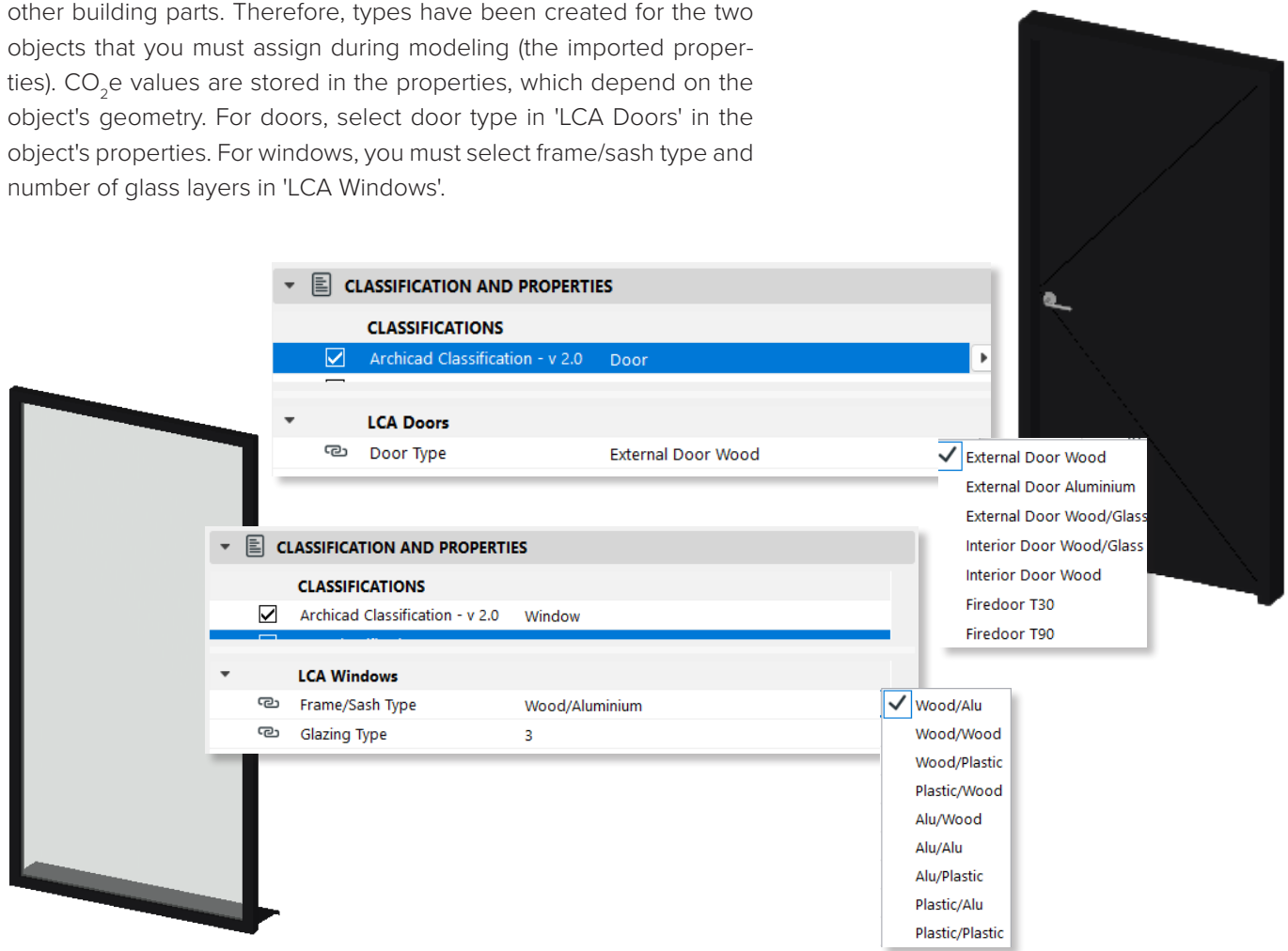
### Curtain Walls

Curtain Walls must be assigned materials on both panels and the different frame types. You can also insert a fixed panel with a composite composed of the material with proper data. When choosing a frame, make sure that the profile matches the desired type. Do you have e.g. an aluminum frame, choose a profiled frame to avoid excess material.



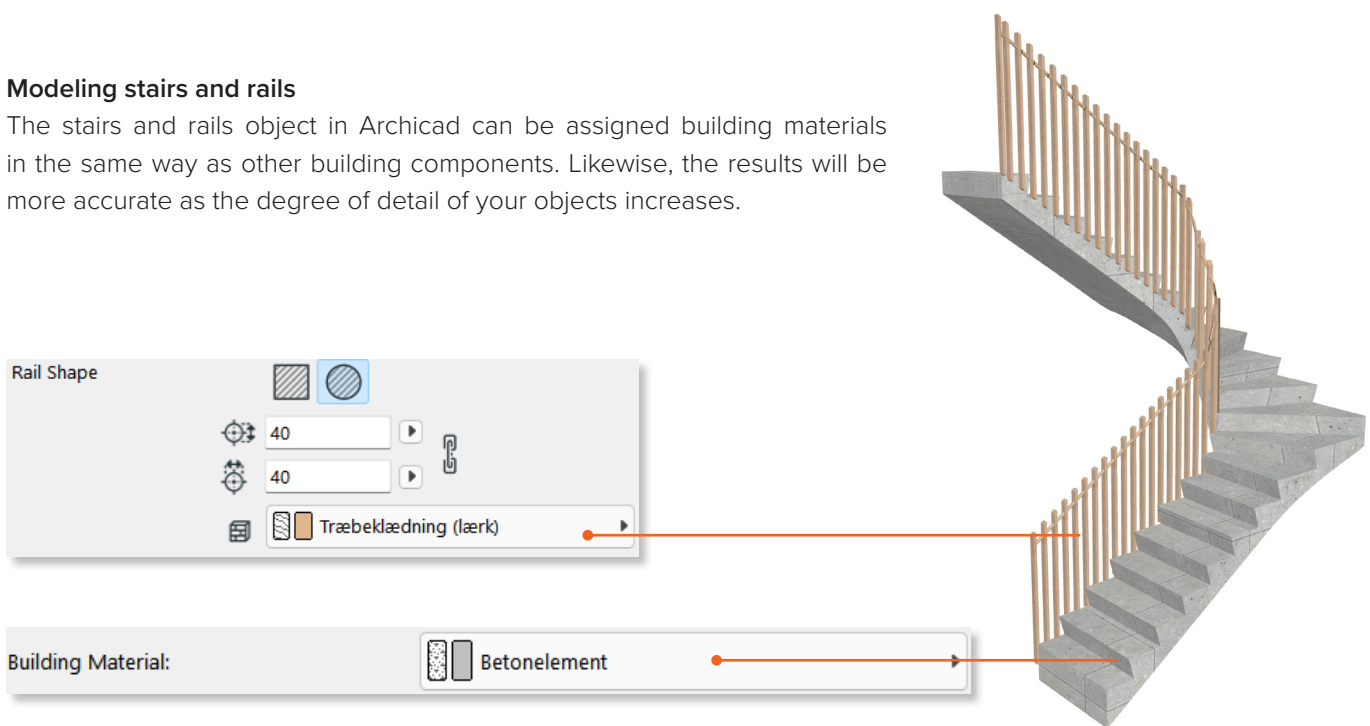
### Modeling Windows and Doors

Doors and Windows do not contain material data in the same way as other building parts. Therefore, types have been created for the two objects that you must assign during modeling (the imported properties). CO<sub>2</sub>e values are stored in the properties, which depend on the object's geometry. For doors, select door type in 'LCA Doors' in the object's properties. For windows, you must select frame/sash type and number of glass layers in 'LCA Windows'.



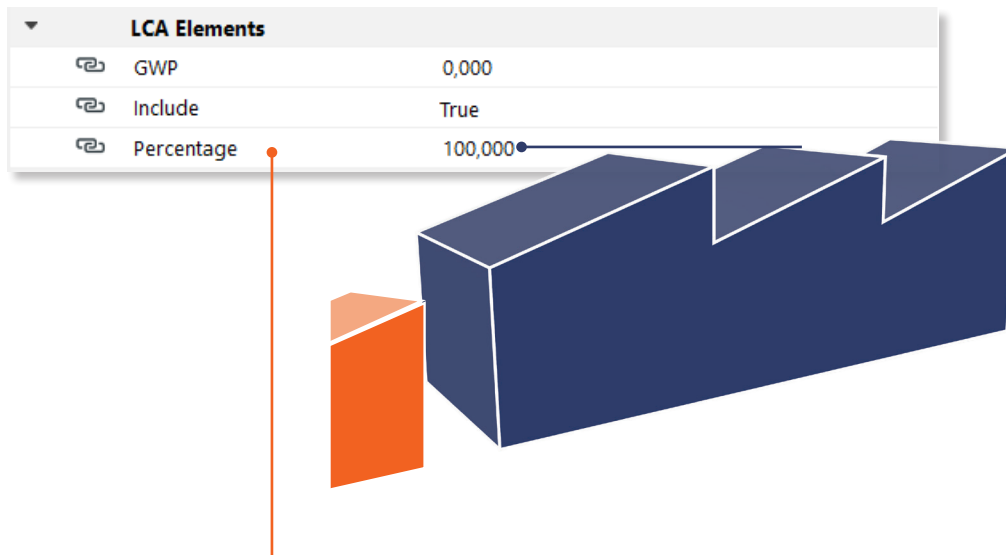
### Modeling stairs and rails

The stairs and rails object in Archicad can be assigned building materials in the same way as other building components. Likewise, the results will be more accurate as the degree of detail of your objects increases.



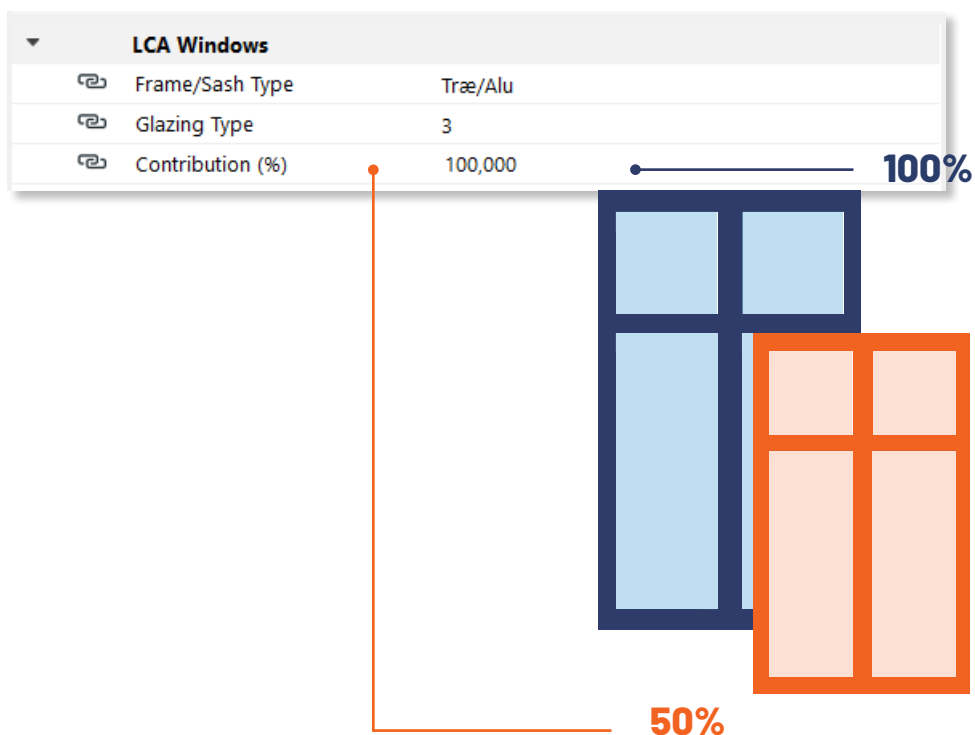
### Contribution in percentage

When considering projects, usually they include multiple secondary components and buildings, which should not necessarily contribute with a 100% of their environmental impact in the final LCA calculation. To accommodate that, there is a possibility to change the percentage of the contribution in **Classifications and Properties > LCA Elements**



### Contribution percentage from windows and doors

For windows and doors the percentage is changed within either LCA Windows or LCA Doors.



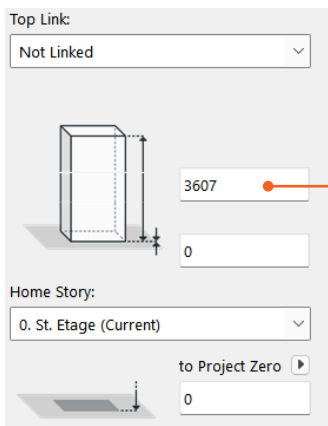
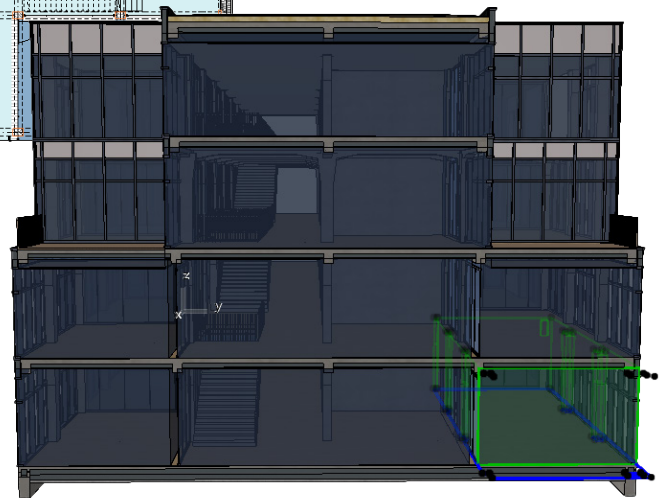
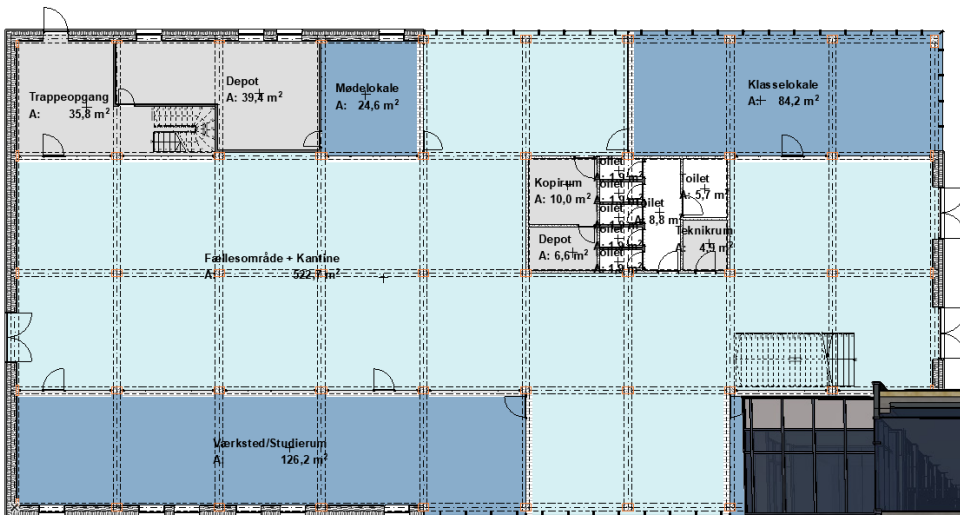
**OPERATIONAL ENERGY CONSUMPTION**

The B6 module implies the buildings' operational energy and the corresponding CO<sub>2</sub> emission – for this you need Archicad's EcoDesigner Star tool ('Design > Energy Evaluation').

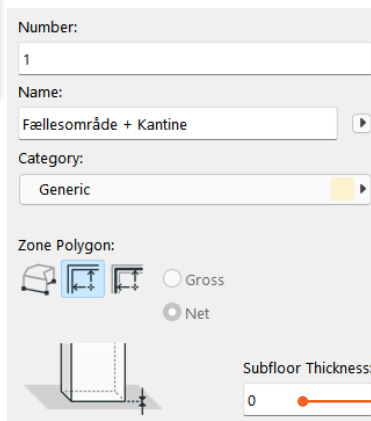
**Zones**

Before opening the tool, prepare the model by creating 3D zones in the building's space. The zones register the room's geometry and building components incl. Windows and doors. When you place zones in 2D, you can assign the zone a function, e.g. kitchen, toilet or classroom.

In order for the zones to register the geometries correctly, they have to reach the inside of all the building components in the room. This means the inside of the wall, the underside of the ceiling (adaptable in 3D) and the upper side of the floor. If you have an oblique slope in the ceiling, you can crop the zone with the ceiling in the same way as walls in 3D. It is important that you update your zones continuously and before you open Energy Evaluation.



The zones must be set to reach the bottom of the ceiling and not be linked to the floor above.



It is important that all building components are included in the zones, therefore Subfloor Thickness must be set to 0.

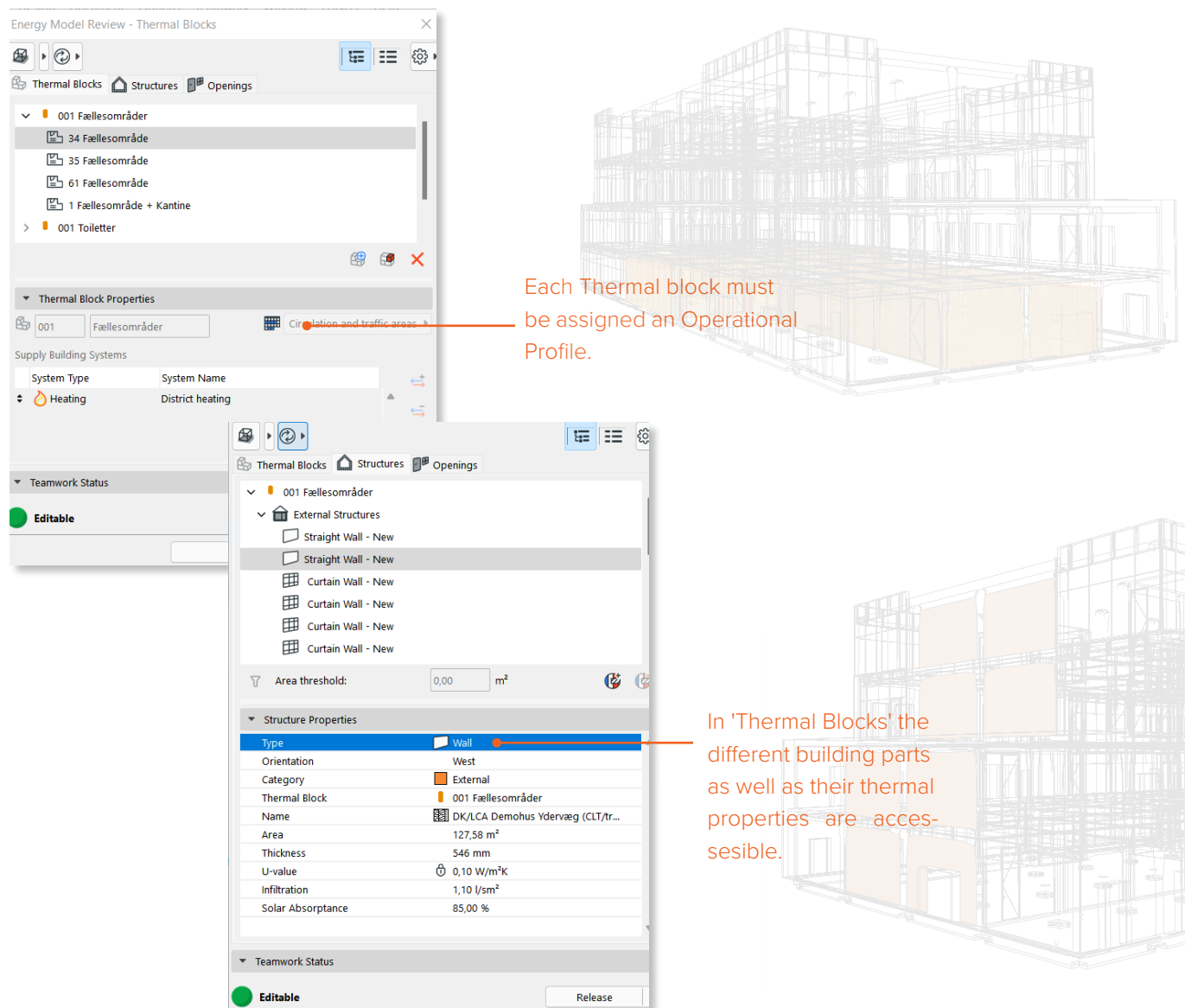
### Thermal Blocks

In order to calculate the model's energy consumption and associated CO<sub>2</sub> emissions, you must group the building's zones into 'Thermal blocks' in Energy Evaluation. Thermal blocks represent a collection of one or more spaces with similar heating or cooling requirements – also called thermostat control requirements and similar operational function.

Once you have created a Thermal block in the EcoDesigner Star tool, you can assign it to the zones. When these are in place, different parameters can be set in relation to heat consumption, ventilation etc. depending on the type of building. Here, it is important to be aware that all building components must be modeled as an overall composite of materials in order for the tool to calculate correctly.

An 'Operation profile' must be set for each Thermal Block. If it e.g. is a classroom, you must assign it the profile 'Classroom' which is set to be in use during the day on all weekdays. You can customize the profiles and create your own as needed.

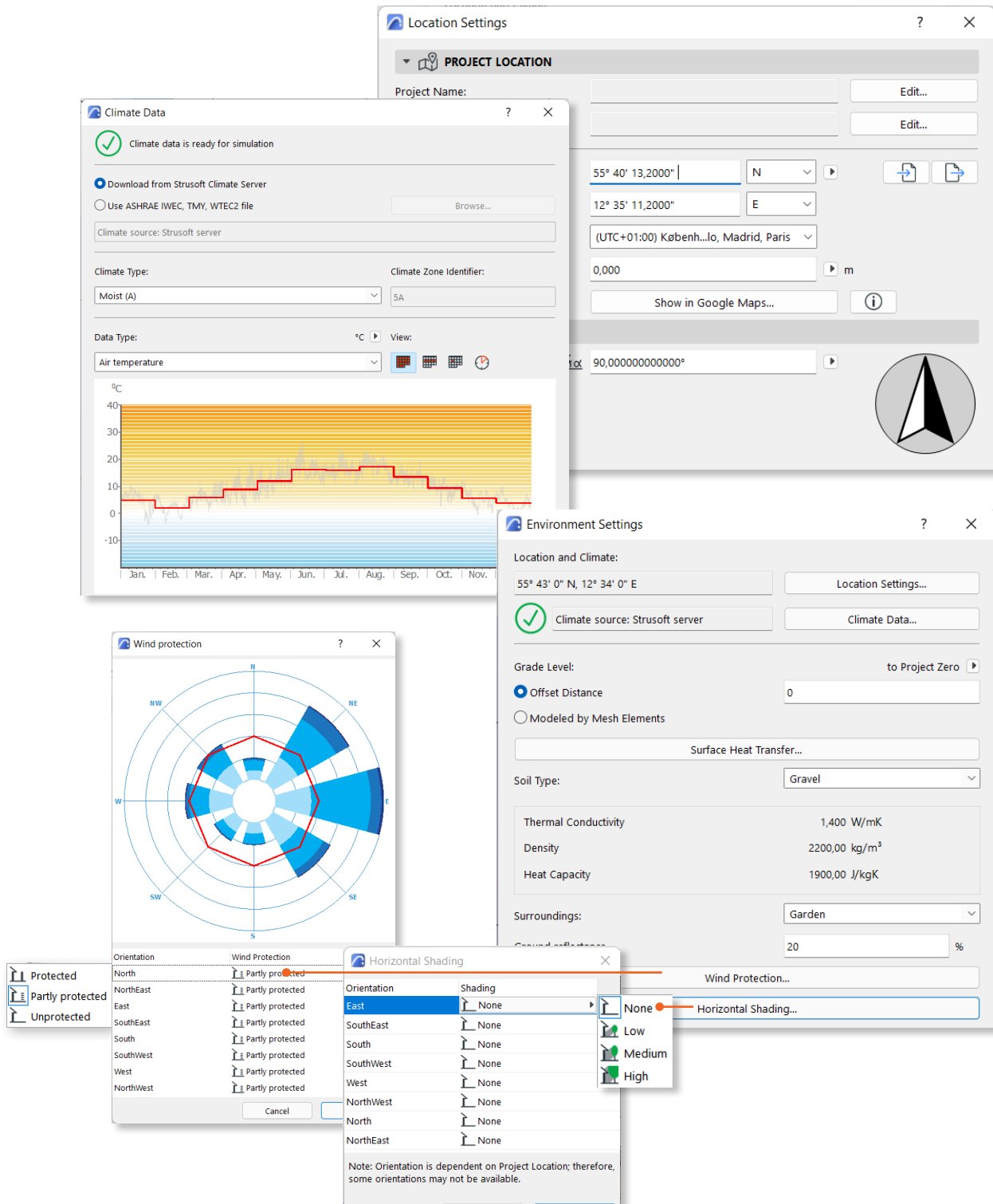
Under the 'Structures' tab you can access all building structures for each zone in each thermal block. Here you can view e.g. orientation, category and u-value for the selected building part. The u-value is calculated in Archicad based on the material composition, but can be overridden manually if you need to work with a specific u-value.



### Location og Climate

The location and surroundings have an impact on the energy demand and thus the amount of CO<sub>2</sub> emitted from the energy consumption. You can therefore set the location to the specific address for your construction and then the location of the plot in relation to True North.

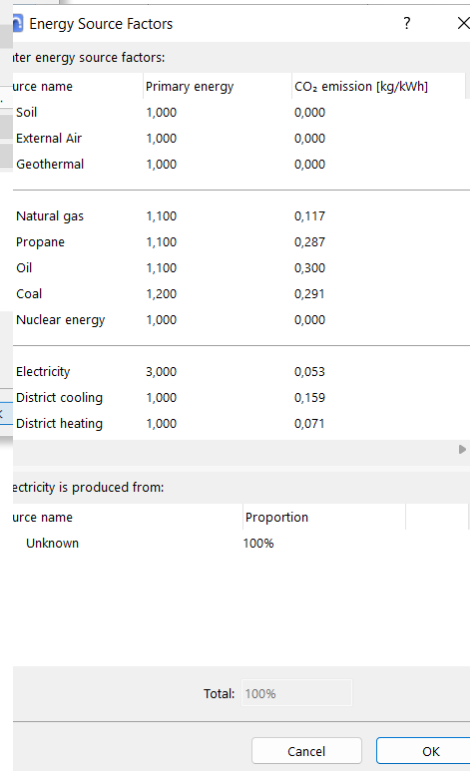
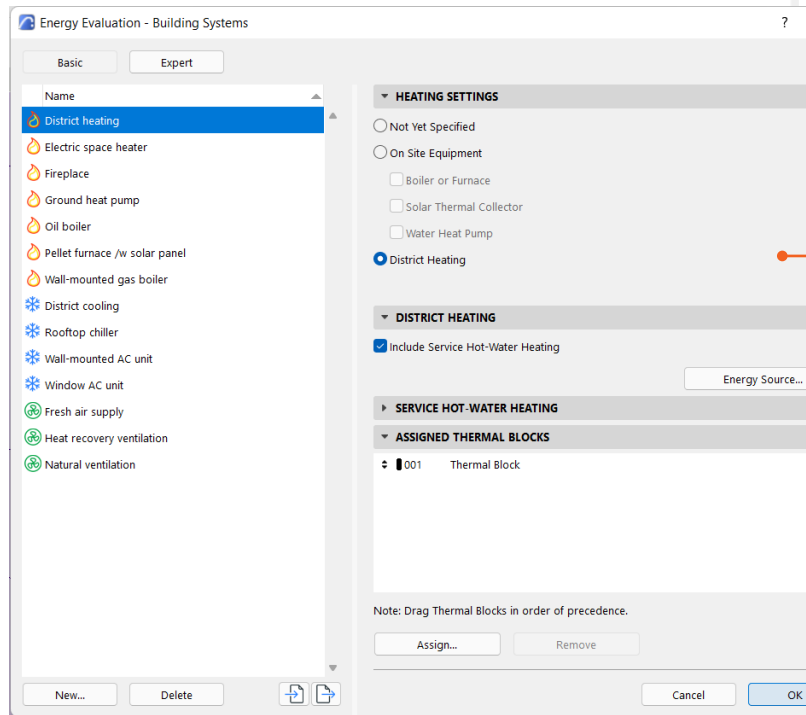
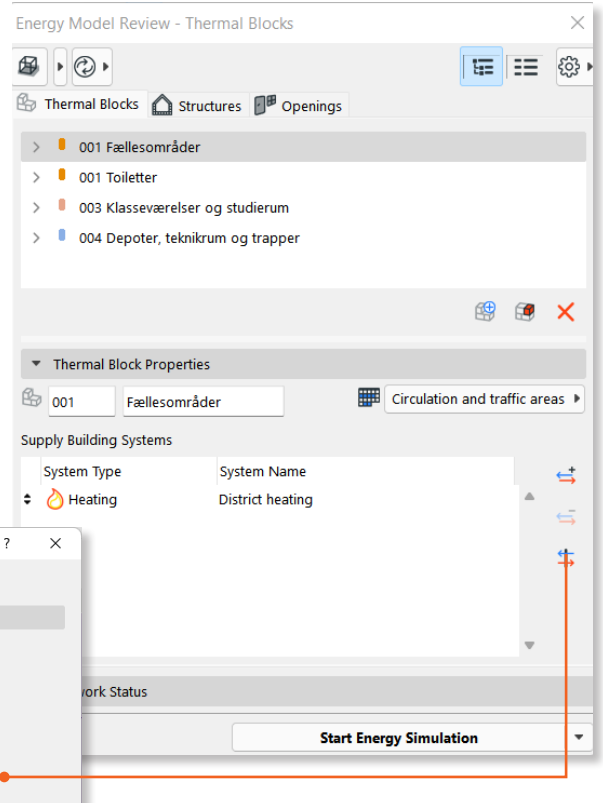
When the location is set, Archicad adapts the weather data for the given area. In Environment Settings, you can set up the environment to avoid modeling the context of the building. Here you can set zone conditions and shade and shelter from surrounding buildings.



**Energy Model - Building systems - Heating, Cooling and Ventilation**

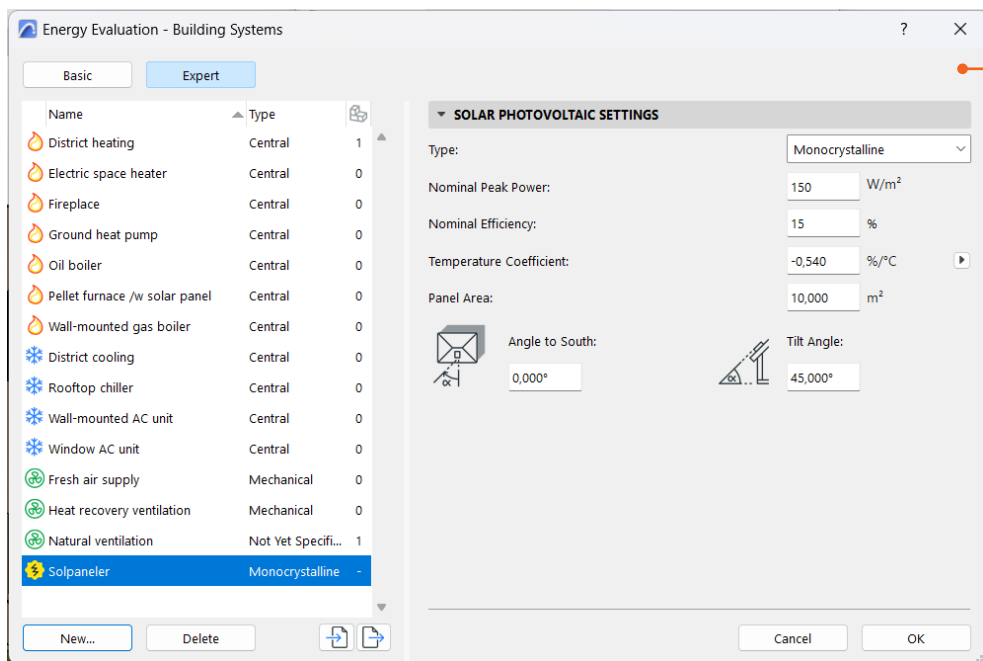
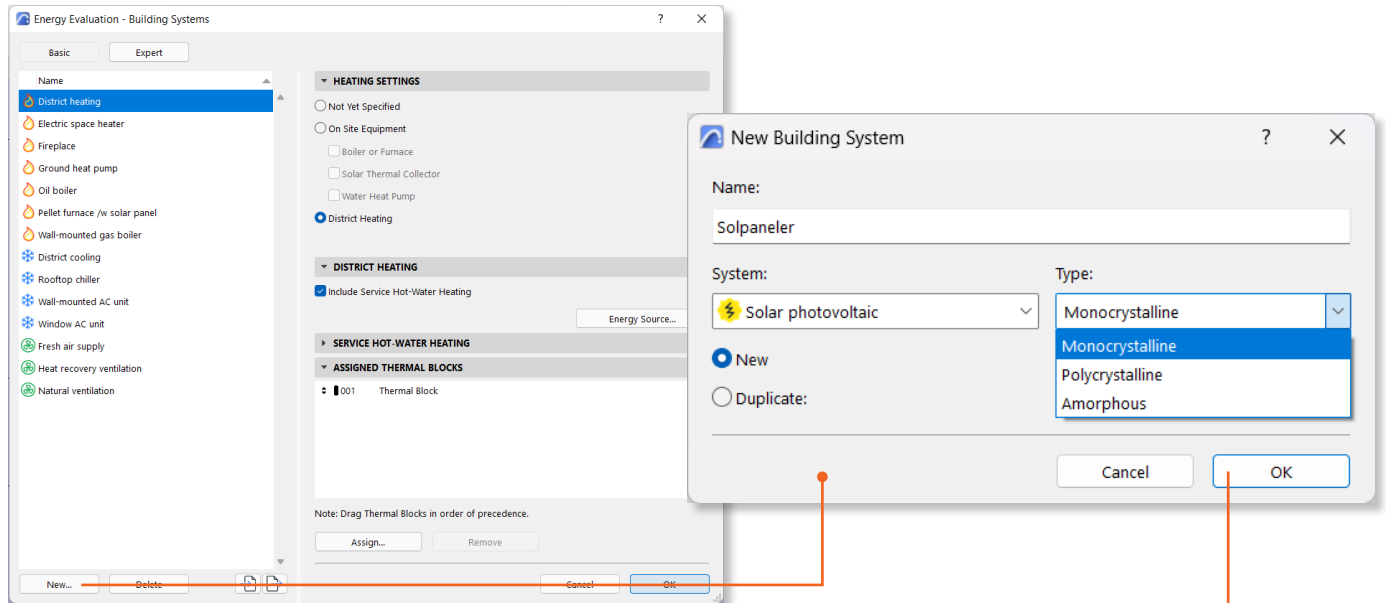
The building systems concerns types of heating, cooling and ventilation supply in the building. The building systems are assigned to each thermal block, so if you have e.g. a living room with a wood-burning stove as a heat source, it must be in its own Thermal Block.

The energy source for the various systems can be set freely but has a default from the Strusoft server. Each energy source has a CO<sub>2</sub> value, and if you want to use e.g. solar energy, this must be completed before running a simulation.



### Building Systems - Solar Panels

In building systems, solar panels can also be added to the project. This is done in a slightly different way to the other building systems. If you want to include a contribution from solar cells, they must be created manually under 'Building Systems'. Here you name the system yourself and select 'Solar photovoltaic' in the drop-down menu for 'System'. Then you select the type of solar cells (Monocrystalline, Polychrystalline or Amorphous) based on the manufacturer's information. Once the solar panels have been created, you can access the settings for their tilt angle, angle to south, area and peak power.

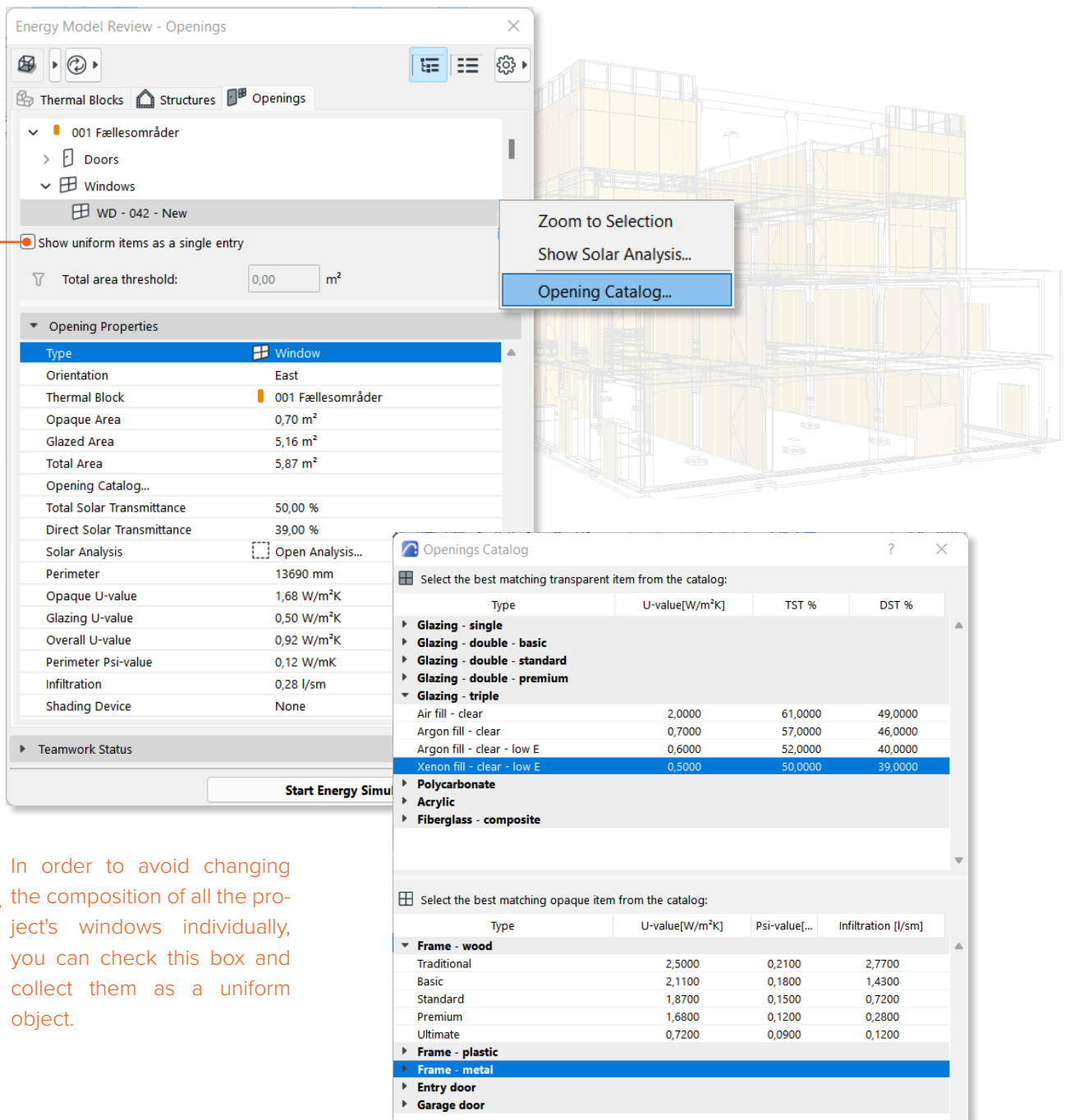


Note that as soon as the solar panels are set up as a system they will be included in your energy simulation. If you are not going to use solar power, it should be deleted from the 'Building Systems' list.



**Energy model – Windows and doors**

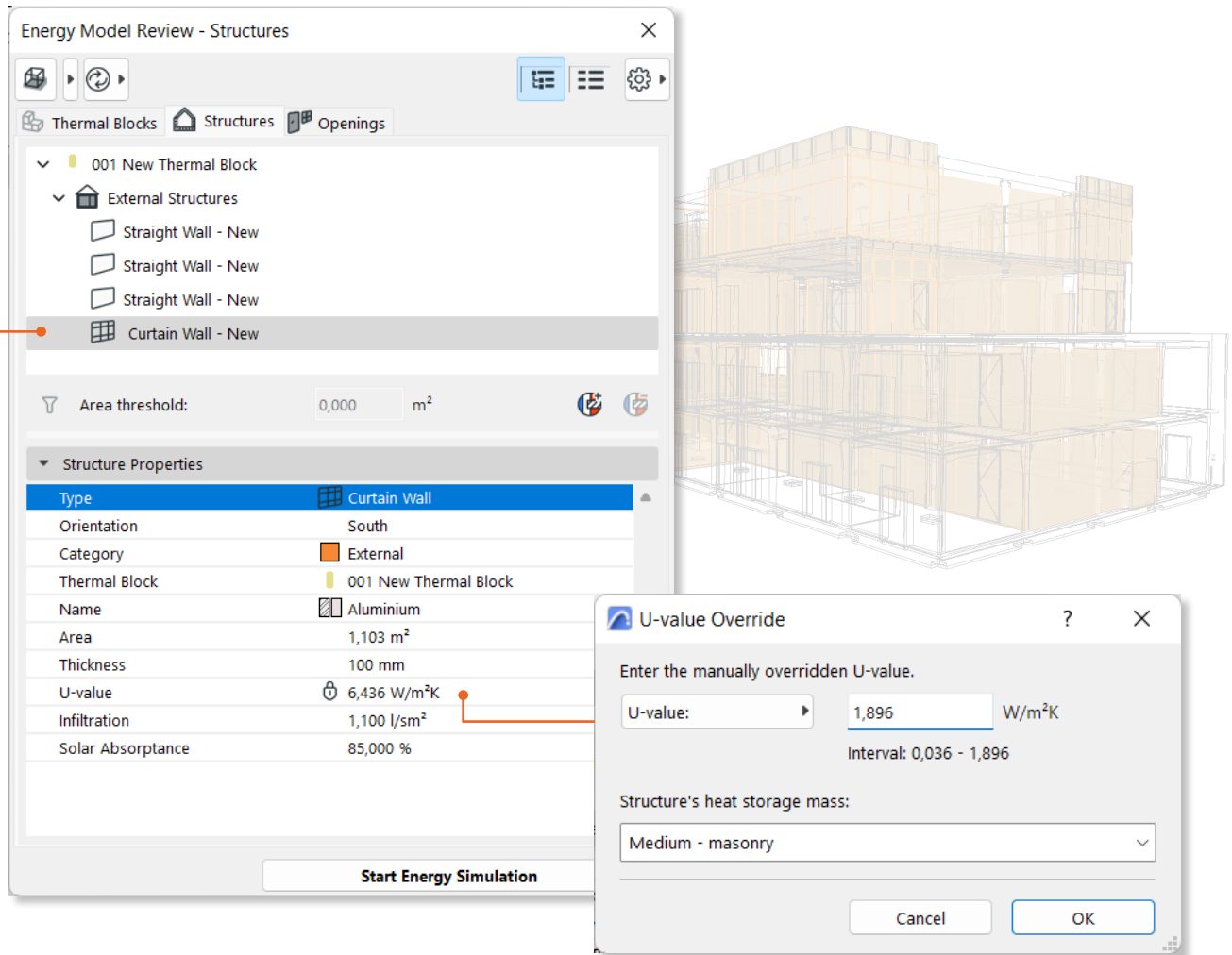
Although the emissions of the windows and doors from the materials are set in the properties of the objects, you need to make sure to set them correctly in the 'Openings' tab in EcoDesigner Star. This is necessary for the energy calculation to be correct. Here you can see both windows, doors and curtain walls as well as their thermal properties. If you right-click on an object, you can open the 'opening catalogue', where you can select the frame type and glass type for the window, so that it has the correct u-value. Now you are ready to run the simulation.



In order to avoid changing the composition of all the project's windows individually, you can check this box and collect them as a uniform object.

**Energy Model - Structures and Curtain Walls**

For the energy calculation of structures, including: external walls, curtain walls and roof structures etc. the thermal data accessed in the 'Structures' tab is used. Here you can customize e.g. orientation, category and u-value for the selected structure. The u-value is calculated in Archicad based on the material composite, but can be overridden manually if you need to work with a specific u-value.

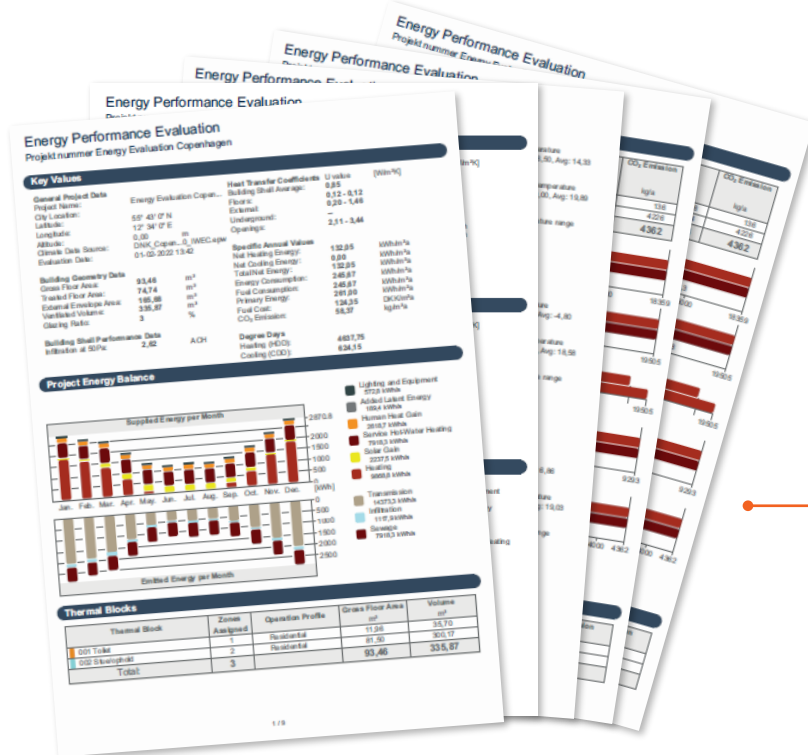
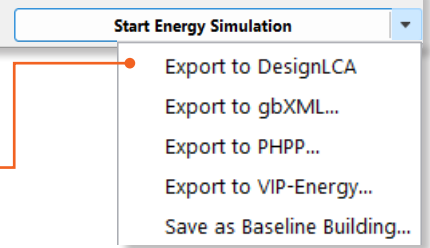
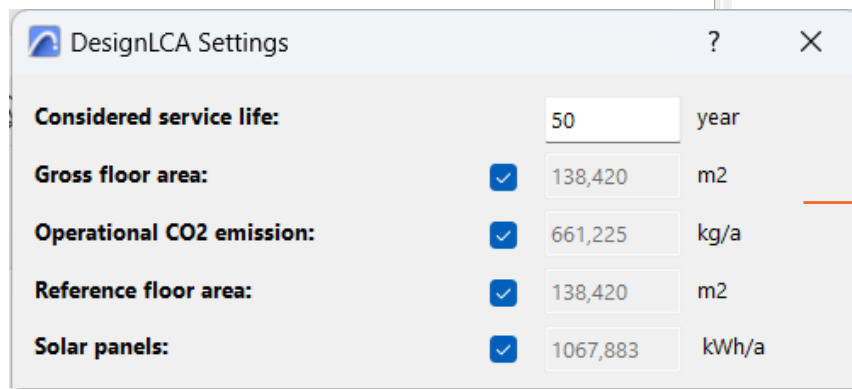
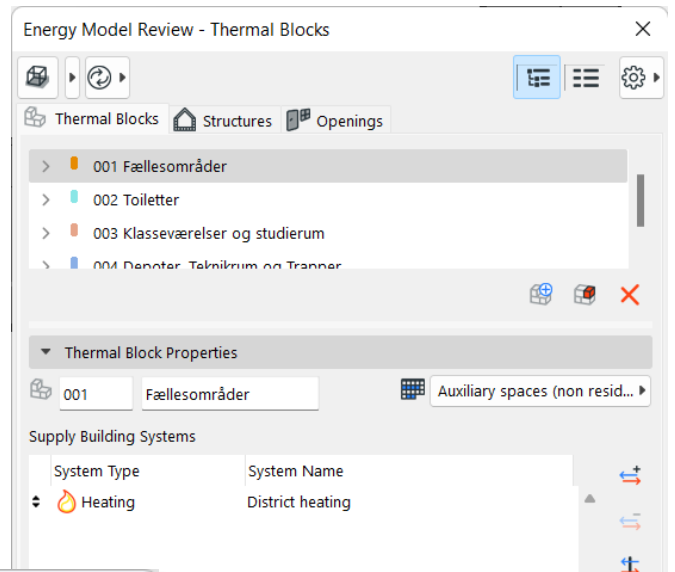


Archicad as default calculates a high u-value on Curtain Walls, which makes it advantageous to use the override function in these cases.

**EXPORT OF DATA FROM ECODESIGNER STAR**

When the entire BIM and BEM model is set up, the LCA calculation can be carried out. DesignLCA uses two data points from the EcoDesigner Star, namely the area of the building calculated from the zones and the CO<sub>2</sub>e emission (GWP) from the building's energy consumption. This must be sent to DesignLCA via the 'Start Energy Simulation' dropdown menu.

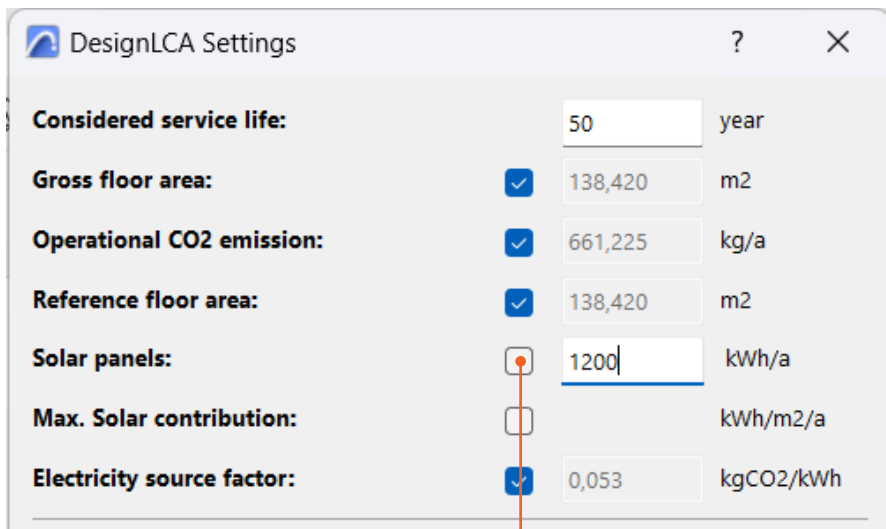
Once exported, the 'Energy Model Review' window can be closed and it can now be seen in the DesignLCA Settings that the area, the kWh/a from Solar Panels and the GWP from operations have been imported.



If you simply run the energy simulation without exporting to DesignLCA, a detailed report on the building's energy performance is generated, which can provide an overview of the CO<sub>2</sub> emissions for the operational use.

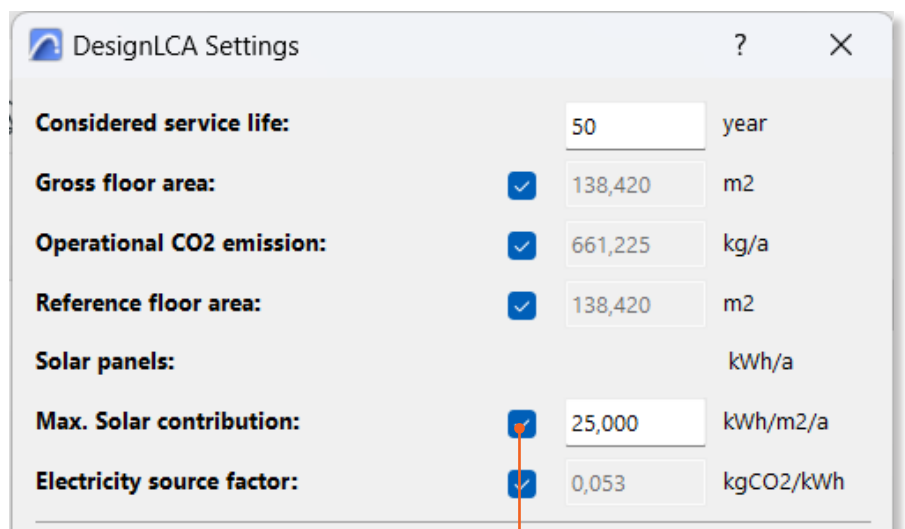
**EKSPORT AF DATA FRA ENERGY EVALUATION - DESIGNLCA SETTINGS**

When you have exported data to DesignLCA, the manually entered areas in DesignLCA's Settings are overwritten. This means that they have to be entered again after the export. If you have solar panels in your project, the kWh/a produced from them also are exported to DesignLCA. In the same way as the areas, these can be adjusted manually. So if you have a specific number of produced kWh/a you want to use, you can simply tick the box and then enter a manual value. According to Danish building regulations, building-integrated electricity production from solar cells corresponding to a maximum of 25 kWh/m<sup>2</sup> per year calculated in primary energy. Because of this you can enter a maximum contribution per area if you activate 'Max. Solar contribution'. DesignLCA withdraws the CO<sub>2</sub> emission from the produced energy from the Solar Panels in the final LCA calculation.



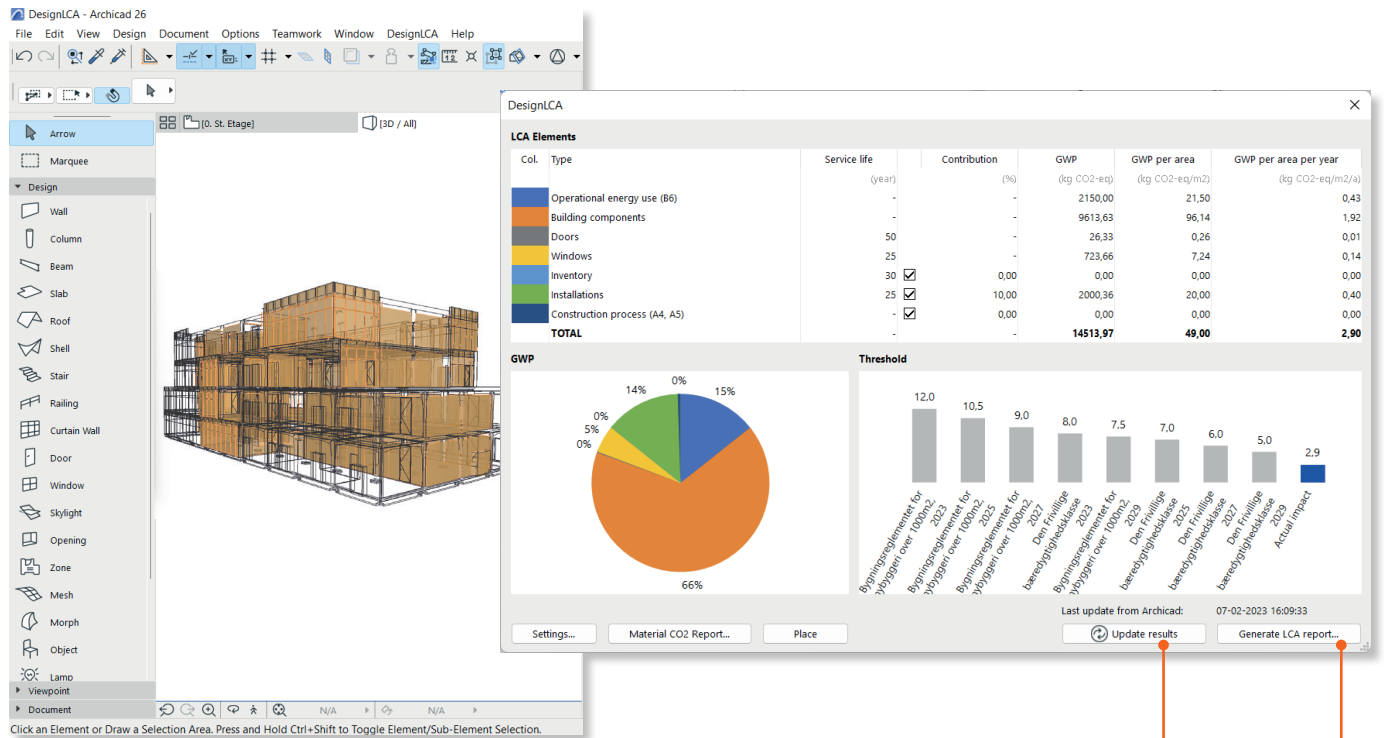
If you want to enter a value manually, simply untick the blue box next to 'Solar panels' and the field will be activated for input.

If you want to enter a maximum contribution, you activate the box next to 'Max. Solar contribution'

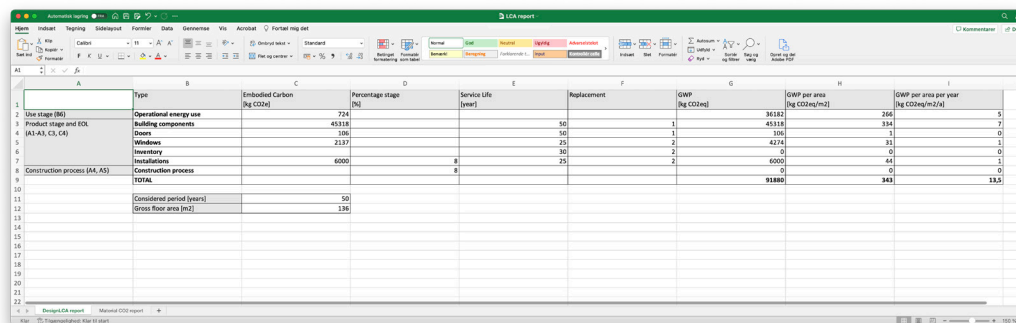


USING THE DESIGNLCA PALETTE

When the results from Energy Evaluation have been retrieved, the DesignLCA palette can display a result. The palette can be docked like other Archicad palettes, which makes it easy to work in the model and see quick results in DesignLCA at the same time.



As soon as a change has been made, you can update the calculation with a single click on 'Update Results'!



When you are satisfied with the resultS, you can export a report to Excel, for processing and analyzing the results

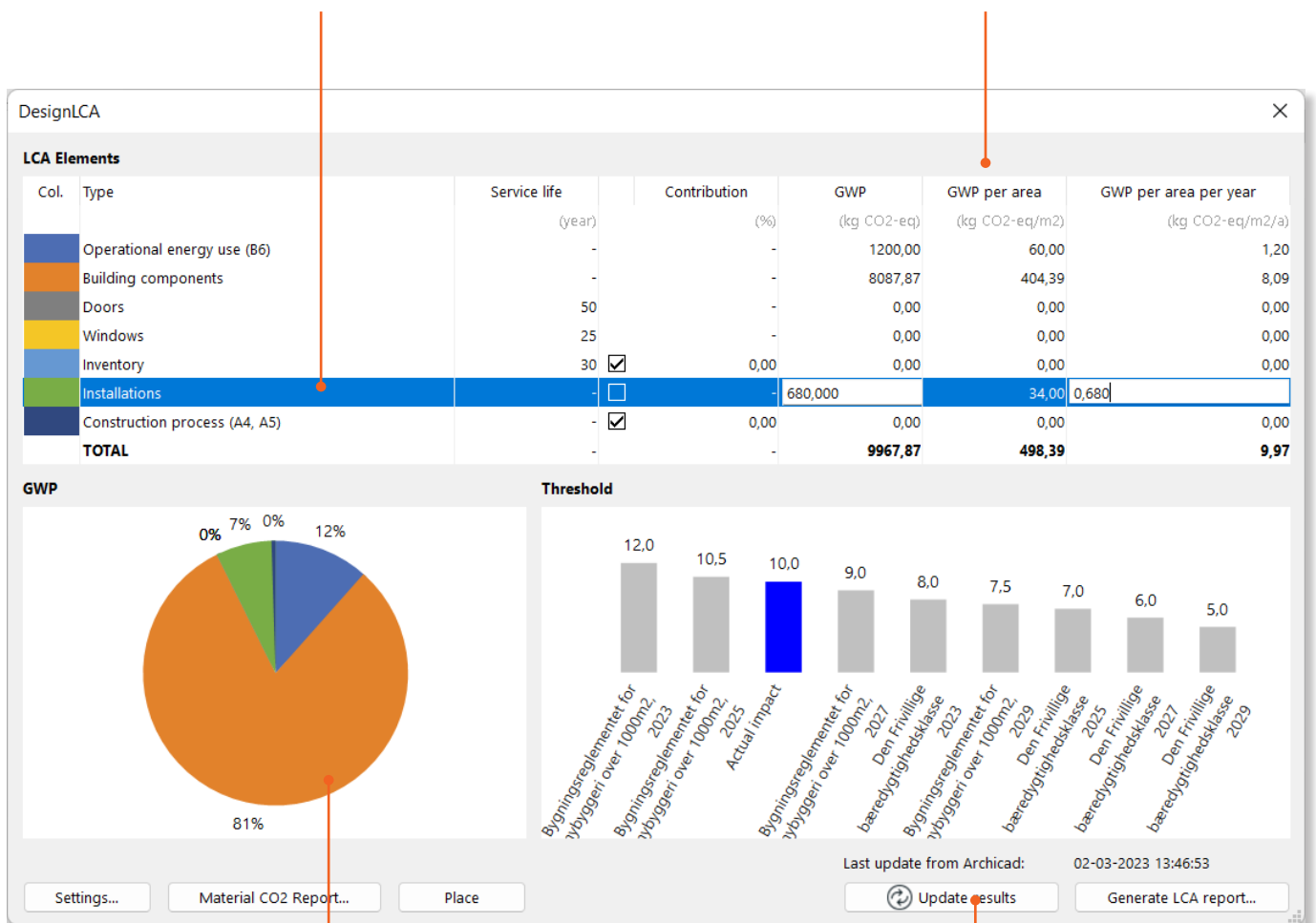
**RESULTS**

The result can reviewed both in the palette and in the Excel report. In the schedule, the total climate impact can be read in kg CO<sub>2</sub>e, CO<sub>2</sub>e/m<sup>2</sup> and kg CO<sub>2</sub>e/m<sup>2</sup>/year.

Furthermore, 2 diagrams are generated for the time being, which respectively shows the distribution of the climate impact in the project and the project's kg CO<sub>2</sub>e/m<sup>2</sup>/year compared to reference values set in the DesignLCA Settings. Please note that DesignLCA only calculates on materials and building parts placed on the shown layers in the project.

It's possible to set a percentage contribution to estimate an impact from inventory, installations and construction site (A4, A5). The default percentages are based on experience data. If you want to avoid the percentage contribution and use a specific value for GWP, simply tick off the box in the 'contribution' column.

The results show both the total climate impact (GWP), the climate impact per m<sup>2</sup> (GWP per area) and the climate impact per m<sup>2</sup> per year. (GWP per area per year). The latter is the unit for the future limit values in Denmark.



The distribution of the project's CO<sub>2</sub> emissions gives an overview of where there is room for improvement when the impact is too high.

Marked in blue, the project's kg CO<sub>2</sub>e/m<sup>2</sup>/year is ranked between various limit values set in the DesignLCA Settings.

**MATERIAL CO<sub>2</sub> REPORT**

With DesignLCA, it's possible to access a report on the impacts of the materials distributed over the project's layers. This means that you can get an in-depth insight into where there is a larger impact in one's overall footprint from the materials. In addition, the report can be placed on a layout, with the option of formatting. Please note that DesignLCA only calculates on materials and building parts placed on the shown layers in the project.



**Material CO<sub>2</sub> Report**

Layer	Name	GWP (kg CO <sub>2</sub> -eq)
A21----	Tunge vægge	<b>7775,875</b>
	Træbeklædning (Lærk)	633,882
	Luftrum ydre ventilation (stærk)	0,000
	Træfiberisolering	2319,180
	CLT	710,325
	Gips	4112,488
A23----	Dæk og bjælk...	<b>109,207</b>
	Fibercement Facade	109,207
A27----	Tagkonstrukt...	<b>1728,549</b>
	Skifer (Tag)	393,175
	Luftrum	0,000
	Træfiberisolering	391,662
	CLT Tag	146,021
	Gips	797,691
<b>Total:</b>		<b>9613,632</b>

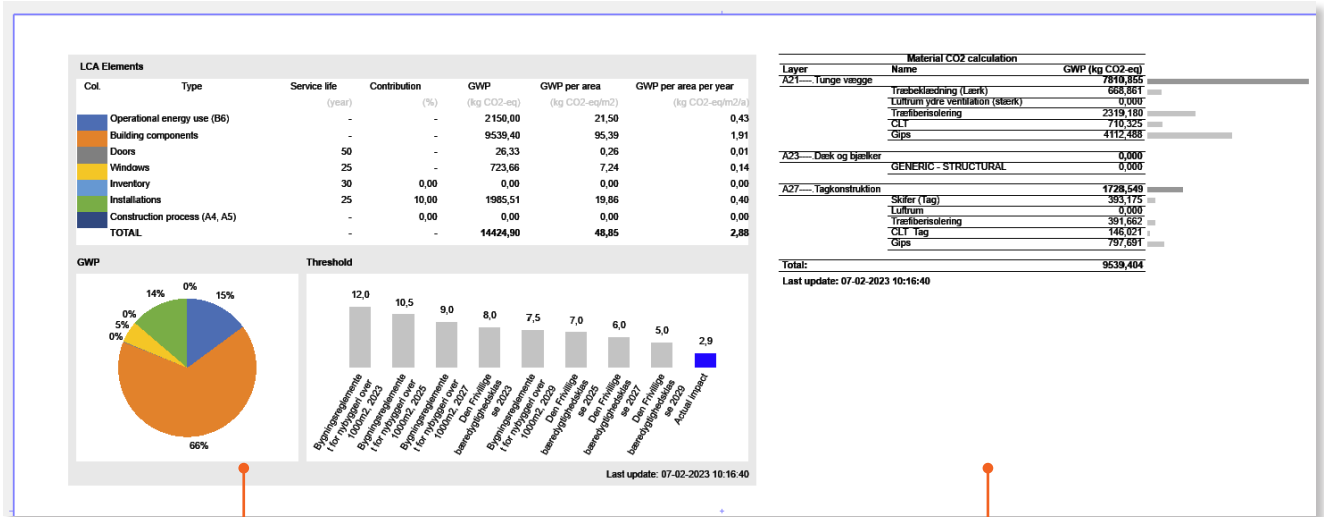
Buttons at the bottom: Default Element Settings, Place, Close.

In the bar-diagram, the distribution of the climate impact for each layer in the building components in relation to each other can be easily assessed.

The report can be placed in a worksheet or on a layout with the option of formatting in the object's settings, as seen on the next page.

### MATERIAL CO<sub>2</sub> REPORT

With the 'Place'-functionality it's possible to place both the LCA-report and the Material CO<sub>2</sub> Report on a layout or a Worksheet in order to document the results. Both objects can be edited in settings to accommodate different preferences on the graphic layout. Please note that DesignLCA only calculates on materials and building parts placed on the shown layers in the project.



**Object Selection Settings**

- Embedded Library
- Linked Libraries
  - AC 26 DK Bibliotek v3.lcf
  - Archicad Library 26
  - Design LCA library
  - DesignLCA library
  - MEP Library 26
- BIMcloud Libraries
- Built-in Libraries

**LCA Result Report** (Selected: 1 Editable: 1)

**PREVIEW AND POSITIONING**

**LCA RESULT REPORT**

Use Model View Option

**Text Settings**

Font Type: Arial  
 Text Size (mm): 2,000  
 Text Pen: 1  
 Text Pen Unit: 18

**Layout Settings**

Linear Layout  
 Pie Chart  
 Bar Chart

Bar Pen: 18  
 'Actual impact' Bar Pen: 6  
 Palettes Fill Pen: -1  
 Background Fill Pen: 181

Show Date  
 Update from Addon

**FLOOR PLAN AND SECTION**

**MODEL**

Override Surfaces: GENERAL

**CLASSIFICATION AND PROPERTIES**

Archicad Layer

**Bar Chart Settings**

Show Bar Chart

Bar Pen: 2  
 Sum Bar Pen: 1

Show Date  
 Update from Addon

**FLOOR PLAN AND SECTION**

**MODEL**

**CLASSIFICATION AND PROPERTIES**

Archicad Layer



**GRAPHISOFT Center Danmark**

Rentemestervej 62  
DK-2400 København NV

+45 8862 6680  
info@formfaktor.dk  
www.formfaktor.dk