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 perfomance of your building throughout its life cycle.



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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.

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#### DESIGNLCA ADDON IMPORT - PROPERTIES

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#### 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. Thesemenus will be explored throughout the manual.

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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 Baterials 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.



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.

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#### DESIGNLCA - MATERIALS

In addition to the thermal properties of the materials, data on the  $CO_2$ 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.

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#### **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  $CO_2$  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).  $CO_2e$  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'.



#### Contribution in percentage

When considering projects, usually they include multiple secondary components and buildings, which should not neccessarily contribute with a 100% of their environmental impact in the final LCA calculation. To accomodate 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  $CO_2$  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 og the ceiling (adaptable in 3D) and the upper side og 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.



#### **Thermal Blocks**

In order to calculate the model's energy consumption and associated  $CO_2$  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  $CO_2$  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.

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#### 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  $CO_2$  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 (Monochrystalline, 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.

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Wall-mounted AC unit		Energy Source	🚽 🤣 Solar photovoltaic 🛛 🗸 🗸	Monocrystalline 🗸
Strach air supply	► SERVICE HO	T-WATER HEATING		Monocrystalling
Heat recovery ventilation	* ASSIGNED T	THERMAL BLOCKS	O New	
Natural ventilation	÷∎001 T	hermal Block		Polycrystalline
			O Duplicate:	Amorphous
			•	Cancel OK
	Note: Drag Then	nal Blocks in order of precedence.		
	Assign	Remove		
	•			
New Delete		Cancel		
Energy Evaluation - Building S	Systems		? ×	
Basic Expert			•	
Name	▲ Type 🚱	▼ SOLAR PHOTOVOLTAIC SETTINGS		
Oistrict heating	Central 1	-		
	Central	type:	Monocrystalline	
C Electric space heater	Central 0	Nominal Peak Power:	150 W/m <sup>2</sup>	
O Fireplace	Central 0			
👌 Ground heat pump	Central 0	Nominal Efficiency:	15 %	
👌 Oil boiler	Central 0	Temperature Coefficient:	-0,540 %/°C 🕨	
Pellet furnace /w solar panel	Central 0	Panel Area	10.000 m <sup>2</sup>	
Wall-mounted gas boiler	Control 0		10,000	
Wair mounted gas bolier	Central 0	Angle to South:	Tilt Angle:	
🗱 District cooling	Central 0			
🗱 Rooftop chiller	Central 0	√∝ 0,000°	∠∞1⊑ 45,000°	Note that as soon as the
🗱 Wall-mounted AC unit	Central 0			color popolo aro cot up ac a
				solal pallels alle set up as a
Window AC unit	Central 0			system they will be included
🛞 Fresh air supply	Mechanical 0			
Heat recovery ventilation	Mechanical 0			in your energy simulation.
	Network Co. 17			If you are not going to use
w Natural ventilation	NOT YET Specifi 1			in you are not going to use
🤣 Solpaneler	Monocrystalline -			solar power, it should be
				dolotod from the Duilding
				deleted from the building
New Delete			Cancel OK	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.



#### **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.

	Start Energy Simulation						
			Mediun	n - masonry			~
		:	Structure	s heat storag	je mas	55:	
Solar Absorptance	85,000 %					Interval: 0,036 - 1	,896
Infiltration	1,100 l/sm <sup>2</sup>	_	o-vaide			1,050	W/III K
U-value	0 6,436 W/m²K		Usvalue			1 906	W/m <sup>2</sup> K
Thickness	100 mm		Enter the	manually ove	erridde	en U-value.	
Area	1,103 m²		5 .u	ar oreinde			
Name	Aluminium		U-val	ue Override			? X
Thermal Block	001 New Thermal Block						
Category	External						
Orientation	South						
Туре	Curtain Wall						
<ul> <li>Structure Properties</li> </ul>							
	0,000 m²	G	Ø				
Curtain Wall - New							
Straight Wall - New							
D Straight Wall - New							
Straight Wall - New							
✓			6				
<ul> <li>001 New Thermal Block</li> </ul>							
Thermal Blocks 💧 Structures	Openings						
	1		ۂ3				
			C				

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

🔼 DesignLCA Settings

Considered service life:

**Operational CO2 emission:** 

Reference floor area:

Solar panels:

Gross floor area:

#### 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.





50

1067,883

kWh/a

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'. DesingLCA withdraws the CO2 emission from the produced energy from the Solar Panels in the final LCA calculation.

🔼 DesignLCA Settings		?	×
Considered service life:	50	year	
Gross floor area:	138	,420 m2	
Operational CO2 emission:	✓ 661	,225 kg/a	
Reference floor area:	138	,420 m2	
Solar panels:	<b>e</b> 120	0 kWh/a	э
Max. Solar contribution:	<b>o</b>	kWh/n	n2/a
Electricity source factor:	<b>Q</b> 0,05	i3 kgCO2	2/kWh

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.



#### 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.



impact is too high.

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

With the 'Place<sup>T</sup>-functionality it's possible to place both the LCA-report and the Material  $CO_2$  Report on a layout or a Worksheet in order to document the results. Both objects can bed 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.



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